BRONCHIAL ASTHMA IN CHILDREN: MODERN PHARMACOTHERAPY AND CRITERIA FOR DRUG SELECTION

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Annotation: *Bronchial asthma in children represents a prevalent chronic inflammatory airway disorder characterized by variable airflow obstruction, airway hyperresponsiveness, and recurrent episodes of wheezing, coughing, and dyspnea. Over the past decades, significant advancements have been made in understanding the pathophysiology, immunological mechanisms, and environmental triggers associated with pediatric asthma. Despite this progress, optimal pharmacotherapy and rational drug selection remain challenging due to age-specific considerations, variable disease phenotypes, and the potential adverse effects of long-term medication. Modern therapeutic strategies emphasize a stepwise approach based on disease severity, frequency of exacerbations, and individual patient response. Inhaled corticosteroids remain the cornerstone of long-term control therapy, effectively reducing airway inflammation and minimizing exacerbation risk, while bronchodilators such as short-acting and long-acting β2-agonists provide rapid symptomatic relief and maintenance therapy, respectively. Adjunctive medications, including leukotriene receptor antagonists and monoclonal antibodies targeting IgE or interleukins, are increasingly utilized for specific phenotypes or severe, refractory cases. The choice of pharmacological agents must consider patient age, inhalation technique, adherence potential, comorbidities, and safety profiles, alongside the minimization of systemic side effects. Additionally, non-pharmacological interventions—including trigger avoidance, environmental modification, vaccination, and patient/caregiver education—play a critical role in overall disease management. Contemporary pediatric asthma care requires individualized treatment plans, regular monitoring of lung function and symptom control, and adherence to evidence-based guidelines to achieve optimal outcomes. This review synthesizes current knowledge on pharmacotherapeutic options for children with bronchial asthma and provides practical criteria for rational drug selection in daily clinical practice, thereby supporting both efficacy and safety of treatment.*

Keywords: *pediatric asthma, bronchial asthma, inhaled corticosteroids, β2-agonists, leukotriene receptor antagonists, monoclonal antibodies, pharmacotherapy, drug selection criteria, airway inflammation, asthma management, evidence-based therapy, patient-centered care.*

Introduction: Bronchial asthma represents one of the most prevalent chronic respiratory disorders in children, affecting global pediatric populations and contributing substantially to morbidity, healthcare utilization, and quality-of-life impairment. The disease is characterized by chronic airway inflammation, variable airflow obstruction, airway hyperresponsiveness, and episodic exacerbations triggered by environmental, infectious, or immunological stimuli. Pediatric asthma exhibits heterogeneity in clinical presentation, severity, and underlying pathophysiology, with phenotypes ranging from intermittent mild disease to severe, persistent asthma that may be refractory to standard therapy. Epidemiological studies indicate an increasing prevalence of childhood asthma in both developed and developing countries, with variations influenced by genetic predisposition, atopic comorbidities, urbanization, pollution, viral infections, and early-life exposures. This trend underscores the need for timely diagnosis, personalized management, and adherence to evidence-based treatment protocols to prevent exacerbations, reduce hospitalization rates, and optimize long-term pulmonary function. Management of pediatric asthma is fundamentally based on a combination of pharmacological and non-pharmacological strategies aimed at controlling airway inflammation, alleviating symptoms, minimizing the frequency and severity of exacerbations, and preventing disease progression. Inhaled corticosteroids (ICS) are widely recognized as the mainstay of long-term control therapy, whereas short-acting β2-agonists (SABA) provide rapid relief of acute bronchospasm. Recent advancements include the incorporation of leukotriene receptor antagonists, long-acting β2-agonists (LABA), and targeted biologic therapies such as anti-IgE and anti-interleukin monoclonal antibodies for children with severe or refractory asthma. Selecting the appropriate pharmacotherapeutic regimen in pediatric populations presents unique challenges. Age-specific pharmacokinetics and pharmacodynamics, inhalation technique proficiency, medication adherence, comorbid conditions, and the risk of systemic adverse effects must all be carefully considered. Furthermore, the heterogeneity of disease phenotypes necessitates individualized, stepwise treatment approaches that are regularly reassessed based on clinical response and objective measures of lung function. In addition to pharmacotherapy, comprehensive asthma management incorporates patient and caregiver education, trigger avoidance, vaccination, and environmental modification to reduce exposure to allergens and respiratory irritants. Multidisciplinary collaboration among pediatricians, pulmonologists, allergists, pharmacists, and primary caregivers is essential for optimizing outcomes and ensuring safety in long-term therapy. This article aims to provide an up-to-date review of modern pharmacotherapy in pediatric bronchial asthma,

highlighting current therapeutic options, evidence-based criteria for drug selection, and practical considerations for individualized patient management. By synthesizing current clinical knowledge and guideline recommendations, the review seeks to support rational, safe, and effective asthma care in children.

