BLOOD GLUCOSE LEVELS IN PEDIATRIC EMERGENCY ADMISSIONS IN JIMMA UNIVERSITY SPECIALIZED HOSPITAL, SOUTHWEST ETHIOPIA

By: Mitsiwa Ruffo (MD)* and Netsanet Workneh (MD)*

ABSTRACT

Background: *Abnormal blood glucose level is one of the problems encountered in children with severe illness. Different studies showed that hypoglycemia is associated with poor prognosis in many severe childhood illnesses especially in sub-Saharan Africa where the prevalence of malaria, diarrhea and malnutrition remains high. To the best of our knowledge there has not been any published work on this subject in Ethiopia; as a result abnormal blood glucose level in pediatric emergency admissions has not received enough attention.*

Objective: *To determine the pattern of blood glucose levels in pediatric emergency admissions.*

Methodology: *The study was conducted at pediatrics Emergency unit of the Jimma University Specialized Hospital, Oromia region,Southwest Ethiopia from May13, 2011 – June 12, 2011. The study design was a prospective cross-sectional and all nondiabetic children aged between 1 month to 14 years who were admitted to the emergency unit during the study period were included. Data was collected by trained medical person using structured questionnaire and by determining random blood glucose. After cleaning and coding, the data was analyzed using Statistical Package for Social Sciences (SPSS) windows version 16.0. Relevant test of statistical association was employed.*

Result: *Six percent of children admitted to Jimma University specialized hospital had an abnormal blood glucose level on admission. Hyperglycemia (4.8%) was more common than hypoglycaemia (1.2%). However, there was a strong association between hypoglycaemia and mortality. Hypoglycemic children with severe illness or malnutrition were having impaired mentation, and died despite an urgent determination of blood glucose and treatment.*

Conclusion: *Hypoglycemia is less common as compared to hyperglycemia in pediatric emergency admissions to Jimma University specialized hospital but it was associated with worst outcome of management.*

*** Department of pediatrics and child health, Jima university**

INTRODUCTION

Abnormal blood glucose level is the most common metabolic abnormality in childhood and is associated with neurological problems and death. Hypoglycemia is associated with poor prognosis in many severe childhood illnesses especially in sub-Saharan Africa where the prevalence of malaria, diarrhea and malnutrition remains high.(1-3) Intercurrent illnesses may trigger hyperglycemia as a result of the secretion of stress hormones and cytokines. In older fants and children, a whole blood glucose concentration of less than 40mg/dl (2.2mmol/l) or plasma glucose less than 45mg/dl (2.5mmol/l) and whole blood glucose >180mg/dl(10mmol/l) represent significant hypoglycemia and hyperglycemia respectively whether or not clinical manifestations are present and hypoglycemia in children with severe malnutrition is defined by WHO as RBS less than 54 mg/dl 4

Most of the time low blood glucose concentration is not associated with the development of the classic clinical manifestations of hypoglycemia. The absence of clinical symptoms does not indicate that glucose concentration is normal or has not fallen below optimal level for maintaining brain metabolism.5

The major long-term sequelae of severe, prolonged hypoglycemia are neurologic damage resulting in mental retardation, transient cognitive impairment, neurological deficit and recurrent seizure activity. Subtle effects on personality are also possible but have not been clearly defined.4, 6

Str hyperglycemia is defined as a transient elevation of blood sugar level associated with illness. Patients with stress hyperglycemia unlike diabetes mellitus usually do not have a lengthy history of polyuria, polydipsia, or weight loss. They do not manifest symptoms or signs of ketoacidosis or biochemical evidence of ketoacidosis is absent. During the acute phase of illness, hyperglycemia may be protective by providing energy to the brain and blood cells. Prolonged hyperglycemia, however, has been shown to increase morbidity and mortality. [7-10, 11]

The prevalence of hypoglycemia was found to be 6.4, 7, and 7.3 percent among emergency admissions in Nigerian, Mozambican, and Kenyan children respectively. Pershad, et al.12 According to the reports of Solomon, et al.3 Pershad, et al., 12 Osier, et al.13, and Elusiyan, et al. 14, among all emergency admissions the major contributors to hypoglycemia in the African studies in

decreasing order of importance were malaria, septicemia, pneumonia and protein energy malnutrition. 15-17

The prevalence and outcome of abnormal blood glucose is one of the clinical scenarios to be more clearly defined. This research is believed to provide a base line information on the prevalence of abnormal blood glucose level in pediatric emergency admissions, pattern of abnormal blood glucose level to underlying disease entity, and outcome of pediatric emergency admissions with abnormal blood glucose level in Jimma university specialized hospital.

