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# NEBULIZER THERAPY IN THE EXACERBATION PHASE OF BRONCHIAL ASTHMA IN CHILDREN

## (Review literature)

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***Annotation:*** *Bronchial asthma (BA) is a disease that develops on the basis of chronic allergic inflammation of the bronchi, their hyperreactivity and is characterized by periodically occurring attacks of difficulty breathing or suffocation as a result of widespread bronchial obstruction. Exacerbations of BA are the leading cause of calls to emergency teams and hospitalization of children.*

### Clinical picture and severity assessment

An exacerbation of the disease may occur as an acute attack or a protracted state of bronchial obstruction. An attack of bronchial asthma is an acutely developed and/or progressively worsening expiratory suffocation, difficult and/or wheezing breathing, spasmodic cough or a combination of these symptoms with a sharp decrease in the peak expiratory flow rate. The introduction of b $_2$ -agonists through a nebulizer allows for the rapid relief of an attack of bronchial asthma.

An exacerbation in the form of a protracted state of bronchial obstruction is characterized by prolonged (days, weeks, months) difficulty breathing, with a clinically expressed syndrome of bronchial obstruction, against the background of which acute attacks of bronchial asthma of varying severity may recur.

Acute asthma attacks are classified as mild, moderate, and severe based on clinical symptoms and a number of functional parameters. The severity of asthma and the severity of attacks are different concepts, although they are certainly related. Mild asthma includes mild and moderate attacks, while moderate and severe asthma

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includes mild, moderate, and severe attacks. If at least one criterion of a more severe degree is present, the attack is considered more severe.

**Treatment**

The development of severe symptoms of respiratory failure due to obstruction, especially in young children, requires the use of fast-acting, effective measures. Parents usually seek emergency care, and children are often hospitalized. In children of the first years of life suffering from bronchial asthma, up to 4-5 hospitalizations per year are observed.

However, to date, various medical institutions have used a wide variety of methods and medications, which are not always effective in acute attacks; intramuscular or intravenous administration of euphyllin is often used.

**The concept of nebulizer therapy**

**In recent years,** nebulizer therapy has become increasingly widespread for the treatment of asthma attacks [1, 2, 3]. The recommendations of the International Pediatric Asthma Group note the need to use nebulizers with an air compressor in children of the first years of life, as well as in children who cannot use any other system, and in young children with an exacerbation of asthma [4]. Nebulizer therapy as an alternative method of delivering drugs to young children is given an important place in the National Program for the Treatment and Prevention of Bronchial Asthma in Children.

**A nebulizer** is an inhalation device for spraying an aerosol with particularly fine particles. The word (nebulizer) comes from the Latin ( nebula ) - fog.

**The purpose of nebulizer therapy** is to deliver a therapeutic dose of a drug in aerosol form in a short period of time. The basis for using nebulizer therapy in children with severe obstruction is the ability to achieve the peak of the dose curve faster than with other methods and methods of administration. Continuous drug delivery for several minutes allows for a rapid creation of a high concentration of the drug in the lungs without increasing side effects. Accordingly, effective bronchodilation is achieved , the need for hospitalization disappears or the duration of hospital stay is reduced. In pediatrics, nebulizer therapy occupies a special place

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due to its non-invasiveness , the possibility of using inhalation from the first months of life. The procedure is easy to perform regardless of age, since there is no need to coordinate breathing with the intake of aerosol. Inhalations of bronchodilators through a nebulizer can be repeated 3 times during the first hour.

Experimental data indicate that aerosol particles smaller than 4.7 nm are most likely to settle in small bronchi and alveoli. As the particle size increases (4.7-10 nm), the probability of their settling in the bronchi, trachea and oropharynx increases [5, 6]. Particles with sizes in the range of 2-5 nm are optimal for getting into small bronchi and lung parenchyma [7].

General principles of therapy for asthma attacks

It is fundamentally important to recognize early symptoms of asthma exacerbation, test the function of external respiration using a peak flow meter . PEF is an objective criterion for the effectiveness of therapy. If possible, pulse oximetry is performed, blood gases are examined.

Removal of causative allergens or trigger factors. Clarification of previously administered treatment:

a) number of doses of bronchodilator , route of administration;
b) time elapsed since the last administration of bronchodilator ;
c) whether corticosteroids were used, in what doses. As early as possible, initiation of emergency therapy, the volume of which depends on the severity of the attack, timely administration of corticosteroids. In the course of therapy and observation, the severity can be revised. Observe the child for at least 1-2 hours. Monitoring clinical symptoms and PEF.

Teaching the child and/or parents how to use a nebulizer and inhaler.

**Types of nebulizers**

The most widely used are continuous action nebulizers (e.g. PARI jet ), which use a compressor for spraying. Modern nebulizers use the Venturi effect, when the air pressure drops as the air flow speed increases in the narrow nozzle area. As a result of this effect, the liquid is sucked out of the nebulizer chamber, forming a cone-shaped stream of polydisperse aerosol.

