



# **WESTERN NIGERIA JOURNAL OF MEDICAL SCIENCES (WNJMS)**

**DETERMINANTS AND OUTCOME OF DYSGLYCAEMIA IN A CHILDREN EMERGENCY  
WARD, SOUTH-WEST NIGERIA**

## DETERMINANTS AND OUTCOME OF DYSGLYCAEMIA IN A CHILDREN EMERGENCY WARD, SOUTH-WEST NIGERIA

Ayeni TO<sup>1</sup>, Oseni SBA<sup>2</sup>, Oluwayemi IO<sup>3</sup>, Adebami OJ<sup>1</sup>, Olaitan PB<sup>4</sup>, Oyedeji GA<sup>2</sup>

1. Department of Paediatrics, College of Health Sciences, Osun State University, Osogbo, Nigeria.
2. Department of Paediatrics, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria.
3. Department of Paediatrics, Ekiti State University, Ado-Ekiti, Nigeria.
4. Department of Surgery, UNIOSUN Teaching Hospital, Osogbo, Nigeria

**Correspondence to:** Adebami OJ, Department of Paediatrics and Child Health, College of Health Sciences, Osun State University, Osogbo, Nigeria. Telephone: +234 (0) 8037115347; Email: [olusegun.adebami@uniosun.edu.ng](mailto:olusegun.adebami@uniosun.edu.ng)

### ABSTRACT

**Introduction:** Dysglycaemia is an abnormal blood glucose concentration. It is not uncommon in acutely ill children and could lead to significant preventable complications. This study evaluates its determinants and outcome in a children emergency ward.

**Method:** The study was carried out at the Children Emergency Unit of LAUTECH (now UNIOSUN) Teaching Hospital, Osogbo. One hundred and one consecutive ill children, aged one month to 14 years were studied. At admission, blood glucose was determined. Patients were managed and followed up to determine duration of hospital admission and immediate outcomes.

**Results:** 56 (55.4%) were males and 45 (44.6%) were females, giving a male: female ratio of 1.24: 1. The mean ages of the patients was 40.83 (3.65) months. The blood glucose of the patients ranged from 1.60 to 10.20mmol/L with a mean of 5.19 (1.42) mmol/L. Eleven (10.9%) of the patients had dysglycaemia comprising 3 (27.3%) with hypoglycaemia and 8 (72.7%) with hyperglycaemia. The remaining 90 (89.1%) patients had normoglycaemia. Of the 3 patients with hypoglycaemia, severe malaria was the commonest diagnosis, while respiratory infection was the commonest

among the 8 patients with hyperglycaemia. The mean duration of admission was longest among patients with hyperglycaemia. Four (4.5%) of the 90 patients with normoglycaemia had varying complications, the outcome is worse in patients with hypoglycaemia compared to those with normoglycaemia ( $p=0.012$ ).

**Conclusion:** In conclusion, dysglycaemia occurred among acutely ill children with prevalence of 10.9%. Worsening morbidity could be associated with dysglycaemia. There was apparent poorer outcome in patients with hypoglycaemia.

**Keywords:** Dysglycaemia, Hypoglycaemia, Hyperglycaemia. Children Emergency. Nigeria

### INTRODUCTION

Dysglycaemia is an abnormal blood glucose level which can be hypoglycaemia (below normal levels) or hyperglycaemia (above normal levels).<sup>1,2</sup> Hypoglycaemia is a metabolic disorder for which there is usually an underlying cause. It is the commonest metabolic problem occurring among critically ill paediatric patients.<sup>3</sup> These children have anorexia with refusal of feeds and are in catabolic state as natural feature of the illness.

Hypoglycaemia is currently defined as plasma glucose below 2.5mmol/L or whole blood glucose level below 2.2mmol/L.<sup>4,5</sup> Studies have shown that patients suffering from severe malaria and other disease conditions who have hypoglycaemia experience poor outcome.<sup>6,7</sup> Thus, the WHO guidelines stipulate blood glucose levels less than 2.5mmol/L as threshold for treatment of hypoglycaemia in children with severe illnesses.<sup>7</sup> The prevalence of hypoglycaemia among infants and children who are ill enough to require hospital admission in rural Africa, is reported to be 7.3%.<sup>8,9</sup>

