Aerosol Delivery Devices

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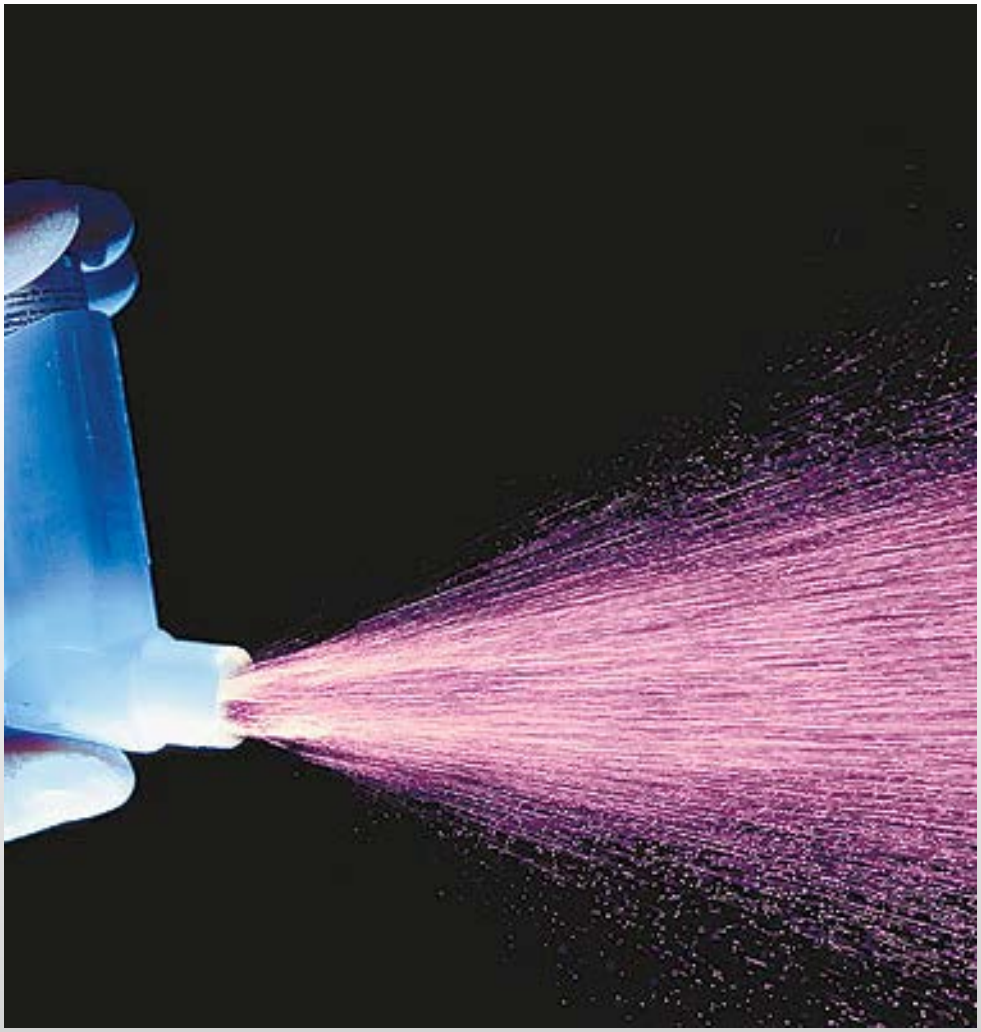
Metered Dose Inhaler (MDI)



Chlorofluorocarbons (CFCs) vs. Hydrofluoroalkanes (HFAs)

- CFCs are being phased out globally to protect the earth's ozone layer
- HFAs do not have ozone-depleting properties
- Non-CFC alternatives must be shown to be safe and effective prior to FDA approval
  - Albuterol inhalers CFC-free 12/31/08
  - Other medications are or will be phased out in the future
- Extra fine aerosols from HFA inhalers may result in more drug delivery to the lungs

Hendeles et al. *N Engl J Med* 2007;356:1344-51.

Chlorofluorocarbons (CFCs) vs. Hydrofluoroalkanes (HFAs)

- Designed to be used the same way
  - Inhalers are similar in shape and size
  - Several now have an automatic dose counter

- Some differences in taste, feel, or smell
  - Different inactive ingredients
  - Sprays from HFA inhalers are less forceful and may feel warmer

Hendeles et al. *N Engl J Med* 2007;356:1344-51.

Metered Dose Inhaler (MDI) Application

- ≥ 5 years old

- Delivers the following medications:
  - $Beta_2$-agonists
  - Corticosteroids
  - Combination of above
  - Cromolyn sodium and nedocromil
  - Anticholinergics

EPR 3 Guidelines (2007)
Open Mouth vs Closed Mouth Technique

- Under laboratory conditions, open mouth technique (holding MDI 2 inches away from open mouth) enhances delivery to the lung. This technique, however, has not been shown to enhance clinical benefit consistently compared to closed mouth technique (inserting MDI mouthpiece between lips and teeth).

Metered Dose Inhaler Administration

- Warm canister to room temperature
- Remove cap, inspect mouthpiece and hold inhaler upright
- Shake the inhaler well
- Breathe out
- Put the mouthpiece in mouth and close lips around it
- Actuation during a slow (30 L/min or 3-5 seconds) deep inhalation
- Hold breath as long as possible up 10 seconds, breathe out normally
- Repeat as needed, waiting at least one minute between puffs
- Rinse mouth after a corticosteroid

Metered Dose Inhaler Replacement/refilling

- If MDI is taken daily (maintenance/controller medication)
  - Take the number of inhalations in canister and divide by total inhalations per day= number of days MDI will last
  - Put date of last day on the canister

