Blood glucose profile in acutely ill children, Abobo North General Hospital, Côte d'Ivoire

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Abstract

This study aimed to determine the blood glucose profile in acutely ill children admitted to a paediatric ward and to evaluate the prognosis of the association between hypoglycaemia (blood glucose < 3.3 mmol/l) or hyperglycaemia (blood glucose ≥ 6.9 mmol/l) and disease condition. A cross-sectional descriptive study was conducted from 16th June 2014 to 16th December 2014 in Abobo North General Hospital in Abidjan. Five hundred and two (502) children aged one month to fifteen years were recruited. Random capillary blood glucose (BG) level was measured in all children using a glucometer Accu-chek Active. Data were analysed by the use of STATA 13 and the Chi-square test was used for proportions analysis. The prevalence rate of hypoglycaemia and hyperglycaemia were respectively 9 and 11%. These blood glucose abnormalities in acutely ill children occurred in various disease conditions and were most common in children under five years – 4.8 % had severe hypoglycaemia (BG >2.2mmol/l) while 11.7 % had hyperglycaemia with 3.3 % reaching a BG >10 mmol/l. In hypoglycaemia, the BG levels ranged from 0.6 to 3.2 mmol/l and were most common in children aged less than five years. The mortality of children who presented on admission with a blood glucose abnormality was 4.0%. We recommend routine determination of BG levels, which may help decrease mortality linked to abnormal levels in ill children admitted to pediatric wards.

Introduction

Disturbances of glucose metabolism can occur in children without diabetes in various critical illnesses like sepsis, meningitis, malaria and malnutrition.[1,2] Determination of the blood glucose (BG) level is important as it will help decisions related to the management of hypoglycaemia or hyperglycaemia as the case might be. According to the World Health Organization (WHO) and the International Society for Paediatric and Adolescents Diabetes[3] (ISPAD), normal fasting blood glucose (BG) is defined as 3.3 to 5.5 mmol/l; with hypoglycaemia defined as a BG < 3.3 mmol/l and hyperglycaemia as a BG ≥ 6.9 mmol/l.[3]

Hypoglycaemia reflects a defect in one or more of the complex interactions that maintain blood glucose levels and may have several etiological factors. In conditions that cause increased catabolic states such as bacterial infections, the rate at which glucose appears in the blood decreases by 30-50%.[4] In resource-poor countries, poor nutritional status, infectious diseases, delay in presentation to hospital, the use of potentially toxic herbal preparations, starvation, accidental poisoning from hypoglycaemic drugs, and alcohol have all been found to be associated with hypoglycaemia.[5] Previous African studies have reported a prevalence of hypoglycaemia ranging from 3.1 % to 18.3 % in critically ill children.[4-7] Detection of hypoglycaemia is especially crucial in children because of its association with neurological damage and death.[6]

Hyperglycaemia results from processes of increased gluconeogenesis, glycogenolysis or reduced peripheral glucose utilisation.[7] Some studies have described hyperglycaemia in children with specific disease conditions such as malaria, gastroenteritis, lower respiratory tract infection and burns.[6] Detection and management of hyperglycaemia is important because of associated higher mortality rates in comparison to normoglycaemic children with similar disease conditions.[7]

In this study, our objectives were to determine the blood glucose profile in acutely ill children admitted to a paediatric ward, and to evaluate the prognosis of the relationship between hypoglycaemia or hyperglycaemia and the underlying disease conditions.

Patients and methods

This study was carried out in the paediatric inpatient unit at Abobo North General Hospital (ANGH) in Abidjan. ANGH is a secondary health care facility and serves as a referral centre for the northern part of Abidjan, the economic capital of Côte d'Ivoire.

The paediatric department is divided in three units: outpatient department (OPD), inpatient department (IPD) and preventive care unit which includes nutrition and

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Table 1: Blood glucose ranges with numbers of patients

Blood glucose (mmol/l)	Number (%)
0.6 – 2.2	24 (5%)
2.2 – 3.3	19 (4%)
3.3 – 6.9	400 (80%)
6.9 – 7.8	23 (4%)
7.8 – 10.	19 (4%)
>10.0	17 (3%)
Total	502 (100%)

immunisation subunits. The IPD has twenty five beds with five beds in an intensive care room (ICR). Children who are critically ill are admitted from the OPD unit through the intensive care room. Patients admitted to the ICR are monitored till they are stable and then transferred to another room for further medical care.

