EURASIAN JOURNAL OF MEDICAL AND NATURAL SCIENCES
Innovative Academy Research Support Center
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PHARMACOTHERAPY IN THE TREATMENT OF BRONCHIAL ASTHMA: AGE-RELATED CHARACTERISTICS OF BRONCHODILATORS AND ANTIBACTERIAL DRUGS

Rasulov Boburjon Abduqahhorovich
Andijan State Medical Institute
Department of Pharmacology, Clinical Pharmacology and Medical Biotechnology
https://doi.org/10.5281/zenodo.19483863

ARTICLE INFO

Received: 01st April 2026
Accepted: 08th April 2026
Online: 09th April 2026

KEYWORDS

Bronchial asthma, bronchodilators, antibacterial drugs, pharmacotherapy, age-related characteristics, pharmacokinetics, pharmacodynamics.

ABSTRACT

This article analyzes the age-related characteristics of bronchodilators and antibacterial drugs used in the pharmacotherapy of bronchial asthma. Differences in pharmacokinetics and pharmacodynamics of these medications among pediatric, adult, and elderly patients, as well as their efficacy and safety, are discussed. The results of the study demonstrate the importance of selecting an individualized, age-appropriate therapeutic approach.

ФАРМАКОТЕРАПИЯ ПРИ ЛЕЧЕНИИ БРОНХИАЛЬНОЙ АСТМЫ: ВОЗРАСТНЫЕ ОСОБЕННОСТИ БРОНХОДИЛАТАТОРОВ И АНТИБАКТЕРИАЛЬНЫХ ПРЕПАРАТОВ

Расулов Бобуржон Абдукаххорович
Андижанский государственный медицинский институт
Кафедра фармакологии, клинической фармакологии и медицинской биотехнологии
https://doi.org/10.5281/zenodo.19483863

ARTICLE INFO

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KEYWORDS

Бронхиальная астма, бронходилататоры, антибактериальные препараты, фармакотерапия, возрастные особенности, фармакокинетика, фармакодинамика.

ABSTRACT

В данной статье проанализированы возрастные особенности бронходилататоров и антибактериальных лекарственных средств, применяемых в фармакотерапии бронхиальной астмы. Рассмотрены различия в фармакокинетике и фармакодинамике препаратов у детей, взрослых и пациентов пожилого возраста, а также их эффективность и безопасность. Результаты исследования свидетельствуют о необходимости выбора индивидуализированного подхода к лечению с учетом возраста пациента.

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FARMAKOTERAPIYADA BRONXIAL ASTMA KASALLIGINI DAVOLASHDA BRONXODILATATORLAR VA ANTIBAKTERIAL DORI VOSITALARNING YOSHGA BOG'LIQ XUSUSIYATLARI

Rasulov Boburjon Abduqahhorovich
Andijon davlat tibbiyot instituti Farmakologiya, klinik farmakologiya va tibbiyot biotexnologiyalari kafedrasi
https://doi.org/10.5281/zenodo.19483863

ARTICLE INFO

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KEYWORDS

Bronxial astma, bronxodilatatorlar, antibakterial preparatlar, farmakoterapiya, yosh xususiyatlari, farmakokinetika, farmakodinamika.

ABSTRACT

Ushbu maqolada bronxial astma kasalligini farmakoterapiya asosida davolashda qo'llaniladigan bronxodilatatorlar va antibakterial dori vositalarning yoshga bog'liq xususiyatlari tahlil qilinadi. Bolalar, kattalar va keksa yoshdagi bemorlarda dori vositalarining farmakokinetikasi va farmakodinamikasidagi farqlar, shuningdek, ularni qo'llash samaradorligi va xavfsizligi yoritilgan. Tadqiqot natijalari yoshga mos individual yondashuvni tanlash zarurligini ko'rsatadi.

Introduction. Bronchial asthma remains one of the most prevalent chronic respiratory diseases worldwide, and bronchodilators play a central role in its pharmacotherapeutic management. From a clinical and pharmacological perspective, bronchodilators not only relieve airway obstruction but also act as modulators regulating smooth muscle tone, mucociliary function, and airway hyperresponsiveness. Therefore, a thorough understanding of their pharmacodynamics and pharmacokinetics is essential for their safe and rational use in both acute episodes and long-term asthma control [1]. The first class of bronchodilators—short-acting beta-2 agonists (SABAs), such as salbutamol and terbutaline—are indispensable for relieving acute bronchoconstriction. Their rapid onset of action (within minutes) and short half-life make them particularly suitable for emergency use. However, clinical pharmacologists emphasize the risks associated with the overuse of SABA agents, as this may indicate poor disease control and can lead to reduced beta-receptor sensitivity, arrhythmias, hypokalemia, and an increased risk of mortality [2].