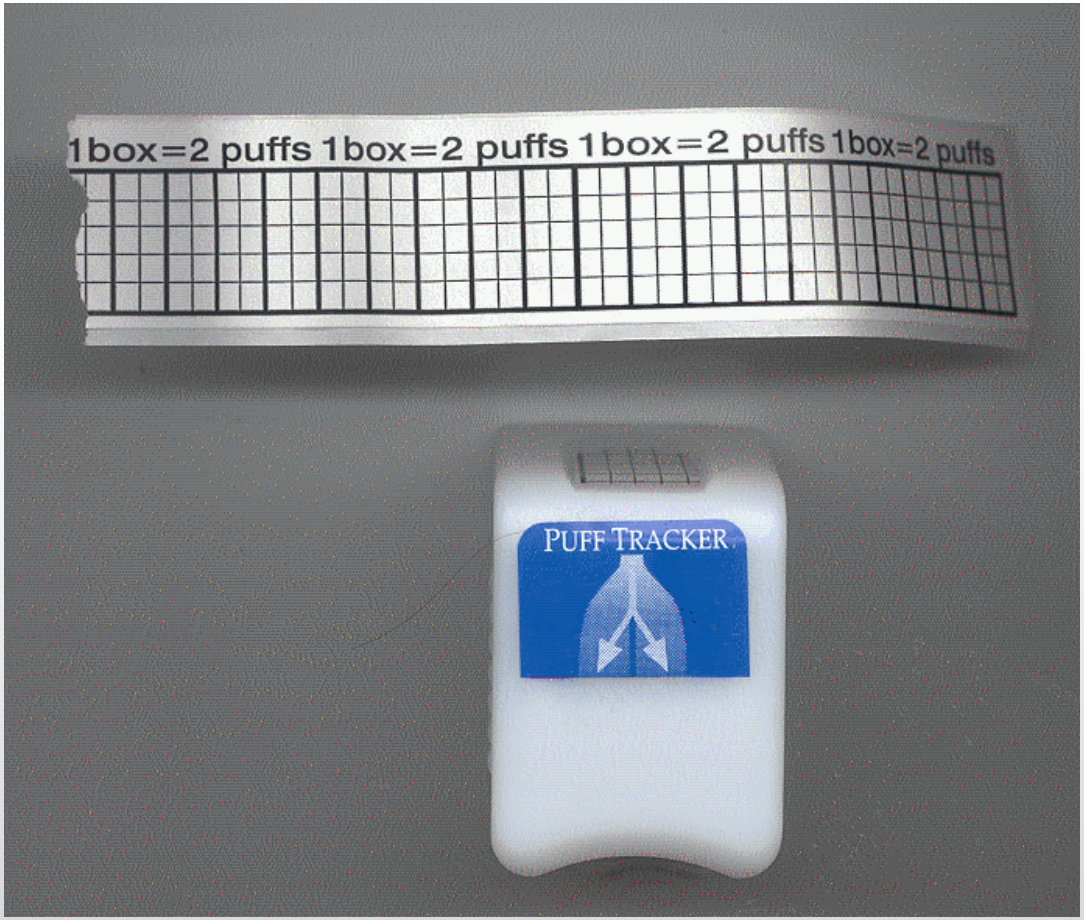
- If MDI is taken PRN (rescue medication)
  - Use an MDI record
  - Use a dose counter
  - DON'T use the "float or sink" test

METERED DOSE INHALER RECORD

Please cross out one number for every puff given
Notify parent when 10 puffs are left

200	199	198	197	196	195	194	193	192	191
190	189	188	187	186	185	184	183	182	181
180	179	178	177	176	175	174	173	172	171
170	169	168	167	166	165	164	163	162	161
160	159	158	157	156	155	154	153	152	151
150	149	148	147	146	145	144	143	142	141
140	139	138	137	136	135	134	133	132	131
130	129	128	127	126	125	124	123	122	121
120	119	118	117	116	115	114	113	112	111
110	109	108	107	106	105	104	103	102	101
100	99	98	97	96	95	94	93	92	91
90	89	88	87	86	85	84	83	82	81
80	79	78	77	76	75	74	73	72	71
70	69	68	67	66	65	64	63	62	61
60	59	58	57	56	55	54	53	52	51
50	49	48	47	46	45	44	43	42	41
40	39	38	37	36	35	34	33	32	31
30	29	28	27	26	25	24	23	22	21
20	19	18	17	16	15	14	13	12	11
10	9	8	7	6	5	4	3	2	1
0									

