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RSPT 1410
Humidity & Aerosol Therapy
Part 3

Wilkins: Chapter 35, p. 775-799
Cairo: Chapter 4, p. 88-143

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Humidification Equipment

- A humidifier is a device that adds molecular liquid (e.g. water vapor) to gas, most often by simple evaporation - these devices are used primarily to humidify inspired gases
- A nebulizer is a device that adds particulate liquid (e.g. saline aerosol) to gas through a process known as nebulization - these devices are used when therapeutic amounts of liquid are needed

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Aerosol Therapy

- Delivery requires
 - gas source
 - aerosol generator (_____)
 - aerosol delivery device
 - aerosol mask
 - face tent
 - Briggs' adapter (t-tube)
 - tracheostomy mask
 - appropriate tubing

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Aerosol Generators

- Large volume jet nebulizers
 - _____ device used to deliver bland aerosol
 - pneumatically powered
 - use the _____ theory (similar to Venturi)
 - create aerosol by passing gas at high velocity through a small jet - this causes a pressure drop which draws fluid up through a siphon tube where the high velocity gas shears it and shatters it into liquid particles – producing a heterodisperse spray

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Heterodisperse refers to an aerosol consisting of particles of varying diameters and sizes. Particle size, in part, determines where aerosol particles will be deposited in the lungs.

| Area of Deposition | Particle Diameter |
|-------------------------------------|-------------------|
| Upper airway: nose, larynx, trachea | 5-20 microns |
| Lower airways | 2-5 microns |
| Parenchyma: alveolar region | 1-3 microns |

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Aerosol Generators

- Large volume jet nebulizers
 - large particles hit against surfaces or fall back into the reservoir (_____)
 - some nebulizers incorporate a built-in structural baffle near the jet
 - smaller, more stable particles are carried through the outlet by the gas stream
 - a venturi with variable entrainment ports allows _____ mixing and various _____

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Aerosol Generators

- Large volume jet nebulizers
 - can deliver cool or heated aerosol
 - total output from a typical unheated large volume nebulizer is approximately mg H₂O/L
 - total output from a typical heated large volume nebulizer is approximately _____ mg H₂O/L
 - heating is accomplished with some type of heater, e.g. hot-plate, immersion, collar or wrap-around - when using heated aerosol, a _____ should be used in-line

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Aerosol Generators

- Large volume jet nebulizers
 - nebulizers that attach to _____ at the bedside are suitable for most general aerosol delivery needs
 - larger versions with reservoirs of 2-3 liters are used for aerosol delivery in _____
 - these devices can generate flows of _____ L/min with water outputs up to _____ ml/hr
 - except where room temperatures are set very low, these systems should be run on " _____ "

Large Volume Nebulizer

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The diagram shows a cylindrical nebulizer. At the top, there is a 'DISS flowmeter inlet' and a 'Variable air entrainment port'. Below these is a 'Jet orifice' where air is blown. To the right is an 'Outlet port'. Inside the cylinder, a 'Siphon tube' extends from the bottom to the level of the 'Water reservoir'. At the very bottom is a 'Filter'. Arrows indicate air flow from the jet orifice and water being drawn up the siphon tube.

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Aerosol Generators

- Ultrasonic nebulizers
 - _____ powered
 - use a radio frequency device and a _____ transducer to generate aerosol
 - the radio frequency device transmits radio waves through a shielded cable to the piezoelectric transducer
 - crystal converts radio waves into high-frequency mechanical waves (sound)

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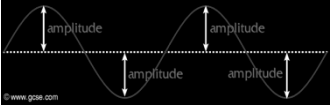
Aerosol Generators

- Ultrasonic nebulizers
 - these waves are transmitted either indirectly through a _____ chamber or directly to a liquid surface where the intense mechanical energy produces a "geyser" of liquid and aerosol particles
 - a _____ generates flow through the aerosol chamber which carries aerosol particles through the outlet to the patient – flow is adjustable only with a simple damper or butterfly valve

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Aerosol Generators

- Ultrasonic nebulizers
 - the radio waves determine aerosol output and particle size
 - aerosol output is determined by _____ (height)
 - aerosol particle size is determined by _____ (cycles per second)



