Abstract. – Background and Objective: Asthma is one of the most common chronic diseases, leading to an increased rate of hospitalization.

Material and Methods: The aim of this report is to review the current concepts and treatment of asthmatic children, focusing our attention on the treatment of children in a Department of Pediatric Emergency.

Discussion: Frequent respiratory infections, personal or familial allergy, disease severity and young age are important factors leading to hospitalization. However, regular clinical follow-up and use of inhaled corticosteroids, the IgE levels and O2 saturation may reduce the probability of hospitalization during asthma attacks. The diagnosis of asthma in children is based on recognizing a characteristic pattern of episodic respiratory symptoms and signs, in the absence of an alternative explanation for them. The presence of these factors increases the probability that a child with respiratory symptoms will have asthma. These factors include age at presentation; sex; severity and frequency of previous wheezing episodes; coexistence of atopic disease; family history of atopy; and abnormal lung function.

Conclusion: Asthma is a chronic condition that often remains uncontrolled for reasons that may be related to the disease process itself, the management decisions of clinicians, the patient’s perceptions of disease control or self-management behaviors, the cost of medications, or a combination of all of these factors. To this end, patients with asthma should be educated not to accept a certain level of symptoms or activity limitations as an inevitable consequence of asthma. Both the levels of current impairment and the future risks (of asthma exacerbations or adverse medication effects) should be used to inform decisions about appropriate levels of asthma therapy, and physicians should be aware of the new medication recommendations.

Key Words: Asthma, Childhood, Emergency, Treatment.

Introduction

Asthma is one of the most common chronic diseases, leading to an increased rate of hospitalization. Frequent respiratory infections, personal or familial allergy, disease severity and young age are important factors leading to hospitalization. However, regular clinical follow-up and use of inhaled corticosteroids, the IgE levels and O2 saturation may reduce the probability of hospitalization during asthma attacks. The aim of this report is to review the current concepts and treatment of asthmatic children, focusing our attention on the treatment of children in a Department of Pediatric Emergency.

A correct diagnosis of asthma is the first step toward attaining disease control. In general, a diagnosis of asthma is established if episodic symptoms of airflow obstruction or airway hyper-responsiveness are present, airflow obstruction is at least partially reversible, and alternative diagnoses are excluded. The guidelines recommend the use of a detailed medical history, the results of a physical examination (focusing on the upper respiratory tract, chest, and skin), and the results of spirometry (for patients aged 5 years or older) in making the diagnosis. Particularly important factors that should be addressed as part of the medical history include the frequency of symptoms (eg, perennial, seasonal, or both; continual, episodic, or both; diurnal variations), precipitating factors (such as the presence of allergic triggers), and a family history of asthma, allergy, or other atopic disorders. Although recurrent cough and wheezing often result from asthma, other causes of airway obstruction should be considered in the initial diagnosis, or if the patient does not respond to initial therapy. Several other conditions may coexist, or complicate the diagnosis or management of asthma. The diagnosis of asthma is confirmed by a positive
response to asthma medication, and treatment should follow the usual stepwise approach to asthma management1-6,9,10.

The diagnosis of asthma in children is based on recognizing a characteristic pattern of episodic respiratory symptoms and signs (Table I) in the absence of an alternative explanation for them (Tables II and III).

The presence of these factors increases the probability that a child with respiratory symptoms will have asthma. These factors include age at presentation; sex; severity and frequency of previous wheezing episodes; coexistence of atopic disease; family history of atopy; and abnormal lung function.

Once the diagnosis has been established, the focus is on classifying to the severity of asthma so that therapy can be initiated, and on monitoring control over time so that therapy can be adjusted. According to the new guidelines, severity and control should be assessed separately, but both are classified on the basis of the domains of current impairment and future risk. Impairment is defined as “the frequency and intensity of symptoms and functional limitations the patient is experiencing currently or has recently experienced,” whereas risk is defined as “the likelihood of either asthma exacerbations, progressive decline in lung function (or, for children, lung growth), or risk of adverse effects from medication”11-15. In assessing impairment, asthma severity should be evaluated using the following categories:

- Intermittent asthma severity
- Persistent asthma severity (mild, moderate, severe).

### Clinical Assessment

Before starting treatment for acute asthma in any setting, it is essential to assess accurately the severity of their symptoms. The following clinical signs should be recorded:

- Pulse rate
- Respiratory rate and degree of breathlessness
- Use of accessory muscles of respiration
- Amount of wheezing
- Degree of agitation and conscious level

Clinical signs do not always correlate with the severity of airways obstruction. Some children with acute severe asthma do not appear distressed.

**Pulse oximetry**: accurate measurements of oxygen saturation are essential in the assessment of all children with acute wheezing.

Consider intensive inpatient treatment for children with SpO2 <92% in air after initial bronchodilator treatment.