Children living in the tropics are particularly prone to developing hypoglycaemia in a wide variety of diseases, including malnutrition, endemic malaria and other infectious diseases.<sup>6,10-13</sup> The developing brain of a child is more susceptible to the ill effects of hypoglycaemia in comparison to an adult's and it is particularly severe in neonates and infants.<sup>1,12</sup> Hypoglycaemia is associated with poor prognosis and long-term neurological damage.<sup>9</sup>

Hyperglycaemia is blood glucose above 7.0mmol/L.<sup>14-16</sup> It is relatively frequent during severe illnesses.<sup>1</sup> It is a form of metabolic dysregulation in response to stress in critically ill patients. Abnormal blood glucose level manifesting as hyperglycaemia in critically ill patients increases morbidity and mortality. Data on hyperglycaemia in children in the tropics is scarce. There is paucity of studies on prevalence and dangers of dysglycaemia in severely ill children in the developing countries and more so in Nigeria, hence the need for the present study.

## METHODS

The study was a cross-sectional descriptive study between August 2017 and July 2018. Ethical clearance for the study was obtained from the Human Research and Ethics Committee of LAUTECH (now UNIOSUN) Teaching Hospital, Osogbo (LTH/REC/2016/03/16/265). Sample size determination was by using the formula for calculating proportion by Leslie-Fischer.<sup>17</sup>  $n =$

$\frac{Z^2pq}{d^2}$  The sample size was increased from the calculated minimum of 92 to 101 patients by adding 10% of this (9.2) to make allowance for possible attrition.

Detailed history and examination of the patients requiring admission into the CEU were done and recorded in a specially designed proforma for the study. On admission before the commencement of fluid therapy, estimation of blood glucose was carried out for each patient using a portable hand-held glucometer (Roche Diagnostics, Mannheim Germany).<sup>18</sup> Treatment of the specific diseases in the study patients were carried out in line with unit protocols. Treatment of hypoglycaemia<sup>19,20</sup> was by immediate administration of bolus of 10% dextrose water infusion 0.25g/kg (2.5mls/kg) and then maintained on intravenous infusion of 10% dextrose water at 8-10 mg/kg/minute (0.08-0.1ml/kg/min). Blood glucose check was repeated at 15 minutes after the bolus had been given while the maintenance glucose was running and a repeat bolus of 0.25g/kg (2.5mls of 10% dextrose water) was administered where the blood glucose remained below 2.5mmol/L. Glucose infusion was adjusted based on glucose values obtained subsequently and ability of the patient to feed such that the plasma glucose was maintained in the normal range. For patients with blood glucose above 7mmol/L but less than 11.1mmol/L, 4.3% dextrose saline was administered and the blood glucose was monitored half hourly to ensure reduction in blood glucose to normal level.

Each child was followed up for the period of admission to determine the immediate outcome of admission in the emergency room or children's ward. The immediate outcome of management of each child was documented as discharged home well, discharged with complications, discharged against medical advice (DAMA), referred/transferred or dead as the case was. The duration of admission at discharge or death and final diagnosis were also recorded.



The data was analyzed using the IBM SPSS software version 20.0. The normoglycaemic subjects were used as internal controls for determining the risk factors significantly associated with hypoglycaemia or hyperglycaemia and comparing outcomes in those found to have dysglycaemia. Statistical significance was set at p value less than 0.05 for all statistical test values.

## RESULTS

Of the 101 children, 56(55.4%) were males and 45(44.6%) females, giving a male: female ratio of 1.24: 1. The ages of the subjects ranged from 1.4 to 168 months with a mean (SD) of 40.8 (3.65) months. Eighty-two (81.2%) of the patients were aged five years and below, 15 (14.9%) aged above five years to 10 years, and 4 (4.0%) aged above 10 years and 14 years.

The blood glucose of the patients ranged from 1.60mmol/L to 10.20mmol/L with a mean (SD) of 5.19 (1.42) mmol/L. Of the 101 patients, 90 (89.1%) had normoglycaemia with blood glucose levels ranging from 2.70mmol/L to 7.0mmol/L and mean (SD) of 5.03 (1.0mmol/L). Eleven (10.9%) had dysglycaemia. Of the 11 patients with dysglycaemia, 3(27.3%) patients with

hypoglycaemia with blood glucose ranging from 1.60mmo/L to 2.10mmol/L and mean (SD) of 1.90 (0.26) mmol/L and 8 (72.7%) had hyperglycaemia with blood glucose ranging from 7.10mmol/L to 10.20mmol/L and mean (SD) of 8.15 (1.05) mmol/L. None of the patients had diabetes mellitus.