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Aerosol Generators

- Ultrasonic nebulizers
 - aerosol output is directly proportional to wave amplitude, whereas aerosol particle size is inversely proportional to wave frequency, so by increasing both, output is _____ and particle size is _____ for optimal aerosol delivery
 - usually the frequency is preset during by the manufacturer – most operate at frequencies of 1.25-2.25 MHz (megahertz = 1 million cycles per second)

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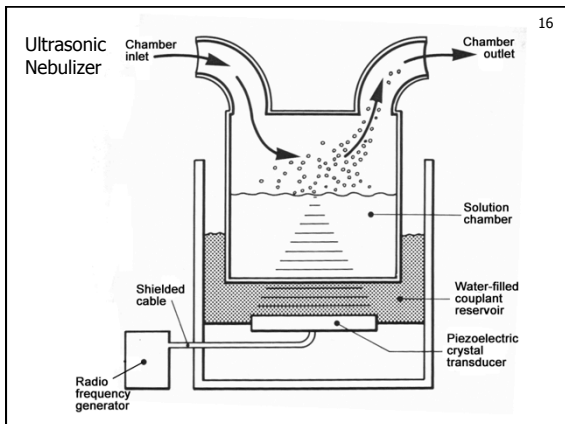
Aerosol Generators

- Ultrasonic nebulizers
 - set properly, some units can deliver _____ ml/min or close to _____ mg/L
 - since the incorporated blowers only move room air, to increase FIO₂ above 0.21, O₂ must be added
 - USNs are quite _____ compared to pneumatic large volume nebulizers – as much as 10 times the cost

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Aerosol Generators

- Ultrasonic nebulizers
 - USNs are most suitable for special uses, such as _____
 - also now available for home use in the form of room humidifiers



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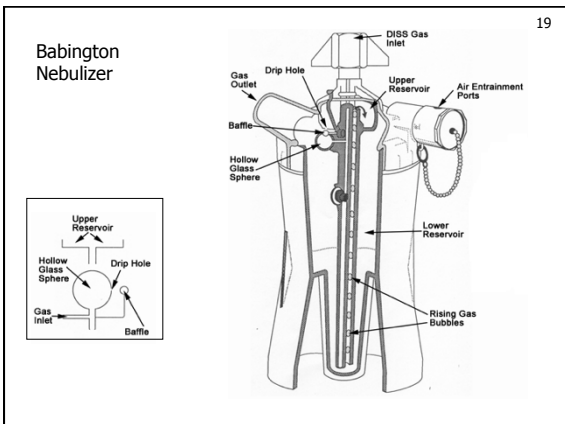
Aerosol Generators

- Babington nebulizers
 - _____ powered
 - use the principle of a jet stream of gas being directed through a thin film of continually flowing liquid spread across a rounded surface
 - the gas penetrates the liquid surface causing aerosol particles to be formed which are then baffled and sent to the patient
 - a venturi with variable entrainment ports allows air/O₂ mixing and various FIO₂s

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Aerosol Generators

- Babington nebulizers
 - while not as expensive as ultrasonic nebulizers, these devices are still considerably more expensive than standard large volume jet nebulizers
 - do have advantages over standard large volume jet nebulizers in terms of output and particle size, but probably not enough to justify the added cost
 - also available in large reservoir sizes that can be used in tents and other enclosures



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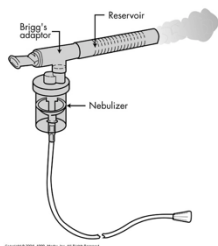
Aerosol Generators

- Small volume jet nebulizers
 - used for the administration of _____
 - work on the same principles as the large volume jet nebulizers (Bernoulli theory)
 - gas passing through the jet passes by the opening of a capillary tube immersed in solution, which is drawn up into the gas stream – the solution is sheared into droplets with diameters in the _____ micron range
 - the droplets are then directed against one or more baffles

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Aerosol Generators

- Small volume jet nebulizers
 - hand-held SVN's
 - the patient's inhalation draws the aerosol through the outlet
 - a t-piece is placed over the outlet – a mouthpiece is attached to one side, a 6-inch reservoir is attached to the other side