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When choosing a nebulizer, it is necessary to know the data on the air flow rate, residual volume, volume of aerosol obtained in 5 and 10 minutes, the proportion of particles smaller than 5 nm. The inhalable fraction of aerosol (the mass of particles entering the lungs from the total product) should be at least 50%. In ***nebulizers with an open hole,*** an additional volume of air enters the chamber, which, when inhaled, brings a greater number of small aerosol particles per unit of time, which reduces the inhalation time. In these constantly open nebulizers, about 50% of the aerosol is lost during exhalation. Some nebulizers have ***a manual interrupter*** and inhalation is done only on inhalation. With such intermittent inhalation, drug losses are reduced, but this technique requires coordination and increases the duration of inhalation. The combination of the convenience of prolonged inhalation and the effectiveness of intermittent Nebulization was developed in the Pari (Germany) and Medic-Aid (Great Britain) nebulizers. In the Pari nebulizers there is ***a valve*** that opens during inhalation, and additional external air, passing through the nebulizer, brings a greater number of particles into the inhaled air flow. During exhalation, the valve closes, the air flow through the chamber decreases, as a result, losses during exhalation are reduced, since air comes out only through one valve located near the mouthpiece.

Most devices used in children are designed for adults and often do not take into account the specific requirements of pediatric practice. Young children are characterized by shallow breathing, small vital capacity, and low expiratory flow rate. During inhalation, children breathe in almost pure aerosol. As the child grows, the peak inhalation flow rate exceeds the aerosol production in the nebulizer and children begin to inhale a mixture of aerosol and ambient air, just like adults. Breathing through the nose reduces the intake of aerosol. However, in children this fact is insignificant, since the upper respiratory tract of infants is larger in relation to body size than in adults, and there are no hairs in the nose. It is very important to use a tightly fitting mask of the appropriate size. In children over 3 years of age, preference is given to inhalation through the mouth, with the child breathing through a mouthpiece.

For effective inhalation, starting from the first months of life, the continuous action nebulizer model Pari Junior Boy has been developed , adapted for low breathing volumes of children and adolescents. Older children and adolescents can also use a nebulizer with an interrupter.

**General approach to nebulizer therapy**

bronchodilators via nebulizer are the first line of therapy for patients hospitalized for asthma exacerbation [8]. During an attack, the inspiratory flow may be too low to inhale an adequate dose from a metered-dose inhaler. In these cases, nebulizer therapy is effective. Treatment is usually carried out with the same drug that the patient received at home, for example, the $b_2$-agonist salbutamol . The reason for this is that the first dose via nebulizer is significantly higher than that received at home by the patient using a metered-dose inhaler, and the resulting concentration of bronchodilator in the lungs with nebulizer administration is significantly higher. Typically, the initial dose of salbutamol is 2.5 mg, while from a metered-dose inhaler the patient receives 0.1 mg. Frequent, repeated administration of $b_2$-agonists via nebulizer is used to treat asthma exacerbations. Frequent inhalations (every 20 min) through a nebulizer lead to a gradual increase in FEV1 $_{and}$ are more effective than low doses [4, 9].

**Bronchospasmolytic drugs for nebulizer therapy**

Salbutamol sulfate is a selective b2-adrenoreceptor antagonist . Plastic ampoules of 2.5 ml contain 2.5 mg of salbutamol . It is used undiluted. If long-term use for more than 10 minutes is necessary, salbutamol can be diluted with sterile saline. For a mild attack, salbutamol is prescribed at a dose of 0.1 mg / kg (minimum dose 1.25 mg). For moderate and severe attacks, a single dose is 0.15 mg / kg (no more than 5 mg).

**Fenoterol hydrobromide** is a selective $b_2$-agonist. 1 ml of solution (20 drops) contains 1 mg of the active substance. For children under 6 years of age (body weight up to 22 kg), fenoterol is prescribed at a dose of 50 mcg per 1 kg of body weight per inhalation, which is 5-20 drops (0.25-1 mg). Physiological solution is poured into the nebulizer chamber and the appropriate dose of fenoterol is added.

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**Ipratropium bromide** is an M- cholinergic receptor blocker, 1 ml (20 drops) contains 250 mcg of ipratropium . The dose of ipratropium bromide in children under one year of age is 125 mcg (10 drops), over one year - 250 mg (20 drops) per inhalation. Ipratropium bromide is used in children with broncho-obstruction , both independently for mild obstruction and in combination with b2 ₋agonists for moderate or severe attacks, enhancing the effect of sympathomimetics [8]. During the first hour, a dose of 250 mcg can be repeated three times, and then after 4-6 hours. The use of high doses of salbutamol and ipratropium bromide in severe asthma in children has proven to be more effective and safer than salbutamol alone [9]. The combination drug **berodual ,** 1 ml contains 500 mcg fenoterol hydrobromide and 250 mcg ipratropium bromide. The combination of b $_2$ -agonist, which has a rapid effect after (5-15 min), and ipratropium bromide with a maximum effect after 30-90 min allows for a rapid and prolonged effect, exceeding the effect of single-component drugs [10]. For children under 6 years of age (less than 22 kg), 25 mcg ipratropium bromide and 50 mcg fenoterol (2 drops) per 1 kg of body weight are recommended. For children over 6 years of age, 0.5-1 ml (10-20 drops) is used per inhalation, which in most cases is sufficient to improve the condition.

