

## Original Article

# Diabetic Ketoacidosis in children admitted to Pediatric Intensive Care Unit of King Fahad Hospital, Al-Baha, Saudi Arabia: Precipitating factors, epidemiological parameters and clinical presentation

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## ABSTRACT

Type I diabetes mellitus is the most common endocrine-metabolic disorder of childhood and adolescence and diabetic ketoacidosis (DKA) can be life-threatening. The study aims at identifying precipitating factors, states epidemiological features and describes clinical presentations in children with DKA admitted to Pediatric Intensive Care Unit (PICU), King Fahad Hospital, Al-Baha, Saudi Arabia. The hospital records of 80 children admitted to PICU with DKA between January 2000 and December 2004 were reviewed. Results were compared with published data from Saudi Arabia and other countries. Age at admission ranged between 8 months and 14 years (mean = 10.7 years). Female to male ratio was 1.22:1. Consanguinity was reported among 32(40%) of all admitted children's parents. A family history of diabetes (either type 1 or 2) was reported in 59 (74%). The leading precipitating

factor for DKA was infections (82.1%). An episode of DKA was the first clinical presentation of diabetes among 52(65%). The common presenting symptoms were: vomiting in 57(71.3%) and abdominal pain in 53 (66.3%). All children were dehydrated. Other signs included acidotic breathing and tachypnea each in 60%. Only two children were comatose (2.5%). Three of presenting cases were initially misdiagnosed as acute appendicitis before correct diagnosis was established. Cerebral edema occurred in one child. There were no deaths. DKA is an important cause of hospital admissions in our hospital, and 65% of newly diagnosed cases present with DKA. More effort should be put to prevent and reduce the incidence of DKA at initial presentation and later.

## Key words

Diabetic ketoacidosis; Child; Clinical features; Al-Baha; Saudi Arabia

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## INTRODUCTION

Type I diabetes mellitus (DM) is the most common endocrine-metabolic disorder of childhood, and adolescence [1]. WHO announced DM as one of the main threats to human health in the 21<sup>st</sup> century [2]. Diabetic ketoacidosis (DKA) is an acute metabolic complication that can be life-threatening and is the major source of mortality and morbidity in this disorder [3, 4]. Frequent causes include stress and infection in a new diabetic or a missed insulin dose in an established diabetic [5]. Ketoacidosis usually develops slowly, but when vomiting occurs it can develop in a few hours [5]. Classic symptoms often are absent in toddlers; and dehydration of 10% in children and up to 15% in infants is common [5]. Some patients (especially children) do not like to have injections [5]. DKA has been reported to occur also in type 2, mainly under stressful conditions such as surgery or infections [6,7]. Approximately 25 to 40% of children with type I DM will initially be diagnosed upon presentation with ketoacidosis [8]. DKA may occur in association with near normal glucose levels. Some patients have the desire to try local medicines [8]. The WHO projected to have almost “221” million cases in the year 2010 and up to “285” million cases in the year 2025 [9]. Many patients will have recurrence of their DKA [10]. The number of episodes of DKA is a significant outcome measure for diabetes care [11]. In Saudi Arabia with a change in life style and increasing prevalence of obesity, diabetes is reaching epidemic proportions [12]. The frequency of hospitalization for DKA has been reduced following diabetes education programs, improved follow up care and access to medical advice [7].

Pediatric DKA requires rapid recognition, yet gradual organized treatment [13]. Cerebral edema is an uncommon (occurs in 1%) but devastating complication of DKA in children, with a mortality that has remained constant for decades, and no guidelines have been shown to eliminate its risk

[14,15]. In order to improve care for diabetic patients in developing countries, specialized clinics need to be established [16]. There is agreement that prevention of DKA and reduction of its incidence should be a goal in managing children with diabetes [17]. Ideally severe DKA should be treated in intensive care units, especially if bicarbonate therapy is contemplated [18]. Treatment of children with DKA uses significant health care resources and the best way to avoid it is through involvement and close follow up by a multidisciplinary team of health care professionals with experience in dealing with diabetes in children and adolescents [7,19]. The ESPED, UK stated that: in early management of DKA, use of lower dose of insulin might be safer, especially in patients with PH<7.1 and when fluid boluses are needed for dehydration [20].

This retrospective study was carried out at King Fahad Hospital (KFH), Al-Baha, Saudi Arabia, where records of all children admitted with DKA to our PICU were reviewed and analyzed. All children diagnosed as DKA will usually be admitted to our PICU. Our objective was to state prevalence, precipitating factors and other epidemiological features, and describes the clinical characteristics among these children, stating complications and time of improvement. Data were compared with other reports on the subject from Saudi Arabia and other countries.