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**Table I.** Clinical features that increase the probability of asthma.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Age Group</th>
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<tr>
<td>&gt; 12 months</td>
<td>&lt;50-60</td>
</tr>
<tr>
<td>1-5 years</td>
<td>&lt;40</td>
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<tr>
<td>&gt; 6 years</td>
<td>&lt;30</td>
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**Table II.** Clinical features that lower the probability of asthma.

- Symptoms with colds only, with no interval symptoms
- Isolated cough in the absence of wheezing or difficulty breathing
- History of moist cough
- Prominent dizziness, light-headedness, peripheral tingling
- No response to a trial of asthma therapy

**Table III.** Value of respiratory and cardiac rate in acute asthma.

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<tbody>
<tr>
<td>&lt; 12 months</td>
<td>&lt;50-60</td>
<td>&lt;160</td>
<td>&gt;50-60</td>
<td>&gt;160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5 years</td>
<td>&lt;40</td>
<td>&lt;120</td>
<td>&gt;40</td>
<td>&gt;120</td>
<td>&gt;50</td>
<td>&gt;140</td>
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<tr>
<td>&gt; 6 years</td>
<td>&lt;30</td>
<td>&lt;110</td>
<td>&gt;30</td>
<td>&gt;110</td>
<td>&gt;40</td>
<td>&gt;120</td>
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</table>
PEF: a measurement of <50% predicted PEF or forced expiratory volume (FEV), with poor improvement after initial bronchodilator treatment is predictive of a more prolonged asthma attack.

Chest X-ray: A chest X-ray should be performed if there is subcutaneous emphysema, persisting unilateral signs suggesting pneumothorax, lobar collapse or consolidation and/or life threatening asthma not responding to treatment.

Blood gases: Blood gas measurements should be considered if there are threatening features not responding to treatment. Normal or raised pCO₂ levels are indicative of worsening asthma. A more easily obtained free-flowing venous blood pCO₂ measurement <45 mmHg excludes hypercapnia.

Treatment of Acute Asthma in Children Aged Over 2 years

There is good evidence supporting recommendations for the initial treatment of acute asthma presenting to primary and secondary healthcare resources. There is less evidence to guide the use of second line therapies to treat the small number of severe cases poorly responsive to first line measures. Despite this, the risk of death and other adverse outcomes after admission to hospital are extremely small irrespective of the treatment options chosen.

Children with severe or life threatening asthma should be transferred to Hospital urgently¹-²⁰.

Oxygen
Children with life threatening asthma or SpO₂ <94% should receive high flow oxygen via a tight fitting face mask or nasal cannula at sufficient flow rates to achieve normal saturations.

Inhaled β₂-Agonists (Salbutamol/Terbutaline)
Inhaled β₂-agonists are the first line treatment for acute asthma. Children receiving a β₂-agonist via pressurized metered dose inhaled (pMDI) + spacer are less likely to have tachycardia and hypoxia than the same drug given via a nebulizer.

Children with severe or life threatening asthma (SpO₂ <92%) should receive frequent doses of nebulised bronchodilators driven by oxygen (2.5-5 mg salbutamol or 5-10 mg terbutaline), although children with mild symptoms can benefit from lower doses.

Doses can be repeated every 20-30 min. Continuous nebulised β₂-agonists are of no greater benefit than the use of frequent intermittent doses at the same total hourly dosage. If there is poor response to the initial dose of β₂-agonists, subsequent doses should be given in combination with nebulised ipratropium bromide.

Ipratropium Bromide
There is good evidence for the safety and efficacy of frequent doses of ipratropium bromide (every 20-30 min) used in addition to β₂-agonists for the first 2 hours of a severe asthma attack. Benefits are more apparent in the most severe patients. Frequent doses up to every 20-30 minutes (250 μg/dose mixed with 5 mg of salbutamol solution in the same nebulizer) should be used for the first few hours of admission. The salbutamol dose should be reduced to one to two hourly thereafter, according to the clinical response. The ipratropium dose should be reduced to four to six hourly or discontinued.

Steroid Therapy

Steroid Tables
The early use of steroids in Emergency Departments and assessment units reduce the need for Hospital admission and prevent relapse in symptoms after initial presentation. Benefits can be apparent within 3 or 4 hours.

Give prednisone early in the treatment of acute asthma attacks. Use a dose of 1-2 mg/kg/day (max 40 mg/dose) 2 to 3 times. Betamethasone 0.1-0.2 mg/kg/day (max 4 mg/dose), in 2 to 3 administrations. Intravenous administration of 1-2 mg/kg/6-8 hours (max 40 mg dose).

Oral and intravenous steroids are of similar efficacy²¹. Intravenous hydrocortisone (5-10 mg/kg/6-8 h; 4 mg/kg repeated every 4 hours should be reserved for severely affected children who are unable to retain oral medication.