Therefore, SABAs should be used only as rescue medications for rapid symptom relief, and frequent need for their use necessitates a reassessment of the patient's baseline (maintenance) therapy. In addition, age-related physiological changes significantly influence drug response. Consequently, drug selection and dosing require an individualized approach across different age groups.

In addition to bronchodilators, antibacterial agents are essential in the management of inflammatory diseases, as pharmacotherapy cannot be considered complete without them. The clinical pharmacology of these medications varies significantly with age.

The global aging of the population has profoundly transformed the landscape of clinical pharmacology. Elderly patients—typically defined as individuals aged 65 years and older—are increasingly represented among those requiring antibacterial therapy for conditions such as pneumonia, bronchial asthma, chronic obstructive pulmonary disease (COPD), urinary tract infections, skin and soft tissue infections, and sepsis. However, the use of antibiotics in this population is considerably more complex. Age-related physiological changes affect the absorption, distribution, metabolism, and excretion of drugs, thereby significantly influencing both therapeutic efficacy and the risk of toxicity [1].

Materials and Methods. This article was prepared based on the analysis of scientific literature, clinical guidelines, and pharmacological sources. The following methods were employed during the study: analytical review, comparative analysis, and generalization of clinical observation data. In addition, existing scientific evidence on the efficacy and safety of medications used in patients with bronchial asthma across different age groups was examined. For instance, several well-established findings support the age-based variation in the use of these drugs. Aging leads to predictable yet clinically significant pharmacokinetic changes. Due to decreased gastric acidity and reduced gastrointestinal motility, the absorption of drugs may be delayed; however, the overall extent of absorption generally remains unchanged.

Changes in body composition—namely a reduction in lean body mass, an increase in adipose tissue, and a decrease in total body water—affect the volume of distribution of medications. As a result, hydrophilic antibiotics such as aminoglycosides may reach higher concentrations in plasma, increasing the risk of nephrotoxicity. In contrast, lipophilic agents, including macrolides and fluoroquinolones, tend to accumulate in adipose tissue, thereby prolonging their half-life. Renal elimination is particularly affected. After the age of 40, the glomerular filtration rate (GFR) declines by approximately 1% per year, and tubular secretion is also reduced. Since many antibacterial agents—including beta-lactams, aminoglycosides, and fluoroquinolones—are excreted via the kidneys, dosage adjustment should be based on creatinine clearance rather than serum creatinine levels alone. Hepatic metabolism is likewise diminished due to a reduction in liver mass and decreased activity of

cytochrome P450 enzymes, which affects the clearance of macrolides, tetracyclines, and certain cephalosporins. These pharmacokinetic changes necessitate dose reduction and/or extension of dosing intervals to prevent drug accumulation and minimize toxicity [2]. From a pharmacodynamic perspective, decreased receptor sensitivity and altered tissue perfusion in elderly patients can affect the delivery of antibiotics to the site of infection. Additionally, the decline in immune function (immunosenescence) reduces the body's ability to control infections, often necessitating longer treatment durations or higher antibiotic concentrations. However, this approach paradoxically increases the risk of adverse effects.

Analysis and Discussion. Bronchodilators act by relaxing bronchial smooth muscle, thereby widening the airways. They are classified into several groups: β2-adrenomimetics (such as salbutamol and formoterol), anticholinergic agents (e.g., ipratropium bromide), and methylxanthines (e.g., theophylline). In contrast, long-acting beta-2 agonists (LABAs), including formoterol and salmeterol, provide bronchodilatory effects lasting at least 12 hours. Their distinct pharmacological properties make them suitable for maintenance (controller) therapy; however, they should never be used as monotherapy, as LABA use alone is associated with an increased risk of asthma-related complications. Clinical guidelines from well-established healthcare systems—such as the UK's NICE, the United States' NHLBI, and European ERS/ATS—strongly recommend the use of LABAs in combination with inhaled glucocorticosteroids (ICS). This approach reduces airway inflammation and helps prevent the development of tolerance [3]. Furthermore, in countries such as Germany and Canada, the use of fixed-dose ICS/LABA combinations has significantly reduced hospitalization rates and exacerbations, highlighting the importance of evidence-based treatment strategies [4]. Methylxanthines, particularly theophylline, represent an older class of bronchodilators but remain clinically relevant in resource-limited settings. Their bronchodilatory effect is mediated through inhibition of phosphodiesterase enzymes and blockade of adenosine receptors. However, due to their narrow therapeutic index, regular monitoring of serum concentrations is required. Clinical data indicate that theophylline enhances diaphragmatic contractility and improves mucociliary clearance; nevertheless, its adverse effects—such as tachycardia, arrhythmias, seizures, and gastrointestinal disturbances—necessitate cautious use and individualized dosing [6].