OBJECTIVES

General objective

To determine pattern of blood glucose levels in pediatric emergency admissions aged 1 month to 14 year.

Specific objectives

- To identify pattern of blood glucose levels among pediatric emergency admissions.

To identify association of abnormal blood glucose levels and underlying medical condition.

- To identify clinical characteristics of abnormal blood glucose levels.
- To identify disease outcome of children with abnormal blood glucose.

METHODOLOGY

Study area and period: The study was conducted at the pediatrics Emergency unit of the Jimma University specialized Hospital, Jimma zone, Oromia region, southwest Ethiopia which is located 350km from the capital city over a 1-month period (May 13, 2011–June 12, 2011).

Study design: The study design was a prospective cross-sectional

Sampling technique: The convenience sampling technique was used.

Source population: All pediatric admissions from 1month to 14 year of age who were admitted during the study period.

Study population: All nondiabetic Pediatric emergency admissions aged between 1 month and 14 year who were admitted during the study period.

Variables: Independent - Age, duration of the illness, time from last meal, mental status, seizure, diagnosis, and hospital stay. Dependent – Random blood glucose.

Data collection Method: Ethical clearance paper was obtained from ethical review board for human studies of Jimma University and permission was obtained from the authorities of the hospital. A structured questionnaire was administered to every recruited patient. The age of the

patients, sex, interval of last meal, duration of illness before admission, the presenting complaints, and pertinent physical findings (mental status and seizure) were obtained and recorded on the questionnaire. The data was collected by trained health personnel (Medical intern) who can speak Amharic and afan Oromo with strict supervision by the principal investigator. Prior to data collection, each material used as source of data for the study was arranged in sequence to avoid confusion and repetition during the data collection.

The procedure that the data collector followed to obtain the subject details was interviewing the parent/s of a child followed by doing physical examination and finally, blood glucose was obtained from capillary blood by pricking with lancet the lateral aspect of the finger tip after cleaning properly with alcohol swab. Sensocard glucometer was used for measuring blood glucose. SensoCard indicates blood glucose concentration by checking reaction between chemical reagents and the blood drop on the strip test. The whole measuring process is controlled by a microprocessor inside the sensoCard meter. The microprocessor also controls the internal calibration of the device and if any failure is detected in the operation, a relevant error message will be displayed. SensoCard is designed to be used only with sensoCard test strip after entering the code of a strip, and checking if the 3-digit code on the vial of strips you are using matches the 3-digit code appearing on the meter's screen. In contrast to other methods of blood glucose measurements, sensoCard is calibrated to be used only with fresh capillary blood. No venous or plasma is suitable for accurate monitoring of glucose level.

Data Quality control: In order to check the validity and reliability of the questionnaire, it was pre –tested on ten patients before the actual study . The glucometer was also checked and set prior to the study. Factors that influence the measurement results (such as insufficient amount of blood, dirt or contaminants on finger, wipping off the blood that disperses first after pricking, and excessive rubbing) were clearly discussed with the data collector.

Data analysis: The data collected was checked for completeness and consistency and then it was cleaned, coded, and entered in to computer. Then it was analyzed using Statistical Package for Social Sciences (SPSS) version 16.0. The Significance level for each analysis was taken as $p < 0.05$.

Exclusion criteria: Diabetic children and neonates were not included in this study.

Operational definition: Hypoglycemia (blood glucose <40mg/dl or <54mg/dl for severely malnourished child). Hyperglycemia (blood glucose ≥ 180mg/dl).