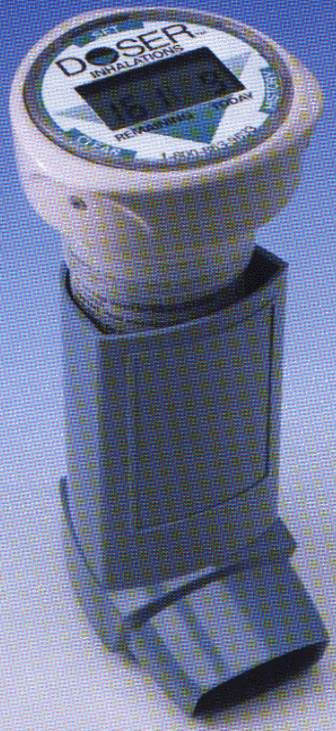
Puff Tracker



Puff Tracker

DOSER™

For the patient and healthcare professional

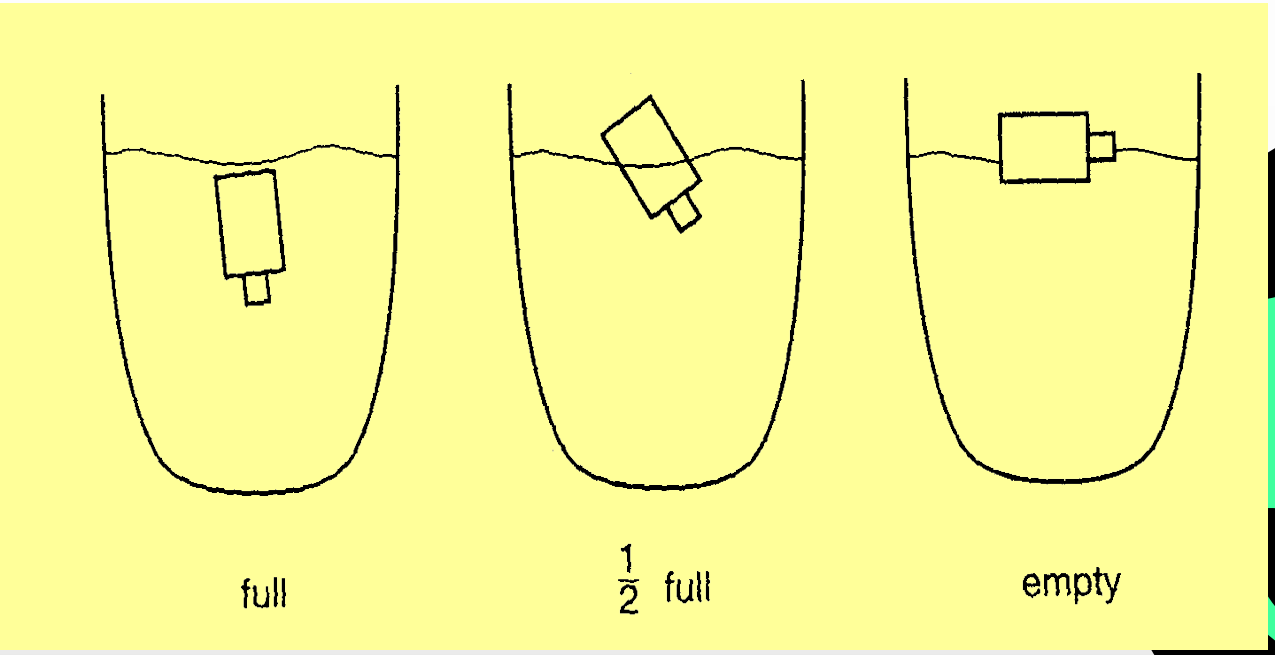


A management device and counter for metered dose inhalers

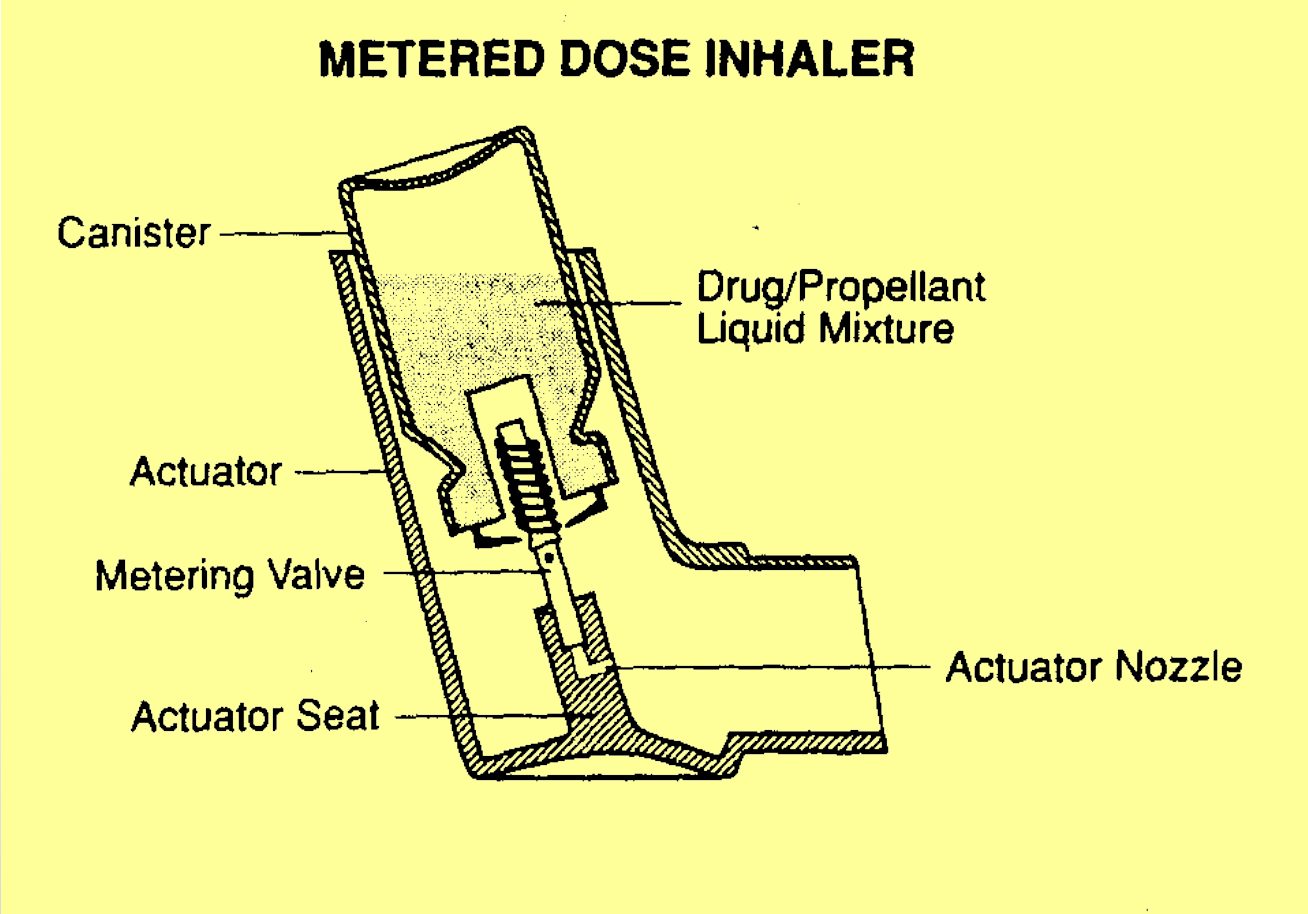
NEWMED
CORPORATION

MDI Log

Sink or Float Test



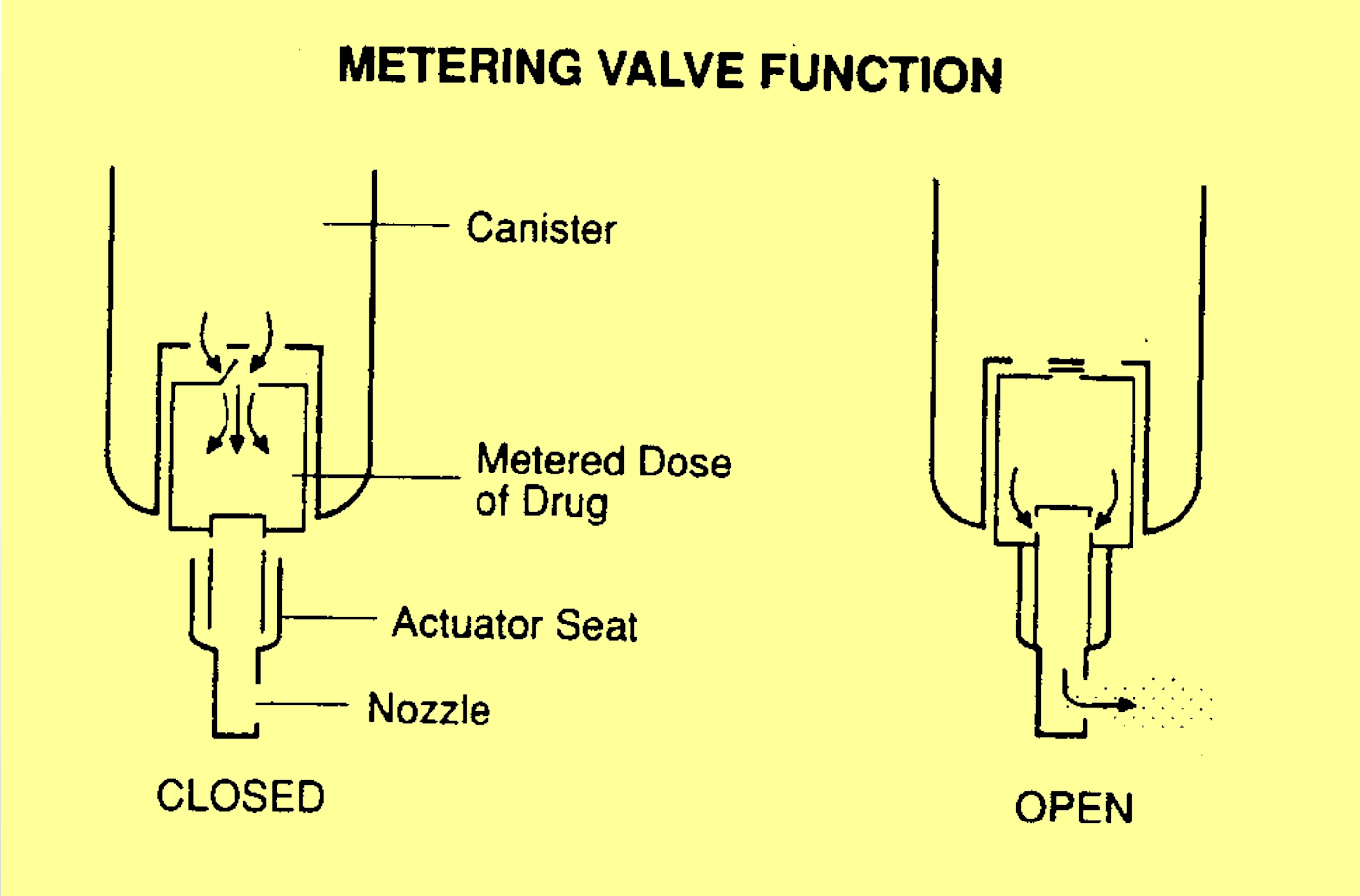
Metered Dose Inhaler



Metered Dose Inhaler Troubleshooting

- Creaming is the separation of drug from other components in the canister
- Occurs in about 4 hours
- Explains the need for shaking the canister before use
- If stored with metering valve down, creaming results in loss of medication from the valve--may need to discharge a waste dose

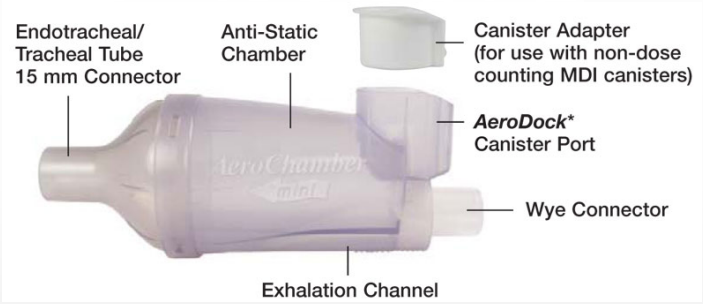
Metered Dose Inhaler Troubleshooting

