Respiratory Care Pharmacology

- Application of pharmacology to the treatment of cardiopulmonary disease and critical care.
- Involves broad area of drug classes
Advantages of Aerosolized Agents for Inhalation

1. Smaller doses than those used for the same purpose and given systemically
2. Usually fewer and less severe side effects than with oral or parenteral delivery
3. Rapid onset of action
4. Targeted delivery to respiratory system
5. Painless, relatively safe, convenient
Related Drug Groups Important to Respiratory Care

- Anti-infective agents
- Neuromuscular blocking agents
- CNS agents
- Anti-arrhythmic agents
- Anti-hypertensive and anti-anginal agents
- Anticoagulant and thrombolytic agents
- Diuretics
<table>
<thead>
<tr>
<th>Drugs with these Endings</th>
<th>Usually belong to this class</th>
</tr>
</thead>
<tbody>
<tr>
<td>-caine</td>
<td>Local anesthetics</td>
</tr>
<tr>
<td>-cillin, -micin, -mycin, -oxacin</td>
<td>Antibiotics</td>
</tr>
<tr>
<td>-dine</td>
<td>Anti-ulcer agents</td>
</tr>
<tr>
<td>-done</td>
<td>Opioid analgesics</td>
</tr>
<tr>
<td>-ide</td>
<td>Oral hypoglygemics</td>
</tr>
<tr>
<td>-iam, -pam</td>
<td>Anti-anxiety agents</td>
</tr>
<tr>
<td>-mide, -zide</td>
<td>Diuretics</td>
</tr>
<tr>
<td>-nium</td>
<td>Neuromuscular blocking agents</td>
</tr>
<tr>
<td>-olol</td>
<td>Beta blockers (cardiovascular)</td>
</tr>
<tr>
<td>-pril</td>
<td>ACE inhibitors</td>
</tr>
<tr>
<td>-sone, -nide, -lide, -lone</td>
<td>Steroids</td>
</tr>
<tr>
<td>-statin</td>
<td>Anti-lipemetics</td>
</tr>
<tr>
<td>-vir</td>
<td>Anti-virals</td>
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</table>
Figure 3-2  Nervous System Divisions

Central Nervous System (CNS)
Brain and spinal cord

Peripheral Nervous System (PNS)
Nerves outside of brain and spinal cord

Sensory

Motor

Somatic or Voluntary (skeletal muscles)

Autonomic (smooth and cardiac muscles and glands)

Parasympathetic Branch (homeostasis, daily maintenance)

Sympathetic Branch (alert system)
<table>
<thead>
<tr>
<th>Organ or System</th>
<th>Parasympathetic Effect</th>
<th>Sympathetic Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>decreases rate and contractile force</td>
<td>increases rate and contractile force</td>
</tr>
<tr>
<td>Lungs</td>
<td>bronchoconstricts</td>
<td>bronchodilates</td>
</tr>
<tr>
<td>Eyes</td>
<td>pupil constriction</td>
<td>pupil dilation</td>
</tr>
<tr>
<td>Hair muscles</td>
<td>relaxes</td>
<td>contracts and causes hair to stand on end (piloerection)</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>increases digestion</td>
<td>decreases digestion</td>
</tr>
<tr>
<td>Urinary</td>
<td>constricts bladder</td>
<td>relaxes bladder</td>
</tr>
<tr>
<td>Drug Group</td>
<td>Therapeutic Purpose</td>
<td>Agents</td>
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<td>Albuterol Arformoterol Formoterol Iloprost Levalbuterol Metaproterenol Pirbuterol Salmeterol Epinephrine Ipratropium bromide Tiotropium bromide Acetylcysteine Dornase alfa Beclomethasone dipropionate Budesonide Ciclesonide Flunisolide Fluticasone propionate Mometasone furoate Triamcinolone acetonide Cromolyn sodium Montelukast Nedocromil sodium Zafirlukast Zileuton Pentamidine Ribavirin Tobramycin Zanamivir Beractant Calfactant Poractant alfa</td>
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*CF,* Cystic fibrosis; *COPD,* chronic obstructive pulmonary disease; $R_{aw},$ airway resistance.
The Nervous System

- Terminology of drugs affecting the nervous system:
  - Terms based on neurotransmitter and receptor:
    - Cholinergic
    - Anticholinergic
    - Adrenergic
    - Antiadrenergic
Parasympathetic Branch

- Cholinergic neurotransmitter function
- Muscarinic and nicotinic receptors and effects
  - Muscarinic effects
  - Nicotinic effects
- Subtypes of muscarinic receptors
  - $M_1$, $M_2$, $M_3$, $M_4$, $M_5$
Figure 3-7  Synapses, Ganglia, Neurotransmitters, and Receptors of the ANS

Note: Adrenergic receptors are classified as alpha (α) or beta (β).
Peripheral Nervous System

- Sympathetic
  - Neurotransmitter: Preganglionic: Acetylcholine, Postganglionic: Norepinephrine
  - Preganglionic Receptors
    - Nicotinic (N)
  - Postganglionic Receptors
    - Alpha (α)
    - Beta (β)