RESULTS

Among 165 patients aged 4 weeks to 14 years, the median age was 24 months (interquartile range (IQR) 7.5 to 72) and 113(68.5 per cent) were aged below five years. (Table 1). There were 100 (60.6 per cent) males and 65 (39.4 per cent) females giving a male: female ratio of 1.5:1. The median duration of illness and subsequent length of hospital stay were both 4 days (IQR 3 to 7). Blood glucose determination was assessed routinely with the glucose oxidase method. Two (1.2 per cent) of them were found to be hypoglycemic, 8(4.8%) of them were found to be hyperglycemic, and the remaining were normoglycemic (Table 2). The age and sex characteristics of the patients are as shown in (Table 3). All cases with abnormal blood glucose concentration were children below the age of five.

Table 1 Age Distribution of pediatric emergency admissions in Jimma university specialized hospital

Age(month)	Frequency	Percent
1-12	57	34.5
12-24	25	15.2
24-36	10	6.1
36-48	13	7.9
48-59	8	4.8
≥59	52	31.5
Total	165	100.0

Table 2 Blood glucose pattern of pediatric emergency admissions in Jimma university specialized hospital

Blood glucose(mg/dl)	**Frequency**	**Percent**
0-40	2	1.2
40-80	10	6.1
80-120	89	53.9
120-160	52	31.5
160-180	4	2.4
≥180	8	4.8
Total	165	100

Table 3 Demographic features of 165 pediatric emergency admissions in Jimma university specialized hospital

Features	**Category**	**Blood Glucose(mg/dl)**			**P value**
		0-40(n=2)	**40-180(n=155)**	**≥180(n=8)**	
Age(Month)	1-12	1(1.8%)	52(91.2%)	4(7%)	.127
	12-24	0(0%)	24(96%)	1(4%)	
	24-36	0(0%)	9(90%)	1(10%)	
	36-48	0(0%)	12(92.3%)	1(7.7%)	
	48-59	1(1%)	6(75%)	1(12.5%)	
	≥59	0(0%)	52(100%)	0(0%)	
Sex distribution	Male	2(2%)	90(90%)	8(8%)	.124
	Female	0(0%)	65(100%)	0(0%)	

The duration of illness before admission and the time of presentation did not significantly influence the prevalence of abnormal blood glucose levels (χ^2 = 4.79; df = 5; p = 0.441, and $\chi 2$ = 8.28; df=5; p=0.141 respectively the prevalence of abnormal blood glucose level was found to increase with impaired level of consciousness (χ^2 = 22.91; df = 5; p < 0.001) (Table 4). Patients with hypoglycaemia were more likely to die than those without (χ^2 = 23.43; df = 5; p =0.009) (see Table 5)

Table 4 Admission characteristics of the 165 pediatric emergency admissions in Jimma university specialized hospital

Features	**Category**	**Blood Glucose(mg/dl)**			**P value**
		0-40(n=2)	**40-180(n=155)**	**≥180(n=8)**	
Duration of Illness before admission (days)	<7	0(0%)	105(67.7%)	5(62.5%)	.441
	≥7	2(100%)	50(32.3%)	3(37.5%)	
Interval of last meal(hrs)	<12	1(50%)	147(94.8%)	7(87.5%)	.141
	≥12	1(50%)	8(5.2%)	1(12.5%)	
Mental status	Alert	0(0%)	138(89%)	4(50%)	.001
	Impaired	2(100%)	17(11%)	4(50%)	

Table 5 Outcome of management of pediatric emergency admissions in Jimma university specialized hospital

Features	Category	Blood Glucose(mg/dl)			P value
		0-40(n=2)	40-180(n=155)	≥180(n=8)	
Length of hospital stay(days)	<1	1(50%)	3(1.9%)	0(0%)	0.022
	1-3	0(0%)	27(17.4%)	1(12.5%)	
	3-7	1(50%)	72(46.5%)	4(50%)	
	≥7	0(0%)	43(27.7%)	1(12.5%)	
	Unknown	0(0%)	10(6.5%)	2(25%)	
Outcome of admission	Alive	0(0%)	122(78.7%)	5(62.5%)	0.009
	Died	2(100%)	14(9%)	1(12.5%)	
	unknown	0(0%)	19(12.3%)	2(25%)	

The mortality in hyperglycemic children was higher than that in normoglycemic children, 1/8 (12.5%) versus 14/155 (9%) respectively (p = 0.009) (Table 5).

