Neb Doctor’s Aerosol Training Program

Part 2  Specifics
Jet Nebulizers Driven by Compressors

Home setting:
Jet nebulizers driven by compressed air created by compressor

Hospital & Clinic use:
Jet nebulizers are driven by “wall” air” which is usually higher pressure and flow
Nebulizers utilize the Bernoulli Principle: when a pressurized flow of air is directed through a constricted orifice, the velocity (not the pressure) of the airflow is increased to create a jet stream.
How Jet Nebulizers Work

- The jet stream creates a sub-atmospheric pressure zone (vacuum) which draws the fluid up the capillary tube.
- The impact of a jet stream with liquid produces aerosol particles.
How Jet Nebulizers Work

- The aerosol stream flows to the baffle; particles collide with baffle and either:
  - fall back into reservoir,
  - break into smaller particles that continue on inspiratory flow path, or
  - follow inspiratory flow path around baffle.
Two Basic Nebulizer Types

Small Volume Nebulizer (SVN)
- “Hand-held Neb” or “Small-volume Nebulizer” or “Handset”
- Primarily used to administer drugs
- Mouthpiece or mask

Large Volume Nebulizer
- May be heated or cool
- Primarily used to administer “bland” solutions to hydrate airways and/or reduce inflammation
- Face or trach mask
Conventional “T” Traditional Small Volume Nebulizers

- Continuous gas flow
- Approx. 50% of solution is wasted
- Approx. 25-30% of particles are in respirable range, depending on liter flow

Closed System:
Patient’s inspiratory flow does NOT contribute to aerosol output.
Conventional “T” Traditional Small Volume Nebulizers

**Advantages**
- Inexpensive for short-term use (14 days max.)
- Higher doses than MDI are possible
- “T” design can be used with ventilator circuits and tracheotomy masks

**Disadvantages**
- Low respirable dose compared to PARI reusable nebulizers
  - Expensive for long term use
- Long treatment times
- High pressure/flow required
- Inspiratory flow dilutes aerosol
- Performance deteriorates in days
- Not dishwasher safe, cannot be boiled
PARI Breath-Enhanced Jet Nebulizers

- Continuous gas flow to neb chamber combined with patient’s inspired air
- Exhaled air does not mix with aerosol, amount of solution wasted is minimized
- Approx. 63-87% of particles are in respirable range, depending on liter flow and nebulizer model

Open System:
Patient’s inspiratory flow DOES contribute to aerosol output.
PARI Breath-Enhanced Jet Nebulizers

Diagram showing the components of a breath-enhanced jet nebulizer:
- Entrained air
- Inspiratory valve
- Air flow
- Control nozzle
- Drug reservoir
- Compressed air
- Mouthpiece with expiratory valve
- Aerosol delivery
PARI Breath-Enhanced Jet Nebulizers

Advantages
- High output, short treatments
- Higher dose than T-Neb or MDI is possible
- Multiple “one-way” valves reduce waste
- Dishwasher safe, may be boiled, or autoclaved
- 6 Month Warranty
- Cost-effective for long-term use
- Reimbursed by Medicare, Medicaid, Private Payors

Disadvantages
- Not cost-effective for short-term use
- Cannot be used in ventilator circuits
- Not readily adaptable to tracheotomy masks
PARI LC® Plus Jet Reusable Nebulizer

- The most clinically tested Reusable Nebulizer in the world
- The only Reusable Nebulizer approved for use with TOBI®
- Breath-enhanced delivery
- Balance of fast treatment time and optimal treatment efficiency
PARI Breath Enhanced Nebulizer Compared to Conventional “T” Nebulizer

Inspiratory Phase
PARI Breath Enhanced Nebulizer
Compared to Conventional “T” Nebulizer

*Expiratory Phase*
Particle Size Comparison

PARI LC Plus Reusable Nebulizer vs. Conventional “T” Nebulizer

Data on file, REV 7/98 FS-22-819
PARI LC ® PLUS Assembly

- Inspiratory Valve Cap
- Baffle Insert
- Mouthpiece w/Exhalation Valve
- Medication Chamber
- Source Gas Tubing (air, O2, He/O2)
10-20% Faster treatment times than PARI LC PLUS