- Parasympathetic
  - Neurotransmitter: Acetylcholine
  - Preganglionic Receptors
    - Nicotinic (N)
  - Postganglionic Receptors
    - Muscarinic (M)

- Somatic
  - Neurotransmitter: Acetylcholine
  - Receptors of Skeletal Muscles
    - Nicotinic (N)
Cholinergic Agents

- Direct acting
- Indirect acting
  - Cholinesterase reactivator (Pralidoxime)
Anticholinergic Agents

- Atropine as a prototype parasympatholytic agent
- Parasympatholytic (antimuscarinic) effects
Sympathetic Branch

- Adrenergic neurotransmitter function
- Enzyme inactivation
  - COMT
  - MAO
Sympathetic Branch

- Sympathetic (adrenergic) receptor types
  - $\alpha$ and $\beta$ receptors
  - $\beta_1$ and $\beta_2$ receptors
  - $\alpha_1$ and $\alpha_2$ receptors
  - Dopaminergic receptors
<table>
<thead>
<tr>
<th>Type</th>
<th>Tissue</th>
<th>Action</th>
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<tbody>
<tr>
<td>Alpha&lt;sub&gt;1&lt;/sub&gt;</td>
<td>vascular smooth muscle</td>
<td>contracts</td>
</tr>
<tr>
<td></td>
<td>pupil</td>
<td>dilation (mydriasis)</td>
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<tr>
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<td>pilomotor smooth muscle</td>
<td>goosebumps</td>
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<td>Beta&lt;sub&gt;1&lt;/sub&gt;</td>
<td>heart</td>
<td>stimulates rate and force</td>
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<tr>
<td>Beta&lt;sub&gt;2&lt;/sub&gt;</td>
<td>respiratory</td>
<td>bronchodilates</td>
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<td>somatic motor (voluntary muscle)</td>
<td>tremors</td>
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<td>Dopamine</td>
<td>renal</td>
<td>relaxes arteries</td>
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Sympathomimetic and Sympatholytic Agents

- Sympathomimetics
  - Stimulate sympathetic system and produce adrenergic effects
- Sympatholytics
  - Block adrenergic effects
Classification of Drugs

- Drugs that stimulate the parasympathetic receptors:
  - Cholinergics / parasympathomimetics
  - Cholinergic agonists
- Drugs that block the parasympathetic receptors:
  - Anticholinergics / parasympatholytics
  - Cholinergic antagonists
  - Useful in treating lung disorders – helps smooth muscle to relax
- Drugs that stimulate sympathetic receptors:
  - Adrenergic / Sympathomimetics
  - Primary bronchodilators
- Drugs that block the sympathetic receptors:
  - Antiadrenergics / sympatholytic
  - Beta blocker
**Structure:**
- Isoproterenol: Catecholamine
- Albuterol: Catecholamine analogue

**Pharmacokinetics:**
- Isoproterenol: Peak effect: 20 minutes, Duration: 1.5-2 hours
- Albuterol: Peak effect: 30-60 minutes, Duration: 4-6 hours

**Side effect:**
- Isoproterenol: Increased heart rate
- Albuterol: Little/no change in heart rate

**Class of drug:**
- Both: Adrenergic bronchodilator

**Therapeutic effect:**
- Both: Relax airway, smooth muscle

Fig. 2-8. Structure–activity relations (SARs) for two drugs representing the same class of bronchodilator. Both isoproterenol and albuterol are β-adrenergic agents, with minor structural differences leading to significantly different clinical effects.
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Pharmacotherapy

Corticosteroids

- Most effective mediation in treatment of asthma
  - Reduces symptoms and mortality
- Use of inhaled steroids for long-term treatment preferred
  - Use spacer and rinse mouth to eliminate or minimize side effects
- Long-term use of oral steroids should be restricted to patients with asthma refractory to other treatment.
- Short-term oral steroid use during exacerbation reduces severity, duration, and mortality.
Pharmacotherapy (cont.)

Cromolyn (NSAID)

- Protective against allergens, cold air, exercise
- Administered prophylactically, CANNOT be used during an acute asthma attack
- Of limited use in adults
- Drug of choice for atopic children with asthma

Nedocromil (NSAID)

- Similar to cromolyn, it is 4–10 times more potent in preventing acute allergic bronchospasm.
Pharmacotherapy (cont.)

Leukotriene inhibitors

- Leukotrienes mediate inflammation and bronchospasm.
- Modestly effective to control mild to moderate asthma

Inhaled steroids remain the antiinflammatory drug of choice for the treatment of asthma.

Methyxanthines (use is controversial)

- Oral or IV use if admitted for acute asthma attack
Pharmacotherapy (cont.)

$\beta_2$-Adrenergic agonists

- Most rapid and effective bronchodilator
- Drug of choice for exercise-induced asthma and emergency relief of bronchospasm
  - Should be used PRN
- Improves symptoms not underlying inflammation
  - Regular use may worsen asthma control and increase risk of death.
Pharmacotherapy (cont.)

Anticholinergics

- Can be used as adjunct to first-line bronchodilators if there is an inadequate response
- Has an additive affect to $\beta_2$-agonists