Diagnostic Challenge in Asthma Attack Concurrent with the First Onset of Diabetic Ketoacidosis in a Pediatric Emergency Unit: A Case Report

KAI-WEI CHIEN¹, HAN-PING WU², WEN-LIANG CHEN¹, CHU-CHUNG CHOU¹, CHIN-FU CHANG¹

We reported on an 8-year-old girl with a history of asthma who presented with shortness of breath and dyspnea. An asthma attack was initially considered after the primary survey. However, it was subsequently determined that the asthma was an exacerbation that was concurrent with the first-onset of diabetic ketoacidosis (DKA). Rapid diagnosis of DKA is important in minimizing subsequent serious consequences and death. The use of glucometry for spot glucose determination aided in the diagnosis, and is of use in rapidly distinguishing DKA from other concurrent respiratory emergencies.

Key words: asthma, children, diabetic ketoacidosis

Introduction

Bronchial asthma is a common cause of respiratory distress in the pediatric emergency unit, affecting approximately 5 to 10% of the pediatric population (1,2). Clinical features include worsening dyspnea, cough, tachypnea, chest tightness, and wheezing over a period of hours to days (1,2). In the absence of appropriate treatment, these various respiratory manifestations can become exacerbated to the point of respiratory failure. Whereas some other extrathoracic causes may cause respiratory distress and lead to rapid exacerbation if delays in diagnosis occur. Among the causes of respiratory distress, diabetic ketoacidosis (DKA) is a less known and relatively uncommon condition in the emergency department (3-7). The condition arises from insulin deficiency (8-11), and manifests as hyperglycemia, dehydration, and metabolic acidosis (4). As we know, the appearance of DKA in children is typically associated with history of abdominal pain, hyperpenia, vomiting and body weight loss. However, the presenting clinical features can be misdiagnosed in the pediatric emergency unit. For example, abdominal pain may be misinterpreted as appendicitis, and hyperpnea may be mistaken for pneumonia or asthma (3). The concurrent development of DKA can further complicate diagnosis, to the point of death.

An asthma attack concurrent with the first-onset of DKA is quite rare and would be a high challenge for emergency physicians to make a definite diagnosis early. The present case report is intended to alert emergency physicians to the presentation of respiratory distress imposed by DKA and to highlight the challenges in differentiating concurrent airway or pulmonary diseases caused by the first-onset of DKA from asthma-related
respiratory distress in the pediatric emergency unit.

**Case Report**

The subject was an 8-year-old girl whose sole malady, prior to her admission, had been history of asthma. She came to the pediatric emergency unit at night complaining of shortness of breath, cough, and dyspnea since this morning. She had visited a local out-patient clinical for help but there was no relief of the symptoms. In our emergency department, she was agitated and looked ill. Examination results revealed blood pressure of 133/78 mmHg and body temperature of 36.2°C. She appeared hyperpenia and was slightly cyanotic. Her breathing was wheezy and abdominal examination results were unremarkable. No stiffness of the neck or local neurological signs was present. The patient was lucid and appropriately responsive to verbal commands.

Under the initial impression of an asthma attack, therapies initially consisted of inhalation with bricanyl (terbutaline sulfate turbuhaler in a nebulizer solution) and an intravenous combination of theophylline and methylprednisolone. According to the records of the hospital chart, these therapies were not very effective for controlling her asthma in previous visits to the pediatric emergency unit. Subsequently, an image study of a chest X-ray and routine laboratory analyses including a complete blood count (CBC) and white blood cell differential count (DC) were performed. The chest X-ray image seemed to show emphysemic changes and air trapping (Fig. 1). The CBC revealed a white blood cell count of 21500/mm³, red blood cell count of 5.29×10⁶/mm³, hemoglobin of 15.4 g/dL, and platelet count of 387000/mm³. In addition, the DC showed a neutrophil count of 81%, lymocyte count of 15%, monocyte count of 3%, and band count of 1% in proportion. After continuous inhalation and intravenous therapies, however, her respiratory distress was not able to be controlled. Tachypnea and wheezing persisted at approximately 60 beats per minute using the ventri mask with an oxygen level of 40%. Under the ventri mask with an oxygen level of 40%, arterial blood gas and acid-base results were also obtained. For the poor control of respiratory distress, clinically, we began looking for other causes that included respiratory distress coexistent with asthma.

The patient did not have history of diabetes mellitus (DM), and her parents did not either. We considered whether any other laboratory or imaging studies were able to aid us in the differential diagnosis of other respiratory distress conditions. In accordance with our experience, we first aimed to determine the blood glucose concentration using glucometry strips for excluding some metabolic or endocrine disorders, such as DKA. Then, we found that the levels exceeded the measurable capacity of the method. At the same time, the arterial blood gas analysis indicated the arterial partial pressure of oxygen (PaO₂) was 132 mmHg; arterial carbon dioxide tension (PaCO₂) was 13.2 mmHg; blood pH was 7.09; bicarbonate was 4.1 mol/L; and the base excess was -22.7. Therefore, the concurrent DKA was highly suggested. Furthermore, measurements of the urine analysis obtained by catheterization of the bladder showed that the glycosuria exceeding 1000 mg/dL and ketonuria of 3+. The definite serum glucose level measured by our emergency laboratory department showed 398 mg/dL, and serum ketone body was 40 mg/dL. As a result, the presumption of DKA was made.

