**Albuterol (Proventil, Ventolin)**

**Functional Class** Bronchodilator, Beta agonist

**Pharmacology:**

Activation of beta-2-adrenergic receptors on airway smooth muscle leads to the activation of adenylcyclase and to an increase in the intra-cellular concentration of cyclic-3',5'-adenosine monophosphate (cyclic AMP). This increase of cyclic AMP leads to the activation of protein kinase A, which inhibits the phosphorylation of myosin and lowers intracellular ionic calcium concentrations, resulting in relaxation. Albuterol relaxes the smooth muscles of all airways, from the trachea to the terminal bronchioles. Albuterol acts as a functional antagonist to relax the airway irrespective of the spasmogen involved, thus protecting against all bronchoconstrictor challenges. Increased cyclic AMP concentrations are also associated with the inhibition of release of mediators from mast cells in the airway. Albuterol and other beta-adrenergic agents induce the intracellular movement of potassium via the stimulation of the sodium/potassium–adenosine triphosphate (Na+/K+ -ATP) pump.

**Pharmacodynamics/Kinetics**

Peak effect: Nebulization/oral inhalation: 0.5-2 hours  
Duration: Nebulization/oral inhalation: 3-4 hours  
Metabolism: Hepatic to an inactive sulfate  
Half-life elimination: Inhalation: 3.8 hours  
Excretion: Urine (30% as unchanged drug)

**Uses:**

Bronchodilator in reversible airway obstruction due to asthma or COPD. To treat hyperkalemia in renal failure patients.

**Dosing:**

For bronchospasm: 2.5mg in 3ml via HHN with O2 at 6 – 8 liters  
For hyperkalemia: 5mg via HHN doses repeated up to 20mg throughout transport
**Adverse Effects:**

Incidence of adverse effects is dependent upon age of patient, dose and route of administration.

Cardiovascular: Angina, atrial fibrillation, arrhythmias, chest discomfort, chest pain, extrasystoles, flushing, hyper-/hypotension, palpitation, supraventricular tachycardia, tachycardia

Central nervous system: CNS stimulation, dizziness, drowsiness, headache, insomnia, irritability, lightheadedness, migraine, nervousness, nightmares, restlessness, seizure

Dermatologic: Angioedema, rash, urticaria

Endocrine & metabolic: Hyperglycemia, hypokalemia, lactic acidosis

Gastrointestinal: Diarrhea, dry mouth, dyspepsia, gastroenteritis, nausea, unusual taste, vomiting

Genitourinary: Micturition difficulty

Neuromuscular & skeletal: Muscle cramps, musculoskeletal pain, tremor, weakness

Otic: Otitis media, vertigo

Respiratory: Asthma exacerbation, bronchospasm, cough, epistaxis, laryngitis, oropharyngeal drying/irritation, oropharyngeal edema, pharyngitis, rhinitis, upper respiratory inflammation, viral respiratory infection

Misc: Allergic reaction, anaphylaxis, diaphoresis, lymphadenopathy

**Warnings/Precautions**

*Concerns related to adverse effects:*

- Bronchospasm: Rarely, paradoxical bronchospasm may occur with use of inhaled bronchodilating agents; this should be distinguished from inadequate response.

- Hypersensitivity reactions: Immediate hypersensitivity reactions (urticaria, angioedema, rash, bronchospasm) have been reported.

*Disease-related concerns:*

- Asthma: Appropriate use: Optimize anti-inflammatory treatment before initiating maintenance treatment with albuterol. Do not use as a component of chronic therapy without an anti-inflammatory agent. Only the mildest forms of asthma
(Step 1 and/or exercise-induced) would not require concurrent use based upon asthma guidelines.

- Cardiovascular disease: Use with caution in patients with cardiovascular disease (arrhythmia or hypertension or HF); beta-agonists may cause elevation in blood pressure, heart rate and result in CNS stimulation/excitation. Beta₂-agonists may also increase risk of arrhythmias.