Treatment for up to 3 days is usually sufficient, but the length of course should be tailored to the number of days necessary to bring about recovery. Weaning is unnecessary unless the course of steroids exceeds 14 days.

Formulations such as hydrocortisone and methylprednisolone can be given parenterally. Studies have found these routes to be equally effective, with the oral route being less painful and invasive²¹.²³. Prednisone is given for 5 days at a dose of 1 to 2 mg/kg daily (maximum 50
mg/dose). Dexamethasone can be given for 1 to 5 days at a dose ranging from 0.3 to 0.6 mg/kg daily. Dexamethasone is a long-acting glucocorticoid with a half-life of 36 to 72 hours, and is 6 times more potent than prednisone. Prednisone is shorter acting, with a half-life of 18 to 36 hours.

In our practice in the Department of Pediatric Emergency we are accustomed to seeing 18% to 20% of our patients with different degrees of asthmatic attack. After therapy almost 90-95% of them return home and 5% of the patients need hospitalization.

**Leukotriene Receptor Antagonists**

There is no clear evidence to support the use of leukotriene receptor antagonists for moderate to severe acute asthma in the Emergency Department. Leukotriene receptor antagonists is important as a chronic support therapy, but not in an acute attack. At the moment we do not have sufficient data to determine if this drug could be used during the acute follow-up phase with some dosing modifications. The use of these treatments is beyond the scope of our review.

**Second Line Treatment of Acute Asthma in Children Aged Over 2 Years**

Children with continuing severe asthma despite frequent nebulised β₂-agonists and ipratropium bromide plus oral steroids, and those with life threatening features, need urgent review by a specialist with a view to transfer to a high dependency unit or paediatric Intensive Care Unit (ICU) to receive second line intravenous therapies. There are three options to consider: salbutamol, aminophylline and magnesium sulphate.

The early addition of a single bolus of intravenous salbutamol (5 μg/kg over 10 min) should be considered in severe cases where the patient has not responded to initial inhaled therapy.

Aminophylline is not recommended in children with mild to moderate acute asthma. Aminophylline should be considered for children with severe or life threatening bronchospasm unresponsive to maximal doses of bronchodilators plus steroids.

A 5 mg/kg loading dose should be given over 20 minutes with ECG monitoring, followed by a continuous infusion at 1 mg/kg/hour. Serum theophylline should be measured in patients already receiving oral treatment and in those receiving prolonged treatment.

Intravenous magnesium sulphate is a safe treatment for acute asthma, but its place in management is not yet established. Doses of up to 40 mg/kg/day (maximum 2 g) by slow infusion have been used. Studies of efficacy for severe childhood asthma unresponsive to more conventional therapies have been inconsistent. Children can be discharged when stable on 3-4 hourly inhaled bronchodilators. This treatment can be continued at home. PEF and/or FEV should be >75% of best of predicted, and SpO₂ >94%.

**Assessment of Acute Asthma in Children Aged Less Than 2 Years**

The assessment of acute asthma in early childhood can be difficult. Intermittent wheezing attacks are usually due to viral infection and response to asthma medication is inconsistent. Prematurity and low birth weight are risk factors for recurrent wheezing. The differential diagnosis of symptoms includes aspiration pneumonitis, pneumonia, bronchiolitis, tracheomalacia, and complications of underlying conditions, such as congenital anomalies and cystic fibrosis.

**Treatment of Acute Asthma in Children Aged Less Than 2 Years**

**β₂-Agonist Bronchodilators**

Inhaled β₂-agonists are the initial treatment of choice for acute asthma. Close fitting face masks are essential for optimal drug delivery. The dose received is increased if the child is breathing appropriately, and not taking large gasps because of distress and screaming.

There is good evidence that pMDI + spacer is as effective as, if not better than, nebulisers for treating mild to moderate asthma in children aged <2 years.

Oral β₂-agonists are not recommended for acute asthma in infants.

**Steroid Therapy**

Consider steroid tablets as early treatment of severe episodes of acute asthma in the hospital setting. Steroid tablet therapy (1-2 mg/kg of soluble prednisolone for up to 3 days) is the preferred steroid preparation for use in this age group.
Inhaled ipratropium bromide should be considered in combination with inhaled β₂-agonist for more severe symptoms.

Many children with recurrent episodes of viral-induced wheezing in infancy do not go on to have chronic atopic asthma. The majority do not require treatment with regular inhaled steroids. Parents should be advised about the relationship between cigarette smoke exposure and wheezy illnesses.

Parents of wheezy infants should receive appropriate discharge plans, along similar lines to those given for older children.

Figure 1 summarizes the therapy in an asthma attack. The use of other new medicaments like omalizumab monoclonal antibody seems to reduce the asthmatic attack in 50% of patients in the first year with a good tolerability in children 6-11 years old, but it is still controversial, and more studies are needed to better clarify the safety of this therapy. The use of these treatments is beyond the scope of our review.

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