- Effective drug delivery comparable to the PARI LC Plus

- Simple, ergonomic design improves **Ease of Use** for Patient

- “No-spill” top

- “Connected” inspiratory valve cap

- Easy view medication level
Key Selling Features – PARI LC®
Sprint Reusable Nebulizer

- Higher aerosol output at similar MMD particle size
- Simple, ergonomic, compact design
- Inspiratory valve cap can’t be lost
- Design prevents medication from spilling
- Fits together only one way
- Easy view™ medication level indicator
- Robust, flexible nozzle construction
- Medication cup self-drains when upside down.
Inspiratory Flow valve cap is attached

Spill Resistant Top

Ergonomic design for easy handling / disassembly

One-Way Twist-On Assembly
Only Four Simple Parts

Nebulizer Top

Mouthpiece

Nebulizer Insert/Baffle

Nebulizer Cup
Transparent Medication Window

Self-Draining Nebulizer Cup
The top is designed to remain attached throughout the 6 month expected life under normal usage.

The PARI LC® Sprint is compatible with the PARI BABY™ conversion kits and Adult aerosol mask.

The PARI LC® Sprint will not work with the current PARI PEP™ adaptor.
1. Specialty product; produces higher percentage of particles in 1-2 micron range than PARI LC PLUS
2. Targets peripheral airways and lung parenchyma (tissue)
3. Treatment time slightly longer than PARI LC PLUS (~ 1-2 minutes)
PARI LC STAR Nebulizer Performance

Nebulization of Dornase Alfa
(Pulmozyme)

Data from Geller et al, Ped Pulm 2001:S22:310-311 „Choice of Nebulizer and Compressor Affects Small Particle Delivery of Dornase Alfa“ – Tested with PARI PRONEB Ultra Compressor, 2.5mg dose of Dornase Alfa (1mg/ml).
Measured with laser diffraction using simulated breathing 18 l/min.
What makes the LC D different?

- No one-way valves
- Specialty product for doctor’s offices, clinics, hospitals, etc.
- Disposable, designed for short term use (plastic not as durable)
- Very fast treatment time: 5.5 - 7 minutes but with higher wastage
# Nebulizer Performance

<table>
<thead>
<tr>
<th>PRONEB Ultra II with</th>
<th>LC® Sprint</th>
<th>LC® Plus</th>
<th>LC® Star</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMD (um)</td>
<td>3.5</td>
<td>3.8</td>
<td>3.1</td>
</tr>
<tr>
<td>Total Output Rate</td>
<td>500</td>
<td>440</td>
<td>400</td>
</tr>
<tr>
<td>% &lt; 5um</td>
<td>65-68 %</td>
<td>65 %</td>
<td>78 %</td>
</tr>
<tr>
<td>Treatment Time</td>
<td>5 min</td>
<td>5-7 min</td>
<td>6.5 – 8 min</td>
</tr>
</tbody>
</table>

1 Measured with Malvern MasterSizer X at 50% RH, 0.9% NaCl solution, inspiratory flow 20 l/min continuous nebulization 23°C, fill volume 2.5 ml
# Particle Size Comparison

<table>
<thead>
<tr>
<th>Nebulizer</th>
<th>Particles Below 5(\mu)</th>
<th>Particles in 1-2(\mu) Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional “T” nebs</td>
<td>25 - 30%</td>
<td>Variable</td>
</tr>
<tr>
<td>LC PLUS</td>
<td>63 - 74%</td>
<td>20 - 33%</td>
</tr>
<tr>
<td>LC Star</td>
<td>78 - 87%</td>
<td>34 - 45%</td>
</tr>
<tr>
<td>LCD</td>
<td>78 - 87%</td>
<td>34 - 45%</td>
</tr>
<tr>
<td>LC Sprint</td>
<td>68%</td>
<td>20 - 33%</td>
</tr>
</tbody>
</table>
Aerosol Masks

PARI Mask
Front Load Design

Traditional Mask
Bottom Load Design
Bottom Load Aerosol Mask

- Does not direct aerosol toward the mouth

- Inefficient because of impaction of aerosol onto bridge of mask
PARI Aerosol Masks

