

**NEUROMUSCULAR
MANIFESTATIONS OF
DIARRHEA RELATED
HYPOKALEMIA**

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ABSTRACT

Twenty three children from 8-60 months (mean age 27.13 months) admitted with neuromuscular manifestations of diarrhea related hypokalemia were studied. Forty four per cent cases were suffering from diarrhea at the time of admission but in majority of cases (56%), the diarrheal episode had already terminated. Mild hypokalemia was seen in 17.4%, moderate in 43.5% and severe in 39.1%. Neck flop was the commonest (100%) neuromuscular manifestation followed by diminished bowel sounds (82.6%), truncal weakness (52.2%), weakness of limbs (52.2%), lethargy (43.5%), abdominal distension (43.5%), respiratory involvement (4.3%) and phantom hernia (4.3%). Two cases (8.7%) had flaccid paralysis of both the lower limbs. Severe hypokalemia was more frequently observed in children below 24 months age and those who had received IV fluids or salt sugar solution before reporting in the hospital. A significant correlation was noticed between severity of hypokalemia and frequency of stools ($p < 0.05$), degree of dehydration ($p < 0.01$), severity of mal-

Disturbance in potassium balance is an important consequence of loss of water and electrolytes during diarrhea. Repeated diarrheal episodes, particularly in malnourished children who have a low body potassium, if managed with oral solutions containing inadequate potassium may increase the risk of significant total body potassium depletion and thereby increase the risk of muscle weakness, arrhythmias, ileus and hypokalemic nephropathy(1). Neuromuscular manifestations become more prominent with serum potassium levels dropping below 3 mEq/L and further decrease in serum potassium levels can result in flaccid muscle paralysis, rhabdomyolysis, elevation of serum levels of muscle enzymes and

nutrition ($p < 0.01$) and extent of neuromuscular involvement ($p < 0.01$). Our results highlights the importance of diarrhea related hypokalemia particularly in young malnourished children who are rehydrated with solutions inadequate in potassium. Early diagnosis and appropriate treatment can promptly reverse these manifestations within 48-72 hours.

Key words: Hypokalemia, Diarrhea, Neuromuscular manifestations.

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myoglobinuria(2). Correlation between potassium concentration and total exchangeable potassium has been studied by several workers with variable results. However, the correlation with clinical presentation seems to be more important for clinicians. Therefore, we have evaluated serum potassium status of patients suffering from diarrhea who presented with neuromuscular manifestations of hypokalemia and correlated these levels with some of the clinical variables.

Material and Methods

Children of either sex below the age of 5 years admitted in Kalawati Saran Children's Hospital, New Delhi with history of diarrhea with or without dehydration and with clinical features of neck flop, muscle paralysis or abdominal distension were included in the study. A detailed history was taken which included duration, frequency, volume and consistency of stool; feeding during the episode of diarrhea, nature of drugs received and type of oral/intravenous fluid given before attending the hospital. Besides a thorough clinical examination, state of hydration and clinical signs suggestive of hypokalemia like lethargy, neck flop, muscular weakness, abdominal distension and bowel sounds were carefully looked for on admission and assessed periodically. Rehydrated weight of the children was taken for assessment of nutritional status as per the recommendation of Nutrition Subcommittee of Indian Academy of Pediatrics(3).

Venous blood sample was drawn from each patient on admission prior to any oral/parenteral fluid therapy for

estimation of serum potassium levels. These levels were repeated after 6, 12, 24,48 hours depending upon the clinical condition, initial serum potassium levels and clinical response to potassium supplementation. Hypokalemia was defined as serum potassium levels lower than 3.5 mEq/L. The degree of hypokalemia was graded as mild (3-3.5 mEq/L), moderate (2-2.9 mEq/L) and severe (<2 mEq/L)(4). Patients were rehydrated and managed as per the recommended treatment protocol(5). Potassium supplementation was done by oral administration of potassium chloride 2 mEq/kg/day(6) or parenterally by using 15% solution of potassium chloride depending upon the clinical condition and potassium levels(7). Severity of hypokalemia has been correlated with various clinical variables. Student's 't' test was applied to test the significance of the results.

Results

Twenty three children between the ages of 8 months-60 months (mean age 21.13 months) including 15 males (65.2%) and 8 females (34.8%) with history of diarrhea ranging from 5-16 days were evaluated. Out of these, 10 cases (43.5%) were suffering from diarrhea and in 13 cases (56.5%), diarrhea had stopped at the time of admission. Three cases (13.0%) had vomiting 2-3 days prior to hospitalization and all of them had hypokalemia. Neuromuscular manifestations included neck flop, truncal weakness, weakness of limbs and lethargy. Respiratory muscle weakness and phantom hernia was observed in 1 case each (*Table I*).

