

# Precipitating risk factors for diabetic ketoacidosis in children with type 1 diabetes mellitus

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(Ann. Coll. Med. Mosul 2005; 31(1): 27- 31)

Received: 12<sup>th</sup> Dec 2004 ; Accepted: 17<sup>th</sup> Jul 2005

## ABSTRACT

**Objective:** To determine the precipitating risk factors for diabetic ketoacidosis (DKA) from medical and social points of view as well as risk of prolonged hospital stay.

**Methods:** Forty-eight patients were admitted to Basrah Maternity and Child Hospital for DKA. Over a 2 years period; September 2001 through to September 2003. Patient's age, sex and family socioeconomic status were identified. Duration of hospital stay was examined, prolonged duration of stay was defined as  $\geq 7$  days.

**Results:** Forty eight patients with DKA, their ages ranged between 1 and 15 years, with a male to a female ratio 1.3:1.

More than half of the children (58.4%) were males and (60.5%) were from low social status. Poor compliance to continue the treatment and infections were the most common precipitating factors, being responsible for 54.2% and 25% of cases of DKA respectively.

Children with prolonged hospital stay were significantly found to be of younger age and of low socioeconomic status.

**Conclusions:** DKA is still a commonly seen complication; it can be the presenting feature of diabetes. Poor compliance and inadequate treatment are the leading precipitating factors in our patients.

## الخلاصة

**الهدف:** تعيين العوامل المسببة لحدوث الحمض الكيتوني السكري من الناحية الطبية والاجتماعية بالإضافة إلى معرفة مسببات طول فترة الرقود في المستشفى.

**الطريقة:** تمت دراسة 48 مريضاً ادخلوا إلى مستشفى البصرة للولادة والطفل خلال فترة عامين ما بين أيلول 2001 إلى أيلول 2003 دون خلالها أعمار وأجناس المرضى والحالة الاجتماعية للعائلة كما تم تحديد فترة الرقود في المستشفى وعرفت فترة الرقود الطويلة بـ 7 أيام أو أكثر.

**النتيجة:** 48 مريضاً لديهم ارتفاع الحمض الكيتوني السكري تتراوح أعمارهم ما بين 1-15 سنة. وكانت نسبة الذكور إلى الإناث 1.3:1 وان أكثر من نصف عدد الأطفال (58.4%) كانوا من الذكور وان (60.5%) كانوا من المستوى المعاشي الواطئ عدم المطاوعة في الاستمرار على العلاج وحالات الالتهابات كانت من المسببات الشائعة وبنسب (54.2%) و(25%) من الحالات المرضية على التوالي. الأطفال الذين رقدوا لفترة طويلة في المستشفى كانوا صغار العمر ومن العوائل ذات المستوى الاجتماعي الواطئ.

**الاستنتاج:** لانزال حالات ارتفاع الحمض الكيتوني السكري من الحالات الشائعة من مضاعفات داء السكري وقد تكون من العلامات الأولى للإصابة بهذا المرض. عدم المطاوعة وعدم كفاية العلاج هي من العوامل المميزة. تحسين مستوى العناية المعيشية ووضع المناهج التنقيفية هي من المهمات الأساسية للحد من ظاهرة عدم المطاوعة وحالات الحمض الكيتوني السكري.

Prior to the discovery of insulin in 1921, children with type 1 diabetes inevitably die of diabetic ketoacidosis (DKA). Despite major advances in the care of diabetes, DKA remains a leading cause of hospitalization and the leading cause of death and morbidity in children and adolescent with type 1 diabetes<sup>(1,2,3)</sup>. Unfortunately, there is no evidence of a decrease in case fatality below 1-2% achieved by the early 1970s, despite improvement in fluid and insulin therapy and more careful monitoring<sup>(4,5)</sup>. Between 20% and 30% of cases occur in patients with newly diagnosed diabetes, while the incidence among known diabetics is between 3 and 8 episodes per 1000 patients per year<sup>(5,6,7)</sup>. Recurrent DKA in established patient had been reduced in frequency by the intervention of multidisciplinary teams<sup>4,5</sup>. Thus, a major goal of diabetes management is to prevent DKA and its complication by a high index of suspicion with early symptoms of diabetes and close supervision of established patients. Correction of ketoacidosis is the primary concern with DKA, but good management requires yet other steps. Once the patient's condition is stable, a search should be made for precipitating causes; so recurrence can be avoided<sup>(8)</sup>. In developed countries, the precipitating factors are well known, but information on these from developing countries has been generally poor<sup>(9)</sup>. Social class, cultural and economic statuses are important precipitating factors adversely affecting DKA<sup>(9,10)</sup>.