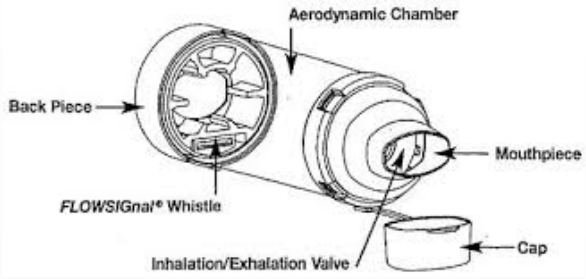


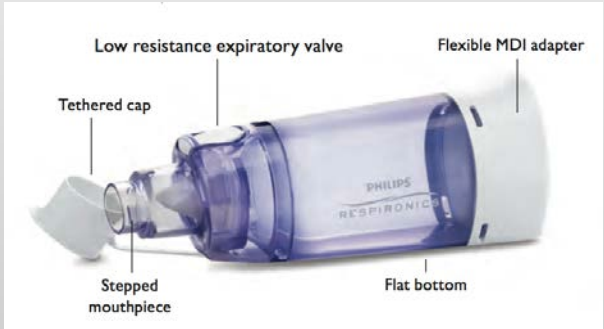
Metered Dose Inhaler Cleaning

- Take metal canister out of plastic container
- Once a week- wash plastic container in light soapy warm water for about 30 seconds.
- Rinse
- Shake off water and let plastic actuator air dry completely
- Do not wipe with a towel, paper towel-air dry
- Replace metal canister in plastic container

Spacers and Valved Holding Chambers (VHC)







Spacer or VHC Application

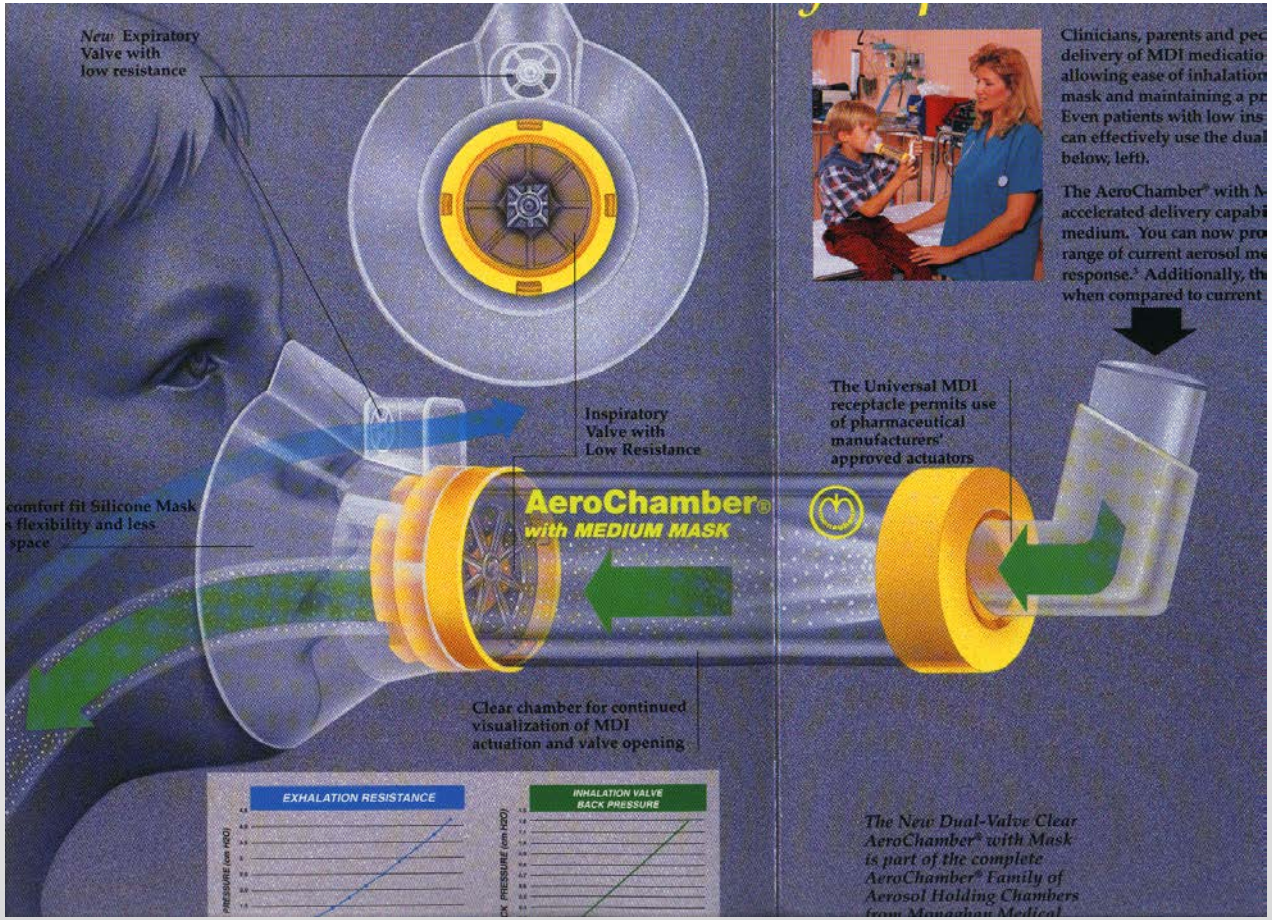
- ≥ 4 years old
- < 4 years old with mask
- For use with most MDIs except
  - Triamcinolone Acetonide (Azmacort®) ICS with integrated spacer
  - Flunisolide (Aerospan™ HFA) ICS with integrated spacer
  - Breath-actuated MDI

