I. Short-Acting Beta Agonists (SABA)
   
a. **SABA** = Short Acting Bronchial Adrenergic, varies from 2 to 8 hours depending on the med.

b. **Epinephrine** is one of the strongest bronchodilators available. However it also has the strongest beta-I side effects and alpha effects. It can be administered by injection or via aerosol. It is most commonly used in the management of acute asthma attacks and administered intramuscularly. If given via aerosol recommended dosage is a dilution of 1:100 for two deep inhalations spaced about one minute apart (Scanlan, 1995). Patients receiving epinephrine should be monitored closely for beta-I side effects. Be especially cautious when it is given to elderly patients. The *side effects* are similar to the other drugs and include tachycardia, nausea, palpitations, hypertension, headaches, and tremors.

c. **Racemic Epinephrine**: Racemic Epinephrine is a sympathomimetic like the other drugs previously discussed. However, its alpha effects are strong and it is commonly used to relieve croup and epiglottis symptoms in children. It may also be used for adults following extubation to relieve subglottic edema and its associated airway obstruction. It is supplied in a solution of 2.25% or 22.5 mg/ml. Recommended dosage via aerosol is 7 mg to 14 mg mixed in normal saline or other diluent. Racemic epinephrine does have beta-I effects as well as beta-2 and alpha effects. The beta-I effects should be monitored when giving this drug.

d. **Albuterol Sulfate (Ventolin, Proventil, ProAir)**: is a drug with primarily a beta-2 effect. There is some beta-1 effect, but when compared to other sympathomimetics in use in the United States, it has the least beta-1 effect. Albuterol is supplied as a solution for inhalation (.5% or 5 mg/ml), MDI preparation, orally, and in solution for intravenous injection. Recommended dosage is 1.25 to 2.5 mg mixed in normal saline or other diluent. Side effects of albuterol include tachycardia, nausea, palpitations, hypertension, headaches, and tremors. These side effects are related to beta-I stimulation. Administration via aerosol route can minimize these effects by administration directly to the target organ (the lungs).

e. **Pirbuterol Acetate (Maxair)**: is another beta agonist available as an MDI preparation (200 mcg/puff). It is also long-acting, with an onset of action of five minutes and a duration of action of five hours. Most patients require two puffs every four to six hours. Side effects include tachycardia, nausea, palpitations, hypertension, headaches, and tremors. These side effects are related to beta-1 stimulation. However, this drug has more beta-2 effects than beta-1 effects.
f. **Levalbuterol Hydrochloride (Xopenex):** Activation of beta2-adrenergic receptors on airway smooth muscle leads to the activation of adenyl cyclase and to an increase in the intracellular concentration of cyclic-3’, 5’-adenosine monophosphate (cyclic AMP). This increase in 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. Levalbuterol relaxes the smooth muscles of all airways, from the trachea to the terminal bronchioles.

II. **Long-Acting Beta Agonists (LABA)**
   a. **LABA** = Long Acting Bronchial Adrenergic, has a 12 hour affect
   
   b. **Salmeterol Xinafoate (Serevent):** is a long-acting beta agonist that has stronger beta-2 than beta-I effects. It is longer-acting than many other beta agonist drugs with a 12-hour duration of action and a 60-minute onset of action. It is only available as a metered dose inhaler (MDI) preparation (50 mcg/puff) with most patients requiring two puffs every 12 hours. Side effects include tachycardia, nausea, palpitations, hypertension, headaches, and tremors. Side effects may be additive if this drug is used in conjunction with other shorter-acting beta agonists.
   
   c. **Arformoterol Tartrate (Brovana):** A selective beta2-adrenergic bronchodilator. Beta2-receptors are the predominant adrenergic receptors in bronchial smooth muscle. They cause stimulation of intracellular adenyl cyclase which in turn causes relaxation of bronchial smooth muscle. Brovana is specifically indicated for the long term, twice daily maintenance treatment of bronchoconstriction in patients with chronic obstructive pulmonary disease (COPD), including chronic bronchitis and emphysema. Brovana is supplied as 2 mL of a sterile solution in unit-dose
   
   d. **Vilanterol Trifenatate:** Vilanterol is a selective long-acting beta2-adrenergic agonist (LABA) with inherent 24-hour activity for once daily treatment of COPD and asthma. Used in combination with Umeclidinium (a long-acting muscarinic antagonist or LAMA) to make the inhaler ANORO ELLIPTA or with Fluticasone Furoate (an inhaled corticosteroid) to make the inhaler BREO ELLIPTA.