Nine (81.8%) of the 11 patients with dysglycaemia and 73 (81.1%) of the 90 patients with normoglycaemia were aged between one month and five years old. There was no significant age, or gender difference between children who had dysglycaemia and those with normoglycaemia (p at least 0.083 respectively). Concerning hypoglycaemia, there was no significant age and gender difference between children who had hypoglycaemia and those with normoglycaemia p = 0.871.

Table I shows the distribution of patients with hyperglycaemia compared to those with normoglycaemia in relation to their ages and gender. Six(75%) of the patients with hyperglycaemia were aged five years and below compared to 73(81.1%) among the normoglycaemic patients.

**Table 1: Distribution of Patients with Hyperglycaemia Compared to Those with Normoglycaemia in Relation to their Ages and Gender.**

Variables	Patients with Hyperglycaemia n (%) n = 8	Patients with Normoglycaemia n (%) n = 90	$\chi^2$	P value
Age (in years)				
< 1	2 (25)	22 (24.4)	0.949	0.813
1-5	4 (50)	51 (56.7)		
> 5-10	2 (25)	13 (14.4)		
> 10	0 (0.0)	4 (4.4)		
Gender				
Male	4 (50)	51 (56.7)	0.133	0.716
Female	4 (50)	39 (43.3)		

**Table 2: Comparison of the diseases in patients with hypoglycaemia and patients with normoglycaemia**

Diseases	Patients with Hypoglycaemia n (%) n = 3	Patients with Normoglycaemia n (%) n = 90	Statistics*
<b>Uncomplicated malaria</b>			$\chi^2 = 0.068$ df = 1
Present	0 (0.0)	2 (2.2)	p = 0.794
Absent	3 (100.0)	88 (97.8)	
<b>Severe malaria</b>			$\chi^2 = 3.446$ df = 1
Present	2 (66.7)	19 (21.1)	p = 0.063
Absent	1 (33.3)	71 (78.9)	
<b>Septicaemia</b>			$\chi^2 = 3.712$ df = 1
Present	1 (33.3)	5 (5.6)	p = 0.054
Absent	2 (66.7)	85 (94.4)	
<b>Respiratory infections</b>			$\chi^2 = 0.165$ df = 1
Present	0 (0.0)	25 (26.7)	p = 0.685
Absent	3 (100.0)	65 (73.3)	
<b>Sickle cell anaemia**</b>			$\chi^2 = 0.596$ df = 1
Present	0 (0.0)	15 (16.6)	p = 0.440
Absent	3 (100.0)	75 (83.0)	
<b>Diarrhoea disease</b>			$\chi^2 = 0.176$ df = 1
Present	0 (0.0)	5 (5.6)	p = 0.675
Absent	3 (100.0)	85 (94.4)	
<b>Meningitis</b>			$\chi^2 = 0.103$ df = 1
Present	0 (0.0)	3 (3.3)	p = 0.748
Absent	3 (100.0)	87 (96.7)	
<b>Seizure disorder</b>			$\chi^2 = 0.103$ df = 1
Present	0 (0.0)	3 (3.3)	p = 0.748
Absent	3 (100.0)	87 (96.7)	
<b>Failure to thrive</b>			$\chi^2 = 0.068$ df = 1
Present	0 (0.0)	2 (2.2)	p = 0.794
Absent	3 (100.0)	88 (97.8)	
<b>Marasmus</b>			$\chi^2 = 0.068$ df = 1
Present	0 (0.0)	2 (2.2)	p = 0.794
Absent	3 (100.0)	88 (97.8)	
<b>Musculoskeletal infections***</b>			$\chi^2 = 0.068$ df = 1
Present	0 (0.0)	2 (2.2)	p = 0.794
Absent	3 (100.0)	88 (97.8)	
<b>Others****</b>			$\chi^2 = 0.252$ df = 1
Present	0 (0.0)	7 (7.8)	p = 0.615
Absent	3 (100.0)	83 (92.2)	

\*Yates correction applied

\*\*The patients had co-morbidities such as septicaemia, vaso occlusssive crisis, hyperhaemolytic crisis, stroke, malaria, pneumonia, severe anaemia and kwashiorkor

\*\*\*One each of pyomyositis and acute osteomyelitis.

\*\*\*\*\*One each of snake bite, stroke syndrome, valvular heart disease, with heart failure, acute asthma, drug ingestion, kerosene ingestion and aspiration pneumonitis.