Adult and Pediatric Masks

- Polyvinylchloride (PVC) Soft Plastic
- Efficient and effective
  - Directs aerosol to mouth
  - Prevents impaction of aerosol
- Minimizes eye and face deposition
BUBBLES THE FISH™ II
Aerosol Mask

- Unique mask design minimizes ocular and facial deposition. Recommended
- Fits children aged 3+ years.
- Elongated mask “snout” creates a “reservoir” where the aerosol velocity slows down and congregates before inhalation by the patient which increases “respirable” dose.
BUBBLES THE FISH II
Aerosol Mask

- The vented underside of the mask allows for efficient evacuation of aerosol from the mask upon inspiration.
- This results in increased “respirable” dose available for inhalation compared to other mask designs.
Inhaled Mass, Facial and Ocular Aerosol Deposition

Facial and ocular deposition of nebulized budesonide. Effect of face mask design.
G. Smaldone. AM J Respir Crit Care Med 169:7; A150. 2004
PARI BABY

- Efficient, closed-circuit delivery system for infants and small children
- Soft, silicon masks with elbow-adapater that can be rotated 180° - enables caregivers to administer treatments to children in a variety of positions
- Dishwasher safe

Size 0: Newborn-1 Month
Size 1: 1 Month-1 Year
Size 2: 1–3 Years
Size 3: 3+Years
Nebulizer and Compressor Interaction

- The interaction between the air source (compressor, wall) and the nebulizer determine the % of particles in the respirable range.
- The air source is just as important to aerosol output as is the nebulizer cup.
### Nebulizer and Compressor Interaction

<table>
<thead>
<tr>
<th>Nebulizer and Compressor</th>
<th>MMAD</th>
<th>TOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARI LC Plus with Ultra</td>
<td>3.5 um</td>
<td>.50 ml/min</td>
</tr>
<tr>
<td>PARI LC Plus @ 6 lpm</td>
<td>3.2 um</td>
<td>.54 ml/min</td>
</tr>
<tr>
<td>PARI LC-D with Ultra</td>
<td>3.1 um</td>
<td>.44 ml/min</td>
</tr>
<tr>
<td>PARI LC-D @ 6 lpm</td>
<td>2.5 um</td>
<td>.52 ml/min</td>
</tr>
<tr>
<td>PARI LC-D @ 8 lpm</td>
<td>2.0 um</td>
<td>.58 ml/min</td>
</tr>
</tbody>
</table>
PARI Compressor Filters

Solid, white micropore air filter:

- Up to 500 hrs. of use
- Changed when filter is soiled, clogged, or wet
- Checked regularly
- Other materials cannot be substituted

*Best Practice: Change when nebulizer is replaced!*
Estimating Filter Duration

Filter duration is on average 1-3 years.
- 2.5 ml of nebulizer solution
- Average treatment time is 7 minutes
- Assume the patient takes treatments 4 times/day

Estimation:
- 500 hours x 60 minutes = 30,000 minutes
- 30,000 minutes ÷ 7 minutes = 4,285 treatments
- 4,285 treatments ÷ 4 treatments per day = 1,071 days
- 1,071 days ÷ 365 days per year = 2.9 years
Our Competitors

Breath-Enhanced Nebulizer

- Non-valve, open vent design
- High efficiency aerosol production
- Reusable and disposable versions

Sidestream®
- Manufactured by MEDIC-AID (UK)
- Sold by Allegiance and Invacare

Invacare Passport
Our Competitors

Breath-Actuated Nebulizer

- “On-demand” therapy
- Spring-valve stops air flow to jet nozzle during exhalation
- “Biofeedback” feature encourages optimum patient effort
- Requires high flows ∼ 8 L/M
- Disposable; no warranty
- Does not fit standard masks

AeroEclipse™
- Manufactured by Trudell (CA)
- Sold by Monaghan
Our Competitors

Breath-Enhanced Nebulizer

- Reusable, w/one-way valves
- 7 ml med chamber
- Operating Liter Flow = 2L/M
- AC, 12V DC, and optional rechargeable battery
- .7 lbs
- 5 Yr. Warranty
- Does not fit standard masks
Our Competitors

