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Hyperglycaemia in Ill Children: A Study of 13 Cases

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Summary

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Background: Hyperglycaemia which is reported to be highly prevalent in critically ill children in many parts of the world, has hitherto received little attention in relation to Nigerian children.

Objectives: To describe the features in children who had hyperglycaemia on admission to the Obafemi Awolowo University Teaching Hospital (OAUTH), Ile Ife.

Method: Three hundred and ninety-two consecutive admissions to the Department of Paediatrics, OAUTH, were studied. Two milliliters of blood was obtained from each patient at admission for plasma glucose determination using a bed-side glucometer and photometric analysis using glucose oxidase methods in the laboratory. Theywere all managed according to standard protocols.

Results: Thirteen (3.3 percent) of the patients, comprising seven males and six females (M: F = 1:1) had hyperglycaemia (plasma glucose >7.8mmol/l). Their ages ranged from three months to 13 years with a mean of 5.34 ± 4.38 years. The mean plasma glucose levels in the 13 patients were 10.88 ± 3.33mmol/l and 11.32 ± 2.52mmol/l by the laboratory and bedside glucometer methods, respectively. Two (15.4 percent) of the 13 hyperglycaemic patients, died.

Conclusion: It would appear that hyperglycaemia is not uncommon among emergency paediatric admissions and should be another reason for routine blood glucose determinations. We recommend that glucose bolus should be given to ill children only after excluding the presence of hyperglycaemia.

Introduction

HYPERGLYCAEMIA refers to blood glucose value above the normal reference range for the age. Hyperglycaemia in Nigerian children has not been given enough attention as evidenced by the paucity of publications on the subject. It has however, been reported to be highly prevalent in critically ill children in other parts of the world.[1,2] A prevalence of 51.9 percent was documented in Spain[1] and 86 percent in the United State of America.[2] In the study from Spain,[1] it was shown to be far more common than hypoglycaemia which was seen in only 1.9 percent of the study population. Hyperglycaemia has been shown in several studies to be associated with higher mortality.[2-10] In a study among Kenyan children,[11] the mortality rate of 14 percent was found among patients with hyperglycaemia as against 3.8 percent among the normoglycaemic group ($P < 0.05$).

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There has been controversy concerning the cut-off blood glucose value that should be regarded as representing hyperglycaemia, and this is evidenced by different cut-off levels used in various reports.[2,3,12] The Committee on the Classification and Diagnostic Criteria of Diabetes Mellitus[5] defined 'diabetic type' hyperglycaemia as fasting plasma glucose (FPG) of 7.0mmol/L (126mg/dl) or higher, and/or plasma glucose two hours after 75g glucose load (2hPG) of 11.1mml/L (200mg/dl) or higher. A casual plasma glucose ≥11.1mmol/l (200mg/dl) also indicates 'diabetes type'. 'Borderline type' hyperglycaemia represents a fasting plasma glucose between 6.1mmol/L (110mg/dl) and 7.0mm/L or a casual plasma glucose level between 7.8mmol/L (140mg/dl) and 11.1mmol/L (200mg/dl).

While carrying out a prospective study on hypoglycaemia in emergency paediatric admissions in our centre,[12] we came across some cases of hyperglycaemia. The aim of the present study was to determine the incidence of, and describe the characteristics of hyperglycaemia among Nigerian children presenting at a University Teaching Hospital's Emergency Ward. It is hoped that this will stimulate

more research into the problems of hyperglycaemia in children.

Subjects and Methods

The study was carried out at the Children's Emergency Ward of the Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, over a nine-month period, January – September 2003. The subjects were children aged between one month and 14 years who were consecutively admitted to the ward during the period. A written informed consent was obtained from the caregivers of all the recruited patients, while ethical clearance was obtained from the Ethical and Research Committee of the hospital.

A research proforma was administered with respect to each recruited patient. The age of each subject, the sex, weight, height, time of admission, interval since last meal, duration of illness before admission, the presenting complaints and plasma glucose values were obtained and recorded on the proforma. The past medical and drug histories were also documented. Referred patients who had received any intravenous infusion within six hours of presentation, trauma patients and known diabetics were excluded from the study. All the patients had their plasma glucose determined at admission (before any intervention) using the routine laboratory method of photometric analysis as well as using a bedside glucometer which employs the glucose oxidase method. The glucometer used was a newly acquired prestige 1Q™ blood glucose monitoring kit model No – 507400-6 that comprises a blood glucose meter and prestige smart system blood glucose test strips. (*Home Diagnostics, Inc., USA*).

The bedside glucometer testing was carried out mostly by one of us (JBE) and on a few occasions, by trained assistants. Hyperglycaemia was defined as plasma glucose ≥7.8mmol/l and hypoglycaemia as plasma glucose ≤2.5mmol/l. All the patients were managed according to standard management protocol. Patients diagnosed with hyperglycaemia received 4.3% Dextrose/0.18 saline infusion where indicated, except one patient with severe dehydration who received normal saline. The initial management decision was based on the glucometer result as this was available within three minutes. The plasma glucose was also checked in the patients with hyperglycaemia upon recovery from the primary morbidities.

