Excerpt from Summary Report 2007, Guidelines for the Diagnosis and Management of Asthma, National Asthma Education and Prevention Program, Expert Panel Report 3, Pages 46-52, 56-57. www.nhlbi.nih.gov/guidelines/asthma

FIGURE 17. USUAL DOSAGES FOR LONG-TERM CONTROL MEDICATIONS*

Medication	0–4 Years of Age	5–11 Years of Age	≥12 Years of Age and Adults	Potential Adverse Effects	Comments (not all inclusive)
Inhaled Corticosteroids (See Figure 18, "Estimated Comparative Daily Dosages for ICSs.")					
Oral Systemic Corticosteroids					**(Apply to all three corticosteriods.)**
Methylprednisolone 2, 4, 8, 16, 32 mg tablets Prednisolone 5 mg tablets, 5 mg/5 cc, 15 mg/5 cc Prednisone 1, 2.5, 5, 10, 20, 50 mg tablets; 5 mg/cc, 5 mg/5 cc	0.25–2 mg/kg daily in single dose in a.m. or qod as needed for control Short-course "burst": 1–2 mg/kg/day, maximum 30 mg/day for 3–10 days	0.25–2 mg/kg daily in single dose in a.m. or qod as needed for control Short-course "burst": 1–2 mg/kg/day, maximum 60 mg/day for 3–10 days	7.5–60 mg daily in a single dose in a.m. or qod as needed for control Short-course "burst": to achieve control, 40–60 mg per day as single or 2 divided doses for 3–10 days	■ Short-term use: reversible abnormalities in glucose metabolism, increased appetite, fluid retention, weight gain, mood alteration, hypertension, peptic ulcer, and rarely aseptic necrosis. ■ Long-term use: adrenal axis suppression, growth suppression, dermal thinning, hypertension, diabetes, Cushing's syndrome, cataracts, muscle weakness, and—in rare instances—impaired immune function. ■ Consideration should be given to coexisting conditions that could be worsened by systemic corticosteroids, such as herpes virus infections, varicella, tuberculosis, hypertension, peptic ulcer, diabetes mellitus, osteoporosis, and Strongyloides	■ For long-term treatment of severe persistent asthma, administer single dose in a.m. either daily or on alternate days (alternate-day therapy may produce less adrenal suppression). ■ Short courses or "bursts" are effective for establishing control when initiating therapy or during a period of gradual deterioration. ■ There is no evidence that tapering the dose following improvement in symptom control and pulmonary function prevents relapse. ■ Children receiving the lower dose (1 mg/kg/day) experience fewer behavioral side effects, and it appears to be equally efficacious. ■ For patients unable to tolerate the liquid preparations, dexamethasone syrup at 0.4 mg/kg/day may be an alternative. Studies are limited, however, and the longer duration of activity increases the risk of adrenal suppression.
Inhaled Long-Acting Beta$_2$-Agonists (LABAs)					**(Apply to both LABAs.)**
Salmeterol DPI 50 mcg/blister Formoterol DPI 12 mcg/single-use capsule	NA NA	1 blister q 12 hours 1 capsule q 12 hours	1 blister q 12 hours 1 capsule q 12 hours	■ Tachycardia, skeletal muscle tremor, hypokalemia, prolongation of QTc interval in overdose. ■ A diminished bronchoprotective effect may occur within 1 week of chronic therapy. Clinical significance has not been established. ■ Potential risk of uncommon, severe, life-threatening or fatal exacerbation; see text for additional discussion regarding safety of LABAs.	■ **Should not be used for acute symptom relief or exacerbations. Use only with ICSs.** ■ Decreased duration of protection against EIB may occur with redgular use. ■ Most children <4 years of age cannot provide sufficient inspiratory flow for adequate lung delivery. ■ Do not blow into inhaler after dose is activated. ■ Each capsule is for single use only; additional doses should not be administered for at least 12 hours. ■ Capsules should be used only with the inhaler and should not be taken orally.