III. **Anticholinergics**
   a. **Anticholinergics:** a class of medications that inhibit parasympathetic nerve impulses by selectively blocking the binding of the neurotransmitter acetylcholine to its receptor in nerve cells. The nerve fibers of the
parasympathetic system are responsible for the involuntary movements of smooth muscles present in the gastrointestinal tract, urinary tract, lungs, etc. Anticholinergics are divided into three categories in accordance with their specific targets in the central and/or peripheral nervous system: antimuscarinic agents, ganglionic blockers, and neuromuscular blockers.

b. **Atropine Sulfate (atropine)**: is available in tablet and liquid form. Dosage for aerosol administration is 1 mg diluted in normal saline or other diluent. Side effects of atropine include dryness of the nose and mouth, bradycardia1 palpitations, and flushing of the skin.

c. **Ipratropium Bromide (Atrovent)**: is another agent which, like atropine, blocks the cholinergic receptor site. It is available in an MDI preparation and in solution. Recommended aerosol dosage is two puffs up to four times per day or 0.5 mg every four hours. The side effects of this drug are similar to atropine's side effects.

d. **Tiotropium Bromide (SPIRIVA)**: consists of a capsule dosage form containing a dry powder formulation of Spiriva intended for oral inhalation only with the HandiHaler inhalation device. Each light green, hard gelatin capsule contains 18 mcg tiotropium. Tiotropium is a long-acting, antimuscarinic agent, which is often referred to as an anticholinergic. It has similar affinity to the subtypes of muscarinic receptors, M1 to M5. In the airways, it exhibits pharmacological effects through inhibition of M3-receptors at the smooth muscle leading to bronchodilation. The competitive and reversible nature of antagonism was shown with human and animal origin receptors and isolated organ preparations.

e. **Umeclidinium Bromide (Incruse Ellipta)**: is a long-acting muscarinic antagonist (LAMA) approved for the maintenance treatment of chronic obstructive pulmonary disease (COPD). It is also approved for this indication in combination with vilanterol (as umeclidinium bromide/vilanterol).

f.

IV. **Combination Drugs**

a. **Combination Drugs** Combination drugs: Deliver both a long lasting bronchial dilator and a corticosteroid or can be a dual bronchial dilator as noted with Combivent or Duo Neb.

b. **Combivent MDI or Duo NEB**: This is a combination of both of the following drugs Albuterol Sulfate (Ventolin, Proventil) and Ipratropium Bromide (Atrovent) It can be delivered in a MDI Form Combivent or Nebulized with both drugs mixed known as a Duo Neb or it is also known as Albuterol and Atrovent (mixed).
c. **SYMBICORT**: Budesonide/formoterol Combination drugs is a combination formulation containing budesonide and formoterol used in the management of asthma and chronic obstructive pulmonary disease (COPD). Symbicort 80/4.5 and Symbicort 160/4.5 each contain micronized budesonide and micronized formoterol fumarate dihydrate for oral inhalation only. These drugs represent two classes of medications (a synthetic corticosteroid and a long-acting selective beta2-adrenoceptor agonist) that have different effects on clinical, physiological, and inflammatory indices of asthma.

d. **ADVAIR**: fluticasone/salmeterol Combination drugs. The combination preparation is a formulation containing fluticasone propionate and salmeterol xinafoate used in the management of asthma and chronic obstructive pulmonary disease little influence on the hypothalamic-pituitary-adrenal axis which also limit the need of tapering before discontinuation. Overall, it has a lower incidence of systemic manifestations than similar medications.

V. **Inhaled Corticosteroids (ICS):**
   a. **Inhaled Corticosteroids**: are widely used in the management of the inflammatory process associated with asthma, reactive airway disease, and other pulmonary disorders. Corticosteroids may be administered systemically (orally or via the intravenous route) or via aerosol. Most corticosteroids that are administered via the aerosol route are given using MDI inhalers. It is important that you understand the actions of these drugs and how they are applied in the management of inflammatory disorders. Always have the patient rinse and spit after use do to the side effect of causing oral candidasis (a yeast infection similar to thrush).

b. **Beclomethesone Diproprionate (Beclovent, Vanceril, QVAR):**
   i. **Beclovent, Vanceril** are two corticosteroids available in an MDI preparation (42 mcg/puff). Most patients require two puffs three to four times per day like other corticosteroids, these drugs act as anti-inflammatory agents. However, since they are inhaled, systemic side effects are fewer than if taken orally or intravenously. Side effects include coughing, oral candidiasis, and dysphonia (difficulty speaking). Side effects may be minimized by thoroughly rinsing the mouth and oral pharynx following use of the MDI.

   ii. **QVAR** is a pressurized, metered-dose aerosol intended for oral inhalation only. Each unit contains a solution of beclomethasone dipropionate in propellant HFA-134a (1,1,1,2 tetrafluoroethane) and ethanol. QVAR 40 mcg delivers 40 mcg of beclomethasone dipropionate from the actuator and 50 mcg from the valve. QVAR 80 mcg delivers 80 mcg of
beclomethasone dipropionate from the actuator and 100 mcg from the valve. Airway inflammation is known to be an important component in the pathogenesis of asthma. Inflammation occurs in both large and small airways. Corticosteroids have multiple anti-inflammatory effects, inhibiting both inflammatory cells and release of inflammatory mediators.