Data generated were analyzed using the Statistical Package for Social Scientists (SPSS) Version 10 and Computer Package for Epidemiological Analysis (CPEA) software.

Results

During the period January to September 2003, 392 patients aged six weeks to 14 years (mean 3.43 ± 3.58 years) were studied. Three hundred and seventeen (80.8 percent) were aged five years and below (Table I). There were 216 (55.1 percent) males and 176 (44.9 percent) females, giving a male: female ratio of 1.2:1. The plasma glucose levels in the 392 patients ranged between 0.5 and 16.4mmol/l (mean 5.41±2.23) and <1.4-16.9mmol/l (mean 5.66±2.48) by the laboratory and bedside glucometer methods, respectively. Twenty-five (6.4 percent) had hypoglycaemia, 354 (90.3 percent) were normoglycaemic and 13 (3.3 percent) had hyperglycaemia.

The hyperglycaemic patients consisted of seven males and six females (M:F = 1:1) and were aged three months to 13 years (mean 5.34±4.38years). The mean plasma glucose levels in the 13 patients were 10.88±3.33mmol/l and 11.32±2.52mmol/l by the laboratory and bedside glucometer methods, respectively. There were 35 (8.93 percent) deaths among whom were two hyperglycaemic children. These two cases had severe intracranial infections. A comparison of the relative incidence of hyperglycaemia in relation to the various final diagnoses in the 392 patients is shown in Table II. The characteristics of the 13 patients with hyperglycaemia are shown in Table III. Nine of the 13 patients presented with convulsions. The interval between the last meal and admission in all the patients ranged between two hours and eight hours. All the 11 survivors had plasma glucose in the normal range upon recovery from the primary morbidity.

Table I

Age Distribution of the Patients Studied

Age (years)	*Frequency*	*Percent of Total*
<1	118	30.1
1-3	155	39.5
>3-5	44	11.2
>5	75	19.2
Total	392	100.0

Table II

Incidence of Hyperglycaemia in Children with Various Diseases

Primary Diagnosis	*All Cases (n=392)*	*No of Hyperglycaemic Patients (% of Total)*	*No of Non-hyperglycaemic Patients (% of Total)*
Severe malaria	210	7(3.3)	203(96.7)
Pneumonia	34	0(0)	34(100)
Septicaemia	38	0(0)	38(100)
Sickle cell anaemia	13	0(0)	13(100)
Gastroenteritis	14	1(7.1)	13(92.9)
Epilepsy	7	0(0)	7(100)
Meningitis	7	2(28.6)	5(71.4)
Malignancy	7	0(0)	7(100)
Measles	5	0(0)	5(100)
Protein energy malnutrition	4	0(0)	4(100)
Tuberculosis	6	0(0)	6(100)
Tetanus	5	0(0)	5(100)
Drug poisoning	2	0(0)	2(100)
Acute renal failure	2	0(0)	2(100)
Miscellaneous	38	3(7.9)	35(92.1)
Total	392	13	379

Table III

Characteristics of the 13 Patients with Hyperglycaemia

Age	*Sex*	*Plasma Glucos*		*Diagnosis*	*Duration of Admission (days)*	*Outcome*
		Glucometer	*Laboratory*			
3mon	F	16.3	16.4	Gastroenteritis	10	Alive
9mth	F	16.7	19.3	Severe malaria	7	Alive
2yrs	M	12.1	9.4	Severe malaria	3	Alive
3yrs	M	10.0	8.1	Severe malaria	3	Alive
3yrs	F	11.9	11.6	Severe malaria	5	Alive
3yrs	M	9.6	9.3	Severe malaria	5	Alive
5yrs	M	10.8	11.0	Severe malaria	3	Alive
5yrs	M	10.4	10.0	Meningitis	1	Died
5yrs	M	11.7	11.1	Severe malaria	3	Alive
6yrs	F	9.6	9.6	Meningitis	18	Alive
11yrs	M	9.6	8.1	Viral exanthem	5	Alive
12yrs	F	8.6	9.0	Acute appendicitis	8	Alive
13yrs	F	9.9	8.5	Cavernous sinus thrombosis	1	Died

Discussion

This report shows that Nigerian children do also present with hyperglycaemia in the emergency wards. The prevalence of 3.3 percent in the present study is however much lower than 51.9 percent and 86 percent reported from Spain[1] and USA,[2] respectively. The mortality in the hyperglycaemia group in this study was low and not significant ($P > 0.05$) unlike what was found in a Kenyan study.[11] Perhaps the low mortality rate in this study was a reflection of the lower prevalence of hyperglycaemia. The types of patients managed could also be a major determinant of overall outcome and prevalence of hyperglycaemia.[5] The prevalence was found to be higher among children admitted to intensive care units than emergency wards.[5] However, the presence of hyperglycaemia may only be contributory to the mortality and not be the sole cause of death. The patients with admission hyperglycaemia were not given dextrose bolus, as opposed to the usual practice of giving glucose bolus to all sick patients; this too might have limited the severity and the adverse effects of the hyperglycaemia. The results of this study also show that the hyperglycaemia occurred in association with various diseases in a way that was similar to that reported for hypoglycaemia.[13,14] It was however, more often associated with conditions presenting with convulsion.

