Unit 5
Humidity/Aerosol Generators

GOAL

On completion of this unit, the student should have an understanding of the principles of operation and proper use of different humidity/aerosol generators.

COMPETENCIES

1. Identify the components of the following humidity/aerosol generators.
   a. bubble humidifier
   b. pneumatic nebulizer
   c. small volume nebulizer
   d. ultrasonic nebulizer
   e. pediatric aerosol tent
2. Assemble for use the humidity/aerosol generators listed in #1.
3. Calculate humidifier evaporation
4. Measure jet nebulizer flowrates and F_IO_2 .
5. Measure ultrasonic nebulizer blower flowrates.
6. Calculate humidity output from an ultrasonic nebulizer.
7. Complete applicable procedures in the clinical simulation lab.

EQUIPMENT

1. bubble humidifiers
2. pneumatic nebulizers
3. small volume nebulizers
4. ultrasonic nebulizer
5. refrigerated pediatric aerosol tent
6. distilled water
7. oxygen source
8. oxygen flowmeter
9. flowmeter nipple
10. 3/8 inch oxygen connecting tubing
11. large bore corrugated aerosol tubing
12. patient mouthpiece
13. Brigg's adaptor
14. oxygen analyzer
15. respirometer
16. graduated beaker
17. thermometer

EXERCISE A - USE OF HUMIDITY/AEROSOL GENERATORS

1. With your lab partner, demonstrate proper techniques for using and/or applying the following humidity/aerosol generators.
   a. bubble humidifier
   b. pneumatic nebulizer
   c. small volume nebulizer
   d. ultrasonic nebulizer
   e. pediatric aerosol tent
2. Complete the Ambient Oxygen procedure in the clinical simulation lab.

EXERCISE B - COMPONENT IDENTIFICATION

1. Identify the following parts on a bubble humidifier and label Fig. 1.
   a. DISS gas inlet
   b. pressure relief valve
   c. water reservoir (note capacity)
   d. gas diffuser stem
   e. gas diffuser
   f. gas outlet

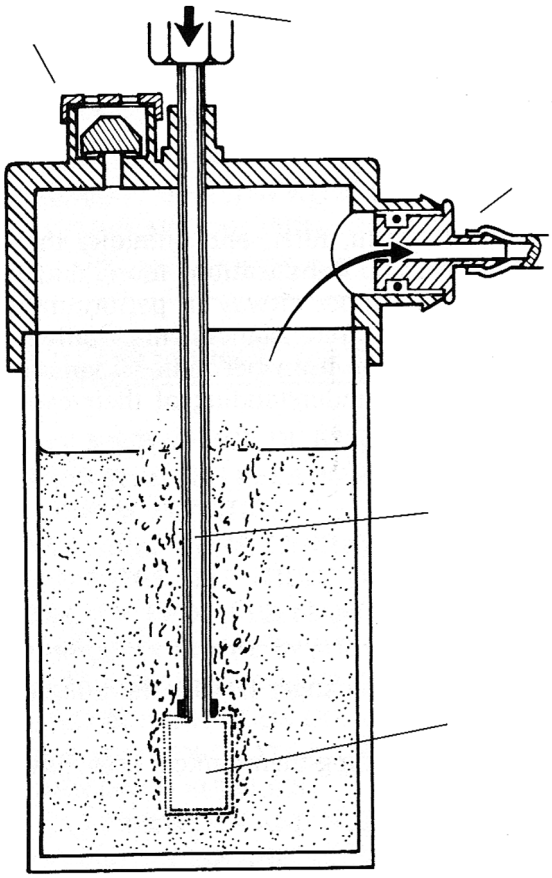

Fig. 1

2. Identify the following parts on a pneumatic nebulizer and label Fig. 2.
   a. DISS gas inlet
   b. water reservoir (note capacity)
   c. siphon tube
   d. filter
   e. gas jet orifice
   f. baffle
   h. gas outlet port
   i. venturi entrainment port adjustment