A descriptive cross-sectional study was conducted during a six month period from 16thJune 2014 to 16th December 2014. Acutely ill children aged from one month to fifteen years old admitted into the inpatient department whose parents gave consent were recruited. Exclusion criteria were lack of parental consent, the known diabetes and children who have received intravenous dextrose fluids, sugar containing drinks or eaten two hours prior to their admission.

The sample size was determined by using Kish L formula $n = z^2pq / d^2$ where n was the sample size, and p was the previous study prevalence. Osier et al[7] in Kenya found the prevalence of hypoglycaemia as 7.3% and hyperglycaemia 2.7%. (Total 10%). The minimum sample size was 276/138 for each group of cases and controls. We included 502 children in this study.

A questionnaire was used to collect data. It was pretested in another general hospital. The relevance of questions and their clarity were appreciated. The questionnaire collected a wide range of information which included socio-demographic characteristics, clinical examination findings, random capillary BG level, and patient outcome. The questionnaire was administered after initial clinical stabilisation.

The blood glucose level was measured using an Accu-chek Active glucose meter that measured levels between 0.6 to 33.3 mmol/l. Values outside this range are displayed as "Lo" meaning the result is less than 0.6 mmol/l or "Hi" meaning the result is greater than 33.3 mmol/l.

Children were categorised into three groups according to their BG levels. Normoglycaemia was defined as a BG from 3.3 to 5.6 mmol/l, hypoglycaemia less than 3.3mmol/l and hyperglycaemia a BG greater than 6.9 mmol/l. Serum BG levels in children with abnormal capillary levels were determined in the hospital laboratory in order to confirm their abnormal values. Subjects with hyperglycaemia had their glycosylated haemoglobin checked subsequently. Those with severe hypoglycaemia were immediately given intravenous 10% dextrose, 5 ml/kg slowly over five minutes as a bolus, and thereafter a maintenance infusion with 5% dextrose. BG level was checked again after fifteen minutes.

Data from the study were stored, validated and analysed using the Statistical STATA version 13. Chi-square test was used for proportional analysis. All were carried out at the level of 5 % significance. The approval of the Ethical Heath Committee of the Republic of Côte d'Ivoire was obtained.

Results

Overall 502 children were recruited – 53% male and 47% female. Ages ranged from 1 month to 15 years with a mean of 3 years and 6 months. Blood glucose disturbances were found in 20.3% of cases (Table I), 11.7% of the subjects had hyperglycaemia and 8.6% of them had 20.4% of them had hypoglycaemia on admission. In hypoglycaemia BG range from 0.6 to 3.2 mmol/l and in hyperglycaemias the range was 7.0 to 31.6 mmol/l with 3.3% above 10 mmol/l. Only two were known to have diabetes.

Blood glucose abnormalities were most common in children under five years (Figure 1). In this age group, eighty two (16%) had an abnormal blood glucose – 7% hypoglycaemia and 9% hyperglycaemia. Among older children, 1.8 % had hypoglycaemia whereas 2.2 % had hyperglycaemia.

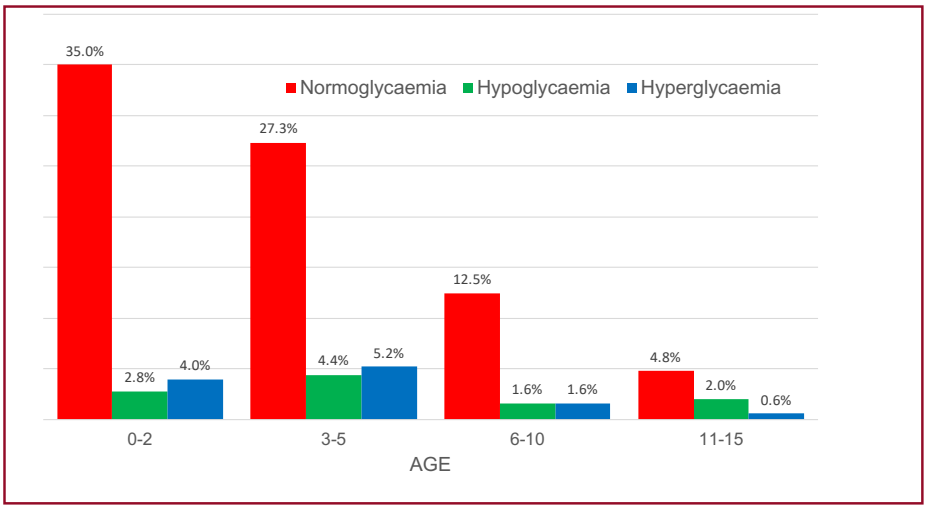
The frequencies of BG disturbances in children with various disease conditions are represented in Table 2. Hypoglycaemic episodes occurred mostly in patients with severe malaria (62%). The overall mortality rate of the study patients was 7.8%, but was 19.6% among those with an abnormal BG compared with 5.9% among those with a normal BG. These proportions were significantly different (p = 0.001). Twelve deaths occurred in the hypoglycaemic children while the remaining six were observed in the hyperglycaemic group.

