Prevalence of hypoglycemia among severe malaria children in a rural African population

Osonuga OA[1,2], Osonuga AA[3], Osonuga IO[4], Osonuga A[2*], Derkyi Kwarteng L[2]

[1]Department of Pharmacology, Olabisi Onabanjo University, Remo Campus, Nigeria

[2]School of Medical Sciences, University of Cape−coast, Ghana

[3]Department of Nursing, University of Cape−coast, Ghana

[4]Department of Physiology, Olabisi Onabanjo University, Remo Campus, Nigeria

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ABSTRACT

Objective: To determine the prevalence of hypoglycemia in severe malaria children in a rural African community. **Methods:** Thirty two children who fulfilled the inclusion criteria were recruited for the study from two hospitals with intensive care facilities. Blood sugar levels of the patients were monitored serially at admission and then every 4 hours (after admission) for 24 hours using a glucometer; taking values <2.2 mmol/L as hypoglycemia. The children received intensive care according to WHO guidelines for severe malaria. **Results:** Fifteen out of 32 children recruited (representing 46.9%) had hypoglycemia with about 60% under 5 years of age. The mean age of the children was (4.49 ± 2.89) years. The pre−correction and average post correction blood glucose levels were (2.04 ± 0.13) mmol/L and (3.18 ± 0.23) mmol/L, respectively. **Conclusions:** The result has demonstrated that about 1 in 2 children with severe malaria may suffer from hypoglycemia in an African rural environment hence there is a need for at least three−point glucose estimation (at recruitment, 4 hours following correction and the end of the 24 hours).

1. Introduction

Malaria continues to be a major global health problem, with over 40% of the world′s population (more than 2 400 million people) exposed to varying degrees of malaria risk in some 100 countries in Africa, Asia, central America, Oceania and south America.

It causes more than one million deaths worldwide each year, and over 90% of them occur in Africa. Severe malaria is caused by *Plasmodium falciparum* infection and usually occurs as a result of delay in treating an uncomplicated attack of falciparum malaria. In children, it could however develop rapidly[1−4].

Severe malaria is approximately 1%−2% of clinical attacks of malaria in African children. About 1−2 million deaths occur mostly in young children (under 5 years) with a child dying every 30 seconds. Hence it is a medical emergency to require specialist care[4,5].

Hypoglycemia (blood glucose <2.2 mmol/L) has been identified as an independent risk of death in children presenting with severe malaria along with coma, repeated convulsions, shock, and hyperparasitemia. In Africa, 153 000−267 000 malaria related deaths are attributed to hypoglycemia. Generally, 8% of adults, 30% of children and 50% of pregnant women in late pregnancy develop hypoglycemia. Sudden unexplained deterioration in a patient with severe falciparum malaria is commonly due to hypoglycemia. It is easily overlooked clinically because the manifestations may be similar to those of cerebral malaria[6−8].

Since studies in African children with uncomplicated malaria cannot be extrapolated to children with severe disease hence[9], this study seeks to find out the prevalence of hypoglycemia in severe malaria cases among Nigerian children on the day of hospital admission.

2. Materials and methods

2.1. Patients

A total of 32 patients were recruited from Overcomers Specialist Hospital, Ilishan and General Hospital Ikenne, Ikenne local government area of Ogun State, Nigeria. The

*Corresponding author: Osonuga Ayokunle, School of Medical Sciences, University of Cape coast, Ghana.
      E−mail: overcomers2007@yahoo.com

hospitals have facilities for resuscitating and handling emergency.

Patients who satisfied inclusion criteria (see below) were admitted for estimation of blood glucose and treatment in the ward. On enrolment, a brief history was obtained from accompanying adult (which may be the parent or guardian) and clinical examination was performed.

Ethical and parental approval for the study was obtained from Olabisi Onabanjo University Teaching Hospital, Nigeria, Joint Ethical Review Committee and informed consent from the parents or guardians.

Inclusion criteria: (1) Children from either sex with age ranging from 1 year to 12 years; (2) Fever with temperature higher than 37.5 ℃ within the last 24 hours; (3) Presence of convulsion, vomiting, hypoglycemia, anemia and headache; (4) Informed consent obtained from the parents and guardians; (5) Assurance that patients will be resident within catchments of study for follow−up; (6) Absence of concomitant illness such as bronchopneumonia, typhoid, meningitis, urinary tract infection; (7) Absent history of administration of antipyrexia; (8) The Blantyre coma score of <3.

Exclusion criteria: (1) History of blood transfusion in the last two months; (2) Presence of concomitant illness; (3) History of previous allergy to quinine and artemether; (4) Lack of informed consent.

Withdrawal criteria: (1) If any concomitant illness developed during the study; (2) If informed consent is withdrawn by parents or guardian; (3) If patient (or parents/guardian) is unwilling to continue in the study; (4) Failure to comply with protocol.