Key: DPI, dry powder inhaler; EIB, exercise-induced broncospasm; HFA, hydrofluoroalkane; ICS, inhaled corticosteroids; IgE, immunoglobulin E; MDI, metered-dose inhaler; NA, not available (either not approved, no data available, or safety and efficacy not established for this age group); SABA, short-acting beta$_2$-agonist

***Note:** Dosages are provided for those products that have been approved by the U.S. Food and Drug Administration or have sufficient clinical trial safety and efficacy data in the appropriate age ranges to support their use.

FIGURE 17. USUAL DOSAGES FOR LONG-TERM CONTROL MEDICATIONS* (continued)

Medication	0–4 Years of Age	5–11 Years of Age	≥12 Years of Age and Adults	Potential Adverse Effects	Comments (not all inclusive)
Combined Medication					
Fluticasone/Salmeterol DPI 100 mcg/50 mcg, 250 mcg/50 mcg, or 500 mcg/ 50 mcg HFA 45 mcg/21 mcg 115 mcg/21 mcg 230 mcg/21 mcg	NA	1 inhalation bid, dose depends on level of severity or control	1 inhalation bid; dose depends on level of severity or control	■ See notes for ICS and LABA.	■ There have been no clinical trials in children <4 years of age. ■ Most children <4 years of age cannot provide sufficient inspiratory flow for adequate lung delivery. ■ Do not blow into inhaler after dose is activated. ■ 100/50 DPI or 45/21 HFA for patients who have asthma not controlled on low- to medium-dose ICS ■ 250/50 DPI or 115/21 HFA for patients who have asthma not controlled on medium to high dose ICS.
Budesonide/ Formoterol HFA MDI 80 mcg/4.5 mcg 160mcg/4.5 mcg	NA	2 puffs bid, dose depends on level of severity or control	2 puffs bid; dose depends on level of severity or control	■ See notes for ICS and LABA.	■ There have been no clinical trials in children <4 years of age. ■ Currently approved for use in youths ≥12 years of age. Dose for children 5–12 years of age based on clinical trials using DPI with slightly different delivery characteristics. ■ 80/4.5 for patients who have asthma not controlled on low- to medium-dose ICS. ■ 160/4.5 for patients who have asthma not controlled on medium- to high-dose ICS.
Cromolyn/Nedocromil					
Cromolyn MDI 0.8 mg/puff	NA	2 puffs qid	2 puffs qid	■ Cough and irritation. ■ 15–20 percent of patients complain of an unpleasant taste from nedocromil. ■ Safety is the primary advantage of these	■ One dose of cromolyn before exercise or allergen exposure provides effective prophylaxis for 1–2 hours. Not as effective as inhaled $beta_2$-agonists for EIB as SABA. ■ 4- to 6-week trial of cromolyn or nedocromil may be needed to determine maximum benefit. ■ Dose by MDI may be inadequate to affect hyperresponsiveness. ■ Once control is achieved, the frequency of dosing may be reduced.
Nebulizer 20 mg/ampule	1 ampule qid NA <2 years of age	1 ampule qid	1 ampule qid		
Nedocromil MDI 1.75 mg/puff	NA <6 years of age	2 puffs qid	2 puffs qid		

FIGURE 17. USUAL DOSAGES FOR LONG-TERM CONTROL MEDICATIONS* (continued)