c. **Budesonide (Pulmicort):** Budesonide is an anti-inflammatory corticosteroid that exhibits potent glucocorticoid activity and weak mineralocorticoid activity. Budesonide has a high first pass metabolism. It has efficacy in the terminal ileum and the right colon. Budesonide in comparison with prednisolone has been associated with fewer bone density losses and unlike other corticosteroids has little influence on the hypothalamic-pituitary-adrenal axis which also limit the need of tapering before discontinuation. Overall, it has a lower incidence of systemic manifestations than similar medications.

d. **Fluticasone (Flovent):** Flovent 44 mcg Inhalation Aerosol, Flovent 110 mcg Inhalation Aerosol, and Flovent 220 mcg Inhalation Aerosol are pressurized, metered-dose aerosol units intended for oral inhalation only. Each unit contains a microcrystalline suspension of fluticasone propionate (micronized) in a mixture of 2 chlorofluorocarbon propellants. Fluticasone propionate is a synthetic, trifluorinated glucocorticoid with potent anti-inflammatory activity.

e. **Mometasone Furoate (Asmanex):** The Asmanex TWISTHALER 220 mcg product is a cap-activated inhalation-driven multi-dose dry powder inhaler containing mometasone furoate and anhydrous lactose (which contains milk proteins). Each actuation of the Asmanex TWISTHALER 220 mcg inhaler provides a measured dose of 1.5 mg mometasone furoate inhalation powder, containing 220 mcg of mometasone furoate. Mometasone furoate is a corticosteroid demonstrating potent anti-inflammatory activity. The precise mechanism of corticosteroid action on asthma is not known.

f. **Triamcinolone Acetonide (Azmacort):** Triamcinolone acetonide (Azmacort) is another corticosteroid available as an MDI preparation (100 mcg/puff). Most patients require two to four puffs four times per day. Azmacort is another anti-inflammatory agent that when given by inhalation, has fewer side effects. Side effects include coughing, oral candidiasis, and dysphonia (difficulty speaking). Side effects may be minimized by thoroughly rinsing the mouth and oral pharynx following use of the MDI.

g. **Flunisolide (AeroBid):** Flunisolide (AeroBid) is another MDI corticosteroid preparation (250 mcg/puff). Most patients take two puffs twice each day. Being an inhaled corticosteroid, systemic side effects are fewer than other steroids given parenterally or orally. Side effects include coughing, oral candidiasis, and
dysphonia (difficulty speaking). Side effects may be minimized by thoroughly rinsing the mouth and oral pharynx following use of the MDI.

VI. **Mast Cell Stabilizers and Asthma Management**

a. Agents that inhibit the degranulation of sensitized mast cells. The drug is very useful in the management of extrinsic (allergic) asthma.

b. **Cromolyn Sodium (Intal):** is a prophylactic agent. That is, it prevents mast cell degranulation. Administration of cromolyn sodium during an acute attack is not indicated. The drug does not have any bronchodilatory action or effect. A patient must use the drug on a regular basis to prevent acute bronchospastic episodes. Most side effects of the drug are related to the MDI preparation and include hoarseness and dry mouth symptoms. Patients sometimes experience periods of coughing with both the MDI preparation and the aerosolized liquid form of the drug.

c. **Nedocromil Sodium (Tilade):** is a pyranoquioline which is a drug used in asthma management. Nedocromil sodium blocks both the early and late asthmatic responses to a variety of allergic and non-allergic asthma triggers. Like cromolyn sodium, it is most effective when used as a prophylactic agent. Nedocromil sodium is available as an MDI preparation (1.75 mcg/puff), with most patients requiring two puffs between two to four times per day.

VII. **Mucokinetic Agents**

a. Agents are drugs that decrease the viscosity of pulmonary secretions, increase mucous production, hydrate retained secretions, or affect the composition of mucous proteins. The goal of all mucokinetic therapy is to increase pulmonary clearance through the normal mechanism and to promote coughing.

b. **Acetylcysteine (Mucomyst):** is a drug that acts on the disulfide bond of mucous proteins. The action of the drug is to break down the disulfide bonds, weakening the mucous molecule (Ziment, 1978). The net effect is to reduce the viscosity of mucous, thinning it such that it is easier to expectorate. The recommended dosage is 1 to 10 ml of the 20% solution every two to six hours. Side effects of acetylcysteine include nausea, bronchospasm in asthmatic patients, and rhinorrhea. Usually acetylcysteine is given with a bronchodilator to prevent the bronchospastic side effect.