In the pediatric emergency unit, immediate intravenous fluid hydration and alkalinization with sodium bicarbonate were administrated. With treatment, the condition of the patient’s respiratory distress improved gradually. Consequently the patient was transferred to the pediatric intensive care unit of our children’s hospital. Biochemical laboratory tests for DM were performed during the
following days and showed serum glycosylated hemoglobin of 12.4%. The results were consistent with the diagnosis of DM and ambulatory follow-up was recommended.

**Discussion**

To our knowledge, an asthma attack concurrent with the first-onset of DKA has been rarely reported. In this case, severe respiratory distress needed emergent management to prevent impending respiratory failure in the pediatric emergency unit. Asthma is a well-known cause leading to respiratory distress and the guidelines for treatment are clear to emergency physicians. Somehow, once the effects of treatment for asthma are unfavorable, additional causes that may coexist with the asthma are needed to be explored.

Endocrine conditions are not currently recognized in the pediatric emergency unit because the symptoms and signs of endocrinologic disease may be associated with a wide range of non-endocrinologic disease\(^{(3,6)}\). However, in order to achieve a favorable outcome, endocrinologic causes should be included in the differential diagnosis of ill patients, and appropriate testing should be performed. Severe ketoacidosis is a life-threatening complication of diabetes that occurs in 20 to 40% of newly diagnosed juvenile-onset diabetic patients. This malady accounts for 65% of all admissions of diabetic patients younger than 19 years\(^{(5)}\). Clinically, severe dehydration and acidosis are the serious immediate risks causing death and complications in children.

In our case report, the first point of interest is that it appeared difficult to differentiate symptoms of asthma with concurrent DKA initially for pediatric emergency physicians.
Diagnosis is particularly difficult upon the initial appearance of DKA in the absence of prior history of DM-related diseases. Therefore, the involvement of DKA may not be considered initially, and may contribute to severe complications, even death. Presently, inhalation therapy with the use of bronchodilators did not improve the patient’s shortness of breath or dyspnea. Early differential diagnosis is the best way to prevent clinical deterioration. However, prompt diagnosis depends on a detailed history, the collection of critical laboratory specimens, and the faculty pediatric emergency physicians’ experiences. The chest X-rays of the appearance of asthma may show emphysematous changes and air trapping. However, the chest X-rays of a patient with DKA with respiratory distress will show smaller lung capacity due to tachypnea and hyperventilation. If not for the prompt use of glucometry, misdiagnosis could well have occurred. The resulting delay in treatment could have had serious consequences including cerebral dysfunction leading to coma or death. Keeping in mind that a wide variety of endocrine/metabolic emergencies exist that may be isolated or concurrent with other illnesses, emotional stress, or noncompliance with medications, glucometry is a prudent course of action for clinicians.

Second, there was no obvious evidence from the present case to explain the relationship between asthma exacerbation and DKA. The mechanism of asthma exacerbation leading to the deterioration of DM is unclear, and this association has hitherto not been reported. It is the awareness of the association that we wish to emphasize without stressing the causal relationship. As little as 10% of DKA episodes may occur in patients with new-onset and insulin-dependent DM. In the emergency department, the primary emergency physician may be the first clinician to face an undiagnosed diabetic patient suffering from atypical symptoms and signs. In addition, delay in diagnosis may bring about severe complications, such as accompanying respiratory emergencies.

In conclusion, asthma attacks with concurrent first-onset of DKA are rare but critical. When confronted with an intractable asthma exacerbation in the pediatric emergency unit, prompt use of glucometry for determination of glucose concentration is beneficial. However, in the hospital, assessment of oxygen saturation and consideration of arterial blood gas measurements in patients with suggested hypoventilation, exhaustion, severe distress, or peak flow 30-50 percent predicted should be common practice.

References


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氣喘發作合併同時發生的首次發作糖尿病酮酸血症
對小兒急診醫師在診斷上的挑戰：一病例報告

簡凱偉¹ 吳漢屏² 陳文良¹
周志中¹ 張進富¹

一個8歲的小女孩因呼吸短促被送入小兒急診，經初步評估為氣喘發作。經治療後，呼吸窘迫的症
狀並沒有得到很好的改善，再追溯其病史並安排快速血糖的檢測，發現是氣喘合併首次發作的糖尿病酮
酸血症。若延誤治療或錯誤診斷將會造成嚴重的後果，甚至導致死亡的發生。因此，本文建議第一線的
臨床醫師應該將Dextrostix用來檢測血糖視為一個有用的鑑別診斷工具。

關鍵詞：氣喘，兒童，糖尿病酮酸中毒