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Prevalence of hypoglycemia in diarrheal dehydration at hospitalization in severe acute malnutrition

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ABSTRACT

Background: Diarrhea is the major cause of death in children below five years of age. Hypoglycemia has been a potential fatal complication of infectious diarrhea in both well-nourished and poorly nourished children. But prevalence of hypoglycemia in diarrheal dehydration is not exactly known. This study was done to evaluate the glycemic status in children having acute diarrhea with dehydration and specifically associated with severe acute malnutrition (SAM).

Methods: This descriptive cross-sectional study was conducted during July 2017 to December 2017 at Bal Chikitsalaya Udaipur, Rajasthan, India. Blood glucose levels were assessed in 150 children of acute diarrhea with dehydration, comprising of 100 SAM and 50 Non SAM children.

Results: Average blood glucose of SAM children was 89 mg/dl and of non-SAM, it was 120 mg/dl. Average blood glucose was low in SAM as compared to non-SAM in both some dehydration (116.08 ± 21.26) and severe dehydration (66.69 ± 19.80) as well as with or without ORS intake. Overall 18 (12%) of children had hypoglycemia and all were in severe dehydration and not taking ORS. Blood glucose levels were statistically low in severe dehydration and those who were not taking ORS at the time of hospitalization (p = 0.001). In severe dehydration 25% of children had hypoglycemia means every fourth child had low blood glucose <54 mg/dl.

Conclusions: Overall prevalence of hypoglycemia is 12% in diarrheal dehydration and 20% in SAM with dehydration. Twenty five percent of severe dehydration children had hypoglycemia, and all have not started ORS. None of the child started ORS developed hypoglycaemia.

Keywords: Dehydration, Diarrhea, Hypoglycemia, Oral rehydration solution, Severe acute malnutrition

INTRODUCTION

In many developing countries diarrhea is the major cause of death in children below five years of age. This has remained true even in areas where oral rehydration therapy has been widely used. He lethal complications of diarrhea, other than dehydration are poorly understood. Hypoglycemia has been found to be a potential fatal complication of infectious diarrhea in both well-

nourished and poorly nourished children.⁴⁻⁶ Malnutrition accounts for 46% of all causes of deaths below five years of age and 7% of all deaths.⁷ Complications of malnutrition with acute diarrhea are many which may leads to death. They are dehydration, shock, hypoglycemia, hyperglycemia, hypothermia, dyselectrolytemia, septicemia, congestive cardiac failure, severe anemia and nutritional deficiencies.⁸ Malnutrition with acute diarrhea is usually associated with

hypoglycemia. However, there are some reports of hyperglycemia in patients with dehydrating gastroenteritis. 9-13

To better understand the hypoglycemia that occurs during diarrhea, this study was carried out to determine the prevalence of hypoglycemia in severely ill children with diarrheal dehydration who were admitted to the hospital.

METHODS

This descriptive cross-sectional study was conducted during July 2017 to December 2017 at Bal Chikitsalaya, Udaipur, Rajasthan India. At the point of care children between the age of 6-59 months, who presented with acute diarrhea (<7 days) were enrolled for the study after explaining the relevant details to their parents/caregivers and obtaining their consent subsequently.

Total 150 children enrolled in study of which 100 were of severe acute malnutrition (SAM) and 50 were well nourished. A structured questionnaire was administered to the caregivers of each patient. Information obtained included socio-demographic characteristics such as age, gender, parent's educational status and occupation. Data were also obtained on history for duration of diarrhea, presence of vomiting or fever, intake of ORS. The severity of dehydration was assessed for each patient by physical examination using WHO criteria. Complete anthropometric assessment was done and categorized as SAM and Non-SAM child. SAM was labelled in a child who fulfil WHO criteria of SAM, in children of age 6 months to 5 years as

- Weight for height/length < 3 SD and/or
- Mid upper arm circumference (MUAC) <11.5 cm and/or
- Bipedal nutritional edema. 15

Following recruitment, sample for blood glucose was taken by heel prick under strict sterile measures. The heel of the foot was first sterilized with 70% alcohol swabs and then pricked using new lancets for each prick. Five micro litre of blood was collected into microcuvette which was then fed into the Accusure® glucose analyzer for a reading to be taken. This analyzer uses electrochemical method. Glucose oxidase-peroxidase strips were used to measure random capillary blood glucose. ¹⁶ A dry cotton swab was then placed on the affected area of the foot and gentle pressure applied to the area until blood stopped oozing. Children who had type 1 diabetes mellitus, inborn error of metabolism and other frequent cause of hypoglycemia were excluded from the study.