Breath-actuated MDI

- ≥5 years old
- Not used with spacer/VHC devices
- Tight seal around mouthpiece and slightly more rapid inhalation than standard MDI followed by 10 second breath hold
- Pirbuterol Acetate (Maxair®)
  - $Beta_2$-agonist

Breath-actuated MDI

Aerochamber® with Mask



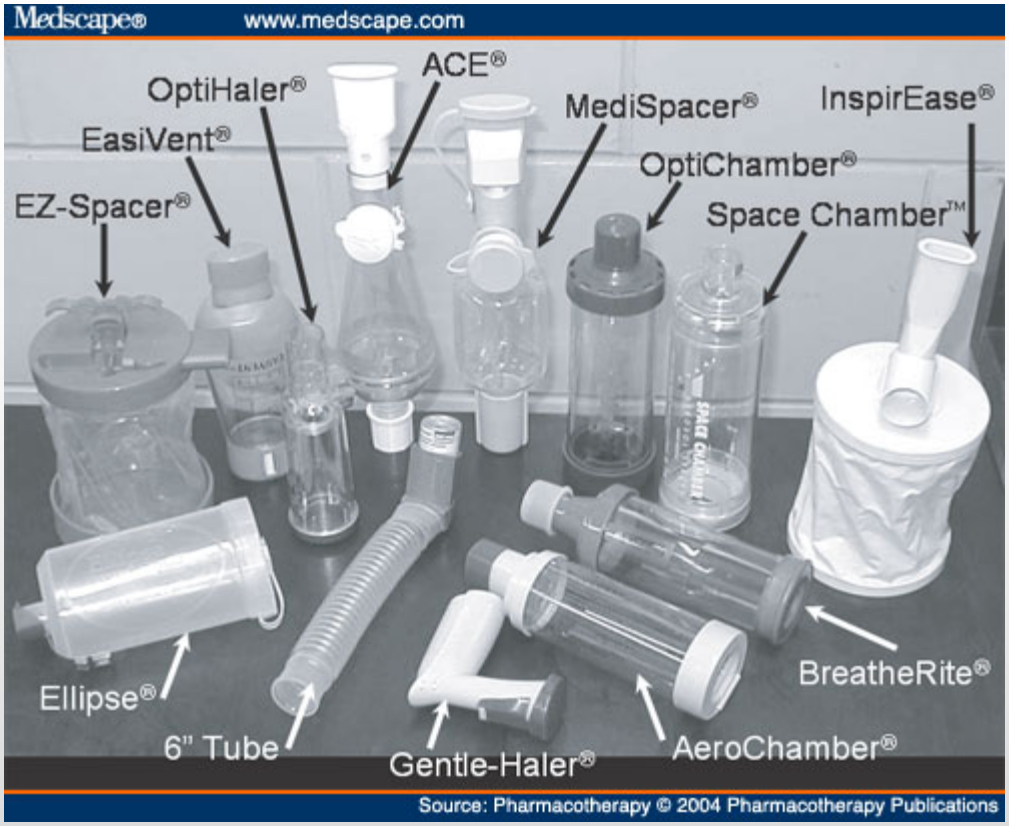
Spacer/VHC Application

- Recommended by NIH guidelines for all patients on medium-to-high doses of inhaled corticosteroids
- A valved holding chamber is almost ALWAYS required in pediatric and geriatric populations
- No clinical data are available on use of spacers or VHCs with ultrafine-particle-generated HFA MDIs

Spacer/VHC Assembly

- Valved Holding Chambers (which have a one-way valve) require coordinated actuations, spacers do not
- Most valved holding chambers have an indicator for excessive inspiratory flows

Spacer/VHC Examples



Spacer/VHC Administration

- Place spacer/VHC in mouth (or mask over both nose and mouth)
- Immediately following actuation, slow (30L/min or 3-5 seconds) deep inhalation followed by 10 second breath hold
- 3-5 inhalations per actuation is appropriate for small children and infants when a mask with a tight fit is used
- Allow at least one minute between actuations
- Rinse mouth after a corticosteroid

Spacer/VHC Cleaning/Replacement

- Care generally consists of simply cleaning the mouthpiece daily (most VHCs are antistatic)

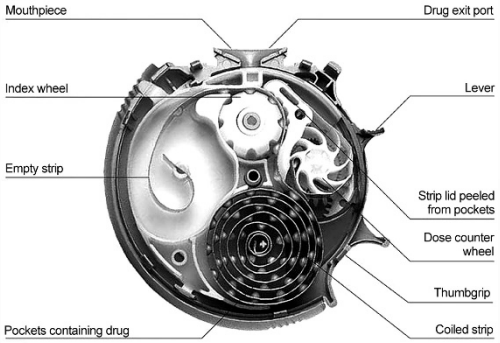
- With continuous use and proper care, spacers and VHCs should last at least 3 months

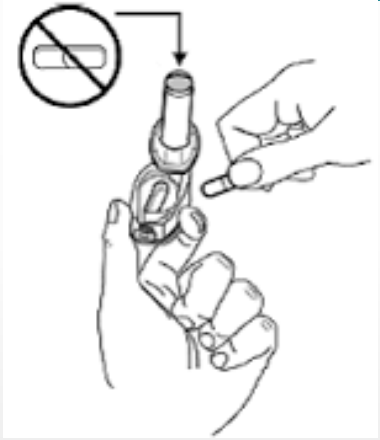
- Rinse plastic nonantistatic VHCs once a month with low concentration of liquid household dishwashing detergent, (1:5,000 or 1–2 drops per cup of water),rinse and let drip dry.