Al-Baha region lies in the South-Western part of Saudi Arabia and has a population of 377739 people where almost half are children less than 15 years of age. Males constitute 191214 and females 186525 “1.03:1 ratio”. Non-Saudis account for 13% of population. KFH is located in Al-Baha city and is the only secondary and tertiary medical center in the region. It is a teaching and governmental hospital, of 378 beds, providing care to a multinational population of mixed socioeconomic status.

## MATERIAL AND METHODS

Hospital records of all children admitted with DKA to our PICU over a 5 year-period from January 2000 to December 2004 were reviewed. Clinical, laboratory and other data at the time of admission and during stay in PICU were collected and analyzed.

## RESULTS

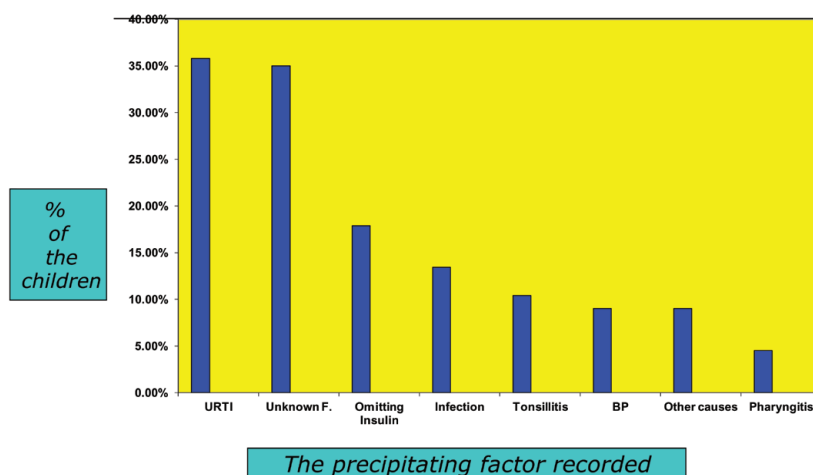
The number of admitted children to our Pediatric Department, during the 5 years of the study, was 8540. The number of all children admitted to our PICU in the study period was 1240, 80 of whom were admitted with DKA (6.5% from all cases admitted to PICU and 0.94% from total children admitted to our Pediatric Department in the same period). The age of children in the study ranged between 8 months and 14 years, with a mean of 10.7 years. Those older than 10 years were 34 (42.5%) and only 3(3.75%) were infants  $\leq$  one year of age. Those aged  $>$  one year up to 10 years

were 43(53.75%). Female to male ratio was 1.22:1 (55% were females and 45% were males). The non-Saudi children were 5 (6.25%).

Consanguinity was reported among 32(40%) of our children's parents with 22(69%) of these as first degree. A family history of diabetes was positive in 59(74%) of children with DKA. Among these 31(52.5%) were from 1<sup>st</sup> degree relatives, whereas siblings accounted for 25.4%, fathers 24% and only 3.1% from mothers. Grandfathers and grandmothers each accounted for 35% of this positive family history of diabetes. Many of our admitted children (40.6%) had more than one diabetic relative.

Childhood infections were the commonest and leading precipitating factor for the development of ketoacidosis (82.1%). Poor compliance with omission of insulin was the second factor (17.9%). Reported infections included upper respiratory infections, bronchopneumonia and tonsillitis. Urinary tract infection and vaginal candidiasis were rare causes (Figure 1).

Figure 1 - Precipitating factors for development of DKA



BP – bronchopneumonia, DKA - diabetic ketoacidosis, F – factor, URTI – upper respiratory tract infection.

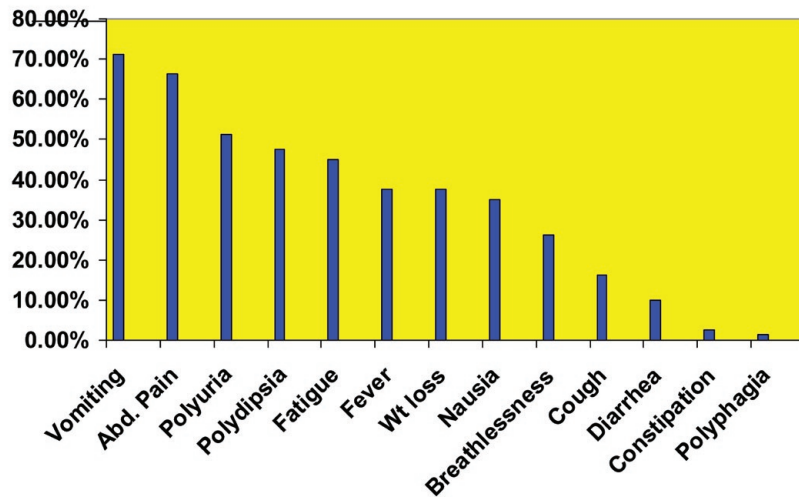
DKA episodes were the 1<sup>st</sup> clinical presentation of diabetes among 52 patients (65%). Only 28 patients (35%) were known diabetics. It was noted that vomiting and abdominal pain were the commonest presenting symptoms (71.3%