Medication	0–4 Years of Age	5–11 Years of Age	≥12 Years of Age and Adults	Potential Adverse Effects	Comments (not all inclusive)
Immunomodulators					
Omalizumab (Anti IgE) Subcutaneous injection, 150 mg/ 1.2 mL following reconstitution with 1.4 mL sterile water for injection	NA	NA	150–375 mg SC q 2–4 weeks, depending on body weight and pretreatment serum IgE level	■ Pain and bruising of injection sites in 5–20 percent of patients. ■ Anaphylaxis has been reported in 0.2% of treated patients. ■ Malignant neoplasms were reported in 0.5 percent of patients compared to 0.2 percent receiving placebo; relationship to drug is unclear.	■ Do not administer more than 150 mg per injection site. ■ Monitor patients following injections; be prepared and equipped to identify and treat anaphylaxis that may occur. ■ Whether patients will develop significant antibody titers to the drug with long-term administration is unknown.
Leukotriene Modifiers					
Leukotriene Receptor Antagonists (LTRAs)					
Montelukast 4 mg or 5 mg chewable tablet 4 mg granule packets 10 mg tablet	4 mg qhs (1–5 years of age)	5 mg qhs (6–14 years of age)	10 mg qhs	■ No specific adverse effects have been identified. ■ Rare cases of Churg-Strauss have occurred, but the association is unclear.	■ Montelukast exhibits a flat dose-response curve. Doses >10 mg will not produce a greater response in adults. ■ No more efficacious than placebo in infants ages 6–24 months. ■ As long-term therapy may attenuate exercise-induced bronchospasm in some patients, but less effective than ICS therapy.
Zafirlukast 10 mg tablet 20 mg tablet	NA	10 mg bid (7–11 years of age)	40 mg daily (20 mg tablet bid)	■ Postmarketing surveillance has reported cases of reversible hepatitis and, rarely, irreversible hepatic failure resulting in death and liver transplantation.	■ For zafirlukast, administration with meals decreases bioavailability; take at least 1 hour before or 2 hours after meals. ■ Zarfirlukast is a microsomal P450 enzyme inhibitor that can inhibit the metabolism of warfarin. Doses of these drugs should be monitored accordingly. ■ Monitor hepatic enzymes (ALT). Warn patients to discontinue use if they experience signs and symptoms of liver dysfunction.
5-Lipoxygenase Inhibitor Zileuton 600 mg tablet	NA	NA	2,400 mg daily (give tablets qid)	■ Elevation of liver enzymes has been reported. Limited case reports of reversible hepatitis and hyperbilirubinemia.	■ For zileuton, monitor hepatic enzymes (ALT). ■ Zileuton is a microsomal P450 enzyme inhibitor that can inhibit the metabolism of warfarin and theophylline. Doses of these drugs should be monitored accordingly.
Methylxanthines					
Theophylline Liquids, sustained-release tablets, and capsules	Starting dose 10 mg/kg/day; usual maximum: ■ <1 year of age: 0.2 (age in weeks) + 5 = mg/kg/day ■ ≥1 year of age: 16 mg/kg/day	Starting dose 10 mg/kg/day; usual maximum: 16 mg/kg/day	Starting dose 10 mg/kg/day up to 300 mg maximum; usual maximum: 800 mg/day	■ Dose-related acute toxicities include tachycardia, nausea and vomiting, tachyarrhythmias (SVT), central nervous system stimulation, headache, seizures, hematemesis, hyperglycemia, and hypokalemia. ■ Adverse effects at usual therapeutic doses include insomnia, gastric upset, aggravation of ulcer or reflux, increase in hyperactivity in some children, difficulty in urination in elderly males who have prostatism.	■ Adjust dosage to achieve serum concentration of 5–15 mcg/mL at steady state (at least 48 hours on same dosage). ■ Due to wide interpatient variability in theophylline metabolic clearance, routine serum theophylline level monitoring is essential. ■ Patients should be told to discontinue if they experience toxicity. ■ Various factors (diet, food, febrile illness, age, smoking, and other medications) can affect serum concentrations. See EPR—3 Full Report 2007 and package inserts for details.

