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IN THIS ISSUE

- Diabetes mellitus in Tuberculosis
- Oxidative Stress in Sickle Cell Anaemia
- Childhood Diabetic Ketoacidosis
- Haemostatis in Hypertension
- Research and Publication Ethics
- Prostate Carcinoma
- Bone scan in Breast Cancer
- Exercise and Basal Insulin levels
- Rheumatic Heart Diseases
- Paediatric Cytopathology

ORIGINAL RESEARCH

Pattern and outcome of Diabetic Ketoacidosis among children with Type 1 Diabetes mellitus at Ile-Ife, Nigeria

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Abstract

Background: Diabetic ketoacidosis (DKA) is a life-threatening complication of Diabetes mellitus. There are few reports on the pattern and outcome of DKA in childhood diabetes in Nigeria but none on the diabetic population from Osun State, Nigeria.

Objective: To determine the pattern and factors influencing the outcome of children managed for DKA at the Paediatric Endocrinology Unit of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Nigeria, over a ten-year period.

Methods: A retrospective review of the clinical records of all the children managed for Type-1 Diabetes mellitus (T1DM) over ten years (2007-2016) was done. Relevant information was obtained from the clinical records and the data were analyzed.

Results: A total of 15 children with DKA comprising 8 (53.3%) males and 7 (46.7%) females were studied. The male to female ratio was 1.1:1. Twenty-eight episodes of DKA were recorded during the period, thus putting the average frequency per patient at 1.9. DKA was the first manifestation of DM in the majority (86.7%) of the subjects. The mean age at diagnosis of DM was 11.9+3.6 years with about half (53.3%) occurring during pre-adolescence. The socio-economic status of the affected families had an inverse relationship with the frequency of DKA.

Conclusion: DKA is the most common initial presentation of Type-1 DM among Nigerian children, with a high rate of recurrence and an inverse relationship with socioeconomic status.

Keywords: Childhood, Diabetes mellitus, Diabetic ketoacidosis, Outcome.

Introduction

Diabetes mellitus (DM) is a common endocrine and non-communicable disease characterized by chronic hyperglycaemia. [1,2] DM causes disturbances in the metabolism of carbohydrates, fat, and protein due to the deficiency of insulin. Type-1 Diabetes mellitus (T1DM) is the predominant type seen among children. [1] The incidence of T1DM increases by 3% per year worldwide,[3] the incidence increases with age with an ethnic and racial variation across the globe.[4] DM is diagnosed in

the presence of hyperglycaemia, which is defined by the World Health Organization (WHO) as fasting blood glucose greater than or equal to 7mmol/l (126mg/dl) or random or 2 hours post-prandial blood glucose greater than or equal to 11.1mmol/l (200mg/dl) coexisting with the symptoms of glycosuria, polyuria, polydipsia, and weight loss. [5]

Diabetic ketoacidosis (DKA) is one of the most severe and life-threatening complications of T1DM.[8 -10] About 0.5%-1% of children with DKA develop cerebral oedema [9,11] from which 24%-28% death occurs. [9] DKA is the most common initial presentation of DM in most studies [6,7,13-16] reported from Nigeria and Saudi Arabia, [17] contrary to the findings in a report from Kuwait. [18] A study in India [19] reported vomiting and generalized weakness as the most common presenting complaints in DKA and were frequently precipitated by infections and non-compliance with anti-diabetic treatment. [19] Similarly, a Bangladeshi study identified infections as the most common precipitating cause of DKA. [20] In Benin-City, Nigeria, dehydration, and polyuria were the most common presenting features of DKA and is usually precipitated by the omission of insulin doses. [6]

There are few reports on the pattern, presentation and outcome of DKA in the childhood diabetic population in Nigeria [6,7,13-16] and other African countries [21,22] but there has been none from Osun-State, Nigeria. Understanding the pattern and factors involved in DKA occurring as part of T1DM in this environment will provide the advantage of improving knowledge of the disease and thereby, helping with interventions aimed at reducing the number of children with DKA in this centre. Therefore, this study aimed at documenting the pattern, presentation and outcome of DKA in children with T1DM who were managed at the Paediatric Endocrine Unit

of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Osun-State, Nigeria over a ten year period.

Methods

This is a retrospective review of the hospital records of all the children managed for T1DM at the Paediatric Endocrinology unit of the OAUTHC, Ile- Ife over a ten-year period (January 2007 to December 2016). Ethical approval was obtained from the Obafemi Awolowo University Teaching Hospital Complex Research and Ethics Committee. Relevant data on age at presentation with DKA, age at diagnosis with DM, duration of diabetic illness, frequency of clinic visits, availability of regular supply of insulin, availability of blood glucose monitoring, number and frequency of DKA episodes, family characteristics, outcome of admission and family's socioeconomic status were retrieved and entered into a proforma. The socio-economic status of the families was determined using the Oyedeji method of classification. [23] The social class was determined by combining the highest educational attainment and occupation of the parents, the mean of the four scores (two for the father and two for the mother) to the nearest whole number was the social class assigned to the family. Social classes I and II were considered as the high socio-economic class, social class III was regarded as the middle class while social classes IV and V were considered as low social class.

