



Aerogen[®]

Pioneering Aerosol Drug Delivery



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Redefining Continuous Aerosol Drug Delivery

PM223

Explanation of Continuous via Traditional Small Volume (Jet) Nebulizer

- Traditional small volume (jet) nebulizers require compressed gas to aerosolize medication
- Solution is placed in a medication cup
- Compressed gas is delivered as a jet through a small orifice at the bottom of the cup creating a pressure change which causes solution to be drawn up a capillary tube sitting in the solution
- The solution is pulled into the gas stream breaking it into particles
- The large droplets impact a baffle which breaks them into smaller particles
- The smaller particles are entrained into the gas stream and are inhaled by the patient
- The larger particles fall back into the nebulizer where they are recycled
- Evaporation increases concentration of drug
- At the end of the treatment residual drug typically 0.5 - 2.2 ml of dose un-nebulized (which in a 3 ml dose can be as much as 2/3 of the solution)

Kacmarek RM, Stoller JK, Heuer AH. (2012). *Egan's Fundamentals of Respiratory Care* (10th ed.). Elsevier Science Health Science Division.

Continuous Aerosol via Traditional Small Volume (Jet) Nebulizer



How did we do it before?

Flow rate = output (for 40 ml of solution)
2 lpm flow rate into the SVN/ jet nebulizer = 8 ml/hour output

Dose (mg/hour)	2.5 mg	5 mg	7.5 mg	10 mg	12.5 mg	15 mg
Medication (5 mg/ml)	0.5 ml	1 ml	1.5 ml	2 ml	2.5 ml	3 ml
Saline (ml)	39.5 ml	39 ml	38.5 ml	38 ml	37.5 ml	37 ml
Total fill Volume (ml)	40 ml	40 ml	40 ml	40 ml	40 ml	40 ml

Continuous Dosing of Albuterol with MiniHeart Jet Nebulizer

- Drive nebulizer with 2 lpm flow
- Fixed output 8 ml/hour
- Preload jet nebulizer with 15 ml solution to prevent nebulizer from running dry
- Use common connector to a common feed set
- Change concentration of solution required for a dose change
- Waste of medication and increased time required to adjust dosing

Dosing based on Westmed Dosing for MiniHeart LoFlo jet nebulizer for continuous aerosol

Aerogen Continuous Nebulization Tube Set

Non standard luer connectors eliminate the risk of misconnection

Unique blue color coding

Drop by Drop aerosolization

Works with standard syringe pumps



Drop by Drop (Volumetric) Dosing with Aerogen Solo



- Pioneering aerosol drug delivery with a new paradigm for continuous aerosol delivery creating the most precise variable delivery system in aerosol history
- Medication is dropped onto the vibrating mesh
- **Volumetric dosing** = delivery of a volume of medication over time (drop by drop) i.e. ml per hour
- The rate of drug entering the Aerogen Solo determines drug output rate
- Aerogen **drop-by-drop** (volumetric) dosing gives you the ability to titrate medication utilizing the infusion rate of the pump
- No need to change concentration of the medication in the syringe or the bag

Rate of the infusion pump = the output of the Aerogen Solo

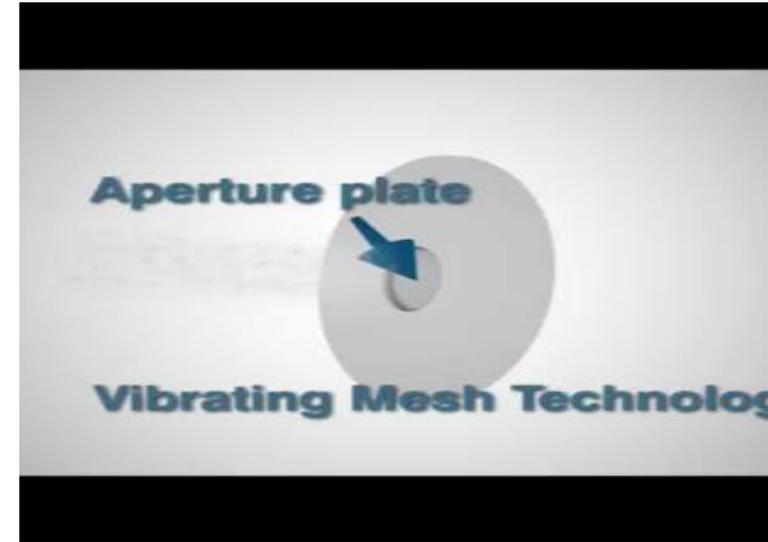
How does Aerogen Technology Work?

Vibrating mesh aperture plate with 1000 precision formed tapered holes

Energy applied to the plate causing it to vibrate > 128,000 times per second

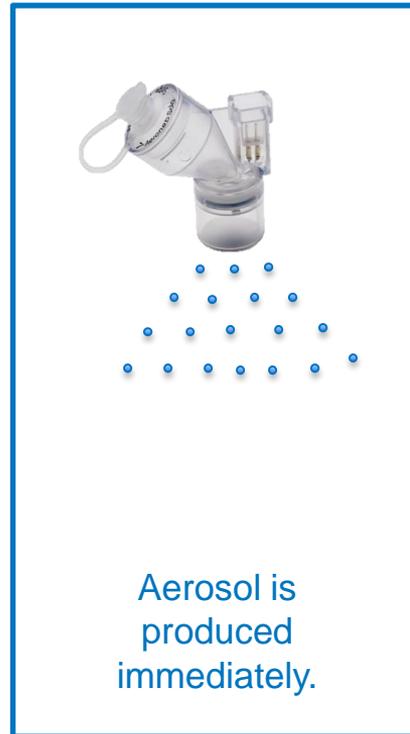
Rapid vibration causes each aperture to act as a micropump drawing liquid through the holes causing to form consistently sized droplets

Results fine particle low velocity aerosol optimized for central and deep lung deposition



Video of fine particle low velocity aerosol created by Aerogen Technology

Drop by Drop Aerosolization



Aerogen Solo Drop by Drop (Volumetric) Dosing



Drop by Drop (Volumetric) Dosing with 0.5% Albuterol Solution

- Albuterol Sulfate 0.5% is a 5 mg/ml medication concentration.
- Load the syringe with desired amount of undiluted 0.5% solution (1, 2, 3 or more bottles based on order).
- Set the rate on the pump to deliver the desired dosage of albuterol.
- See example on the next slide.