The duration of illness before presentation of all the patients studied ranged between 1 hour to 6 months with a mean (SD) of 8.58(2.29) days. The mean (SD) duration of illness in patients with hypoglycaemia, hyperglycaemia and normoglycaemia were 5.00 (1.15), 3.56

(0.95), and 9.14 (2.57) days respectively. The difference in the means of duration of illness between normoglycaemia and hypoglycaemia or hyperglycaemia was not statistically significant {p>0.05}.

All (100%) of the hypoglycaemic and 87.5% (7 of 8) hyperglycaemic subjects had fever (>37.5 celcius). The presence of fever at

presentation in patients with hypoglycaemia and hyperglycaemia compared to patients with normoglycaemia was not statistically significant ( $p = 0.313, 0.411$  respectively). Six (54.5%) of the eleven patients with dysglycaemia, comprising 2 (66.7%) of 3 hypoglycaemic, and 4 (50%) of 8 hyperglycaemic patients had convulsions at presentation. The difference in proportion of patients who convulsed was statistically significant ( $p = 0.027$ ).

One each of patients with hypoglycaemia (33.3%) and hyperglycaemia (12.5%) were unconscious at presentation while 10 (11.1%) normoglycaemic patients were unconscious. The difference in the proportion of patients with normoglycaemia that presented unconscious and that of hypoglycaemic and hyperglycaemic patients respectively was not statistically significant ( $p$  values = 0.241 and 0.905).

The three diseases most frequently diagnosed in the 101 study patients were respiratory infections 28 (27.7%), malaria 25 (24.8%), and sickle cell anaemia 17 (16.8%). These accounted for 69.3% of the diagnoses. The leading disease associated with dysglycaemia was malaria, 36.4% (4 of 11). Out of the 25 patients diagnosed with malaria, 22 (88.0%) had severe malaria (malaria complicated with features such as severe anaemia, prostration, haemoglobinuria, multiple convulsions or cerebral malaria e. t. c). However, differences in frequency of occurrence of the diseases between patients with dysglycaemia and their normoglycaemic counterparts were not statistically significant.

Table 2 Shows the diseases diagnosed in patients with hypoglycaemia compared with patients with normoglycaemia. Severe malaria and septicaemia were the diseases diagnosed among patients with hypoglycaemia. Two (66.7%) of 3 patients with hypoglycaemia had severe malaria compared with 19 (21.1%) of 90 patients with normoglycaemia that had severe malaria. There was no statistically significant difference in the frequency of occurrence of

the various disease diagnoses between hypoglycaemic and normoglycaemic patients.

#### **Comparison of the diseases diagnosed in patients with hyperglycaemia and patients with normoglycaemia**

Three (37.5%) had respiratory infections compared with 25 (27.8%) of the 90 patients with normoglycaemia who had respiratory infection and two (25.0%) had sickle cell anaemia as compared to 15 (16.7%) of the normoglycaemic patients. There was no statistically significant difference between the normoglycaemic and hyperglycaemic patients in the frequency of occurrence of various diseases indicated.

#### **Comparison of the diagnoses in patients with hypoglycaemia and hyperglycaemia**

Severe malaria was diagnosed in two patients with hypoglycaemia and in one patient with hyperglycaemia. There was no statistically significant difference between the hypoglycaemic and hyperglycaemic patients in the frequency of occurrence of various diseases diagnosed.

#### **Comparison of duration of admission between patients with normoglycaemia and hypoglycaemia or hyperglycaemia and between hypoglycaemia and hyperglycaemia**

The patients with normoglycaemia had a duration of admission that ranged between six hours and 23 days with a mean (SD) of 6.25 (0.44). Also there was no statistically significant difference in the means of duration of admission between patients with hypoglycaemia and those with hyperglycaemia ( $p = 0.442$ ).

#### **Outcome of Management of the Study Patients**

Three (3.0%) patients died among the 101 study patients.

#### **Comparison of Outcome of Management between patients with hypoglycaemia and hyperglycaemia**

One patient with hypoglycaemia who had septicaemia died while one patient with

hyperglycaemia who had sickle cell anaemia had complication (neurologic deficit) at discharge. Six (85.7%) of the patients with hyperglycaemia were discharged home well and one patient discharged against medical advice. Though one (33.3%) out of the three patients with hypoglycaemia died, the difference in outcome of management between patients with hypoglycaemia and hyperglycaemia was not statistically significant ( $p = 0.240$ ).