DKA was defined with the symptoms of ketoacidosis coexisting with biochemical parameters of hyperglycaemia (random blood glucose > 11mmol/L), serum bicarbonate < 15mmol/L and ketonuria, according to the International Society for Paediatric and Adolescent Diabetes (ISPAD) and European Society for Paediatric Endocrinology/Lawson

Wilkins Pediatrics Endocrine Society Consensus.[8,12]

The data gathered from the hospital records were analysed using the Statistical Package for Social Sciences for Windows version 20. Descriptive statistics such as frequencies, means, standard deviations, ratios, and percentages were used for all variables while the determinants of frequency and outcome of management of DKA were analysed. The statistical significance level was put at *P*-value <0.05.

Results

A total of 15 children, comprising 8 males (53.3%) and 7 females (46.7%) were included in the study. The male/female ratio was 1.1:1. DKA was the initial presentation in the majority of cases (13; 86.7%) while 2 (13.3%) initially presented with features such as polyuria, nocturia, polydipsia, and weight loss and later had episodes of DKA. DM was diagnosed at a mean±SD age of 11.9±3.6 years with an age range of 7 to 18 years. The Body Mass Index (BMI) of the children ranged from 10.6 to 19.7 kg/m² with a mean of 16.5±2.1 kg/m². The other socio-demographic characteristics of the children are shown in Table I with a male predominance (53.3%) and almost three-quarters of the children were underweight. The majority of the study population (80.0%) belonged to the low socioeconomic classes with none in the high socioeconomic class. More than half of the children were diagnosed at the pre-adolescent age.

Table I: Socio-demographic characteristics of the children with DKA

Variables	Frequency (n=15)	Percentage (%)
Sex		
Male	8	53.3
Female	7	46.7
Body Mass Index(kg/m²)		
Underweight (<18.0)	11	73.3
Normal weight (18.1-24.9)	4	26.7
Overweight (25-29.9)	0	0.0
Socioeconomic Status of Parents*		
High socioeconomic class	0	0.0
Middle socioeconomic class	3	20.0
Low socioeconomic class	12	80.0
Age at diagnosis of Diabetes Mellitus (Years)		
<12	8	53.3
12-14	2	13.3
15-17	4	26.7
18-20	1	6.7

*Socioeconomic status was defined using Oyedeji's classification of social class[17]

Table II shows the number of episodes of DKA recorded over the study period. In all, there were 28 episodes putting the average frequency at 1.9 per child. The maximum frequency of DKA per child was 3, as recorded among 4 (26.7%) children, while 6 children (40.0%) had

DKA only once. The time interval of recurrence of episodes of DKA ranged from 4 to 72 months with 20.0% re-occurring within 4 months and 6.7% within 72 months. Twelve of the children (80.0%) had a glucometer at home but only 3 of them monitored their blood glucose regularly at home. Insulin is often available through donations from Non-Governmental Organizations (NGOs) and staff of the hospital.

Only 3 of the children and their families were able to buy insulin as required whenever the donated insulin was not available. All the children included in the study had a good clinical outcome of DKA management while on admission. Two (13.3%) of them, died at home after discharge with a history suggestive of recurred DKA.

Table II: Frequency of glucose monitoring habit and diabetic ketoacidosis

Variables	Frequency (n=15)	Percentage (%)
Frequency of DKA*		
Once	6	40.0
Twice	5	33.3
Thrice	4	26.7
Interval between occurrence of DKA* (in months)		
0	6	40.0
4	3	20.0
5	2	13.3
9	1	6.7
12	2	13.3
72	1	6.7
Availability of glucose monitoring machine		
Yes	12	80.0
No	3	20.0
Home monitoring of glucose (n=12)		
Yes	3	25.0
No	9	75.0

*DKA – Diabetic Ketoacidosis

Table III shows the presenting features of DM in the children studied. All (100%) presented with polyuria, thirteen (86.7%) with polydipsia and none presented with convulsion. There was a negative correlation between the number of DKA episodes and the families' socioeconomic status (Table IV). However, there were positive but weak correlations between the number of DKA and home monitoring of glucose and the duration of diagnosis of DM.