c. **Sodium Bicarbonate:** increases the pH of sputum making it more alkaline (Ziment, 1978). The viscosity of sputum decreases in an alkaline environment. When the viscosity is reduced, sputum is easier to expectorate. Also sodium bicarbonate is hypertonic and may increase the water content of sputum through its onocotic action. Recommended dosage is to aerosolize 2 to 5 ml of 2-
solution three to four times per day. Side effects are primarily related to irritation of the respiratory tract. These symptoms include hoarseness and a sore throat.

d. **Deoxyribonuclease (Dornavac)**: is an enzyme preparation that is used to break down purulent sputum. It is a proteolytic enzyme that breaks the DNA bonds of purulent sputum. The net effect is to reduce the Viscosity of the sputum, making it easier to expectorate. Recommended dosage is 50,000 to 100,000) units aerosolized up to four times per day. Side effects are pharyngeal and tracheal irritation. Some patients may complain of a burning sensation in the mouth during administration.

e. **Bland Aerosols (Hypertonic Saline)**: Bland aerosols are commonly administered in respiratory care. The goals of bland aerosol therapy include humidification of medical gases, mobilization of pulmonary secretions, and sputum induction. Bland aerosols include distilled water; saline solutions1 and propylene glycol. Propylene glycol is primarily used as a stabilizing agent for other drugs administered via the aerosol route. It stabilizes solutions because of its detergent-like property that reduces surface tension. Hypertonic (3%, 5%, 7%), Isotonic (Normal Saline), Hypotonic (irritating to the airway)

VIII. **Aerosolized Antimicrobial Agents**: Antimicrobial agents such as antibiotics have been aerosolized for the treatment of pulmonary infections. The aerosol route targets the lungs specifically, while in some cases avoiding systemic side effects (pentamidine administration). It is important to understand these drugs, what they are, and why they are administered.

a. **Antibiotics**: Antimicrobial agents such as antibiotics have been aerosolized for the treatment of pulmonary infections. The aerosol route targets the lungs specifically, while in some cases avoiding systemic side effects (pentamidine administration). It is important to understand these drugs, what they are, and why they are administered.

b. **Tobramycin Sulfate**: is an aminoglycoside antibiotic used to treat various types of bacterial infections, particularly Gram-negative infections. Tobramycin works by binding to a site on the bacterial 30S and 50S ribosome, preventing formation of the 70S complex. As a result, mRNA cannot be translated into protein and cell death ensues. Tobramycin is preferred over gentamicin for Pseudomonas aeruginosa pneumonia due to better lung penetration and bactericidal activity
c. **Antiviral Agents**: The primary aerosolized antiviral agent is ribavirin, in the treatment of respiratory syncytial virus (RSV) in pediatric patients. Ribavirin is administered using a special small-particle aerosol generator (SPAC) nebulizer. Ribavirin has been shown to be effective in conjunction with other therapies in the treatment of RSV.

d. **Antiprotozoa Agents**: Pentamidine is often administered to patients with pneumocystis carinii infections, a secondary complication of HIV infection. Aerosolized pentamidine is more effective and has fewer side effects than systemic administration of the same drug. When aerosolized.

IX. **Metered Dose Inhalers**: Metered dose inhalers (MDIs) are small, portable aerosol dispensing devices, Figure 3. These devices are hand-operated and are powered by a Freon propellant, much like an aerosol spray can. Each activation of the trigger dispenses a known dosage of medication. The patient squeezes the MDI during a deep inhalation, depositing the aerosol into the respiratory tract. These devices are convenient, and can be very effective if properly used. The greatest difficulty in MDI application is patient instruction. The patient must completely understand how to use this device. Clear, concise instructions must be given, and a placebo MDI should be used for instructional purposes and demonstration. Ideally, written directions should also be given to the patient for future reference. The medication will be administered as desired only when the patient uses the MDI correctly.

X. **MDI / Spacer (Holding Chambers)**: MDI spacer devices are used in conjunction with MDIs and enhance the effectiveness of aerosol deposition and improve medication delivery 100%. The spacer serves as a baffle, removing larger particles from suspension, and a reservoir that helps to increase the evaporation of the MDI propellant. The use of a spacer ensures that a smaller particle size is delivered to the patient. Patients who have difficulty coordinating their breathing (inspiration) with hand coordination (squeezing) will achieve better results by using a spacer.

XI. **Valved Holding Chambers**: are devices designed for use with metered-dose inhalers (MDI). Their purpose is to improve medication delivery, decrease deposition of medication in the mouth and throat, and eliminate the need to coordinate activating the MDI with inhaling the medication. Holding chambers have valves that prevent medication loss during exhalation by allowing air to flow through the chamber only during inspiration. For children with asthma, an MDI with a holding chamber may be easier to use and more effective than an MDI alone.