Excerpt from Summary Report 2007, Guidelines for the Diagnosis and Management of Asthma, National Asthma Education and Prevention Program, Expert Panel Report 3, Pages 46-52, 56-57. www.nhlbi.nih.gov/guidelines/asthma

FIGURE 18. ESTIMATED COMPARATIVE DAILY DOSAGES FOR INHALED CORTICOSTEROIDS

Drug	Low Daily Dose			Medium Daily Dose			High Daily Dose		
	Child 0–4 Years of Age	Child 5–11 Years of Age	≥12 Years of Age and Adults	Child 0–4 Years of Age	Child 5–11 Years of Age	≥12 Years of Age and Adults	Child 0–4 Years of Age	Child 5–11 Years of Age	≥12 Years of Age and Adults
Beclomethasone HFA 40 or 80 mcg/puff	NA	80–160 mcg	80–240 mcg	NA	>160–320 mcg	>240–480 mcg	NA	>320 mcg	>480 mcg
Budesonide DPI 90, 180, or 200 mcg/inhalation	NA	180–400 mcg	180–600 mcg	NA	>400–800 mcg	>600–1,200 mcg	NA	>800 mcg	>1,200 mcg
Budesonide Inhaled Inhalation suspension for nebulization	0.25–0.5 mg	0.5 mg	NA	>0.5–1.0 mg	1.0 mg	NA	>1.0 mg	2.0 mg	NA
Flunisolide 250 mcg/puff	NA	500–750 mcg	500–1,000 mcg	NA	1,000–1,250 mcg	>1,000–2,000 mcg	NA	>1,250 mcg	>2,000 mcg
Flunisolide HFA 80 mcg/puff	NA	160 mcg	320 mcg	NA	320 mcg	>320–640 mcg	NA	≥640 mcg	>640 mcg
Fluticasone **HFA/MDI:** 44, 110, or 220 mcg/puff	176 mcg	88–176 mcg	88–264 mcg	>176–352 mcg	>176–352 mcg	>264–440 mcg	>352 mcg	>352 mcg	>440 mcg
DPI: 50, 100, or 250 mcg/inhalation	NA	100–200 mcg	100–300 mcg	NA	>200–400 mcg	>300–500 mcg	NA	>400 mcg	>500 mcg
Mometasone DPI 200 mcg/inhalation	NA	NA	200 mcg	NA	NA	400 mcg	NA	NA	>400 mcg
Triamcinolone acetonide 75 mcg/puff	NA	300–600 mcg	300–750 mcg	NA	>600–900 mcg	>750–1,500 mcg	NA	>900 mcg	>1,500 mcg

Key: DPI, dry power inhaler; HFA, hydrofluoroalkane; MDI, metered-dose inhaler; NA, not available (either not approved, no data available, or safety and efficacy not established for this age group)

Therapeutic Issues:

- The most important determinant of appropriate dosing is the clinician's judgment of the patient's response to therapy. The clinician must monitor the patient's response on several clinical parameters and adjust the dose accordingly. Once control of asthma is achieved, the dose should be carefully titrated to the minimum dose required to maintain control.
- Preparations are not interchangeable on a mcg or per puff basis. This figure presents estimated comparable daily doses. See EPR—3 Full Report 2007 for full discussion.
- Some doses may be outside package labeling, especially in the high-dose range. Budesonide nebulizer suspension is the only inhaled corticosteroid (ICS) with FDA-approved labeling for children <4 years of age.
- For children <4 years of age: The safety and efficacy of ICSs in children <1 year has not been established. Children <4 years of age generally require delivery of ICS (budesonide and fluticasone HFA) through a face mask that should fit snugly over nose and mouth and avoid nebulizing in the eyes. Wash face after each treatment to prevent local corticosteroid side effects. For budesonide, the dose may be administered 1–3 times daily. Budesonide suspension is compatible with albuterol, ipratropium, and levalbuterol nebulizer solutions in the same nebulizer. Use only jet nebulizers, as ultrasonic nebulizers are ineffective for suspensions. For fluticasone HFA, the dose should be divided 2 times daily; the low dose for children <4 years of age is higher than for children 5–11 years of age due to lower dose delivered with face mask and data on efficacy in young children.