In the present study, hypoglycemia was defined as blood glucose value below 3mmol/L (<54 mg/dl) while hyperglycemia was defined as blood glucose value greater than 8.3 mmol/L (>150 mg/dl). Ochildren found to have hypoglycemia were treated with 10% dextrose in

water at 5 ml/kg bolus. No treatment was given to the children with hyperglycemia. Attention was equally paid to their fluid and electrolyte status with treatment as determined by the child's clinical condition.

Statistical analysis

The sample size was calculated at a confidence interval (CI) of 90% and allowable error of 15%. The permission was taken from the institutional ethical committee. The results were then formulated and analyzed using standard software of biostatics (SPSS version 21) using the suitable statistical tests for statistical significance. The Z-test was used in ascertaining the significance of differences between two proportions with the p-value set at <0.05.

RESULTS

Out of 150 cases, 100 were of SAM while 50 were of non-SAM. In SAM children 67 (67%) were males and rest were females. In non-SAM children 42 (84%) were males and rest were females. In children with SAM 70 (70%) had weight for length/ height <-3 SD, 52 (52%) MUAC <11.5cm and 10(10%) children had bipedal edema.

Table 1: Basic distribution of study population (n=150).

	SAM (100)	Non-SAM (50)
Male	67 (67%)	42 (84%)
Female	33 (33%)	8 (16%)
Mean weight (kg)	5.34±1.27	8.62±1.84
Mean age (months)	14.11±6.99	14.42±8.97
Mean height (cm)	69.29±5.58	76.5±7.36
MUAC (cm)	10.22±1.19	12.65±2.48
Some dehydration	45 (45%)	32 (64%)
Severe dehydration	55 (55%)	18 (36%)
ORS taking	32 (32%)	27 (54%)
ORS not taking	68 (68%)	23 (46%)
Mean glucose (mg/dl)	88.92±32.02	120±46.74

In SAM children, 45(45%) had some dehydration and 55 (55%) had severe dehydration and only one third (32%) were taking ORS while two third (68%) were not taking ORS before hospitalization. In non-SAM children, 32 (64%) had some dehydration and 18 (36%) had severe dehydration and 27 (54%) were taking ORS while 23 (46%) were not. Average blood glucose of SAM children was 89 mg/dl and of non-SAM, it was 120 mg/dl (Table 1).

When blood glucose levels were assessed with degree of dehydration and status of ORS intake before hospitalization it was like as shown in Table 2. Average blood glucose was low in SAM as compared to Non-SAM in both some and severe dehydration as well as with or without ORS intake. Blood glucose was

significantly low in SAM who were not taking ORS and having severe dehydration (p = 0.001).

Table 2: The average blood glucose in dehydrated and with intake of ORS.

	Blood glucose		
	SAM (100)	Non-SAM (50)	P value
Some dehydration	116.08±21.26	135.03±48.67	0.009
Severe dehydration	66.69±19.80	95.67±30.43	< 0.001
ORS taking	125.75±16.24	144.96±47.97	0.007
Not taking ORS	71.58±20.96	92.57±24.41	< 0.001

More number of children were found to have subnormal and low glucose in SAM category while hyperglycemia was observed in non-SAM children which was statistically significant. Overall 18(12%) of children with diarrhea had low glucose though it was 15% in SAM while only 6% in Non-SAM children which was not statistically significant (p=0.11). Among the children who had hypoglycemia two third (12/18) had vomiting also, as shown in Table 3.

Table 3: Distribution of blood glucose level according to nutritional status.

Blood glucose (No. of children)	SAM (100)	Non-SAM (50)	P value
<54 (18)	15 (15%)	3 (6%)	0.11 (NS)
55-80 (37)	34 (34%)	3 (6%)	<0.001 (HS)
80- 110 (37)	22 (22%)	15 (30%)	0.28 (NS)
110-150 (51)	29 (29%)	22 (44%)	0.07 (NS)
>150 (07)	0	7 (14%)	<0.001 (HS)

Almost equal number of children were admitted with some and severe dehydration. None of child was admitted who had no dehydration.

Table 4: Distribution of blood glucose level according to hydration status.