Main part: Bronchial asthma in children is a chronic inflammatory airway disorder with complex pathophysiology involving immune dysregulation, airway remodeling, and hyperresponsiveness. The disease is characterized by repeated episodes of wheezing, coughing, shortness of breath, and chest tightness, which can vary in frequency and severity. In pediatric populations, asthma phenotypes are heterogeneous, ranging from intermittent mild forms to persistent severe disease, often complicated by atopy, allergic rhinitis, or food sensitivities. The underlying pathophysiological mechanisms involve T-helper 2 (Th2) cell-mediated inflammation, eosinophilic infiltration, IgE-mediated hypersensitivity, mast cell activation, and overproduction of pro-inflammatory cytokines such as interleukin (IL)-4, IL-5, and IL-13. Chronic inflammation leads to structural changes in the airway, including subepithelial fibrosis, smooth muscle hypertrophy, and increased mucus secretion, which collectively contribute to airflow obstruction and symptom persistence.

Effective management of pediatric asthma requires an integrated pharmacotherapeutic approach tailored to age, disease severity, phenotype, and comorbid conditions. Inhaled corticosteroids (ICS) remain the cornerstone of long-term control therapy due to their potent anti-inflammatory effects, ability to reduce airway hyperresponsiveness, and evidence-based efficacy in minimizing exacerbation risk. Low-to-moderate doses of ICS are generally sufficient for children with mild to moderate persistent asthma, while higher doses may be indicated in severe cases, with careful monitoring for potential systemic effects such as growth suppression, adrenal axis suppression, or osteoporosis. Patient adherence and correct inhaler technique are critical determinants of ICS effectiveness, emphasizing the importance of education and regular technique assessment.

Short-acting β2-agonists (SABA) are the first-line therapy for acute symptom relief, providing rapid bronchodilation by stimulating β2-adrenergic receptors in airway smooth muscle. These agents are highly effective for intermittent symptoms but should not be used as monotherapy for persistent asthma due to lack of anti-inflammatory activity. Long-acting β2-agonists (LABA), when combined with ICS, provide extended bronchodilation and symptom control, particularly in children with moderate to severe persistent asthma. The combination therapy allows reduction of ICS doses while maintaining disease control, though LABA should never be used as monotherapy due to safety concerns.

Leukotriene receptor antagonists (LTRAs) are a valuable adjunct therapy, particularly in children with exercise-induced bronchospasm, allergic rhinitis, or aspirin-sensitive asthma. By blocking leukotriene-mediated bronchoconstriction, inflammation, and mucus production, LTRAs provide modest anti-inflammatory benefits and improve symptom

control in selected patients. Additionally, emerging biologic therapies targeting IgE (omalizumab) or interleukins (mepolizumab, benralizumab, dupilumab) have expanded options for severe, refractory asthma in pediatric populations. These therapies are indicated for specific phenotypes characterized by high eosinophilic inflammation or elevated IgE levels and have been shown to reduce exacerbation frequency, corticosteroid requirements, and hospitalizations.

Drug selection in pediatric asthma requires careful consideration of age-appropriate dosing, inhalation technique, adherence potential, comorbidities, and long-term safety. Younger children may have difficulty with metered-dose inhalers, necessitating the use of spacers or nebulizers. Pharmacokinetic and pharmacodynamic variability in children necessitates individualized dosing to ensure therapeutic efficacy while minimizing systemic exposure. Regular assessment of asthma control, lung function (spirometry, peak expiratory flow), and frequency of exacerbations is essential for titrating therapy, adjusting stepwise management plans, and preventing overtreatment or undertreatment.