The **Aim of this study** was to determine the precipitating factors from medical and social points of view as well as the risk of prolonged hospital stay.

## PATIENTS AND METHODS

All patients admitted to Basrah Maternity and Childhood hospital with the diagnosis of diabetic ketoacidosis (DKA), over a 2 years period; September 2001 through to September 2003, were included in the study. The diagnosis of DKA was established on the following criteria; hyperglycemia (>12mmol/L), ketonuria, dehydration with metabolic acidosis and concurrent symptoms consistent with DKA such as polyuria, polydipsia, vomiting, abdominal pain and rapid breathing<sup>(4,5)</sup>.

Their clinical presentation, laboratory parameters, and mode of therapy with final outcome were compiled and evaluated. The mean precipitating factors for DKA were determined including data regarding social history and status of diabetic education from well written records<sup>(9,10,11)</sup>. The children were classified into Low (n=29) and Middle (n=19) socioeconomic status according to the occupation and educational level of the head of the household, who was usually the father<sup>(12)</sup>. The unemployed fathers with primary school education were considered to be of low socioeconomic status while those employed with secondary school education were considered as of middle socioeconomic status. Prolonged hospital stay was defined as duration of hospital stay  $\geq 7$  days<sup>13</sup>. All patients were admitted to the emergency department and standard treatments of DKA were followed. This included intravenous fluid, intravenous regular insulin and antibiotics whenever indicated.

Statistical analysis was carried out. To find the significance of the differences between proportions Chi-square test<sup>14</sup> was used. Results were considered significant if the P value is < 0.05.

**Table(1): Patients Characteristics (No.=48).**

Characteristic	No.	(%)
Age in years		
≤10	22	(45.8)
>10	26	(54.2)
Sex		
Male	28	(58.4)
Female	20	(41.6)
Socioeconomic status	19	(39.5)
Middle	29	(60.5)
Low		
Known cases of DM*	38	(79.2)
First presentation of DM	10	(20.8)
No° of DKA° episodes		
1	32	(66.7)
≥2	16	(33.3)

\*DM=Diabetes Mellitus, ° No.=Number, ° DKA=Diabetic ketoacidosis

**Table(2): Precipitating factors in diabetic ketoacidosis.**

Factor	No.	(%)
Poor compliance and inadequate treatment	26	(54.2)
Upper respiratory tract infection	6	(13)
Pneumonia	2	(4)
Gastro enteritis	1	(2)
Urinary tract infection	1	(2)
Others	2	(4)
First presentation of DM	10	(20.8)
Total	48	(100)

## RESULTS

Forty eight patients were included in the study (28 males and 20 females) with a male to female ratio 1.3:1, their ages ranged between 1 and 15 years. Twenty six patients (54.2%) were above the age of 10 years, 29 patients (60.5%) from low social status, 38 patients were known cases of type 1 diabetes mellitus (DM). Thirty-two patients had only one admission with DKA, while in sixteen patients it was more than one episode, (table1).

Poor compliance and inadequate treatment were the main precipitating factors in 26 cases (54.2%). Infection was the second most common precipitating factor accounting for DKA in 12 patients (25%). In 10 out of 48 patients (20.8%) DKA was the first manifestation of DM. (table2).

Patients were divided into those with or without a prolonged hospital stay ( $\geq 7$  days). There were 28 children who had duration of hospital stay < one week and 20 children with prolonged duration of hospital stay. Children with prolonged hospital stay were significantly younger ( $P$  value =0.0045) and of low social class ( $P$  value =0.0032), (table3).

There was one death (2%) in our study group due to gram negative septicemia precipitating DKA. Lack of awareness of a disease contributed to poor control of blood glucose. Only 6 patients (12.5%) had regular blood glucose monitoring, as a consequence of which blood glucose levels were controlled

during their follow-up in the diabetic clinics, whereas 24 patients (50%) had no home blood glucose monitoring with repeatedly high blood levels during follow up. Eighteen patients (37.5%) were lost to follow up after discharge.