Discussion

Diabetic ketoacidosis (DKA) was the initial presentation in the majority of the subjects in this study, similar to the findings in other studies in Nigeria, [6, 7,13-16] Africa [21,22] and Poland. [24] This has been documented to be due to poor knowledge and awareness of early features of DKA in developing countries unlike in developed countries where children are

managed in the early stages of the disease before the onset of DKA. [25]

Table III: Frequency of Presenting Clinical Features of Diabetes mellitus in the study population

Variables	Frequency (n=15)	Percentage (%)
Polyuria		
Yes	15	100.0
No	0	0.0
Polydipsia		
Yes	13	86.7
No	2	13.3
Polyphagia		
Yes	3	20.0
No	12	80.0
Difficulty with breathing		
Yes	8	53.3
No	7	46.7
Convulsion		
Yes	0	0.0
No	15	100.0
Loss of consciousness		
Yes	9	60.0
No	6	40.0
Weight loss		
Yes	6	40.0
No	9	60.0
Abdominal pain		
Yes	4	26.7
No	11	73.3
Weakness		
Yes	6	40.0
No	9	60.0
Vomiting		
Yes	2	13.3
No	13	86.7

The most frequent clinical features included polyuria and polydipsia, similar to the reports from Kano [16] whereas dehydration and polyuria were reported as the most common features in the Benin study. [6] In India, [19] vomiting and generalized weakness were reported as the major clinical features in children with DKA. This could be that most cases of DM presented on account of polyuria which could present as nocturia or bedwetting. Bedwetting is a major cultural concern in Africa and is often a reason for seeking health care.

The frequency of DKA was more than once in the majority of the children, similar to what was

reported by Mahesh. [19] This could be attributed to non-compliance with insulin therapy, poor blood glucose control, and monitoring and low socioeconomic situation.

Table IV: Relationship between the number of Diabetic Ketoacidosis and socio-demographics of children

Variables		Socioeconomic Status	Home Monitoring of Blood Glucose	Availability of Blood Glucose monitoring devices	Duration of diagnosis of Diabetes mellitus
Number of DKA in lifetime	Pearson Correlation	-0.522	0.184	-0.154	0.437
	P value	0.046	0.567	0.599	0.104
	N	15	12	15	15

This is corroborated by the fact that only three of the children monitored blood glucose at home despite glucometer being made available to twelve of the children. Most of the children in this study developed DKA once the free insulin given to them finished or was out of stock in the hospital, which might have contributed to the increase in the number of DKA episodes.

It is worthy of note that the majority of the subjects belonged to the low socioeconomic classes with none from the high socioeconomic class. This is contrary to the findings in the studies by Onyiriuka *et al* [6] and Oyenusi *et al* [7] who reported that most children belonged to the middle socioeconomic class and a few to the high socioeconomic class in their respective population. The difference could be due to the population studied which is a reflection of the socioeconomic status of the environment. While the study of Onyiriuka *et al* [6] was done in Benin City, Oyenusi *et al* [7] studied children in Lagos; both centres are metropolitan and state capital cities when compared to Ile-Ife, Osun-State, a semi-urban town with the majority of the population belonging to the middle and low socioeconomic class. There is an inverse relationship between the socioeconomic class and the frequency of DKA. This might have contributed to the high recurrence rate of DKA.

This is similar to the findings in a study done by Tull *et al* [26] who reported a higher prevalence of T1DM in children whose parents belonged to the low socioeconomic class. The financial constraint in such families may be responsible for the insufficient supply of insulin and consequently, non-compliance with insulin therapy. It has been suggested that a scale-up of the National Health Insurance Scheme in Nigeria may improve access of affected families to quality care. [27] Similarly, the role of Non-governmental Organizations such as the Life for a Child Care (LFAC), in making insulin available to indigent patients may reduce the recurrence of DKA. [28]

Most children in the present study were diagnosed with DM in the pre-adolescent age in agreement with previous reports in Nigeria [6,7] and Malta. [29] This is in contrast to the findings in a Polish study by Pawlowicz [30] where the diagnosis was made in adolescence. All the children with DKA in the present study had a good clinical outcome of management. However, two of the children died at home without resorting to the hospital for treatment, probably from episodes of DKA.

The major limitation of this study was the small number of children studied. Although a study

spanning a four-year period in Kano, Nigeria, reviewed eighteen children, [16] other Nigerian studies [6, 7] reviewed a remarkably larger number of children with DKA. Nevertheless, there is a disparity in the prevalence of T1DM across the African sub-region. [31] The reason for this disparity in prevalence is not as yet very clear. More research is needed to be able to elucidate this. However, it is likely that the documented pattern of DKA among children with T1DM in the study population may not be significantly different were the sample size larger. A multidisciplinary team approach, involving counseling, diabetic education, improved awareness of the possibility of DM in children and appropriate health care - seeking behaviour may reduce the incidence of DKA. This is based on the premise that it may be the initial presentation of T1DM among affected children while the availability of insulin and adequate self, home-based blood glucose monitoring may help reduce the occurrence of DKA.

Conclusion

DKA is the most common initial presentation of T1DM among children in our unit with a high rate of recurrence among the patients. The frequency of DKA has an inverse relationship with the socio-economic status of the families.

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