and 66.3%, respectively) (Figures 2 and 3). All were dehydrated (100%), of whom 33 (43.4%) had severe, 29 (38.2%) moderate and 14 (18.4%) mild degree. Only 2 (2.5%) admitted children presented with coma. Infections were

the most common precipitating factor (82%). Nevertheless, only 30 patients (37.5%) had fever and only (26.25%) were actually febrile at the time of admission. On presentation, three of admitted children were initially diagnosed as cases of “acute appendicitis”. Fortunately DKA was discovered and confirmed before surgical intervention. All children except one (who developed cerebral edema) recovered without apparent complications. Most of children (66%) improved at a time between 12 and 24 hours following admission and management (66%);

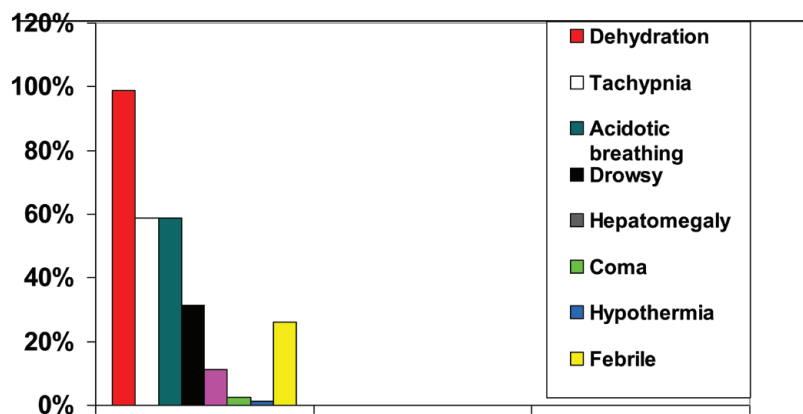
those who improved during the first 12 hours were 22.7%; and only 11.3% did so after 24 hrs. Cerebral edema as a complication occurred in one child: a 9-year-old girl who was transferred from a peripheral hospital after starting management there in the form of intravenous fluid and a bolus dose of insulin. Parents were first degree cousins. The father and a brother were diabetic. She was known diabetic since 4 years of age. Tonsillitis was the precipitating factor. On admission she was severely dehydrated with a level of HbA<sub>1c</sub> equal to 10.9%.

Figure 2 - Symptoms at the time of admission to PICU



Abd. – abdominal, PICU – Pediatric Intensive Care Unit, Wt - weight

Figure 3 - Profile of signs in our admitted children



## DISCUSSION

In our study, children admitted to PICU with DKA constituted 6.5% of total admissions to PICU which we consider a significant percentage. So, DKA in children is a genuine problem in Al-Baha area that needs mobilization of more resources to deal with it and try to prevent most of it before reaching the hospital. It is clear from age distribution that the incidence of DKA increases with increasing age reaching the maximum at preadolescent and adolescent age. In the study done in Leicester, UK in 2002 [21], the frequency of DKA peaked during adolescence who may continue to have bouts of recurrent DKA in adulthood [21].

The female to male ratio in our study was 1.22:1. In the study done in Al-Madina Region, KSA, females with DKA were 58.7% and males were 41.3% [22], i.e almost similar to our findings. In one study, it was stated that adolescent girls were at higher risk for DKA than other groups of children and young people. The study done in Al-Madinah Al-munawarah in 1991 showed a male to female ratio of 1:2 [23]. Another study done in Al-Kharj Armed Forces Hospital, Riyadh in 2000 [24] revealed that the prevalence of DM was generally more in females (5.32%) than males (2.55%). This was for all age groups, mainly under 35 years of age [24]. Also the study done in Germany among children with DKA in 2003 revealed that the frequency of DKA is higher in girls than in boys (28.9 vs 23.8%) [25].

In the present study, first degree consanguinity was found among 27.5% of children's parents. This is comparable to the study done in Suleimania Children Hospital, Riyadh between 1985 and 1989, which reported first degree consanguinity to be about 31% in children's parents [26]. 74% of our admitted children with DKA had positive family history of diabetes, of whom 52.5% were first degree relatives. Salman and associates' [26] study in Riyadh among 110 diabetic children between 1985 and 1989, found positive first degree family history of diabetes in only 28%, where

siblings accounted for 26% (similar to our result; 25.4%), fathers for only 2% (in contrast to ours of 24%) and none in mothers (also different from our result of 3.1%). We can say that the impact of a positive history of diabetes among sibs is stronger than due to other family members. It seems that mothers had the least effect.