Example of Drop by Drop (Volumetric) Dosing for a 25 mg/hour Dose

Problem: What infusion rate do I use to deliver 25 mg per hour of albuterol? What is the output of the solo for a 25 mg per hour dose of albuterol?

Infusion rate pump = Solo output= $\frac{\text{Desired Dosage (mg/hour)}}{\text{Medication Concentration (mg/ml)}}$

– **Solo output** = $\frac{25 \text{ mg per hour}}{5 \text{ mg /ml}} = 5 \text{ ml per hour}$

Answer: To deliver 25 mg per hour with undiluted 0.5% albuterol, set the **infusion pump rate** to **5 ml per hour**. The *pump rate* is the *output of the Solo*.

Note: Maximum input rate (to the Solo from the pump) of 12 mL per hour.

Drop by Drop (Volumetric) Dosing

- No added saline required
- Delivery rate of infusion = aerosol output rate
- Easy titration available allows quick response to clinical needs of the patient
- Saves clinician time
- Reduces medication waste (use one concentration of medication for the range of doses)

Albuterol 0.5% = 5 mg/ml medication concentration (undiluted)					
Dose (mg/hr) Physician prescribed dose	5mg	7.5 mg	10mg	15m g	20mg
Infusion Rate = Aerosol output rate*	1 ml	1.5 ml	2 ml	3 ml	4 ml

*Desired Dose (mg/hr) / medication concentration (mg/ml)



Note: Aerogen's recommended input rate of medication into the Aerogen Solo nebulizer during continuous nebulization is up to a maximum of 12 mL per hour. The upper limit of 12 mL per hour is based on Aerogen's specification for the minimum nebulizer flow rate.

Additional advantages

Control

Change dose (up or down) with change in pump rate (adjustable up to 12 ml per hour)

Volumetric control of dosing

Consistent dose per minute, consistent dose per hour

Easy To Use

Less rainout in the circuit due to due unstable particles reducing the risk of saturated filters

Efficiency

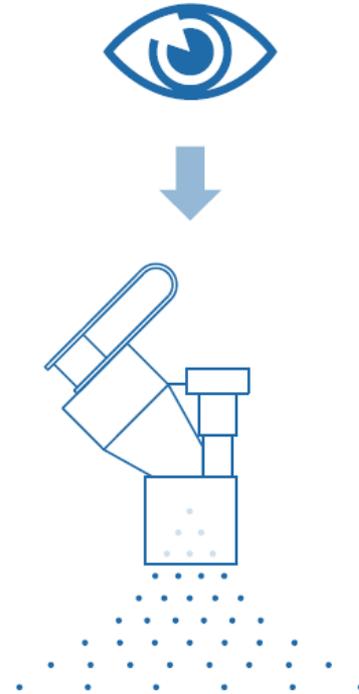
Same drug concentration over time reducing medication waste

Volumetric precision with drop by drop nebulization

Makes weaning easier – just change the pump rate

Functional Test*

- Perform a functional test with the initial use of Solo prior to inserting into the circuit or accessory (or at any time to verify proper operation).
- Pour 1-6 mL of normal saline (0.9%) into the solo and turn on the power.
- Visually check that aerosol is produced.



*Adapted from Aerogen solo instruction manual. Aerogen.com

Best Orientation of Aerogen Solo for Optimal Aerosol Delivery



Filling the Syringe

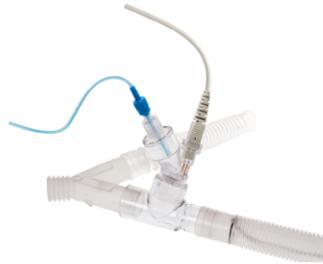
Use another syringe to draw up the medication with a needle or needleless connector and with the plunger pulled back on the Aerogen syringe insert the medication through the cap end of the Aerogen syringe.

The syringe is usually filled with medication by pharmacy and provided to the clinician to deliver the therapy.



Aerogen Solo Set Up

At The Wye*



Dry Side of
the Humidifier



- 1 Remove the syringe cap from the medication filled syringe and attach the syringe end of the tubing onto the syringe.



- 2 Prime the tubing until the medication reaches the end of the tubing.

Note: the tubing priming volume maximum is 3.65mL



- 3 Unplug the tethered cap from the Aerogen Solo, do not remove it from the nebulizer. Screw the nebulizer end of the tubing onto the top of the nebulizer.



- 4 Insert the syringe filled with medication into the syringe pump.

Refer to pump manual or manufacturer for guidance on pump usage.



Turn on continuous mode on the controller. Press & hold the on/off button for 3 seconds from the off position to select continuous mode.

Note: Medication is nebulized on a drop by drop basis. Observe continuous mode in action.

*Parts not supplied by Aerogen. Consult manufacturer for usage guidelines.

Continuous Mode Delivery

FYI: Rising fluid level in the aerosol cup indicates that the fill rate has exceeded the output rate of the Solo. For further information refer to the instruction manual and/or contact Aerogen clinical support at MedicalScience@aerogen.com

*Reference: Aerogen solo instruction manual. Aerogen.com

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