2.2. Blood sugar monitoring

Blood sugar level was monitored upon arrival of the patient by using a digital glucometer. Hypoglycemia was defined as blood glucose level < 2.2 mmol/L. Prompt correction of hypoglycemia (in children who were hypoglycemic) was done by infusion of 50% dextrose at a dose of 1.0 mL/kg b.w. to the child, diluted in an approximately equal volume of normal saline infusion fluid over a period of about 5 minutes. This was followed with a continuous intravenous infusion of 5% glucose fluid. Serial monitoring was done every 4 hours on the day of admission. The blood glucose level upon admission and the average values (post correction) over a period of 24 hours were recorded.

Standard treatment protocols for treating severe malaria children were employed for the treatment of other symptoms.

2.3. Statistical analysis

All calculations were done using the SPSS−V15 statistical software package for analysis of the data. The data were presented as Mean±SD, and statistical analysis was carried out using the student's paired t−test and ANOVA. Differences were considered to be statistically significant at an error probability of less than 0.05 ($P \leqslant 0.05$).

3. Results

Fifteen out of 32 children recruited (representing 46.9%) had hypoglycemia with about 60% were under 5 years of age. Table 1 showed the pattern of their blood sugar levels at enrollment and the average values obtained for blood glucose after correction with glucose infusion. The mean age of the children was (4.49±2.89) years. The pre−correction and average post correction blood glucose levels were (2.04±0.13) mmol/L and (3.18±0.23) mmol/L, respectively. P value less than 0.05 was significant.

4. Discussion

Effort in this study was to evaluate the prevalence of hypoglycemia in children presenting with severe malaria on hospital admission.

The mechanism of hypoglycemia in severe malaria is unknown. Impaired hepatic gluconeogenesis (even in the presence of needed substrate *e.g.* glycerol and alanine), increasing metabolic demands of the host and the parasite are thought to be probable causes[6,10]. In our study, 46.9% of the children were hypoglycemic. This supports work done previously by other researchers who identified hypoglycemia as one of the common features of severe malaria in children (independent of quinine induced hypoglycemia)[11,12]. However, an Indian study concluded that hypoglycemia is observed in up to 30% of cases[13]. This disparity may be

Table 1
Pattern of hypoglycemia among severe malaria children at recruitment and after correction.

Age (months/years)	Blood sugar level (at enrolment)*	Average blood sugar level (post−correction)*
12.0**	1.8	3.00
13.0**	2.0	3.00
15.0**	2.1	2.80
2.0	1.8	3.00
2.5	2.0	3.20
3.0	2.0	3.00
3.5	2.0	3.10
4.0	2.1	3.30
4.5	2.2	3.10
5.0	2.0	3.20
6.0	2.2	3.06
6.5	2.2	3.50
8.0	2.0	3.60
9.0	2.2	3.50
10.0	2.0	3.40

*: Blood glucose < 2.2 mmol/L was considered as hypoglycemia. **: Age in months.

attributed to late presentation of patients to the hospital in most rural Nigerian communities as well as few referral hospitals in the rural areas that can handle such pediatric emergency. Also, there is usually a history of prolonged vomiting, anorexia and forceful feeding with native medication (rampant among rural dwellers). Other newer studies have also reported associated risk of hypoglycemia in severe malaria to starvation[14,15].

Hypoglycemia being associated with higher risk of death as well as being an inclusive criteria for severe malaria, deserves close monitoring unlike other parameters commonly monitored in severe malaria treatment such as parasitemia clearance, temperature and PCV which are usually done on day 0, 3 and 14[16].

Age also had an impact on hypoglycemia presentation in the children with severe malaria studied. 60% of the children with hypoglycemia were under 5 years. This is in agreement with the findings of other researchers that indicated that hypoglycemia is more common in younger children than older ones[15,17–21].

The burden of hypoglycemia is multifactorial as it can worsen convulsion and may deepen coma in children with cerebral malaria making recovery and prognosis very poor[22–27]. The hypoglycemic children were offered prompt glucose correction. No patient had hypoglycemia after 24 hours of correction.

The result has demonstrated that about 1 in 2 children with severe malaria may suffer from hypoglycemia in an African rural environment where there is dearth of health care practitioners with specialist training, paucity of investigation and facilities, poor environmental sanitation, lack of door and window netting. All these factors contribute to high severe malaria burden. Since hypoglycemia has been identified as a common feature of severe malaria, there is a special need for serial monitoring and management of blood glucose. The study has demonstrated the need for at least three–point glucose estimation (at recruitment, 4 hours following correction and the end of the 24 hours) in such communities.

Conflict of interest statement

We declare that we have no conflict of interest.

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