As shown in Table 3, among the normoglycaemic patients, 82 (93.2%) were discharged home well, two (2.3%) with diarrhoea disease and respiratory infection died while four (4.5%) diagnosed with sickle cell anemia, meningitis, stroke syndrome and marasmus respectively had various neurologic complications at discharge. The difference in the proportion of patients with poor outcome between patients with hypoglycaemia and those with normoglycaemia was statistically significant ( $p = 0.012$ ).

### Outcome of Management of Patients with Hyperglycaemia compared with Normoglycaemic Patient

Among the patients with hyperglycaemia, one (14.3%) patient diagnosed with sickle cell anaemia had complication of quadriplegia while two (2.3%) patients diagnosed with diarrhoea disease and respiratory infection each respectively died among the remaining

88 patients with normoglycaemia and four (4.5%) diagnosed with sickle cell anemia, meningitis, stroke syndrome and marasmus respectively had various neurologic complications at discharge. The comparison of the outcome of management between patients with hyperglycaemia and patients with normoglycaemia showed no statistically significant difference ( $p = 0.505$ ).

## DISCUSSION

The prevalence of dysglycaemia in the present study was 10.9%. Thus, in line with other reports, abnormal blood glucose concentration is a fairly common occurrence in children with acute illnesses in this locality and constitutes a significant health burden.<sup>9,10</sup> The observed prevalence rate of dysglycaemia in the present study is lower than in reports from Madagascar (34.1%) and Cote d'Ivoire (20.3%) but comparable to rate of 10% reported from Kenya.<sup>1,10,21</sup> The much larger population studied in Madagascar and Cote d'Ivoire and the different thresholds used to define abnormal blood glucose concentrations in both studies probably accounted for the higher prevalence rate reported.<sup>1,2,21</sup> In the Madagascar study,<sup>1</sup> dysglycaemia was defined to be any blood glucose level lower than 4.4 mmol/L or higher than 8.6 mmol/L while in the Cote d'Ivoire study,<sup>21</sup> blood glucose values below 3.3 mmol/L or above 6.9 mmol/L were regarded as abnormal glucose concentrations.

**Table 3:** Comparison of Outcome management Between Patients with Hypoglycaemia and Normoglycaemia

Outcome	Patients with Hypoglycaemia n (%) n = 3	Patients with Normoglycaemia n (%) n = 88	$\chi^2$	p value
Dead	1 (33.3)	2 (2.3)	8.847	<b>0.012</b>
Complications	0 (0.0)	4(4.5)		
Well	2 (66.7)	82 (93.2)		

In the present study, patients with dysglycaemia were found to be five years and below. Age has been observed to be an

important demographic risk factor for hypoglycaemia.<sup>3,12</sup> The highest incidence of hypoglycaemia occurs in young children and decreases with increasing age, being very rare

in adolescents.<sup>12</sup> The prevalence of hypoglycaemia among age group of one month to five years agreed with the finding in other studies in which hypoglycaemia was predominant in the under-five children<sup>10,22</sup> In an earlier study in Lagos Nigeria, The highest prevalence of hypoglycaemia occurred in children aged 1-3years while in Kenya, Osier *et al.* reported highest prevalence in children aged 2- 4years.<sup>9,22</sup> The peculiarity of glucose metabolism in under-five age group could account for this.<sup>10,23</sup> This peculiarity includes reduction in glucose derivable from glycogenolysis and gluconeogenesis during periods of increased metabolic demands.<sup>24</sup> Furthermore, poor intake, vomiting and diarrhoea associated with illnesses also predispose these patients to hypoglycaemia. Moreover, in the present study, children aged five years and below tended to be more ill and so required admission as they constituted 78.2% of the study population.

Malaria was the commonest cause of hypoglycaemia in the present study. Two (66.7%) out of the three patients with hypoglycaemia in the present study, were diagnosed with severe malaria comprising cerebral malaria and severe anaemia. This showed that malaria was a common cause of hypoglycaemia in ill children. This agreed with what Solomon *et al*<sup>24</sup> found in Mozambique. It was also similar to the report by Elusiyan *et al*<sup>10</sup> in Ile Ife in which 44% of the patients with hypoglycaemia had severe malaria. The present study showed that hypoglycaemia complicated 7.2% of all cases of malaria which was comparable to what was found in Tanzanian, Mozambican and Nigerian<sup>10</sup> children.<sup>10,24,25</sup> Differences in inherent factors in the individual patients such as time of last meal before presentation in the hospital, nutritional status of patient and duration of illness before presentation may account for the observed differences in the prevalence of hypoglycaemia among patients with malaria.