Potential Adverse Effects of Inhaled Corticosteroids:

- Cough, dysphonia, oral thrush (candidiasis).
- Spacer or valved holding chamber with non-breath-actuated MDIs and mouthwashing and spitting after inhalation decrease local side effects.
- A number of the ICSs, including fluticasone, budesonide, and mometasone, are metabolized in the gastrointestinal tract and liver by CYP 3A4 isoenzymes. Potent inhibitors of CYP 3A4, such as ritonavir and ketoconazole, have the potential for increasing systemic concentrations of these ICSs by increasing oral availability and decreasing systemic clearance. Some cases of clinically significant Cushing syndrome and secondary adrenal insufficiency have been reported.
- In high doses, systemic effects may occur, although studies are not conclusive, and clinical significance of these effects has not been established (e.g., adrenal suppression, osteoporosis, skin thinning, and easy bruising). In low-to-medium doses, suppression of growth velocity has been observed in children, but this effect may be transient, and the clinical significance has not been established.

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FIGURE 19. USUAL DOSAGES FOR QUICK-RELIEF MEDICATIONS*

Medication	<5 Years of Age	5–11 Years of Age	≥12 Years of Age and Adults	Potential Adverse Effects	Comments (not all inclusive)
Inhaled Short-Acting Beta$_2$-Agonists					
	Dose applies to Albuterol.	***Dose applies to Albuters/and Levalbuterol.***	***Dose applies to all four SABAs***		***Apply to all four (SABAs)***
MDI					
Albuterol CFC 90 mcg/puff, 200 puffs/canister	1–2 puffs 5 minutes before exercise	1–2 puffs 5 minutes before exercise	2 puffs 5 minutes before exercise	■ Tachycardia, skeletal muscle tremor, hypokalemia, increased lactic acid, headache, hyperglycemia. Inhaled route, in general, causes few systemic adverse effects. Patients with preexisting cardiovascular disease, especially the elderly, may have adverse cardiovascular reactions with inhaled therapy.	■ Drugs of choice for acute bronchospasm. ■ Differences in potencies exist, but all products are essentially comparable on a puff per puff basis. ■ An increasing use or lack of expected effect indicates diminished control of asthma. ■ Not recommended for long-term daily treatment. Regular use exceeding 2 days/week for symptom control (not prevention of EIB) indicates the need for additional long-term control therapy. ■ May double usual dose for mild exacerbations. ■ For levalbuterol, prime the inhaler by releasing 4 actuations prior to use. ■ For HFA: periodically clean HFA actuator, as drug may plug orifice. ■ For autohaler: children <4 years of age may not generate sufficient inspiratory flow to activate an auto-inhaler. ■ Nonselective agents (i.e., epinephrine, isoproterenol, metaproterenol) are not recommended due to their potential for excessive cardiac stimulation, especially in high doses.
Albuterol HFA 90 mcg/puff, 200 puffs/canister	2 puffs every 4–6 hours, as needed for symptoms	2 puffs every 4–6 hours, as needed for symptoms	2 puffs every 4–6 hours, as needed for symptoms		
Levalbuterol HFA 45 mcg/puff, 200 puffs/canister	NA <4 years of age				
Pirbuterol CFC Autohaler 200 mcg/puff, 400 puffs/canister	NA	NA			
Nebulizer solution					■ May mix with cromolyn solution, budesonide inhalant suspension, or ipratropium solution for nebulization. May double dose for severe exacerbations.
Albuterol 0.63 mg/3 mL 1.25 mg/3 mL 2.5 mg/3 mL 5 mg/mL (0.5%)	0.63–2.5 mg in 3 cc of saline q 4–6 hours, as needed	1.25–5 mg in 3 cc of saline q 4–8 hours, as needed	1.25–5 mg in 3 cc of saline q 4–8 hours, as needed	(Same as with MDI)	■ Does not have FDA-approved labeling for children <6 years of age. ■ Compatible with budesonide inhalant suspension. The product is a sterile-filled preservative-free unit dose vial.
Levalbuterol (R-albuterol) 0.31 mg/3 mL 0.63 mg/3 mL 1.25 mg/0.5 mL 1.25 mg/3 mL	0.31–1.25 mg in 3 cc q 4–6 hours, as needed for symptoms	0.31–0.63 mg, q 8 hours, as needed for symptoms	0.63 mg–1.25 mg q 8 hours, as needed for symptoms	(Same as with MDI)	