## DISCUSSION

Diabetes mellitus (DM) is the second most common chronic disease of childhood (second to asthma)<sup>(13)</sup>. The prevalence has been estimated to be 120 cases per 100000 population among children < 14 years of age<sup>(15)</sup>, with an annual incidence of approximately 20 new cases per 100000 children per year. There are approximately 4 hospital admissions/100000 children/year for DKA in the United States. One study reported that after an initial diagnosis of DM in children aged 8 to 13 years, 25% were re-hospitalized within 2 to 5 years<sup>(17)</sup>. DKA was the most common reason for rehospitalization<sup>(18)</sup>. The cost of care of a child with diabetes is high. Even families with health insurance can incur large out-of-pocket expenses for treatment of a child with diabetes. In one study of the financial impact of DM, 17% of families were found to have out-of-pocket expenses >10% of their household income. Therefore, poor families and families without insurance may have to make difficult choices between paying for health care expenses and other family needs.

**Table (3): Risk factors for prolonged hospital stay.**

Factors	No. of cases	<1 week (No.=28) No. (%)	$\geq 1$ week(No.=20) No. (%)	P-value ( $\chi^2$ test)
Age(year)				
≤10	22	8 (36.4)	14 (63.6)	P=0.0045 (S)
>10	26	20 (77)	6 (23)	
Sex				
Male	28	17 (65)	11 (33)	P=0.7710 (NS)
Female	20	11 (60)	9 (40)	
Social status				
Middle	19	16 (84)	3 (16)	P=0.0032 (S)
Low	29	12 (41)	17 (59)	
No. of DKA episode				
1	32	19 (59)	13 (41)	P=0.8360 (NS)
$\geq 2$	16	9 (56)	7 (44)	

In this study DKA patients were presented as the first manifestation of DM in 20.8% of cases, a finding consistent with other studies<sup>(1,2,3,19)</sup>. Our study revealed poor compliance and inadequate therapy as the main precipitating factors of DKA in 54.2%, this is in similarity to other studies carried out in the neighboring Arab countries<sup>(9,20,21)</sup> and to that seen in urban-Africans-Americans<sup>(22,23)</sup>. The high percentage of non-compliance in this study is probably multifactorial; lack of patients and family medical education and awareness of the disease and failure to comply with diet and therapy. Lack of supply from the hospital and the high cost of insulin therapy poses a financial burden on our patients who are from low socioeconomic class. To overcome this situation they either decrease the dose of insulin or discontinue it altogether leaving them at risk for DKA. Lack of health education and dominance of wrong belief especially regarding insulin also adversely affect diabetes control. There is still a general reluctance to accept insulin therapy among patients needing it; they often prefer to use local remedies, including cautery and herbal mixtures, thus contributing to the high percentage of non-compliance in our study. Infections were important DKA precipitators in 12 patients (25%). The most frequent is upper respiratory tract infection. Most patients presented with nausea, vomiting and abdominal pain, which was interpreted as an indication to reduce or stop their insulin. This situation is made worse when such patients consume large amounts of sugar-rich fluid to counteract a presumed hypoglycemia<sup>(24,25)</sup>. The study also found that children of low socioeconomic status were more likely to be admitted for diabetes mellitus and to have prolonged hospital stay, which is in agreement with previous studies<sup>(6,13,26,27)</sup>. These children should be targeted for intensive diabetes education and out-patient medical support both to improve their health and potentially to decrease total health care costs. The low mortality rate (2%) appears encouraging as compared with other series<sup>(1,2,19,28)</sup>. This reflects a good standard of hospital care for patients with DKA although it does not satisfy the urgent need for well planned health education aimed at the prevention of poor compliance and hence of DKA.

**Conclusions:** DKA is still a commonly seen complication; it can be the presenting feature of diabetes. Poor compliance and inadequate treatment is the leading precipitating factor in

our patients. Implementing a patient's education program to increase awareness of the disease is the most important step in the prevention of this complication. The authorities should ensure availability of insulin to all patients either free or at low prices. The role of cultural and socioeconomic factors in aggravating or precipitating DKA should always be considered and, where possible, eliminated.

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