Breath-Enhanced Nebulizer

- Reusable, w/one-way valves
- Anti-drool feature
- Requires high flows $\sim 7 \text{L/M}$
- 3cc in 7 min @ $7 \text{L/M}$
- PEP device available
- Dishwasher safe, autoclavable
- Does not fit standard masks

NebuTech™ HDN™
by Salter
Our Competitors

Breath-Enhanced Nebulizer

- Reusable, w/one-way valves
- Minimum driving gas flow - $5^\text{L/M}$
- MMAD 3.6 - 4.0 Microns ($\mu$)
- Spill-proof design
- Dishwasher safe, not autoclavable
- Does not fit standard masks

Model 800
by DeVilbiss / Sunrise
Our Competitors

Nic the Dragon
Pediatric Mask
Sold by Allegiance

Traditional
T-Neb Mas

PARI
“Bubbles” Mask
Ultrasonic Nebulizers

- High frequency sound waves applied to piezoelectric transducer to create vibrations. The vibrations pass through the solution that breaks the surface of the liquid into particles.
- Sound wave frequency determines particle size.
- Amplitude influences aerosol output.
Ultrasonic Nebulizers

Advantages
- Portable, lightweight
- Small residual volume
- Quiet
- Minimal waste
- MMAD ~ 3.5 μ

Disadvantages
- Expensive
- Not reimbursed by Medicare, Medicaid
- Ultrasonic waves may inactivate some drugs
- Not durable, requires careful handling, prone to breakdown

Mystique by AirSep

MicroAir by Omron
Metered-Dose Inhalers

- A drug-filled canister fitted to a mouthpiece
- Compression of canister opens a valve to release a precise ("metered") dose of medication under the force of a pressurized propellant
- New drug formulations are being offered with HFA instead of CFC propellants
Correct MDI Use

1. Warm MDI to body temperature, and shake vigorously.
2. Open mouth wide, keep tongue from obstructing mouthpiece.
3. Place MDI between lips or ~ 4 cm (2 fingers’ width) from mouth.
4. Breathe out normally.
5. Breathe in slowly (<0.5 L/sec) and actuate MDI at beginning of inspiration.
6. Continue to inhale to Total Lung Capacity.
7. Hold breath for 4-10 seconds.
8. Wait at least 30 seconds between inhalations.
Metered-Dose Inhalers

Advantages
- Portable
- No residual volume
- Quiet
- Fast

Disadvantages
- Expensive
- Not reimbursed by Medicare, Medicaid
- Technique dependent
- Higher risk of over use or under use
Holding Chambers

- Sometimes referred to as “spacers”
- Designed to overcome patient technique problems
- When MDI is actuated, aerosol is temporarily suspended within chamber
Holding Chambers

Advantages
- Minimizes importance of timing coordination
- Ensures sufficient distance
- Reduces incidence of side effects
- Improve MDI dose delivery significantly; approx. 18-22% vs. 9-11% with MDI alone

Disadvantages
- Can be expensive
- Not reimbursed by Medicare, Medicaid
- Bulky, extra item to carry
- Electrostatic charge may reduce delivered dose
Aerosol Characteristics

Electrostatic charge

- Inherent to all plastic devices because of the nonconductive properties of plastic
- Particles develop a charge when they are produced, by nebulizer or MDI, with random variation (+ or -).
- In the airways, deposition is enhanced by the effect of electrical charge. Particles that carry an opposite charge than bronchial walls are attracted to the airway wall (opposite charges attract); particles with the same charge as airway walls are repelled, enhancing deposition by inertial impaction.
Dose Variation Factors

- Delay of Inhalation
- Multiple Actuations
- Electrostatic Charge
- Ventilatory Pattern
- Chamber Size
- Chamber Shape
- Valve Resistance
- Dead Volume
Consistent Delivery

PARI VORTEX™ Valved Holding Chamber

- Static-Free, Anodized Aluminum
- Latex-Free
- Universal MDI Receptacle
- Clear Mouthpiece
- 3 Mask Sizes
- Dishwasher Safe
The VORTEX™ Difference

- PARI's VORTEX™ holding chamber is made of anodized aluminum, a non electrostatic or "static-free" material
- By eliminating static, the VORTEX™ enables the patient to receive more of their medication and CONSISTENTLY get an OPTIMAL DOSE.
- VORTEX™ cyclonic flow design may improve dose delivery to patients with low tidal volumes
- VORTEX™ is more economical than conventional devices to improve prescription-fill compliance.
The VORTEX™ Difference