The pathogenesis of hypoglycaemia in severe malaria is multifactorial. Various mechanisms such as increased glucose consumption by the host and the parasite leading to depletion of

blood glucose<sup>47</sup> variable depletion of hepatic glycogen due to starvation and cytokine-induced impairment of hepatic gluconeogenesis and/or increased peripheral utilization of glucose as a result of increased anaerobic glycolysis, have been suggested.<sup>11,26,27</sup>

In the present study, the second most common diagnosis associated with hypoglycaemia was septicaemia. Similarly, Elusiyan *et al.* in their study reported septicaemia as the second most frequent diagnosis associated with hypoglycaemia after malaria.<sup>10</sup> Hypoglycaemia has been documented to occur in bacteria sepsis and the pathogenesis of hypoglycaemia in septicaemia is multifactorial often with overlapping pathways.<sup>7</sup> Productions of endotoxin may stimulate secretion of insulin causing, among other things, inhibition of gluconeogenesis which may be responsible for the hypoglycaemia in bacteria sepsis.<sup>7</sup> Consumption of glucose by microorganisms and depletion of glycogen stores without replenishments in the presence of vomiting, anorexia and diarrhoea are other pathways of blood glucose reduction in septicaemia. There was no statistically significant association between the occurrence of fever on admission and hypoglycaemia. This may be because of the high number of patients that had fever among the study patients.

Respiratory tract infection was the leading diagnosis among patients with hyperglycaemia, followed by sickle cell anaemia, and malaria. There was overlap in the associated illnesses among the patients with hypoglycaemia and hyperglycaemia. The reason for this is not clear. The association of fever with hyperglycaemia when compared with proportion of patients with normoglycaemia who had fever at presentation was not statistically significant ( $p = 0.4111$ ). The reason may be because of the high number of patients that had fever in the present study. In Madagascar, fever was reported to be associated with hyperglycaemia.<sup>1</sup> Increased cytokines like interleukin-1 or tumour necrosis factor during febrile illness have been suggested to be



responsible for increased secretions of cortisol and inhibition of insulin release leading to hyperglycaemia.<sup>10</sup>

In the present study, there was a statistically significant association between convulsion and dysglycaemia ( $p = 0.027$ ). While hypoglycaemia can cause convulsions due to neuroglycopenia, hyperglycaemia can be a stress response in patients with convulsion. Convulsion was associated with hyperglycaemia as four (50.0%) of the eight patients with hyperglycaemia presented with convulsions. Probably the increased stress and metabolic demand during a convulsive episode induce increased release of the stress hormone with resultant increase in blood glucose. This was however not statistically significant;  $p = 0.097$ . In Madagascar, convulsions were more frequent among patients with hyperglycaemia than normoglycaemia which is comparable to the finding in this study.<sup>1</sup>

We found an increased prevalence of hypoglycaemia with duration of illness of more than three days before admission. However, no statistically significant difference was observed between duration of illness before presentation and the occurrence of hypoglycaemia. It is understandable that the longer the duration of illness, the more the likelihood of development of hypoglycaemia as glycogen stores gets depleted in the events of poor oral intake that accompany many illnesses. Similar observation was made by Elusiyan *et al.* in their study.<sup>10</sup> Conversely, there was increased prevalence of hyperglycaemia with presentation within three days of onset of illness. This could be reflective of the effect of stress hormones that are elevated during acute illnesses which counter regulatory effect of insulin on glucose metabolism. Counter regulatory hormones (growth hormone, glucagon, cortisol and catecholamine) and inflammatory cytokines promote lypolysis and proteolysis, and consequently gluconeogenesis; hepatic insulin resistance prevails and there is abundant endogenous production of glucose despite elevated glucose levels.<sup>28</sup> No literature was found on the effect of duration of illness

and hyperglycaemia. More studies may be needed in this direction.