The commonest precipitating factor in our study was infections; (82.1%). Worldwide, infection is the most common precipitating factor for DKA in both children and adults (30 - 50%), mainly pneumonia and urinary tract infection [7]. The study [27] in North India between 1993 and 2000, among children with DKA showed that precipitating factors were sepsis (37%), omitting insulin (15%) and sepsis with insulin omission in 7%.

A study done in Addis Abeba Children's Hospital [28], showed that the most common precipitating factors for DKA in children were infections (52%), omission of insulin (16%) and parasitic infection (12%). In contrast the study done among children and adults with DKA in Jeddah between 1999 and 2001 showed that poor compliance i.e omitting insulin was the most common factor (54.4%), followed by infections, only in 28% [12]. In our study, omission of insulin contributed to only 17.9%. A study done in Sudan [29] revealed that DKA (among children and adults) was precipitated by poor compliance to therapy or diet and infections, particularly malaria. Two studies done in Saudi Arabia in 1987 and 1994 stated that the precipitating factors for DKA include the reason that the patients do not like to have injections (especially children) or the desire to try local medicines [5,8].

Among 52(65%) of children, DKA was the first clinical presentation of the disease. This is comparable to figures of 58% and 66% reported from Ethiopia and India [27, 28]. In our study, vomiting was the commonest presenting symptom (71.3%), followed by abdominal pain (66.3%). This is similar to experiences from India and Saudi Arabia where



vomiting and abdominal pain were the commonest presenting symptoms [12, 27]; but is different from another study from Saudi Arabia where polydipsia and polyuria were the leading presenting symptoms in 98% of the cases [22]. This difference is partly explained by the fact that most of our patients were in younger age groups. Thus polyuria and polydipsia might not be well appreciated. All our patients were dehydrated with 43.4% having severe degree. This is unlike the experience from India where only 50% had clinical evidence of dehydration [27]. It could well be that our patients arrived relatively late to the hospital or most of them were vomiting. In our study almost 31.3% of cases had altered level of consciousness with two (2.5%) being comatose. This is similar to a German experience where almost 23% had altered level of consciousness, with 10.9% of them being comatose [25]; but is unlike the experience of another Saudi center where only 12.2% were said to have been drowsy with no cases of coma [22].

Three of our children were initially diagnosed as "Acute Appendicitis" but fortunately the correct diagnosis was made before surgical intervention. We therefore concur with the recommendation that diabetes should be ruled out in all cases of acute abdomen. In their study in Paris, Blanc et al [30] found that misdiagnosis was more frequently observed in children with DKA than in children without DKA [30-32]. As noted in our results, 88.7% of our admitted children with DKA recovered at a time between 12 and 24 hours following management. This is comparable to a report from Miami Children's Hospital, USA in 1996 which revealed that acidosis was corrected within 6 hours in children admitted with DKA in 69% of mild cases and in 11% of moderate cases [31].

We had only one case of clinical cerebral edema, who fortunately recovered completely. Our figure is similar to reports from UK and USA where less than 1% of cases developed cerebral edema [32]. Cerebral edema accounts for 20% of diabetes-related deaths.

No deaths occurred in our admitted children. The mortality rate from DKA in Developed Countries is from 0.15% to 0.31%, with higher rate (13%) being reported from Developing Countries where infections remains as one of the most important precipitating factors for DKA [17,27]. In a study done in Saudi Arabia no deaths occurred in children with DKA [22]. DKA was reported to be the principal cause of hospital admissions in Sudan, with infections, particularly malaria as the commonest cause of diabetes-related mortality [29].

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## CONCLUSION

Diabetic ketoacidosis (DKA) is an important cause of hospital admissions in our hospital and 65% of newly diagnosed cases presented with DKA. Girls were facing more risk. Positive family history of diabetes was significant in as many as 3/4 of our children and consanguinity was reported among 40% of children's parents. Infections are the most common precipitating factor; therefore, preventive measures aiming at childhood infections can help in reducing significantly the incidence of DKA.

Vomiting and abdominal pain are the commonest presenting symptoms, with only 2.5% presenting with coma. Current availability of intensive care facilities, as well as standardized guidelines for management, has resulted in management outcome and complications similar to the experience in Developed Countries. We had no mortalities, and almost all cases recovered within 12-24 hours. More efforts should be put to prevent and reduce the incidence of DKA at initial presentation and later on. We also recommend that diabetes should be ruled out in all cases of acute abdomen.

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