Performance Data

Respirable Dose Delivered*

<table>
<thead>
<tr>
<th>Drug</th>
<th>PARI Vortex™</th>
<th>AeroChamber Plus™</th>
<th>MDI Inhaler Alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventolin® (CFC)</td>
<td>60.5</td>
<td>36.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Atrovent® (CFC)</td>
<td>45.0</td>
<td>26.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Vanceril® (CFC)</td>
<td>58.0</td>
<td>50.0</td>
<td>17.0</td>
</tr>
</tbody>
</table>

*Respirable dose: particles from 0.45 to 5.8 microns
Nelson Laboratories, Holding Chamber Comparative and Characterization Study, Protocol No. 200133408-02, 2002
The VORTEX™ Difference

Performance Data

Inhaled Beclomethosone (HFA) Dose Delivery

56% more fine particle dose than AeroChamber Plus™

Beclomethosone, 4 Yr. Old
30.5 micrograms

Beclomethosone, Adult
64.5 micrograms

64.5 micrograms

27% more fine particle dose than AeroChamber Plus™

Beclomethosone, Adult
54.7 micrograms

1 Sinusoidal tidal breathing pattern of a 4 year old with face mask, 230 ml, 24 breaths/minute. Single breath of an adult with mouthpiece, 28.3 liters/minute
The VORTEX™ Difference

Performance Data

Time Delay after MDI Actuation vs. Dose Delivery

18% more fine particle dose than AeroChamber Plus™

- 0 second delay: 73.4 %, 62.3 %, 61.2 %
- 5 second delay: 41.4 %, 30.4 %, 29.5 %
- 15 second delay: 25.8 %, 22.1 %, 20.4 %


Data is on file. PARI Respiratory Equipment, Inc. Ventolin® is a trademark of GlaxoSmithKline. Vanceril® is a trademark of Shering-Plough. IngridEase® is a trademark of Key Pharmaceuticals, Inc. Atrovent® is a trademark of Boehringer Ingelheim. AeroChamber Plus™ is a trademark of Monaghan Medical Corporation. Vortex™ is a trademark of PARI Respiratory Equipment, Inc.
Dry Powder Aerosolization

- Carrier/drug static powder bed
- Carrier/drug dilated powder
- Carrier and stripped drug aerosol dispersion
Dry Powder Inhalers

Spinhaler, Rotohaler, Diskhaler

5 Steps to Use a DPI

1. Load medicine into device
2. Breathe out normally
3. Place DPI in mouth and close lips tightly around it
4. Breathe in slowly and deeply
5. Hold breath for 5-10 sec and exhale normally
Dry Powder Inhalers

**Advantages**
- Portable
- Minimal technique coordination needed
- Quiet
- Fast
- No propellant required

**Disadvantages**
- Expensive
- Not reimbursed by Medicare, Medicaid
- Requires fast inspiratory flow
- Single dose unit
- Limited drug formulations available
Peak Flow Meters

- Peak Expiratory Flow Rate (PEFR)
- Measures how fast you can move air out of your lungs
- PEFR are highest when large airways are clear and lower when they are narrowed or blocked
- Used by patients to monitor asthma severity
Peak Flow Meters

Green Zone = All Clear
(80-100% of personal best)
No asthma symptoms are present, patient is instructed to follow their Self Management Plan as usual, by taking their prevention (“Controller”) medicine(s).
Peak Flow Meters

Yellow Zone = Warning!
(50-80% of personal best)
The patient may be having an episode of asthma that requires an increase in their medicines. Or, the patient’s overall asthma may not be under control. Patient is instructed to increase prevention medicines.
Peak Flow Meters

Red Zone = Danger!
(below 50% of personal best)
The patient must take an inhaled bronchodilator (rescue medicine) right away and seek medical attention immediately if their peak flow number does not return to and stay in their Yellow or Green Zone.
Correct Use of PFM