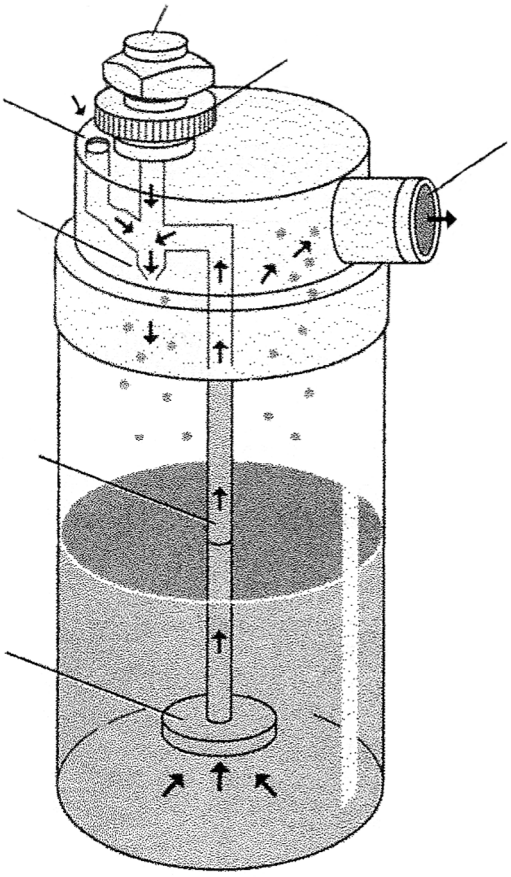

Fig. 2

3. Identify the following parts on a small volume nebulizer and label Fig. 3.
   a. patient mouthpiece
   b. cap
   c. gas inlet
   d. medication reservoir (note capacity)
   e. siphon tube
   f. gas jet assembly
   g. baffle
   h. gas outlet

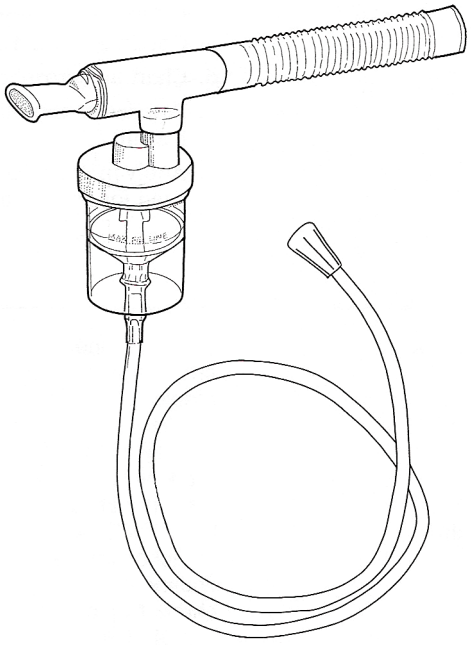

Fig. 3a

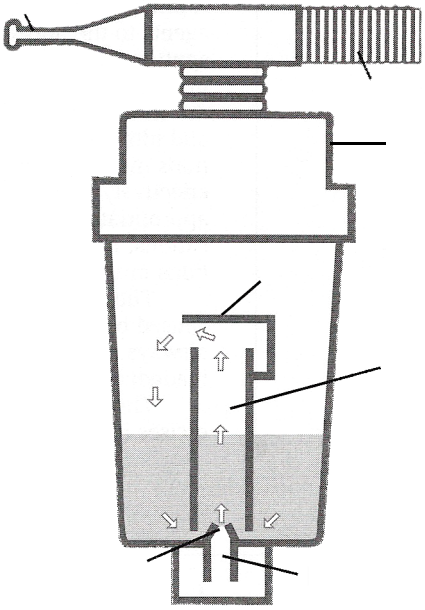

Fig. 3b

4. Identify the following parts on an ultrasonic nebulizer and label Fig. 4.
   a. on/off switch
   b. output control
   c. blower
   d. blower tubing
   e. feed assembly
   f. medication/water reservoir (note capacity)
   g. couplant chamber
   h. diaphragm
   i. coaxial cable
   j. piezoelectric transducer
   k. gas outlet