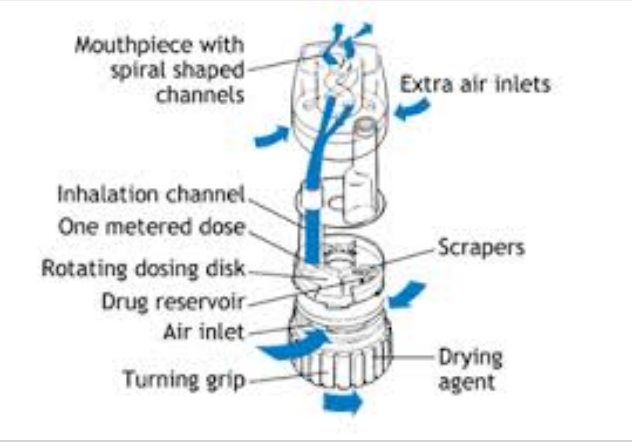
Spacer/VHC Troubleshooting

- The following are indications that replacement is necessary:
  - MDI actuator no long fits snuggly
  - Excessive flow indicator no longer works
  - Gaskets shows signs of wear and tear
  - Small holes or tears in the chamber become apparent

Dry Powder Inhalers (DPI)







Dry Powder Inhaler Application

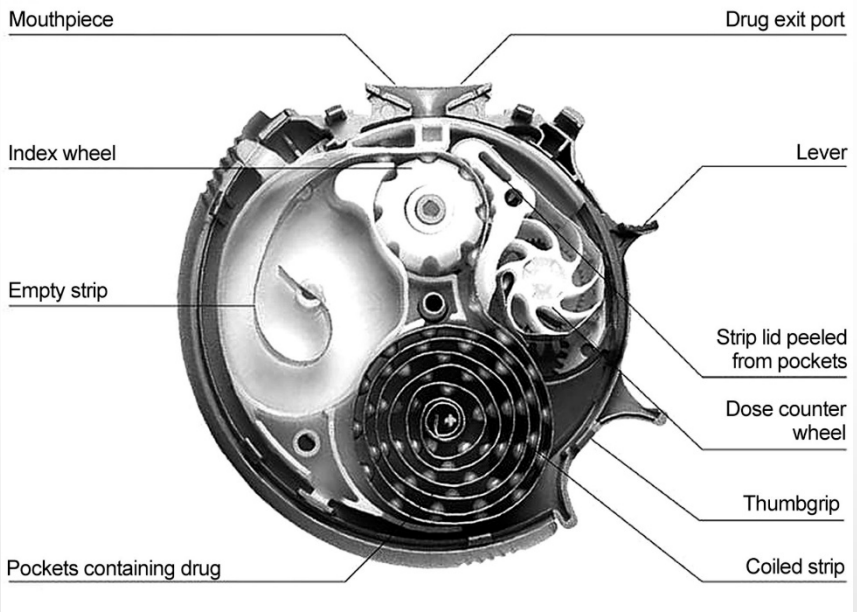
- Can be used for children 4 years old (if able to generate enough inspiratory flow), effects are more consistent with children > 5 years old

- Delivers the following medications
  - $Beta_2$-agonists
  - Corticosteroids
  - Combination of above

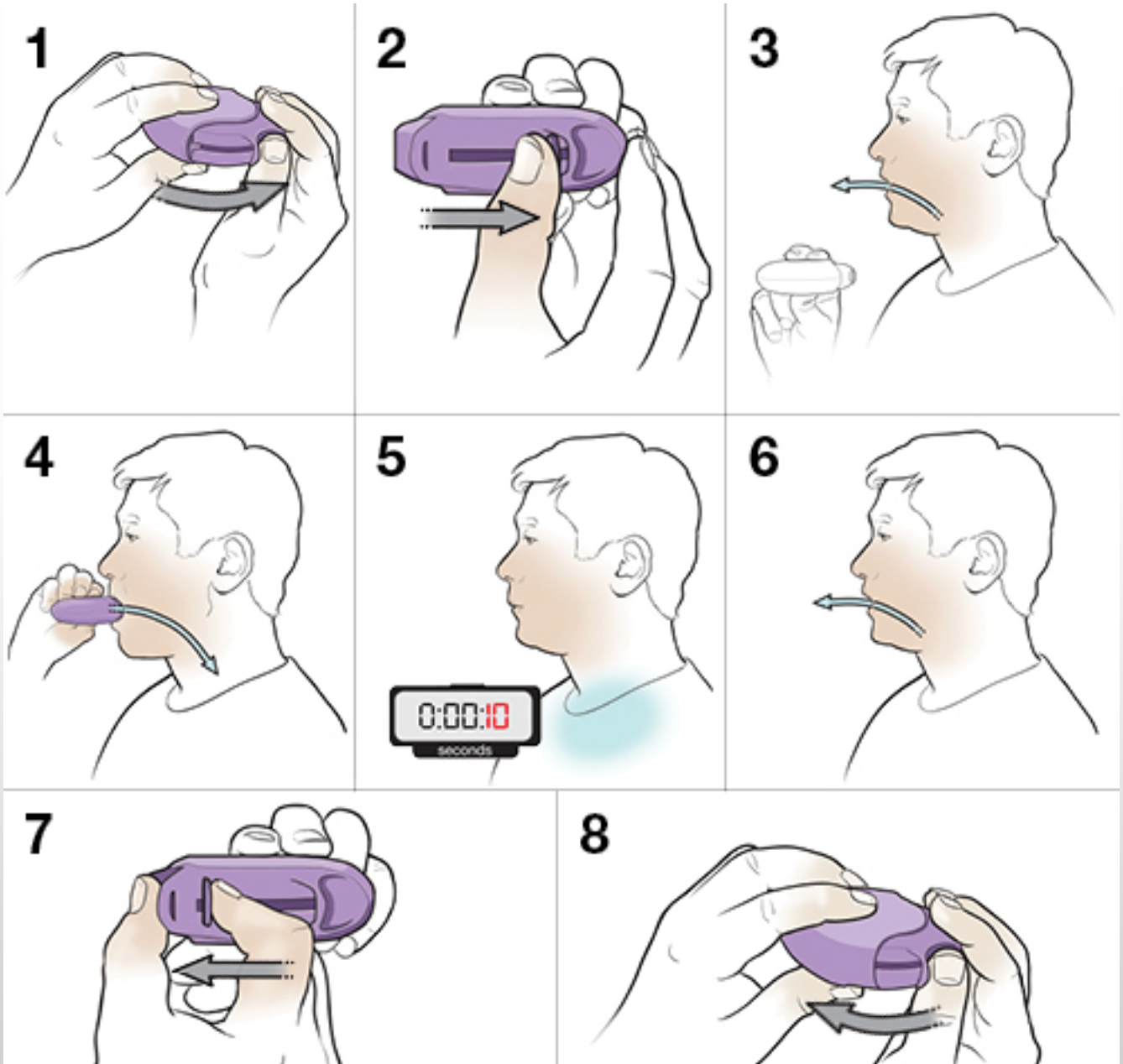
Dry Powder Inhaler Administration

- Load dose and do not tip device
- Exhale slowly to FRC (facing away from device)
- Seal lips around mouthpiece
- Inhale rapidly (60 liters/min or 1-2 seconds)
  - Minimally effective inspiratory flow is device dependent
- Hold breath for as long as possible up to 10 seconds
- Rinse mouth with water if taking corticosteroid