For the purpose of analysis, neuro-

TABLE I—Spectrum of Neuromuscular Manifestations (n=23)

Neuromuscular manifestations	No. of cases	Percentage
Neck flop	23	100.0
Diminished bowel sounds	19	82.6
Abdominal distension	16	69.6
Truncal weakness	12	52.5
Weakness of limbs	12	52.5
Lethargy	10	43.5
Respiratory muscle involvement	1	4.3
Phantom hernia	1	4.3

muscular manifestations were categorized as Group 1 (neck flop), Group 2 (neck flop, mild weakness of muscle power and variable degree of hypotonia, and diminished bowel sounds with or without abdominal distension) and Group 3 (neck flop, weakness of muscle power of trunk and limb muscles with hypotonia and impaired or absent deep tendon reflexes, abdominal distension, decreased bowel sounds with/without respiratory muscle involvement). Out of 12 cases with weakness of trunk and limb muscles, all of them had variable degree of hypotonia of affected muscles, and deep tendon reflexes were impaired in 10/12 cases (83.3%) and absent in 2/12 cases (16.7%). All these cases identified by one or more of these signs had hypokalemia. Four cases (17.4%) had mild degree of hypokalemia, 10 (43.5%) moderate and 9 cases (39.1%) had severe hypokalemia. Severity of hypokalemia had a significant correlation with frequency of stools ($p < 0.05$), degree of dehydration ($p < 0.01$),

severity of malnutrition ($p < 0.01$) and extent of neuromuscular involvement ($p < 0.01$). Abdominal distension was more common in severe hypokalemia but diminution of bowel sounds and duration of diarrhea had no significant correlation with severity of hypokalemia (Table II).

Feeding during the present episode of diarrhea was uniformly unsatisfactory but in none of the children feeding was stopped. It was not possible to evaluate potassium content of the diet given to these children at home. Details of fluids given before hospitalization revealed that IV fluids were given to 6 cases (26.1%), home made salt and sugar solution (SSS) in 6 (26.1%), WHO-ORS in 5 (21.7%), plain water in 3 (13.0%) and other home fluids in 3 cases (13.0%). Severe hypokalemia was observed in 6/6 cases (100%) who had received IV fluids and 3/6 cases (50%) who were given SSS. Mild and moderate hypokalemia was also observed in some cases who had consumed WHO-ORS, but the volume of water added to make 1 litre of ORS at home and the amount given for each loose stool before coming to hospital could not be correctly ascertained. None of the patients had any clinical evidence of cardiac arrhythmias.

Discussion

Potassium is lost in diarrheal stool along with other electrolytes in all age groups but more in children(8). Hypokalemia has been reported in as many as 24% cases of diarrhea(9). Disturbances of potassium equilibrium in the body may produce a wide range of clinical disorders(10,11) from

TABLE II—Correlation of Severity of Hypokalemia with Clinical Variables

Clinical features	Total cases		Degree of hypokalemia			p value
	No.	%	Mild	Moderate	Severe	
Age (mo)						
<12	5	21.7	2	2	1	<0.05
13-24	14	60.9	1	5	8	
25-60	4	17.4	1	3	-	
Duration of diarrhea (days)						
<7	10	43.5	1	5	4	>0.05
7-14	7	30.4	2	5	-	
>14	6	26.1	1	-	4	
Frequency of stools						
<5	4	17.4	2	1	1	<0.05
5-10	8	34.8	1	4	3	
>10	11	47.8	-	6	5	
Degree of malnutrition						
Grade I	2	8.7	1	1	-	<0.01
Grade II	6	26.1	2	2	2	
Grade III	6	26.1	1	4	1	
Grade IV	9	39.1	-	3	6	
State of hydration						
No dehydration	13	56.5	4	7	2	<0.01
Some dehydration	4	17.4	-	2	2	
Severe dehydration	6	26.1	-	1	5	
Neuromuscular manifestations						
Group I	10	43.5	4	5	1	<0.01
Group II	7	30.4	-	4	3	
Group III	6	26.1	-	1	5	

asymptomatic hypokalemia to frank rhabdomyolysis(2). Since our selection criteria enrolled only the cases with one or the other neuromuscular manifestations suggestive of hypokalemia in children who were suffering or recovering from a diarrheal episode, all of them had serum potassium levels below 3.5 mEq/L. Majority of these cases (82.6%)

had moderate or severe degree of hypokalemia.

Majority of cases (56.5%) presented with neuromuscular involvement attributed to hypokalemia 1-5 days after diarrhea had stopped which highlights the critical role of potassium after rehydration therapy and during conva-

lescent phase of a diarrheal episode. All the 9 cases with severe hypokalemia had either been given IV fluids or ORT with home made salt and sugar solution. Lack of potassium in the commonly prepared salt and sugar solution and association of Grades III and IV malnutrition in 5/6 (83.3%) of these cases could be the cause of moderate and severe degree of hypokalemia. WHO formulation ORS had been consumed by 21.7%. Even though the preparation of ORS and total volume replaced would greatly influence the potassium intake, it may also suggest that the present concentration of potassium in WHO recommended ORS formulation may not be sufficient to correct potassium deficits in some patients(1).