In this study sepsis, protein energy malnutrition, gastroenteritis, and malaria were the leading diagnoses associated with abnormal blood glucose levels. Eight (4.8%) children were hyperglycemic on admission. The main primary diagnoses were protein energy malnutrition (PEM) and gastroenteritis each accounting 25% of cases. None of these children had insulin dependent diabetes mellitus (Table 6).

Table 6 Distribution of blood glucose concentrations among various among various diagnoses in the 165 pediatric emergency admissions in Jimma University specialized hospital

Primary diagnosis	All cases	Blood Glucose(mg/dl)		
		0-40(n=2)	40-180(n=155)	≥180(n=8)
Pneumonia	51(30.9%)	0(0%)	50(32.2%)	1(12.5%)
Malaria	8(4.8%)	0(0%)	7(4.5%)	1(12.5%)
Gastroenteritis	12(7.3%)	0(0%)	10(6.5%)	2(25%)
PEM	21(12.7%)	1(50%)	18(11.6%)	2(25%)
Sepsis	11(6.7%)	1(50%)	9(5.8%)	1(12.5%)
Meningitis	4(2.4%)	0(0%)	4(2.6%)	0(0%)
Others	58(58%)	0(0%)	57(36.8%)	1(12.5%)
Total	165(100%)	2(100%)	155(100%)	8(100%)

DISCUSSION

Six percent of children admitted to Jimma University specialized hospital had an abnormal blood glucose level on admission. Hyperglycemia (4.8%) was more common than hypoglycemia (1.2%). However, there was a strong association between hypoglycemia and mortality.

In the present study, hypoglycaemia was found in 2(1.2 per cent) of the patients. This figure was less than the findings from other African countries. According to the reports of Solomon, et al.,3 Pershad, *et al*., 9 Osier, *et al*.18, and Elusiyan, et al. 19, the prevalence of hypoglycemia among all pediatric emergency admissions were 7, 6.54,7.3, and 6.4 percent respectively. Many factors might be responsible for observed differences in prevalence such as short study period, small sample size, and few cases of malaria which accounted 4.8 percent of the diagnoses of this study; however malaria was the leading primary diagnosis associated with hypoglycemia in other mentioned studies.

Hypoglycaemia has been reported in bacterial sepsis; it was thought to be due to production of endotoxins which may stimulate insulin secretion. 17, 20, 21 In present study, the diagnoses associated with

hypoglycemia were sepsis and PEM. Eleven(6.7 percent) of cases were having a diagnosis of sepsis, and one out of eleven cases of sepsis was hypoglycemic which made the likelihood of hypoglycemia in sepsis 9 percent . Elusiyan, et al.19 in Nigerian children reported septicaemia as a second major diagnosis with 24 per cent of the hypoglycemic patients having a diagnosis of sepsis. In the present study, the diagnosis of septicaemia was based on clinical assessment, with only a few laboratory investigations.

In this study Protein energy malnutrition was the other diagnosis associated with hypoglycemia. Among 21(12.7%) cases with a diagnosis of PEM in this study, one was hypoglycemic; therefore the possibility of hypoglycemia in children with PEM was 4.8 percent. While Osier, et al.18 in Kenyan children reported PEM as a second primary diagnosis with 6.6% of the hypoglycemic children having PEM as their diagnosis. Among emergency admissions in Nigerian children PEM was the fourth diagnosis associated with hypoglycemia. The observed differences could be attributed to factors like small sample size, and short study period in the present study.

In the present study, there was a statistically significant association (p<0.001) between the mental status of the patients and presence of hypoglycemia. Other researchers 3, 12, 18, 19, 22 had similarly reported a significant association between coma and hypoglycemia on admission. Since altered mental status/coma is one of the clinical presentations of hypoglycemia, all patients with altered mental status should be sought for hypoglycemia.