Key: CFC, chlorofluorocarbon; ED, emergency department; EIB, exercise-induced bronchospasm; HFA, hydrofluoroalkane; IM, intramuscular; MDI, metered-dose inhaler; NA, not available (either not approved, no data available, or safety and efficacy not established for this age group); PEF, peak expiratory flor; SABA, short-acting beta$_2$-agonist

*Dosages are provided for those products that have been approved by the U.S. Food and Drug Administration (FDA) or have sufficient clinical trial safety and efficacy data in the appropriate age ranges to support their use.

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FIGURE 19. USUAL DOSAGES FOR QUICK-RELIEF MEDICATIONS* (continued)

Medication	<5 Years of Age	5–11 Years of Age	≥12 Years of Age and Adults	Potential Adverse Effects	Comments (not all inclusive)
Anticholinergics					
Ipratropium HFA					
MDI					
17 mcg/puff, 200 puffs/canister	NA	NA	2–3 puffs q 6 hours	■ Drying of mouth and respiratory secretions, increased wheezing in some individuals, blurred vision if sprayed in eyes. If used in the ED, produces less cardiac stimulation than SABAs.	■ Multiple doses in the emergency department (not hospital) setting provide additive benefit to SABA. ■ Treatment of choice for bronchospasm due to beta-blocker medication. ■ Does not block EIB. ■ Reverses only cholinergically mediated bronchospasm; does not modify reaction to antigen. ■ May be an alternative for patients who do not tolerate SABA. ■ Has not proven to be efficacious as long-term control therapy for asthma.
Nebulizer solution					
0.25 mg/mL (0.025%)	NA	NA	0.25 mg q 6 hours		
Ipratropium with albuterol					
MDI					
18 mcg/puff of ipratropium bromide and 90 mcg/puff of albuterol 200 puffs/canister	NA	NA	2–3 puffs q 6 hours		
Nebulizer solution					
0.5 mg/3 mL ipratropium bromide and 2.5 mg/3 mL albuterol	NA	NA	3 mL q 4–6 hours		■ Contains EDTA to prevent discoloration of the solution. This additive does not induce bronchospasm.
Systemic Corticosteroids					
Methylprednisolone 2, 4, 6, 8, 16, 32 mg tablets Prednisolone 5 mg tablets, 5 mg/5 cc, 15 mg/5 cc Prednisone 1, 2.5, 5, 10, 20, 50 mg tablets; 5 mg/cc, 5 mg/5 cc	***Dosages apply to first three corticosteroids.*** Short course "burst:" 1–2 mg/kg/day, maximum 60 mg/day, for 3–10 days	Short course "burst": 40–60 mg/day as single or 2 divided doses for 3–10 days	Short course "burst": 40–60 mg/day as single or 2 divided doses for 3–10 days	■ Short-term use: reversible abnormalities in glucose metabolism, increased appetite, fluid retention, weight gain, facial flushing, mood alteration, hypertension, peptic ulcer, and rarely aseptic necrosis. ■ Consideration should be given to coexisting conditions that could be worsened by systemic corticosteroids, such as herpes virus infections, varicella, tuberculosis, hypertension, peptic ulcer, diabetes mellitus, osteoporosis, and *Strongyloides*.	***(Applies to the first three corticosteroids.)*** ■ Short courses or "bursts" are effective for establishing control when initiating therapy or during a period of gradual deterioration. Action may begin within an hour. ■ The burst should be continued until patient achieves 80 percent PEF personal best or symptoms resolve. This usually requires 3–10 days but may require longer. There is no evidence that tapering the dose following improvement prevents relapse in asthma exacerbations. ■ Other systemic corticosteroids such as hydrocortisone and dexamethasone given in equipotent daily doses are likely to be as effective as prednisolone.