Since details of IV fluids given before coming to hospital could not be known, it is possible that IV solutions which do not contain sufficient potassium might have been given to these children. This is likely to happen particularly in a child with severe dehydration who has not passed urine for several hours. Such patients, who are usually managed with rapid infusion of potassium free fluids, are at risk to develop hypokalemia which may clinically manifest after the dehydration has been corrected. Severity of malnutrition has been observed to have a significant correlation with the degree of hypokalemia(12), but it was interesting to observe that 2/6 cases (33.3%) who had severe hypokalemia belonged to Grade II PEM. This would highlight the problem that even those cases who do not have severe PEM run a risk of getting severe hypokalemia if inappropriate IV fluids are given for rehydration. More-

over, while intravenous fluids are administered, oral feeding is not adequately stressed by the physicians and not encouraged by the mothers which may further influence the potassium status of a child particularly if he is malnourished. Feeding during diarrhea, therefore, assumes an importance of even greater significance besides its impact on nutrition. Even though precise details of food intake during an episode of diarrhea, particularly in terms of potassium content could not be found out, it was noticed that feeding was unsatisfactory in all the cases both in terms of total quantity of food and its potassium content.

The exact mechanism whereby hypokalemia causes muscle weakness is still not known, but it has been shown to change resting membrane potential, limit increase in blood flow in exercising muscles and causes a reduction in muscle glycogen content of experimental animals(2). The commonest neuromuscular manifestation of hypokalemia was neck flop which was more frequently noticed by mothers as well. Other manifestations included weakness of trunk and limb muscles, abdominal distension and absent/sluggish bowel sounds. Weakness of limb muscles ranged from inability to move against resistance to flaccid paralysis. Respiratory muscle involvement was noticed in one case with severe hypokalemia. It was interesting to note that one infant with severe hypokalemia had a phantom hernia on left lower abdomen besides neck flop, truncal and limb weakness, and abdominal distension. With parenteral potassium supplementation, along with the recovery of other neurological signs,

phantom hernia disappeared within 48 hours. This child had received all the doses of OPV and his stool examination was negative for polio virus. Phantom hernia due to post diarrheal hypokalemia has been described earlier(13). Hypokalemia is known to produce muscle weakness which may be asymmetrical and patchy mimicking poliomyelitis(14) but presence of significant hypokalemia and dramatic response to potassium supplementation helps in distinguishing one from the other.

Comparison of various clinical variables with the degree of hypokalemia revealed a significant correlation with potassium losses due to increased frequency of loose stools. Vomiting, often associated with diarrhea, may lead to alkalosis which may result in hypokalemia. All the three cases in our study who had history of vomiting 2-3 days prior to hospitalization, had variable degree of hypokalemia. However, in view of small number of cases, the observation did not reach statistical significance. A significant association was observed with severity of dehydration which could account for rapid depletion and inadequate replacement of potassium losses. Severity of malnutrition was also observed to have a significant correlation with the degree of hypokalemia as has been observed by other workers(12) further stressing the risk of hypokalemia in already potassium depleted children.

Degree of hypokalemia seems also to have a significant correlation with clinical spectrum of neuromuscular manifestations(2). Patients who have mild hypokalemia (serum potassium 3-3.5

mEq/L) are often asymptomatic but some cases may complain of malaise, muscular weakness or fatiguability. With serum potassium levels below 3 mEq/L both symptoms and findings become more prominent(2): Elevation of muscle enzyme activity in serum such as creatine phosphokinase, aldolase or glutamic oxaloacetic transaminase are usually not observed until serum potassium levels fall below 2.5 mEq/L. Frank rhabdomyolysis and marked elevation of enzymes and myoglobinuria has been observed when serum potassium levels were below 2.0 mEq/L(2). We have also observed a significant correlation between serum potassium levels and the extent of neuromuscular involvement ($p < 0.01$). It is quite reassuring that the reversal of these signs is quite dramatic with improvement in serum potassium levels. In most of the cases all such signs disappear by 48-72 hours.

Our results highlight the magnitude of hypokalemia associated with or following an episode of diarrhea and its correlation with some of the clinically demonstrable neuromuscular manifestations. There is an indirect evidence of the problem getting compounded by oral rehydration therapy with solutions having inadequate amount of potassium. Rehydration with solutions containing optimum amount of potassium particularly in severely malnourished children is of paramount importance. Feeding during and after an episode of diarrhea with potassium rich foods(6) can considerably limit this common consequence of a diarrheal episode from becoming a major clinical problem. Hypokalemic myopathy is a reversible illness if the deficit is corrected prompt-

ly. Hence it is important to diagnose and treat it correctly and as early as possible.

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