Non-pharmacological interventions are integral to comprehensive asthma management. Identification and avoidance of environmental triggers such as dust mites, tobacco smoke, pet dander, pollen, and indoor mold reduce the frequency and severity of exacerbations. Vaccination against influenza, pneumococcus, and other relevant pathogens lowers the risk of secondary infections that can precipitate asthma attacks. Education of patients and caregivers regarding trigger recognition, correct inhaler technique, adherence to therapy, and action plans for acute exacerbations enhances self-management and treatment outcomes.

Asthma exacerbations remain a significant cause of morbidity in pediatric populations. Prompt recognition and early intervention with SABA, systemic corticosteroids when indicated, and monitoring of oxygen saturation are essential to prevent progression to severe or life-threatening episodes. Risk stratification, including assessment of prior exacerbation history, frequency of hospitalizations, and severity of symptoms, helps guide therapy escalation and preventive measures. Stepwise management strategies, as outlined in current guidelines, emphasize escalation and de-escalation of therapy based on objective assessment of control, ensuring rational pharmacotherapy and minimizing adverse effects.

The integration of pharmacotherapy with regular monitoring, individualized care plans, and adherence to evidence-based guidelines has demonstrated significant improvements in disease control, reduction in exacerbation rates, and improved quality of life. Pediatric asthma management is evolving to incorporate precision medicine approaches, including phenotype- and biomarker-guided therapy, to optimize drug selection and treatment outcomes. Multidisciplinary collaboration among pediatricians, pulmonologists, allergists, nurses, and pharmacists is essential for ensuring the safety, effectiveness, and sustainability of asthma care.

In conclusion, contemporary pharmacotherapy in pediatric bronchial asthma is founded on a stepwise, evidence-based, and patient-centered approach. Rational selection of medications—including ICS, β2-agonists, LTRAs, and biologic therapies—requires thorough consideration of disease severity, phenotype, age, adherence, and safety. Non-pharmacological interventions and caregiver education are integral to optimizing outcomes. Ongoing assessment, adherence monitoring, and individualized therapy adjustments remain critical components of effective asthma management in children, ultimately aiming to achieve sustained control, reduce exacerbations, and preserve long-term pulmonary function.

Discussion: The management of pediatric bronchial asthma has evolved substantially over the past decades, reflecting advances in pathophysiological understanding, pharmacological development, and evidence-based guideline implementation. Despite these advancements, effective disease control remains a challenge, particularly in children with severe or refractory phenotypes, poor adherence, or comorbid conditions such as allergic rhinitis, obesity, or atopic dermatitis. The heterogeneity of pediatric asthma necessitates individualized approaches that integrate pharmacotherapy, environmental control, education, and ongoing monitoring.

Pharmacotherapeutic choices are central to asthma management, with inhaled corticosteroids (ICS) serving as the cornerstone of long-term anti-inflammatory therapy. Evidence demonstrates that consistent use of ICS reduces airway hyperresponsiveness, prevents exacerbations, and improves lung function. However, clinical effectiveness is highly dependent on correct inhaler technique, adherence, and appropriate dosing. Non-adherence and improper administration remain significant barriers to optimal outcomes, particularly in younger children who may require spacers, nebulizers, or caregiver supervision.

Short-acting β2-agonists (SABA) provide rapid symptomatic relief but do not address underlying inflammation. Overreliance on SABAs without concurrent controller therapy is associated with increased exacerbation risk, hospitalizations, and poor disease control. Long-acting β2-agonists (LABA), when combined with ICS, provide sustained bronchodilation and improved symptom management, yet their use must be carefully monitored to prevent adverse cardiovascular events and ensure adherence to guideline-recommended combination therapy.

Adjunctive pharmacological agents, including leukotriene receptor antagonists (LTRAs) and biologics targeting IgE or interleukins, have expanded therapeutic options for children with specific phenotypes or severe asthma. Biologic therapies have demonstrated efficacy in reducing exacerbation frequency, corticosteroid dependence, and hospital admissions in children with eosinophilic or IgE-mediated disease. Nevertheless, access, cost, and long-term safety data remain challenges, emphasizing the importance of phenotype-guided therapy and careful patient selection.