The result of outcome of management in the present study, showed a worse outcome in the hypoglycemic group. The hypoglycemic group was more likely to stay on admission for shorter duration. This is because they were more likely to die. This association between presence of hypoglycaemia and worst outcome of management was found to be statistically significant (p=0.009). This was also the findings of researchers in other studies.3, 16, 18,19, It appears however, that hypoglycaemia, is a function of the severity of illness in childhood, and more severely ill children will be more likely to die than less severely ill ones. It may be very difficult to assert or conclude that it is the presence of hypoglycaemia that causes the death. It may just be enough to say that whenever hypoglycaemia is present in any disease, that case is a severe one, and the risk of dying is higher.

During the acute phase of illness, hyperglycemia may be protective by providing energy to the brain and blood

cells.11 In the present study, hyperglycemia was found in 8(4.8 per cent) of the patients. This finding was comparable to the findings in other studies. The reports of Osier, *et al*.13, and Bhisitkul, et al.23, assessed the prevalence of hyperglycemia among all emergency admissions, and the findings were 2.9, and 3.8 percent. The cause of hyperglycemia during illness is multifactorial, with the primary contributors being increased gluconeogenesis coupled with increased resistance to insulin-induced glucose utilization. Counterregulatory hormones (hormones opposing the actions of insulin) play an important role. These hormones include cortisol, catecholamines, glucagons, and growth hormone. Stress activates the hypothalamic-pituitary-adrenal axis, leading to the release of cortisol, which impairs insulin-mediated glucose uptake by skeletal muscle and increases gluconeogenesis. Catecholamines inhibit insulin binding and increase hepatic glucose production. Glucagon increases gluconeogenesis, and growth hormone inhibits insulin action by decreasing insulin receptors and impairing insulin activation. 24,25

The main primary diagnoses found in hyperglycemic children in this study were PEM (25%), gastroenteritis (25%), sepsis (12.5%), pneumonia (12.5%), and malaria (12.5%). While Osier, et al.14 in Kenyan children reported malaria (49.4%), gastroenteritis (12.9%), lower respiratory tract infection (11.8%), and burns (7.5%) as the main primary diagnoses associated with hyperglycemia.

In the present study, the mortality in hyperglycemic children was higher than that in normoglycemic children, 1/8 (12.5%) versus 14/155 (9%) respectively ($p = 0.009$); and this was in agreement with the findings in other studies.8,23 In the present study, there was no observed statistically significant association between age and sex of the patients and blood glucose levels. This was also in agreement with the findings of other researches.12,16,19. Also, no statistically significant difference was observed between the duration of illness before admission and the presence of abnormal blood glucose. There was however an increasing prevalence of hypoglycemia, the longer the duration of illness before admission.

Overall, in this study, hypoglycemia was less common than hyperglycemia but both were associated with worst outcome of management in children with PEM; sepsis was the other diagnosis which was associated with both hypoglycemia and hyperglycemia. Altered mental status was significantly associated with hypoglycemia.

CONCLUSION

Hypoglycemia was less common as compared to hyperglycemia in pediatric emergency admissions to Jimma University specialized hospital but both were associated with poor outcome of management in cases with a diagnosis of protein energy malnutrition. Altered mental status was significantly associated with hypoglycemia. Sepsis was the diagnosis associated with both hypoglycemia and hyperglycemia in pediatric emergency admissions to Jimma University specialized hospital.

RECOMMENDATION

We recommend all medical professionals working in pediatric emergency unit to consider blood glucose determination for all pediatric emergency admissions to look for the presence of hypoglycemia or hyperglycemia. Glucometer with adequate supply of strips need to be always available in pediatric emergency unites. And serial measurement is important if the child has hypo or hyperglycemia and if the child is seriously sick. In all cases of pediatric emergency admissions with altered mental status hypoglycemia should be sought and managed aggressively if present. Emergency admissions with diagnosis of sepsis and protein energy malnutrition are at increased risk of having abnormal blood glucose; so cases with these diagnoses need more emphasis. And further study with larger samples size and longer duration of study is needed to prove the consistency of the findings of this research.

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ACKNOWLEDGMENT

We would like to acknowledge Jimma University College of public health and medical sciences for the financial support and all health professionals and care takers in pediatrics department who were involved in the process of data collection of this research.