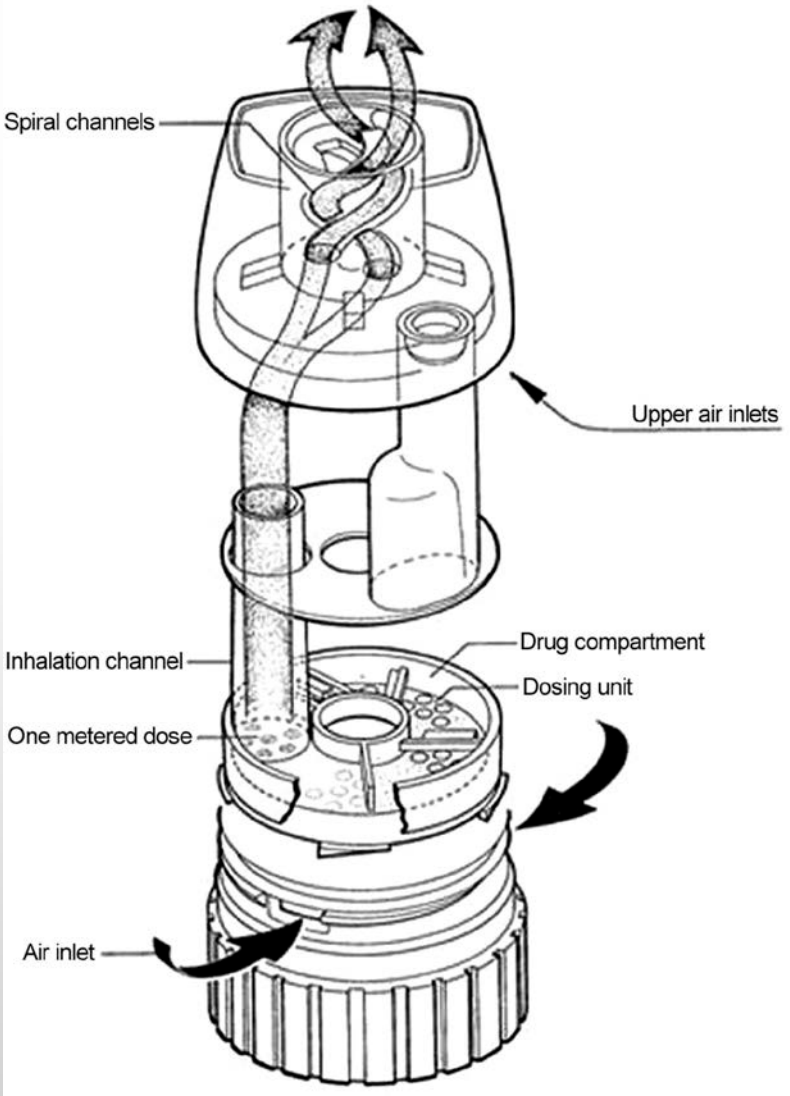
Dry Powder Inhaler Assembly--Diskus®



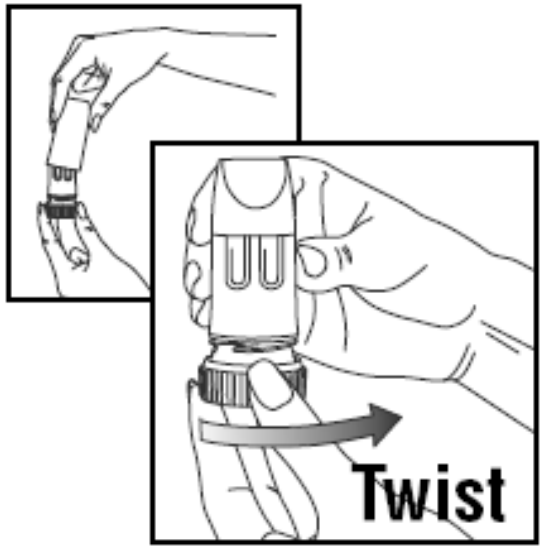
Dry Powder Inhaler Assembly--Diskus®

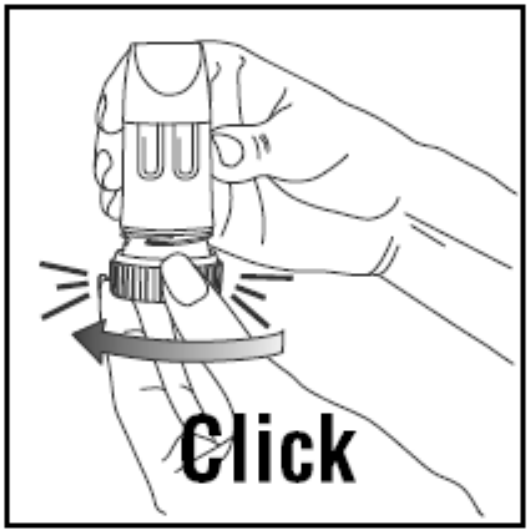


Dry Powder Inhaler Assembly– Pulmicort Flexhaler®



Dry Powder Inhaler Assembly- Pulmicort Flexhaler®





- Has dose counter in increments of 10
- On first dose must twist fully to the right, then the left twice to prime
  - No more priming required after first dose
- On subsequent doses twist fully to the right then to the left to load dose in device

Asmanex Twisthaler®

- Hold device with the pink base at the bottom.
- Twist white cap counter clockwise and remove. This loads one dose and counts down remaining doses
- When the are no doses left the cap will lock on the device

Dry Powder Inhaler Replacement/refilling

- The diskus® has a dose counter (usually 60 doses)
- The flexhaler® has 60 or 120 doses in increments of 10 on the counter
- The twisthaler® has 14, 30, 60 or 120 doses

Dry Powder Inhaler

Dry Powder Inhaler Assembly--Aerolizer®

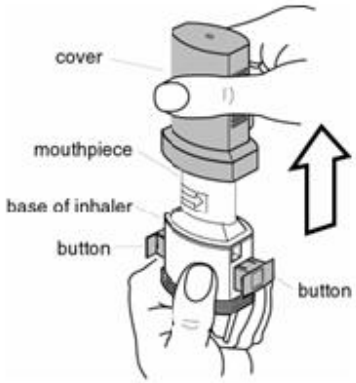
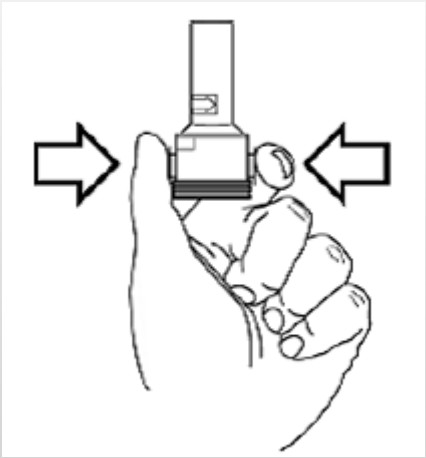


Figure 1



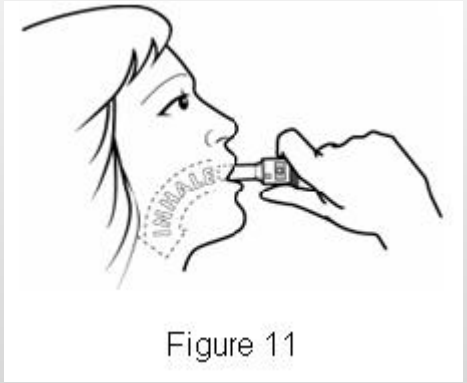


Figure 11

Aerolizer® Administration

- 1. Hold the Aerolizer® with mouthpiece straight up and remove cover
- 2. Twist mouthpiece in the direction of the arrow
- 3. Remove capsule from the blister pack (should not be removed until patient is ready for that dose) and place into device
- 4. Close the mouthpiece (a click should be heard) then squeeze the two buttons on both sides and let go
- 5. Breathe all the way out (away from device)

Aerolizer® Administration (cont.)