Environmental and behavioral factors play a critical role in pediatric asthma exacerbations and overall disease control. Exposure to allergens, tobacco smoke, air pollution, and respiratory infections significantly increases symptom burden and reduces pharmacological effectiveness. Comprehensive management strategies must therefore include trigger identification, avoidance, and mitigation measures. Patient and caregiver education regarding inhaler technique, adherence, early recognition of exacerbations, and emergency action plans are equally essential, reinforcing the concept of shared responsibility in asthma care.

Emerging evidence supports the use of objective monitoring tools, such as spirometry, peak expiratory flow measurement, and biomarkers (e.g., fractional exhaled nitric oxide), to guide therapy adjustment and assess response. These tools facilitate individualized treatment decisions, prevent overtreatment or undertreatment, and enhance long-term disease control. Integration of precision medicine approaches, including biomarker-guided therapy, phenotypic stratification, and risk-based stepwise management, represents a promising avenue for improving pediatric asthma outcomes

Despite the availability of effective pharmacotherapy, barriers such as socioeconomic disparities, limited healthcare access, and variability in guideline adherence can impede optimal disease control. Multidisciplinary collaboration among pediatricians, pulmonologists, allergists, pharmacists, nurses, and caregivers is therefore critical to ensure safe, effective, and sustainable management. Regular follow-up, medication review, adherence assessment, and patient-centered education remain cornerstones of successful long-term outcomes.

In summary, pediatric asthma management requires a comprehensive, individualized, and evidence-based approach. Rational pharmacotherapy, guided by disease severity, phenotype, and patient-specific factors, must be complemented by environmental control, education, and continuous monitoring. Integrating these elements into clinical practice not only improves symptom control and reduces exacerbations but also preserves lung function, enhances quality of life, and minimizes long-term morbidity. The discussion highlights that modern asthma care is multidimensional, necessitating a balance between pharmacological efficacy, safety, patient adherence, and broader public health considerations.

Conclusion: Pediatric bronchial asthma continues to represent a major global health challenge, with significant implications for morbidity, healthcare utilization, and quality of life. Modern pharmacotherapy, grounded in a stepwise, evidence-based approach, provides effective control of airway inflammation, symptomatic relief, and prevention of exacerbations. Inhaled corticosteroids (ICS) remain the foundation of long-term therapy, while β2-agonists, leukotriene receptor antagonists (LTRAs), and biologic agents offer targeted, phenotype-specific treatment options. Optimal outcomes are contingent upon correct inhaler technique, adherence to prescribed regimens, individualized dosing, and careful monitoring for adverse effects. Integration of non-pharmacological interventions,

including trigger avoidance, vaccination, environmental control, and caregiver education, is essential for comprehensive disease management. Effective management requires continuous assessment, patient-centered therapy adjustment, and multidisciplinary collaboration. Precision medicine strategies, incorporating biomarkers and phenotypic characterization, have the potential to further enhance therapeutic efficacy and reduce unnecessary medication exposure. Overall, rational and individualized pharmacotherapy in combination with supportive interventions represents the cornerstone of successful pediatric asthma care, aimed at achieving sustained control, minimizing exacerbations, and preserving long-term pulmonary function.

Recommendations:

1. **Evidence-based stepwise therapy:** Prescribe medications according to disease severity, phenotype, and current guideline recommendations, ensuring appropriate escalation and de-escalation.
2. **Emphasis on inhaled corticosteroids:** Use ICS as the primary long-term controller therapy, with individualized dosing and ongoing monitoring of growth and systemic effects.
3. **Adjunctive therapy for specific phenotypes:** Consider LTRAs or biologic agents for children with exercise-induced bronchospasm, allergic sensitization, or severe refractory asthma, guided by biomarkers and clinical response.
4. **Optimization of inhalation technique and adherence:** Educate patients and caregivers on proper inhaler use, monitor adherence, and utilize spacers or nebulizers in younger children as needed.
5. **Monitoring and objective assessment:** Implement regular lung function testing, symptom tracking, and biomarker evaluation to guide therapy adjustments and ensure effective disease control.
6. **Environmental and lifestyle interventions:** Identify and mitigate exposure to allergens, pollutants, and tobacco smoke; encourage vaccination against influenza, pneumococcus, and other relevant pathogens.
7. **Patient and caregiver education:** Provide structured education programs on trigger recognition, asthma action plans, early exacerbation management, and medication adherence.

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