1. Place the indicator at base of numbered scale
2. Stand up
3. Take a slow deep breath
4. Place PFM in mouth and close lips around mouth piece
5. Blow out as hard and fast as possible—a short, sharp blast
6. Record peak flow number; repeat steps 1-5 two more times. The highest of three measurements is patient’s personal best.
PEP Therapy

- Positive Expiratory Pressure
- Adjunct to Chest Physical Therapy
- Self-administered
- Used to facilitate the mobilization and removal of tenacious pulmonary secretions.
Airway Clearance

- Mucociliary transport is responsible for normal clearance of secretions from the lower respiratory tract.
- Cough is responsible for secretion clearance in cases of acute and chronic respiratory disease.
Mucociliary Transport
Cough Mechanism

Irritation

Inspiration

Compression

Expulsion
Chest Physical Therapy

Hand positioned 3 inches from chest
Strike chest in waving movement
PEP Therapy

- Pressure manometer is used to set a therapeutic pressure range: 10-20 cmH20
- Patient uses diaphragm to breathe in a volume of air larger than normal, but not to total lung capacity, and exhales through the PEP valve
- Sets of 10-20 breaths, followed by controlled coughing moves secretions up and out of the airways
Respiratory Medications

Beta-2 Adrenergic Drugs

SYMPATHETIC

Agonists
stimulate production
of cAMP

bronchial relaxation

Anti-Cholinergic Drugs

PARASYMPATHETIC

Antagonists
block production
of cGMP

normal tone
bronchial constriction
Bronchodilators

- Category 1 - Referred to as rescue or reliever drugs
- Beta-agonists
- Fast acting: 2-10 minutes
- Prevents and treats bronchospasm

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Generic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proventil</td>
<td>Albuterol</td>
</tr>
<tr>
<td>Ventolin</td>
<td>Albuterol</td>
</tr>
<tr>
<td>Alupent</td>
<td>Metaproteronol</td>
</tr>
<tr>
<td>Xoopenex</td>
<td>Levalbuterol</td>
</tr>
</tbody>
</table>
Bronchodilators

- Category 2 – “maintenance reliever” drugs
- Anti-cholinergic
- Fast acting: 15-30 minutes
- Prevents and treats bronchospasm

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Generic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrovent</td>
<td>Ipratropium bromide</td>
</tr>
<tr>
<td>DuoNeb</td>
<td>Ipratropium and Albuterol</td>
</tr>
</tbody>
</table>
# Anti-inflammatory Agents

- Category 1: “controllers” or “maintenance” drugs
- Slow acting: 20-30 minutes
- Prevents / treats airway swelling by decreasing response to histamine release

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Generic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmicort Respules</td>
<td>Budesonide</td>
</tr>
<tr>
<td>Flovent</td>
<td>Fluticasone propionate</td>
</tr>
<tr>
<td>Azmacort</td>
<td>Triamcinolone acetonide</td>
</tr>
<tr>
<td>Vanceril</td>
<td>Beclomethasone dipropionate</td>
</tr>
</tbody>
</table>
Anti-inflammatory Agents

- Category 2: nonsteroidal drugs - “maintenance” or “stabilizer” medications
- Slow acting: require 1-2 wks to become effective
- Prevent airway swelling by inhibiting release of histamine

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Generic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intal</td>
<td>Cromolyn sodium</td>
</tr>
<tr>
<td>Tilade</td>
<td>Nedocromil sodium</td>
</tr>
</tbody>
</table>
Mucolytics

- Liquefies secretions to facilitate mobilization
- Indicated for pulmonary patients with thick, tenacious secretions: cystic fibrosis, chronic bronchitis, etc.

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Generic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucosil</td>
<td>Acetylcysteine</td>
</tr>
<tr>
<td>Pulmozyme</td>
<td>Dornase alfa</td>
</tr>
</tbody>
</table>
Antimicrobials

- Research for the delivery of antimicrobials by aerosol therapy an expanding field
- Currently accepted clinical applications include:
  - anti-pseudomonal antibiotic: TOBI → CF
  - Pentamidine prophylaxis → HIV+
  - Ribavirin → RSV
Clinical Trials

CHIRON

SEPRACOR

AstraZeneca

Genentech, Inc.
Genentech, Inc.
Genentech, Inc.
Genentech, Inc.
Genentech, Inc.