FIGURE 19. USUAL DOSAGES FOR QUICK-RELIEF MEDICATIONS* (continued)

Medication	<5 Years of Age	5–11 Years of Age	≥12 Years of Age and Adults	Potential Adverse Effects	Comments (not all inclusive)
Systemic Corticosteroids (continued)					
Repository injection (Methylprednisolone acetate) 40 mg/mL 80 mg/mL	7.5 mg/kg IM once	240 mg IM once	240 mg IM once		■ May be used in place of a short burst of oral steroids in patients who are vomiting or if adherence is a problem.

FIGURE 22. DOSAGES OF DRUGS FOR ASTHMA EXACERBATIONS

Medication	Dosage		
	Child Dose*	Adult Dose	Comments (not all inclusive)
Inhaled Short-Acting Beta$_2$-Agonists (SABA)			
Albuterol Nebulizer solution (0.63 mg/3 mL, 1.25 mg/3 mL, 2.5 mg/3 mL, 5.0 mg/mL)	0.15 mg/kg (minimum dose 2.5 mg) every 20 minutes for 3 doses then 0.15–0.3 mg/kg up to 10 mg every 1–4 hours as needed, or 0.5 mg/kg/hour by continuous nebulization.	2.5–5 mg every 20 minutes for 3 doses, then 2.5–10 mg every 1–4 hours as needed, or 10–15 mg/hour continuously.	Only selective beta$_2$ agonists are recommended. For optimal delivery, dilute aerosols to minimum of 3 mL at gas flow of 6–8 L/min. Use large volume nebulizers for continuous administration. May mix with ipratropium nebulizer solution.
MDI (90 mcg/puff)	4–8 puffs every 20 minutes for 3 doses, then every 1–4 hours inhalation maneuver as needed. Use VHC; add mask in children <4 years.	4–8 puffs every 20 minutes up to 4 hours, then every 1–4 hours as needed.	In mild-to-moderate exacerbations, MDI plus VHC is as effective as nebulized therapy with appropriate administration technique and coaching by trained personnel.
Bitolterol Nebulizer solution (2 mg/mL)	See albuterol dose; thought to be half as potent as albuterol on mg basis.	See albuterol dose.	Has not been studied in severe asthma exacerbations. Do not mix with other drugs.
MDI (370 mcg/puff)	See albuterol MDI dose.	See albuterol MDI dose.	Has not been studied in severe asthma exacerbations.
Levalbuterol (R-albuterol) Nebulizer solution (0.63 mg/3 mL, 1.25 mg/0.5 mL 1.25 mg/3 mL)	0.075 mg/kg (minimum dose 1.25 mg) every 20 minutes for 3 doses, then 0.075–0.15 mg/kg up to 5 mg every 1–4 hours as needed.	1.25–2.5 mg every 20 minutes for 3 doses, then 1.25–5 mg every 1–4 hours as needed.	Levalbuterol administered in one-half the mg dose of albuterol provides comparable efficacy and safety. Has not been evaluated by continuous nebulization.
MDI (45 mcg/puff)	See albuterol MDI dose	See albuterol MDI dose.	
Pirbuterol MDI (200 mcg/puff)	See albuterol MDI dose; thought to be half as potent as albuterol on a mg basis.	See albuterol MDI dose.	Has not been studied in severe asthma exacerbations
Systemic (Injected) Beta$_2$-Agonists			
Epinephrine 1:1,000 (1 mg/mL)	0.01 mg/kg up to 0.3–0.5 mg every 20 minutes for 3 doses sq.	0.3–0.5 mg every 20 minutes for 3 doses sq.	No proven advantage of systemic therapy over aerosol.
Terbutaline (1 mg/mL)	0.01 mg/kg every 20 minutes for 3 doses then every 2–6 hours as needed sq.	0.25 mg every 20 minutes for 3 doses sq.	No proven advantage of systemic therapy over aerosol.
Anticholinergics			
Ipratropium bromide Nebulizer solution (0.25 mg/mL)	0.25–5 mg every 20 minutes for 3 doses, then as needed	0.5 mg every 20 minutes for 3 doses, then as needed	May mix in same nebulizer with albuterol. Should not be used as first-line therapy; should be added to SABA therapy for severe exacerbations. The addition of ipratropium has not been shown to provide further benefit once the patient is hospitalized.
MDI (18 mcg/puff)	4–8 puffs every 20 minutes as needed up to 3 hours	8 puffs every 20 minutes as needed up to 3 hours	Should use with VHC and face mask for children <4 years. Studies have examined ipratropium bromide MDI for up to 3 hours.