Convulsion was frequent among patients with hypoglycaemia compared with normoglycaemia but the difference was not statistically significant ( $p = 0.087$ ). The reason for this may not be far-fetched as it is known that hypoglycaemia with consequent neuroglycopenia can cause convulsion in children.<sup>3</sup> Cerebral glucose uptake occurs through a glucose transporter molecule (which are carrier mediated) that facilitate the diffusion process along the concentration gradient.<sup>3</sup> Cerebral and cerebrospinal fluid (CSF) uptake of glucose are not regulated by insulin hence when hypoglycaemia occur, cerebral glucose uptake will be impaired.<sup>20</sup> Therefore, hypoglycaemia should be considered a medical emergency, and treated promptly and aggressively especially in acutely ill children.

In contrast to what was reported in Madagascar and Kenya, there was no association of increased risk of death in patients with hyperglycaemia.<sup>1,9</sup> This might partially be as a result of early presentation of patients with hyperglycaemia in the hospital and prompt intervention. Out of the three patients who had hypoglycaemia, one (33.3%) diagnosed with septicaemia died and two (66.7%) were discharged well. The hypoglycaemic patient that died stayed for less than four hours on admission. There was statistically significant difference in the outcome of patients with hypoglycaemia and that of the patients with normoglycaemia ( $p = 0.012$ ). Hypoglycaemia occurs in acutely ill patients and could on its own be used as an index of severity of illness, which can portend a poor outcome. The mortality recorded in this patient might not be solely due to hypoglycaemia. The severity of the illness in the patient on its own could have led to death of the patient with or without hypoglycaemia.

Patients with hyperglycaemia did not show any statistically significant differences in their outcomes when compared with patients with normoglycaemia in the present study.

## Limitation

The small number of patients with dysglycaemia is a disadvantage to making firm conclusions. A study with larger population would have been more revealing and conclusive.

## CONCLUSION

Dysglycaemia is a common metabolic problem in acutely ill children aged five years and below. Acutely ill children in the early days of their illness are likely to have hyperglycaemia while hypoglycaemia tends to occur with longer duration of illness before admission. Children with dysglycaemia are at increased risk of convulsions. Age, duration of illness, malaria and occurrence of convulsions are determinants of dysglycaemia in acutely ill children. Children with hypoglycaemia tend to have poorer outcome.

## Recommendation

Blood glucose monitoring should be routine in all cases where children present with acute illnesses and abnormality, if identified, should be promptly treated.

## REFERENCES

1. Sambany E, Pussard E, Rajaonarivo E, Raobinjaona H, Barennes H. Childhood Dysglycemia: Prevalence and outcome in a referral hospital. PLOS ONE. 2013; 8: e65193. doi:10.1371/journal.pone.0065193.
2. Ameyaw E, Amponsah-Achiano K, Yamoah P, Chanoine J. Abnormal blood glucose as a prognostic factor for adverse clinical outcome in children admitted to the Paediatric emergency unit at Komfo Anokye Teaching Hospital Kumasi, Ghana. Int J Pediatr. 2014; 2014:149070
3. Christi MJ, Ahmed T, Ashraf H, Faruque ASG, Huq S, Hussain M. Hypoglycemia in children attending the critical care medicine in developing countries, Diabetes-Damages and Treatments. Prof. Everlon Rigobelo (Ed.), ISBN: 978-953-307-652-2, InTech. DOI:10.5772/23406. Available from <http://www.intechopen.com/books/diabetes-damages-and-treatments/hypoglycaemia-in-developing-countries>. (Accessed 1<sup>st</sup> September 2020).
4. Hay WW, Levin MJ, Sondheimer JM, Deterding RR. Hypoglycemia. In: Current Diagnosis & Treatment. Pediatrics 20<sup>th</sup> Edition. McGraw-Hill Co; 2011.1:18-19.
5. Hay WW, Sparks JW. Placental foetal and neonatal carbohydrate metabolism. Clin Obstet Gynecol. 1985; 28:4730-4785.
6. White NJ, Miller KD, Marsh KK, Berry CD, Turner RC, Williamson DH, et al. Hypoglycemia in African Children with Severe Malaria. Lancet. 1987; 1:708-711.
7. World Health Organization. Pocket Book of Hospital Care for Children: Guidelines For the Management of Common Childhood Illnesses. 2<sup>nd</sup> Edition. WHO 2013.
8. Cornblath M, Hawdon JM, Williams AF, Aynsley-Green A, Ward-Platt MP, Schwartz R et al. Controversies Regarding Definition of Neonatal Hypoglycemia: Suggested Operational Thresholds. Pediatrics. 2000; 105:1141-1145.
9. 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: 621-625.
10. Elusiyan JB, Adejuyigbe EA, Adeolu OO. Hypoglycaemia in a Nigerian Paediatric Emergency ward. J Trop Pediatr. 2006; 52:96-102.
11. Oluwayemi IO, Ogundare EO, Ajite AB, Raimi TH. Profile of Random Blood glucose of Children Seen at the Children Outpatient Department of Ekiti State University Teaching Hospital, Ado-Ekiti, Nigeria. Glob J Endocrinol Metab. 2018; 1:1-4.
12. Zijlmans WCWR, vanKempen AAMW, Ackermans MT, de Metz J, Kager PA, Sauerwein HP. Very young children with uncomplicated falciparum malaria have higher risk of