Blood Glucose (No. of children)	Some Dehydration	Severe Dehydration	P value
<54 (18)	0	18 (25%)	<0.001 (HS)
55-80 (37)	4 (5%)	33 (45%)	<0.001 (HS)
80- 110 (37)	22 (29%)	15 (20%)	0.26 (NS)
110-150 (51)	44 (57%)	07 (10%)	<0.001 (HS)
>150 (7)	7 (9%)	0	<0.01 (S)
Total	77 (51%)	73 (49%)	

Over all 18 (12%) of children had hypoglycemia and all were in severe dehydration. None of the child with some dehydration had hypoglycemia while in reverse none of the child with severe dehydration had hyperglycemia. In Severe dehydration 70% children had either subnormal and low blood glucose and 9% of some dehydrated had hyperglycemia which was statistically significant, as shown in Table 4.

Table 5: Distribution of blood glucose level according to ORS intake.

Blood glucose (number of children)	ORS taking	ORS not taking	P value
<54 (18)	0	18 (20%)	<0.001 (HS)
55-80 (37)	0	37 (40%)	<0.001 (HS)
80- 110 (37)	7 (12%)	30 (33%)	<0.01 (S)
110-150 (51)	45 (76%)	67 (%)	<0.001 (HS)
>150 (07)	7 (12%)	0	<0.001 (HS)
Total	59 (40%)	91 (60%)	

Again 18 (12%) of overall children had hypoglycemia and all were in not taking ORS. Almost 40% children were taking ORS at time of hospitalization and 60% were not taking ORS. When blood glucose was assessed based on ORS intake, it was observed that hypoglycemia and subnormal glucose was found in 18 (20%) and 37 (41%) of children who were not taking ORS. Hyperglycemia was observed in 7 (12%) of those who were taking ORS. No child had hypoglycemia and subnormal glucose, who started taking ORS after diarrhea, as shown Table 5.

This study was to assess blood glucose at the time of admission. We did not follow clinically but at end we came to know that 5 patients of total (5/150) died during hospitalization and of which 4 children had hypoglycemia and severe dehydration.

DISCUSSION

In this present study, the prevalence of hypoglycemia at the point of care in under-five children with acute diarrhea was analyzed. We observed that hypoglycemia was more prevalent at point of care in severely dehydrated SAM children, presented with acute diarrhea and not taking ORS. We found hypoglycemia in 18 (12%) of overall and 25% among severe dehydration children.

The mechanism by which diarrhea predisposes to hypoglycemia is poorly understood. However, Bennish et al, linked it to defective gluconeogenesis. They observed that the glucose counter regulatory hormones were appropriately elevated in the children with hypoglycemia whereas the substrates for gluconeogenesis were inappropriately low in them, leading to the conclusion that hypoglycemia in such children was most likely due to impaired hepatic gluconeogenesis.¹⁷ The report of

another study also linked hypoglycemia associated with diarrheal illnesses in children to glycogen depletion and impaired hepatic gluconeogenesis.¹⁸

Surabhi et al, studied blood glucose levels in diarrhea dehydration. Blood glucose levels were normal in children of acute diarrhea with some or severe dehydration. They conclude that blood glucose is a poor predictor of the severity of diarrheal dehydration. ¹⁹

The higher risk of hypoglycemia observed in the present study of SAM with severe dehydration who were not taking oral rehydration therapy. None of the child in whom ORS was started developed hypoglycemia. This means starting ORS is not only to prevent from dehydration, but it prevents from hypoglycemia also. WHO programme clearly states that starting early ORS after diarrhea prevents from dehydration which is lifesaving. With this we can say that ORS not only prevent and treat dehydration it prevents development of hypoglycemia in diarrhea if started early at onset.

Hyperglycemia was present in 4.6% of overall patients in the present study. There was no remark about occurrence of hyperglycemia in the study of Calabar et al, making it impossible to judge whether or not any of their subjects had hyperglycemia.²⁰ The severe dehydration may impair the function of various enzymes involved in gluconeogenesis as well as interfere with the transport of substrates.¹⁷

Limitation of this study is that we have not assessed duration of ORS intake, timing of meal before hospitalization. Further studies are needed taking care of these along with ultimate outcome of the patient.

What is the clinical implication of these findings, in childhood diarrheal illnesses management, clinician needs in addition to consider the role of non-dehydrating complication like hypoglycemia causing death in children presenting with diarrhea. Thus, it might be beneficial for clinicians to consider the possibility of hypoglycemia when developing appropriate protocol for management of children hospitalized for acute diarrhea, thereby reducing the already high mortality associated with childhood diarrheal illnesses in developing countries. After treatment of shock, the use of dextrose-containing intravenous solution in hospitalized children requiring parental fluid therapy is advocated, particularly where facilities for determination of blood glucose level is not available.