**Nebulizer therapy tactics**

In case of a mild attack, as a rule, a single inhalation of a bronchodilator through a nebulizer is sufficient; if necessary, the inhalation is repeated after 4-6 hours. In case of moderate and severe attacks, inhalations are repeated every 20 minutes (3 doses) for an hour, then every 4-6 hours. The positive effect of the inhalation is a decrease in shortness of breath and the involvement of additional respiratory muscles, a decrease in the respiratory rate, distant wheezing, and restoration of normal activity.

If there is no improvement within 4 hours or the condition worsens, hospitalization is necessary. When using bronchospasmolytic therapy at home, parents should be warned that if the effect of the usual dose becomes less effective or shorter-lasting, the dose and frequency of drug administration should not be increased independently, but a doctor should be consulted immediately. An increased need for inhaled b $_2$ -agonists indicates a worsening of the condition. Very high doses of b $_2$ -

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agonists can lead to the development of adverse reactions, so the question of increasing the frequency and dose of drug administration is decided by the doctor. Particular caution is recommended in the treatment of severe asthma attacks, when a combination of hypoxia and therapy with methylxanthines , glucocorticosteroids can lead to hypokalemia .

bronchodilators are insufficient in their effect in patients with a moderate attack, ***systemic glucocorticosteroids*** are added to the therapy parenterally or orally. In children with a severe attack, glucocorticosteroids are administered simultaneously with bronchodilators at a dose equivalent to 1-2 mg/kg of prednisolone. If the effect is insufficient, methylxanthines are administered intravenously , although a number of studies have shown that the addition of aminophylline has no advantages over increasing the dose of the b-agonist.

**Technique of inhalation through a nebulizer**

To carry out inhalation through a nebulizer, the total volume of the sprayed drug should be 2-3 ml, therefore, initially, a saline solution is poured into the nebulizer chamber, and then the required dose of bronchodilator is added .

Preference is given to inhalation through the mouth, with the child breathing through a mouthpiece; in children of the first years of life, a specially selected tight-fitting mask can be used. The duration of inhalation is 5-10 minutes (until the drug spraying stops completely). Before inhalation, it is necessary to wash your hands thoroughly with soap, since the skin always contains microorganisms, assemble the nebulizer and attach the mouthpiece or mask. The pharmacy packaging with the drug should be stored in the refrigerator in a tightly closed package. The drug is used for 2 weeks after the package has been opened. It is desirable that the child be calm during inhalation, although the effect of the child's scream on the aerosol penetration is unknown. Older children are seated in a comfortable position, the muscles should be relaxed. The mouthpiece is tightly grasped by the lips. After each deep breath, the breath is held for a while, then a deep and full exhalation follows.

After each use, the nebulizer must be disconnected from the compressor and disassembled. Remove any remaining medication. Wash all parts that were in contact

with the patient or the medication with hot water. Disinfection is carried out at home twice a week by boiling, in a hospital - in accordance with hygiene requirements. Before use, all parts of the nebulizer must be dry. To do this, wipe them after washing with a soft, lint-free cloth. You can use warm air from a hair dryer for drying, especially if frequent inhalations are carried out with a short break.

**Tactics after liquidation acute attack**

After the acute condition has been eliminated, the child is monitored, peak expiratory flow rate is monitored using a peak flow meter , pulse oximetry is performed in hospital , and blood gases are determined. Bronchospasmolytic therapy is performed every 4-6 hours of wakefulness for 3-5 days. After a mild attack, b2 -agonists are prescribed in the form of a metered-dose aerosol or enterally ; in moderate or severe attacks, inhalation nebulizer therapy is preferable, with a switch to prolonged bronchodilators (b2 ₋agonists, methylxanthines ).

Bronchospasmolytics are not the only and main direction of therapy for exacerbation of bronchial asthma. Consistently conducted basic anti-inflammatory therapy ( sodium nedocromil , sodium cromoglycate , inhaled steroids) allows to reduce the frequency of exacerbations and their severity. The dose of anti-inflammatory drugs can be increased by 1.5-2 times for 7-10 days. It is very important to give parents written recommendations on what to do during an attack of bronchial asthma.

Portability and ease of use allow the nebulizer to be used in outpatient and inpatient settings, as well as at home. Early initiation of therapy and training parents in the use of the nebulizer prevents the development of severe bronchial obstruction in many cases and reduces the stressful impact of the disease on the child and parents.

The development of nebulizer therapy, its introduction into the practice of emergency care for children in domestic pediatrics will allow providing effective, qualified care already at the outpatient stage, reducing the duration and frequency of hospitalizations of children with bronchial asthma, especially at an early age, and reducing the need for parenteral administration of drugs. All this contributes to the rapid achievement of therapy results, reducing the length of a child's stay in hospital.

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