Table 2: Disease types and blood glucose (BG) patterns

Disease	Normal BG	Low BG	High BG	Total
Malaria	216	28 (62%)	31 (54%)	275
Malnutrition	33	0 (0%)	2 (4%)	35
Infection	42	8 (18%)	7 (12%)	27
Hypertension	3	1 (2%)	2 (3.5%)	6
AIDS	4	0 (0%)	1 (2%)	5
Renal diseases	3	0 (0%)	0 (0%)	3
Diabetes	0	0 (0%)	2 (4%)	2
Anaemia	56	2 (4.4%)	5 (8%)	63
Hyponatraemia	4	4 (8.9%)	3 (4%)	11
Comorbidities	13	1 (2.2%)	2(3.5%)	16
Other	26	1 (2.2%)	2 (4%)	29
Total	400	45 (100%)	57 (100%)	502

Footnote: 1. Infections included those of respiratory, urinary, gastrointestinal and central nervous systems, as well as skin infections. 2. Comorbidities = patients with at least two of the other conditions listed

Figure 1. Proportions with normal, high and low blood glucose (BG) levels by patient ages



Discussion

This study shows a blood glucose abnormality in approximately one in five of acutely ill children, with a prevalence rate of hypoglycaemia and hyperglycaemia at 9% and 11% respectively. The observed hypoglycaemia rate of our study is higher than in reports from Madagascar[6] (3%) in 1 month to 15 years old children, Kenya[7] (7%) in post-neonatal children. These discrepancies may be explained by different thresholds used to define hypoglycaemia. In the Kenyan and Madagascar studies hypoglycaemia was defined as a BG less than 2.2 mmol/l.

However the prevalence rate of hypoglycaemia in this study was lower than that reported in Nigerian4 children (10%) aged from 29 days to 14 years. This finding may be explained by both the small sample size and the cut-off value of below 2.2 mmol/l defined as hypoglycaemia. Hypoglycaemia was most common in children less than five years in our study – a little lower than reported elsewhere.[5]

The prevalence of hyperglycaemia in our study was 11% – similar to that in Madagascar,[6] but higher than some other studies;[7,8] though definitions of hyperglycaemia do vary between reports.

As elsewhere, our patients with blood glucose disturbances had a variety of underlying diseases. However, 62% of hypoglycaemic events occurred in children with severe malaria – similar to a figure of 47% from another African study.[9]

In this study, the overall mortality rate among acutely ill children admitted to our ward was 7.8%. A statistically significant relationship was found between blood glucose level and patient outcome. Indeed, the mortality rate in patients with BG disturbances was three times higher than that observed in those with no disturbances, with more children dying among the hypoglycaemic than the hyperglycaemic group. This finding is similar to that reported in the Kenyan study.[7] However, a higher mortality rate was observed among hyperglycaemic children in the Kenyan and Madagascar6 studies where a mortality rate was found of 14% and 13% respectively.

We conclude that BG glucose disturbances occur frequently in acutely ill children with various disease conditions admitted to hospital. Hypoglycaemia is most common in small children less than five years, and carries a higher mortality risk.

Routine determination of blood glucose level in sick children admitted to paediatric wards may help to decrease the mortality rate linked to blood glucose disturbances.

Author declaration

The authors confirm that they have no competing interests to declare; that no animals were used in the research, and that informed consent was obtained from patients (documentary evidence on this provided to the publisher).

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