- Diabetes: Use with caution in patients with diabetes mellitus; beta₂-agonists may increase serum glucose.

Glaucoma: Use with caution in patients with glaucoma; may elevate intraocular pressure.

- Hyperthyroidism: Use with caution in hyperthyroidism; may stimulate thyroid activity.

- Hypokalemia: Use with caution in patients with hypokalemia; beta₂-agonists may decrease serum potassium.

- Seizures: Use with caution in patients with seizure disorders; beta-agonists may result in CNS stimulation/excitation

**Ipratropium Bromide (Atrovent)**

**Functional Class:** Bronchodilator, anticholinergic

**Pharmacology**

It blocks muscarinic cholinergic receptors, without specificity for subtypes, resulting in a decrease in the formation of cyclic guanosine monophosphate (cGMP). Most likely due to actions of cGMP on intracellular calcium, this results in decreased contractility of smooth muscle in the lung, inhibiting bronchoconstriction and mucus secretion. It is a non-selective muscarinic antagonist, and does not diffuse into the blood, which prevents systemic side-effects. Ipratropium is a derivative of atropine but is a quaternary amine and therefore does not cross the blood-brain barrier, which prevents central side-effects (anticholinergic syndrome). Ipratropium simply blocks the muscarinic cholinergic receptors in the smooth muscles of the bronchi in the lungs. This opens the bronchi, and provides relief in chronic obstructive pulmonary disease and acute asthma. Ipratropium is considered a short-acting bronchodilator.
**Pharmacodynamics/Kinetics**
Onset of action: Bronchodilation: Within 15 minutes

  Peak effect: 1-2 hours

Duration: 2-5 hours

Absorption: Negligible

Distribution: Inhalation: 15% of dose reaches lower airways

Protein Binding: $\leq 9\%$

Half-life elimination: 2 hours

Excretion: Urine

**Uses**

Bronchospasm associated with moderate to severe allergic reaction, COPD and asthma.

**Dosing**

0.5 mg (500mcg) in 2.5ml NS added to 1st albuterol dose via HHN age 12 years and older

**Adverse Effects**

**Note:** Ipratropium is poorly absorbed from the lung, so systemic effects are rare

Cardiovascular: Palpitations, tachycardia (including SVT), flushing, hypotension, hypertension, atrial fibrillation, angioedema

Central nervous system: Nervousness, dizziness, headache, fatigue, drowsiness, insomnia

Dermatologic: Rash, pruritus, alopecia, urticaria

Gastrointestinal: Nausea, xerostomia, constipation

Genitourinary: Dysuria, urinary retention

Ocular: Blurred vision, mydriasis
Respiratory: Cough, hoarseness, dry secretions, epistaxis (with nasal spray), laryngospasm, bronchospasm

Miscellaneous: Hypersensitivity reactions

**Contraindications**

Hypersensitivity to ipratropium, atropine.

Patient under the age of 12 years

**Precautions**

Use with caution in patients with narrow-angle glaucoma, bladder neck obstruction, or prostatic hypertrophy

Neb mouth piece preferred over mask to avoid contact with eyes.
1. Explain how albuterol works to reverse airway obstruction due to asthma or COPD.

2. Peak effect of albuterol is _____________ and the duration is _____________.

3. List 5 cardiovascular adverse effects albuterol may have.
   A. ______________________
   B. ______________________
   C. ______________________
   D. ______________________
   E. ______________________

4. The correct dosing of Albuterol is:
   For bronchospasm: __________________________
   For hyperkalemia: __________________________

5. Explain how albuterol helps to treat hyperkalemia.
6. Explain how atrovent works to treat asthma and COPD.

7. Correct dosage for atrovent is ________________________________.

8. A contraindication to atrovent is a patient who has hypersensitivity to
   _______________________________ or _________________________________.

9. Another contraindication to atrovent is ________________________________.

10. Atrovent should be used with caution in patients with these three disease entities:
    A. __________________________
    B. __________________________
    C. __________________________

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