The morbidity and mortality from hyperglycaemia is thought to be explained among other reasons, by its ability to exacerbate ischaemic neurological injury.[15] This was shown in animal studies to be due to a reduction in the brain adenosine production. Adenosine being an endogenous neuroprotector causes cerebral vasodilation, inhibits the release of neuronal excitotoxins and affects neutrophil – endothelial interaction.[15] Hyperglycaemia has also been shown to be significantly related to distinct changes of humoral and cellular immune functions.[6] But why a certain disease will be associated with hyperglycaemia in one patient and hypoglycaemia in another is not fully understood. It may be related to the way individuals react to stress and this may also be influenced directly or indirectly by hormonal and metabolic interplay. The overall effect of stressful states on glucose metabolism is increased gluconeogenesis via cortisol and glucagon, increased glycogenolysis via epinephrine and peripheral insulin resistance via glucagon and epinephrine.[3] Clearly, there is a need for more prospective studies that will encompass studies on hormonal profiles in patients presenting with hyperglycaemia. A long-term follow-up of identified cases is also imperative to document the long-term outcome of this transient occurrence.

We conclude that hyperglycaemia is not uncommon in emergency paediatric admissions and should be another reason for routine blood glucose determinations. We recommend that glucose boluses should not be given to ill children until hyperglycaemia has been excluded.

References

1. Ruiz Magro P, Aparicio López C, López-Herce Cid J, Martínez Campos M, Sancho Pérez L. Metabolic changes in critically ill children. *An Esp Pediatr* 1999;**51**:143-8.
2. Srinivasan V, Spinella PC, Drott HR, Roth CL, Helfaer MA, Nadkarni V. Association of timing, duration and intensity of hyperglycaemia with intensive care unit mortality in critically ill children. *Pediatr Crit Care Med* 2004;**5**:329-36
3. Laird AM, MillerPR, Kilgo PD, Meredith JW, Chang MC. Relationship of early hyperglycaemia to mortality in trauma patients. *J Trauma* 2004;**56**:1058-62.
4. Finney SJ, Zekveld C, Elia A, Evans TW. Glucose control and mortality in critically ill patients. *JAMA* 2003;**290**:2041-7.
5. Kuzuya T, Nakagawa S, Satoh J, *et al.* Report of the committee on the classification and diagnostic criteria of diabetes mellitus. *Diabetes Res Clin Pract* 2002;**55**:65-85.
6. Faustino EV, Apkon M. Persistent hyperglycaemia in critically ill children. *J Pediatr* 2005; **146**: 30-4.
7. Wasmuth HE, Kunz D, Graf J, *et al.*. Hyperglycaemia at admission to the intensive care unit is associated with elevated serum concentration of interleukin-6 and reduced ex vivo secretion of tumor necrosis factor-alpha. *Crit Care Med* 2004; **32**:1109-14.
8. Hall NJ, Peters M, Eaton S, Pierro A. Hyperglycaemia is associated with increased morbidity and mortality rates in neonates with necrotizing enterocolitis. *J Paediatr Surg* 2004; **39**:898-901.
9. Krinsley JS. Association between hyperglycaemia and increased hospital mortality in a heterogenous population of critically ill patients. *Mayo Clin Proc* 2003; **78**: 1460-2.
10. Capes SE. Hunt D, Malonberg K, Pattak P, Gerstain HC. Stress hyperglycaemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview. *Stroke* 200; **32**: 2426-32.
11. Osier FH, Berkley JA, Ross A, Sanderson F, Mohammed S, Newton CR. Abnormal

blood glucose concentrations on admission to a rural Kenyan district hospital: prevalence and outcome. *Arch Dis Child* 2003; **88**: 621-5.

12. Elusiyan JBE. Hypoglycaemia in Emergency Paediatric Admissions. Dissertation submitted for the Fellowship of the West African College of Physicians (FWACP). Oct. 2004.

13. Elusiyan JBE, Adejuyigbe EA, Adeodu OO. Hypogycaemia in a Nigerian paediatric emergency ward.. *J Trop Pediatr* 2006. 2006;**52**:96-102.

14. Solomon T, Felix TM, Samuel M, *et al.* Hypoglycaemia in paediatric admissions in Mozambique. *Lancet* 1994; **343**: 149-50.

15. Sieber FE, Traystman RJ. Special issues: Glucose and the brain. *Crit Care Med* 1992:**20**:104.