CONCLUSION

To conclude, hypoglycemia is an important co-morbidity of acute diarrhea among children below the age of 5 years, more commonly with severe dehydration, SAM and not taking oral rehydration therapy. Routine assessment of blood glucose at the point of care is advocated and where facility for determination of blood

glucose level is not available should be treated empirically for hypoglycemia. We recommend that ORS should be started immediately at onset of diarrhea which not only prevent from dehydration it prevent from hypoglycemia also.

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Institutional Ethics Committee

REFERENCES

- The burden of disease resulting from diarrhea. In: Division of health promotion and disease prevention, Division of International Health, Institute of Medicine. New vaccine development: establishing priorities. Vol. 2. Diseases of importance in developing countries. Washington, D.C.: National Academy Press; 1986:159-169.
- 2. Chen LC, Rahman M, Sardar AM. Epidemiology and causes of death among children in a rural area of Bangladesh. Int J Epidemiol. 1980;9:25-33.
- 3. Ronsmans C, Bennish ML, Wierzba T. Diagnosis and management of dysentery by community health worker. Lancet. 1988;2:552-5.
- 4. Hirschhorn N, Lindenbaum J, Greenough WB III, Alam SM. Hypoglycemia in children with acute diarrhea. Lancet. 1966;2:128-32.
- 5. Jones RG. Hypoglycemia in children with acute diarrhea. Lancet. 1966;2:643.
- Molla AM, Hossain M, Islam R, Bardhan PK, Sarker SA. Hypoglycemia: a complication of diarrhea in childhood. Ind Pediatr. 1981;18:181-5.
- 7. Mathur GP, Kushwaha KP, Mathur S. Protein energy malutrition. In: Gupte S, eds. Recent advances in Pediatrics (special vol 6): Gastro enterology, hepatology, and nutrition. New Delhi: Jaypee Brothers; 2000:479-82.
- 8. Udani PM. Protein energy malnutrition, In: PM Udani (eds). Text Book of Pediatrics (revised 1st ed). New Delhi: Jaypee Brothers; 1998:476-55.
- 9. Seth A, Aneja S. Hyperglycemia in malnourished children with dehydrating gastro enteritis. Indian J Pediatr.1995;65:353-5.
- 10. Heggarty H, Trindade P, Bryan EM. Hyperglycemia in hyper osmolar dehydration. Arch Dis Childhood. 1973;48:740-1.
- 11. Mandell F, Fellers FX. Hperglycemia in hypernatremic dehydration. Clin Padiatr. 1974;13:367-9.
- 12. Rabinowitz L, Joffe BI, Abkiewicz C, Shires R, Greef MC, Seftel HC. Hyperglycemia in infantile gastro enteritis. Arch Dis Childhood. 1984;59:771-5
- 13. Stevenson RE, Bowyer FP. Hyperglycemia with hyper osmolar dehydration in non-diabetic infants J Pediatr. 1970;77:818-25.
- 14. Srivastava A, Jagadisan B, Yachha SK. Diseases of gastrointestinal system and Liver. In: Ghai OP, Paul

- VK, Bagga A, eds. Essential pediatrics. New Delhi: CBS Publishers; 2009:260-265.
- 15. WHO. WHO child growth standards and the identification of severe acute malnutrition in infants and children. a joint statement by WHO and UNICEF. 2009. Available at http://who.int/nutrition/publications/severe malnutrition/9789241598163-eng.pdf
- American Association for Clinical Chemistry. Diabetes Mellitus. Available at https://www.aacc.org/science-and-practice/practiceguidelines/diabetes-mellitus Accessed 15th June, 2010
- 17. Bennish ML, Azad AK, Rahman O, Phillips RE. Hypoglycemia during diarrhea in childhood: prevalence, pathophysiology and outcome. New Engl J Med. 1990;322(19):1357-63.
- 18. Butler T, Arnold M, Islam M. Depletion of hepatic glycogen in the hypoglycaemia of childhood

- diarrheal illnesses. Trans Royal Soc Trop Med Hyg 1989;83(6):839-43.
- 19. Chandra S, Singh DK, Ansari MA, Pareek P. Blood glucose as a predictor of diarrheal dehydration in children. Indian J Child Health. 2016;3(3):261-2.
- Ntia HN, Anah MU, Udo JJ, Ewa AU, Onubi J. Prevalence of hypoglycemia in under-five children presenting with acute diarrhea in University of Calabar Teaching Hospital, Calabar. Niger J Paediatr. 2012;39(2):63.

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