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Aerosol Generators

- Small volume jet nebulizers
 - one problem with hand-held SVN's is that they run _____, so if a patient is breathing at a 1:2 I:E ratio, only 33% of the aerosol will be inhaled
 - to help conserve medication, some SVN's utilize a patient-controlled thumbport – the patient closes the thumbport during inhalation, directing the gas through the jet; on exhalation, the thumbport is open, directing the gas out through the port – this effectively stops nebulization

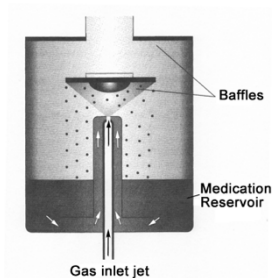
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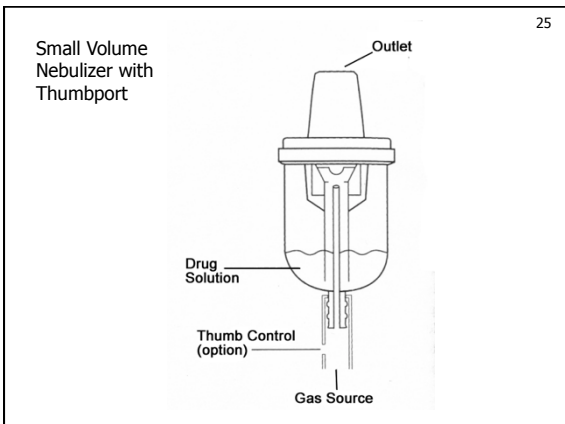
Aerosol Generators

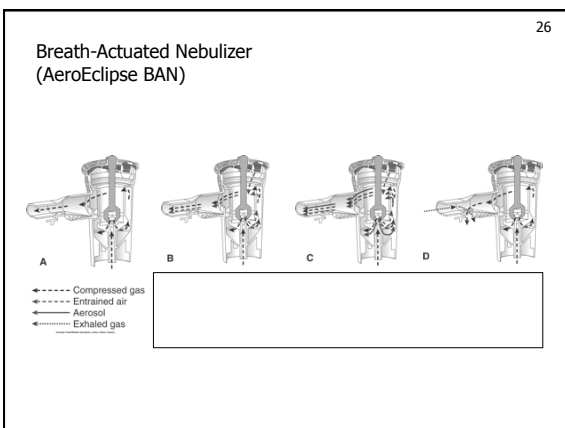
- Small volume jet nebulizers
 - the gas flow powering the nebulizer should be set at the manufacturer's recommended liter flow – usually about _____ L/min
 - in the hospital setting, O₂ is used to power the nebulizer more out of convenience than necessity
 - hand-held SVN's will run as well using air
 - _____ can also be used, but aerosol production will be significantly decreased

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Small Volume Nebulizer







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Aerosol Generators

- Small volume jet nebulizers
 - manifold units
 - incorporated into breathing circuits for IPPB and other devices
 - operating principle is the same
 - do not rely on patient's inhalation, flow is controlled by the positive pressure device
 - most of these devices can be set to power the nebulizer continuously or during inhalation only

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Aerosol Delivery Devices

- Aerosol mask
 - similar in design to O₂ masks, except that the exhalation port openings are larger
 - device of choice for short-term therapy to patients with intact _____
 - has the same disadvantages and problems with patient compliance as O₂ masks

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Aerosol Delivery Devices

- Face tent
 - better choice for long-term therapy and for patients who will not wear the _____ mask
 - has a large reservoir extending out from the face
 - more comfortable and patient compliance is better
 - tolerated well by most patients

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Aerosol Delivery Devices

- Briggs' adapter (TP; t-piece; t-tube)
 - most commonly used device for patients with an _____ in place
 - only choice for endotracheal tubes
 - since it does attach directly to the airway, it put traction on the tube, causing discomfort and possibly accidental _____
 - for best results, attach a 6-inch reservoir to the distal side of the airway

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Aerosol Delivery Devices

- Tracheostomy mask
 - better choice for the patient with a tracheostomy tube in place
 - more _____ with no traction on the tube
 - if not kept clean, it can pose a risk of infection
 - position should be monitored

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Aerosol Delivery Devices

- the choice of the device used should be based on the patient's condition, comfort and compliance with therapy