- 6. Tilt head slightly back and breathe in fast and deep while your lips form a tight seal (as the patient inhales they will hear the device vibrate)

- 7. Remove the device from mouth and hold breath for as long as they can for up to 10 seconds.

- 8. Open the mouthpiece and look at the capsule. If there is powder in the capsule close the mouthpiece and repeat steps 5-7

- 9. Open the mouthpiece and discard the capsule into trash and place mouthpiece cover on the device

Dry Powder Inhaler Troubleshooting

- Main problems that are likely to occur are either
  - clumping of powdered medication due to moisture or
  - loss of powdered medication due to careless handling

Dry Powder Inhaler Cleaning

- Store in a cool, dry location
- Keep mouthpiece capped or closed
- DO NOT rinse, wash, or immerse in water
- Use a dry cloth to keep it clean

In-Check Dial™

- Accurately simulates the resistance of popular inhaler devices
- Enables clinicians to train patients to use more or less inspiratory force to achieve their optimal flow rate with a particular device
- Optimum inspiratory flow rates
  - Diskus 30-90 lpm
  - Flexhaler 60-90 lpm
  - Autohaler 30-60 lpm
  - Aerolizer 25-90 lpm
  - Twisthaler 30-60 lpm
  - Standard metered-dose inhaler 25-60 lpm

Small Volume Nebulizer

Small Volume Nebulizer Application

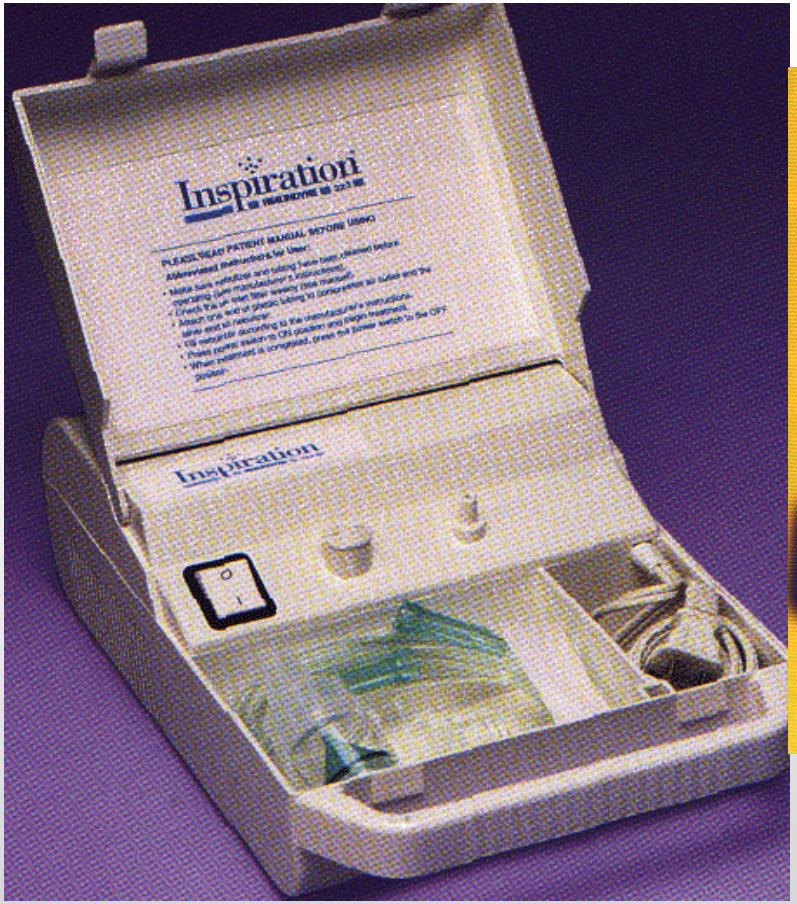
- Patients of any age
  - Less dependent on patient's coordination and cooperation

- Delivers the following medications:
  - $Beta_2$-agonists
  - Cromolyn sodium
  - Anticholinergics
  - Corticosteroids (rinse mouth after)

Small Volume Nebulizer Assembly

- Medication is placed in reservoir
- Nebulizer reservoir is attached to a “T” piece
- A mouthpiece is attached to one side of the “T” piece and one section of wide-bore tubing is attached to the other side
- Oxygen tubing is used to connect the SVN with pressurized air source
- Assume comfortably upright position
- Mouthpiece or mask: breathe through mouth normally with occasional deep breaths with low inspiratory flow

Small Volume Nebulizer Assembly



Small Volume Nebulizer Cleaning

- After each use
  - Rinse mask/mp, T-piece in warm running water
- Once/day
  - Wash mask/mp, T-piece in mild dish soap
- Once/week
  - Wash mask/mp, T-piece in dish soap and soak 30 minutes in vinegar solution (1:2)

Small Volume Nebulizer Cleaning (cont.)

- Never get the tubing wet--wipe the outside down if needed
- Air-dry the washed components
- Blow-dry the nebulizer (20-30 seconds)
- Keep assembled SVN in a zip-lock bag
- Cover the compressor--check the filter periodically, rinse in water when needed

Small Volume Nebulizer Troubleshooting

- Most likely, the jet nozzle will be the first to malfunction
- Look, listen, and feel for adequately dense aerosol produced by the SVN
- Don’t keep tapping the SVN after it sputters regularly
- Stop the treatment if tremors or palpitations occur

Miscellaneous

- Pure nasal inhalation during mask SVN tx results in a 50% drop in delivered meds
- Blow-by administration is NOT supported by studies--it is likely that NO delivery of meds to the lungs may occur
- Effectiveness of SVN tx (and all aerosol delivery devices) decreases as asthma severity worsens
- MDIs with VHCs are as effective as nebulizers for delivering bronchodilators in mild to moderate exacerbations; data in severe exacerbations are limited

Selecting an inhalation device

- Consider
  - Device/drug availability
  - Clinical setting
  - Patient age and ability to use selected device correctly
  - Device use with multiple medications
  - Cost and reimbursement
  - Drug administration time
  - Convenience in both outpatient and inpatient settings
  - Provider and patient preference

Dolovich MB, Hess DR, Dhand R, & Smaldone GC. Device selection and outcomes of aerosol therapy: evidence-based guidelines. *Chest*. 2005;127(1):335-371

QUESTIONS??