- hypoglycaemia: a study from Suriname. *Trop Med Int Health*. 2008;13: 623-34.
13. Schellenberg D, Menendez C, Kahigwa E, Font F, Galindo C, Acosta C. African children with malaria in an area of intense *Plasmodium Falciparum* transmission: Features on admission to the hospital and risk factors for death. *Am J Trop Med Hyg*. 1999; 61:431-438.
14. American Diabetes Association. *Diabetes Care*. 2000; 23:54-519.
15. World Health Organisation: Definition, diagnosis and classification of diabetes mellitus and its complications: Report of a WHO Consultation. Part 1, diagnosis and classification of diabetes mellitus. Geneva, WHO/NCD/NCS/99.2; 1999:59: 32-33 <https://iris.who.int/handle/10665/55040> (Accessed: 1st September 2020).
16. Faustino EV, Apkon M. Persistent hyperglycemia in critically ill children. *J Pediatr*. 2005;146:30-34.
17. Araoye MO. Subject Selection. Araoye MO editors. *Research Methodology with Statistics for health and social sciences* 2nd edition, Ilorin; Nathadex 2004: 115-120.
18. Accucheek Active® *Blood Glucose Meter* [user's manual]. Mannheim, Germany: Roche Diagnostics; 2013.
19. Toggle DW, Kuhn MA, Jones SK, Garza JJ, Skinner S. Hyperglycemia and infections in pediatric trauma patients. *Am Surg*. 2008; 74:195-198.
20. Kliegman RM, Berhrman RE, Jensen HB, Stanton BF. Hypoglcemia In: *Nelson textbook of Pediatrics*, 18<sup>th</sup> ed. Philadelphia, Saunders Elsevier; 2007: 655-668.
21. Soro-Coulibaly T, Oduwole A, Tayo A, De Beaufort C, Oyenusi E, Abodo J, et al. Blood glucose profile in acutely ill children, Abobo North General Hospital, Cote d'Ivoire *AJDM*. 2018; 1:26-32.
22. Oyenusi EE, Oduwole AO, Oladipo OO, Njokanma OF, Esezobor CI. Hypoglycaemia in children aged 1month to 10years admitted to the Children's Emergency Centre of Lagos University Teaching Hospital, Nigeria. *S Afr J C H*. 2014;8:107-111.
23. Okoronkwo NC, Eke FU, Oruamabo RS. Hypoglycaemia among children presenting to emergency paediatrics unit of Abia University Teaching Hospital, Aba, Nigeria. *Int J Med Health Sci*. 2013; 2:410-418.
24. Usman AD, Aishatu YM, Abdullahi B. Laboratory assessment of hypoglycaemia due to malaria in children attending general hospital Katsina. *Bayero J Pure Applied Sci*. 2008; 1: 6-9
25. Kawo NG, Msengi AE, Swai AB, Chuwa LM, Albertti KG, McLarty DG. Specificity of hypoglycaemia for cerebral malaria in children. *Lancet*. 1990; 336:454-457.
26. Wilcox ML, Forster M, Dicko MI, Graz B, Mayon-White R, Barennes H. Blood glucose and prognosis in children with presumed severe malaria: Is there a threshold for 'hypoglycaemia'? *Trop Med Int Health*. 2010; 15:232-340.
27. World Health Organisation and United Children's Fund {UNICEF}. *Management of the child with a serious infection or severe malnutrition. Guidelines for care at the first referral level in developing countries*. Geneva. World Health Organisation 2000. <https://iris.who.int/handle/10665/42335>
28. Poddar B. Treating hyperglycemia in the critically ill Child: Is there enough evidence? *Indian Pediatr*. 2011; 48:531-536.