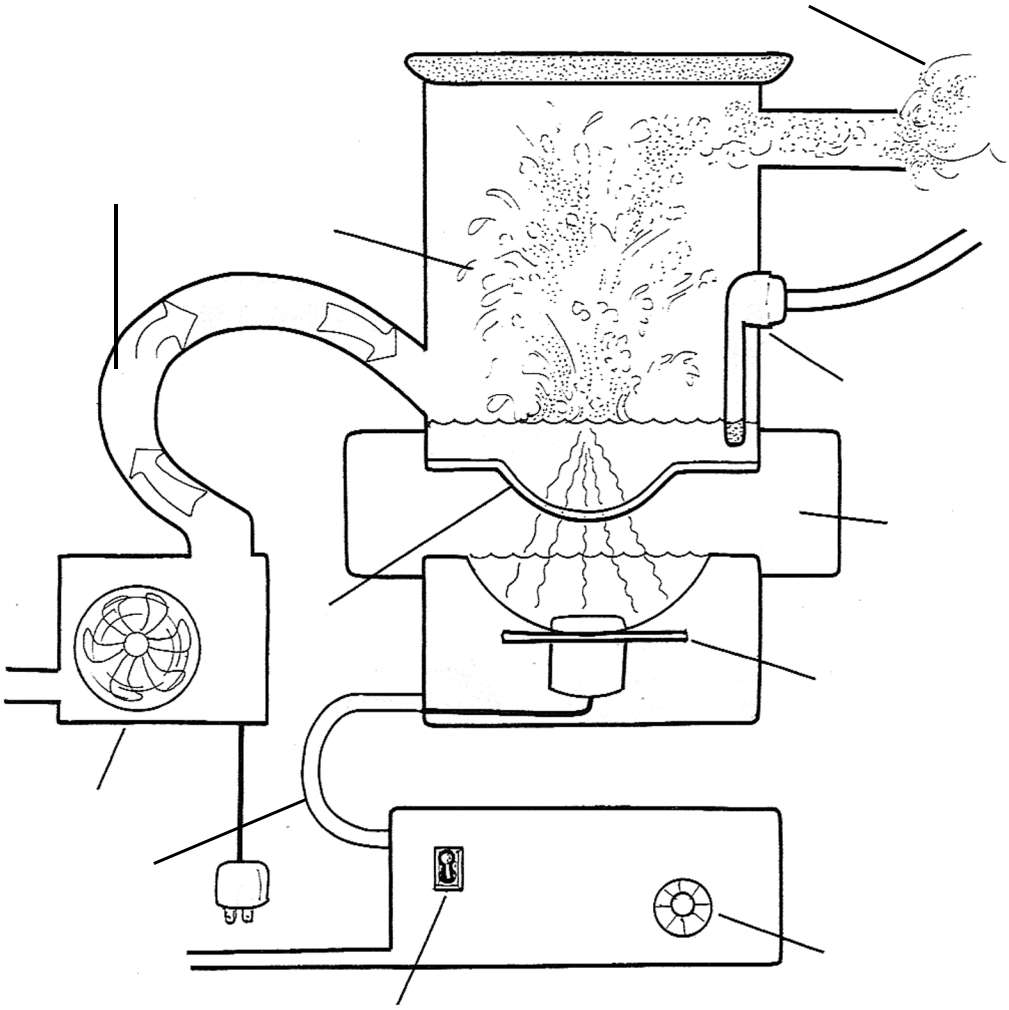

Fig. 4

EXERCISE C - JET NEBULIZER FLOWRATE AND F_{IO_2} MEASUREMENT

1. Attach a flowmeter to an oxygen source.
2. Attach a 500 cc jet nebulizer to the flowmeter.
3. Attach a 6 ft. corrugated tube to the nebulizer outlet port.
4. Attach an oxygen analyzer in line at the end of the tube.

5. Attach a spirometer in line at the end of the tube.
6. Record the oxygen concentration and liter/minute output in the following table for each oxygen setting on the nebulizer.
7. Repeat steps 1-6 with 50 cc water in the aerosol tubing. This will simulate a situation in which tubing is not drained often enough.

Flowmeter Flowrate (L/min.)	Venturi Setting (%)	F_IO_2	Predicted Flowrate Output	Observed Flowrate Output	Water in F_IO_2	Tubing Flowrate Output
5	33%					
10	33%					
5	50%					
10	50%					
5	100%					
10	100%					

Explain any differences between predicted flowrate and observed flowrate (aerosol tubing dry).

What effect did water in the tubing have on total liter flow output and F_IO_2? Explain why.

EXERCISE D - USN BLOWER FLOWRATE MEASUREMENT

1. Attach a flow-measuring device to the end of the blower outlet port.
2. Run the blower for at least one minute.
3. Record the blower output.

	Measured Blower Flowrate (L/min)
Ultrasonic Nebulizer	

Why is the blower flowrate important to aerosol delivery?

Explain any differences in your observations.

EXERCISE E - USN HUMIDITY OUTPUT CALCULATION

1. Pour a measured amount (approx. 75 cc) of water into the nebulizer chamber (medicament cup) from a graduated beaker. Record the amount of water poured into the nebulizer as “original water volume”.
2. Turn the nebulizer on to maximum output.
3. Allow the nebulizer to run for exactly 15 minutes.
4. After 15 minutes, measure the water remaining in the chamber in a graduated beaker. Record this volume as “remaining water volume”.
5. Calculate cc per minute and mg per liter . Record the data in the following table.
   (Note: The cc output is equal to the original volume in the nebulizer chamber minus the volume in the chamber after 15 minutes. Divide the cc delivered, by the time it took to deliver [15 minutes] to get cc per minute.)

Input		Output	
		cc/min	mg/L
Original H_2O volume	mL		
Remaining H_2O volume	mL		

WORKSHEET

1. What is the purpose of heating a ventilator humidifier?

2. Explain the evaporation process in a humidifier.

3. Explain the difference between humidifiers and nebulizers.

4. If gas is flowing through a bubble humidifier at 8 L/min. and the water temperature is 50°F, how many milligrams of water will be removed from the humidifier in one minute? (assume a relative humidity of 55%)

5. If gas is flowing through a cascade humidifier at 40 L/min. and the water temperature is 98.6°F, how many milligrams of water will be removed from the cascade in one minute? (assume a relative humidity of 100%)

6. List four ways that particles are baffled in a jet nebulizer.

7. Is particle size an important factor in choosing a nebulizer? If so, why? If not, why not?