FIGURE 22. DOSAGES OF DRUGS FOR ASTHMA EXACERBATIONS (continued)

Medication	Dosage		
	Child Dose*	Adult Dose	Comments (not all inclusive)
Anticholinergics (continued)			
Ipratropium with albuterol Nebulizer solution (Each 3 mL vial contains 0.5 mg ipratropium bromide and 2.5 mg albuterol.)	1.5 mL every 20 minutes for 3 doses, then as needed	3 mL every 20 minutes for 3 doses, then as needed	May be used for up to 3 hours in the initial management of severe exacerbations. The addition of ipratropium to albuterol has not been shown to provide further benefit once the patient is hospitalized.
MDI (Each puff contains 18 mcg ipratropium bromide and 90 mcg of albuterol.)	4–8 puffs every 20 minutes as needed up to 3 hours	8 puffs every 20 minutes as needed up to 3 hours	Should use with VHC and face mask for children <4 years.
Systemic Corticosteroids (Apply to all three corticosteriods.)			
Prednisone Methylprednisolone Prednisolone	1 mg/kg in 2 divided doses (maximum = 60 mg/day) until PEF is 70 percent of predicted or personal best	40–80 mg/day in 1 or 2 divided doses until PEF reaches 70 percent of predicted or personal best	For outpatient "burst," use 40–60 mg in single or 2 divided doses for total of 5–10 days in adults (children: 1–2 mg/ kg/day maximum 60 mg/day for 3–10 days).

* Children ≤ 12 years of age

Key: ED, emergency department; MDI, metered-dose inhaler; PEF, peak expiratory flow, VHC, valved holding chamber

Notes:

- There is no known advantage for higher doses of corticosteroids in severe asthma exacerbations, nor is there any advantage for intravenous administration over oral therapy provided gastrointestinal transit time or absorption is not impaired.
- The total course of systemic corticosteroids for an asthma exacerbation requiring an ED visit of hospitalization may last from 3 to 10 days. For corticosteroid courses of less than 1 week, there is no need to taper the dose. For slightly longer courses (e.g., up to 10 days), there probably is no need to taper, especially if patients are concurrently taking ICSs.
- ICSs can be started at any point in the treatment of an asthma exacerbation.

- No single measure is best for assessing severity or predicting hospital admission.
- Lung function measures (FEV_1 or PEF) may be useful for children ≥5 years of age, but these measures may not be obtainable during an exacerbation.
- Pulse oximetry may be useful for assessing the initial severity; a repeated measure of pulse oximetry of <92–94 percent after 1 hour is predictive of the need for hospitalization.
- Signs and symptoms scores may be helpful. Children who have signs and symptoms after 1–2 hours of initial treatment and who continue to meet the criteria for a moderate or severe exacerbation have a >84 percent chance of requiring hospitalization.

— For adults:

- Repeated lung function measures (FEV_1 or PEF) at 1 hour and beyond are the strongest single predictor of hospitalization. Such measures may not be helpful, or easily obtained, during severe exacerbations.
- Pulse oximetry is indicated for patients who are in severe distress, have FEV_1 or PEF <40 percent predicted, or are unable to perform lung function measures. Only repeat assessments after initial treatment, not a single assessment upon admission, are useful for predicting the need for hospitalization.
- Signs and symptoms scores at 1 hour after initial treatments improve the ability to predict need for hospitalization. The presence of drowsiness is a useful predictor of impending respiratory failure and is reason to consider immediate transfer to a facility equipped to offer ventilatory support.