Age-related characteristics are particularly important. In children, the bronchial tree is narrower and more reactive. Due to the incomplete development of enzymatic systems, drugs may undergo more rapid metabolism, and the risk of adverse effects is higher; therefore, inhalational forms are generally preferred. β2-adrenomimetics are among the most commonly used agents in pediatric patients due to their rapid onset of action. An often underappreciated aspect

in children under three years of age is their unique pharmacokinetic and pharmacodynamic profile. Infants and toddlers exhibit significant physiological differences compared to older children and adults—including immature hepatic metabolism, variability in airway receptor expression, and increased lung elasticity—all of which can influence drug absorption, distribution, and overall therapeutic response. These differences may result in subtherapeutic effects or, conversely, an increased risk of systemic reactions even when standard pediatric doses are administered. For example, the insufficient development of β_2-adrenoceptors in peripheral airways may partly explain the limited bronchodilatory response observed in some infants despite appropriate dosing. Therefore, drug selection and dose adjustment in this age group require special caution and careful clinical evaluation [2]. At the same time, dosing must always be approached cautiously. In adults, anatomical, morphological, and physiological characteristics of the bronchi differ significantly from those in children. Drug absorption and distribution are relatively stable in adults; combination therapy is widely used, long-acting bronchodilators are effective, and individualized dosing remains essential. In elderly patients, hepatic and renal functions decline, leading to slower drug elimination and an increased risk of accumulation. Cardiovascular adverse effects are also more common in this group; therefore, the use of the minimum effective dose is recommended.

Role of Antibacterial Agents. Bronchial asthma itself is not an infectious disease; however, antibiotics are indicated when a bacterial infection is present. In pediatric patients, antibiotics should be used only when clearly necessary due to the high risk of dysbiosis; penicillins and macrolides are generally preferred. In adults, antibiotic selection is guided by clinical signs of infection, with broad-spectrum agents often being used. In elderly patients, renal function must be carefully considered, doses should be adjusted accordingly, and the risk of drug–drug interactions is significantly higher.

Results. The analysis demonstrated that bronchodilators constitute a core component of bronchial asthma management, while age-related pharmacokinetic changes play a crucial role in drug selection. Antibiotics should be used only when a bacterial infection is present. An individualized approach significantly improves treatment outcomes. Clinical practice also requires careful assessment of the compatibility between the medication and the inhalation device, as incorrect inhalation technique is one of the leading causes of reduced treatment efficacy worldwide. When bronchodilators are used as part of a broader asthma management strategy—particularly in children with recurrent wheezing episodes, growth retardation, or a history of hospitalization—pediatric asthma specialists may introduce maintenance therapy based on inhaled glucocorticosteroids (ICS) alongside intermittent bronchodilator use. However, such an approach should only be applied in clearly confirmed cases and

is not recommended without comprehensive diagnostic evaluation and regular follow-up [1]. Studies conducted in the United Kingdom, Germany, and Japan indicate that up to 60% of patients with bronchial asthma use inhalers incorrectly, which reduces drug delivery to the lower airways. Therefore, a rational pharmacological approach should include systematic patient education, practical demonstration of proper inhalation technique, regular reassessment, and selection of a device appropriate to the patient's age, motor skills, and cognitive abilities. This is particularly important in elderly patients and children, in whom coordination difficulties may necessitate the use of spacers or nebulizer therapy [3].

Conclusion. Bronchodilator medications play a central role in the management of bronchial asthma; however, their clinical and pharmacological use requires precision, continuous monitoring, and individualized planning. Evidence-based approaches emphasize that short-acting beta-agonists (SABAs) should be used only for rapid symptom relief, while preference in maintenance therapy should be given to combinations of inhaled glucocorticosteroids (ICS) and long-acting beta-agonists (LABAs). When necessary, anticholinergic agents may be added, whereas methylxanthines should be used cautiously due to their narrow therapeutic index. In pediatric practice—especially in children under three years of age—the effective use of bronchodilators requires careful, evidence-based decision-making. Although short-acting beta-agonists may be beneficial in selected clinical situations, their routine use in viral wheezing or bronchiolitis is not supported by current scientific evidence. In this age group, key principles include accurate diagnosis, short-term therapeutic trials, parental education, and avoidance of unnecessary polypharmacy to minimize risks and maximize benefits. As research continues to evolve, adherence to updated clinical guidelines will help ensure the responsible use of bronchodilators in this vulnerable population. International experience demonstrates that combination therapies, proper inhalation techniques, and consideration of pharmacogenetic factors significantly improve treatment outcomes. A rational approach—integrating drug mechanisms of action, individual patient characteristics, safety monitoring, and treatment adherence—contributes to optimal asthma control and reduces the risk of exacerbations..

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