Original Article

SERUM ELECTROLYTE IN CHILDHOOD DIARRHEA AND ITS VARIATION IN SUMMER AND WINTER SEASONS

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ABSTRACT

OBJECTIVE: To determine mean of plasma electrolyte levels in childhood diarrhea and comparison of electrolytes mean levels in winter & summer seasons.

STUDY DESIGN: Cross sectional study

PLACE AND DURATION OF STUDY: In-patient pediatric medicine department at DHQ hospital Faisalabad from December 2009 to July 2010.

MATERIAL AND METHODS: Three hundred and thirty patients suffering from acute gastroenteritis of either sex were enrolled in this study. While those diarrhea patients who were having third degree malnutrition, chronic diarrhea, renal failure or any history of rehydration were excluded from the study. The study was conducted over 8 months duration. Winter season was assigned from December 2009 to March 2010 and summer from April 2010 to July 2010. Blood samples were collected before starting of any rehydration therapy and serum levels of sodium (Na^+) and potassium (K^+) were measured at hospital pathology laboratory. Data were analyzed with SPSS version 10. Percentages for gender were determined more over t-test was applied for evaluating seasonal variation of serum levels of Na^+ and K^+ (p-value < 0.05).

RESULTS: Plasma electrolytes disturbance occur in patients with acute gastroenteritis. Out of total 330 patients, hypernatremia was seen in 5.45% and 47.87% had hyponatremia. Hypokalemia was documented in 56.36% patients and hyperkalemia in only 0.306%. Hyponatremia and hypokalemia was noted in diarrhea patients in summer season. However, more patients were having hypernatremia and hyperkalemia in winter season. The seasonal variations of Na^+ and K^+ levels were found statistically significant
(p value = 0.000).

CONCLUSION: Serum electrolyte levels fluctuate in patients with acute gastroenteritis and seasonal variations in electrolyte changes are observed. Hyponatremia and hypokalemia was documented in summer season while hypernatremia was seen in winter months.

KEY WORDS: Acute diarrhea, Gasteroentritis, Seasonal variations, Serum electrolytes.

INTRODUCTION:

Acute gastroenteritis is a very common pediatric medical emergency. It is the most leading cause of mortality in children under five

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years of age and accounts for 1.7 million deaths annually worldwide.[1]In 2010 it was estimated that there were almost 1.731 billion episodes of diarrhea (36 million of which progressed to severe episodes).[2]Causative organism include bacterial pathogens (20%) including *Vibrio cholera*, *Escherichia coli*, *Shigella, Salmonella*. While viruses like *Rotavirus*(30%)*, adeno virus* and *entropatasites*;*Giardia* and *Entamoeba* species also cause gastroenteritis in 5% cases. Theseorganisms have their own interaction with gut mucosa and as a result produce different spectrum of body changes.[3]

Diarrhea still is the most common cause of childhood deaths worldwide despite of use of oral rehydration solution. Clinical sign of critical illness in severe dehydration are still not well recognized and surprisingly there is little understanding of the etiology and electrolyte disturbances.[4]Clinical signs are not having required diagnostic accuracy to identify the electrolyte disturbances in children with dehydrating diarrhea.[5]

Electrolyte homeostasis is essential for normal functioning of body and minor derangement can sometimes lead to serious complications.

Regulation of sodium and potassium depends upon excretion absorption occurs through gastro intestinal system. Imbalance between the two ions causes disturbances in the normal body functioning.[9]

Seasonal plasma electrolyte variation in childhood diarrhea has been seen previously.[6]Seasonal variation has already been observed in the enteric infections and specific patterns have been documented. The occurrence of bacterial pathogens increases during months of summer while viruses characteristically hit thepopulation during dry winter.[14,15,7,8]

The rationale of this research work is to find significant seasonal association with plasma electrolytes in diarrhea patient so that management of these cases can be dealt accordingly.

PATIENTS AND METHODS:

The study was conducted in department of Pediatric medicine, DHQ hospital Faisalabad over 8 months duration from December 2009 to July 2010. Observations for winter season were recorded from December 2009 to March 2010 and for summer from April 2010 to July 2010. A total of 330 patients were registered and purpose, procedure were explained. The risk factors were discussed with the parents. The study protocolwas reviewed and approved by ethical committee. Informed written consent was taken from parents.

INCLUSION AND EXCLUSION CRITERIA:

All the patients with acute gastroenteritis of both genders were included. The children having diarrhea but having third degree malnutrition, history of rehydration of chronic diarrhea were excluded form study as these conditions could alter plasma electrolyte concentration and could act as confounding factor.

Data based on detailed history and examination was registered as per designed proforma. For serum electrolytes, a 2cc of blood sample was taken from each patient before start of any rehydration therapy and sent to hospital laboratory. Records of the patients were maintained on the monthly basis from December 2009 to July 2010. Electrolyte analyzer using ion selective electrodes was used to measure serum levels of Na^+ and K^+. The reports were collected and the values were noted down in the respective proforma. Data were analyzed with the help of SPSS version 10. The percentages for genders were calculated. Mean as well as standard deviation for age and serum electrolyte levels were determined and t-test was applied for evaluation seasonal variation of serum levels of Na^+ and K^+ (p – value < 0.05).

RESULTS:

We included 330 patients during study period of 8 months from December 2009 to July 2010. Four months (Dec. 2009 to March 2010) were taken in winter and four months (April 2010 to July 2010) for summer season. There were 37,45,38,33,55,47,35 and 40 patients enrolled during the months of December 2009 to July 2010 respectively. Out of them 57.2% were males and 42.7% were females. Minimum age of patient enrolled for study was 5.0 months and maximum was 168.0 months while mean

age was 41.68± 42.467 months.

Normal range for serum sodium (Na^+) level was taken between 135-145 mEq/L. Hyperkalemia was labeled at serum level of > 145 mEq/L, while hyponatremia at < 135 mEq/L. Over the 8 months of study period, 158(47.87%) patients were found to have hyponatremia.However, 154(46.68%) patients had normal Na^+ levels and hypernatremia was recorded in 18(5.45%). Data of mean serum sodium for each month are shown in table I (a).

For serum K^+ levels normal range was taken as 3.5 – 5.5 mEq/L. Hyperkalemia was labeled at values > 5.5 mEq/L while hypokalemia at< 3.5 mEq/L. Out of the total enrolled patients, 186 (56.36%) were hypokalemic, while normal K^+ level was found in 143(43.33%) children and only 0.306% had hyperkalemia. Our observations taken during study revealed a wide range of values as presented in Table I (b).It is obvious from the collected data that average serum Na^+ level remained within the normal range for the firstfive months of the study i.e. Dec 2009 to April 2010, whereas for the next three months (May 2010 to July 2010) the levels reported were below the cut off value as represented in Figure I.

Observations made for K^+ in each month depict levels within normal range for initial four months of study period while hypokalemia was seen for next four months as illustrated in Figure II.

In winter season 153 (46.36%)samples were collected and 177 (53.64%) in summer season. As far as, the serum levels on Na^+, average levels for winter calculated as 138.862 mEq/L, while in summer it was 129.672 mEq/L. These mean values were found statistically significant when their association was calculated with seasons (p=0.000).So marked hyponatremia was observed in summer season.

Mean K^+ levels recorded in winter as 3.744 mEq/L, whereas in summer it was 3.206 mEq/L. The association of K^+ was found statistically significant with seasonality (p=0.000) as illustrated in Table (II).Serum potassium level was found low in summer season.

DISCUSSION:

Acute diarrhea is one of the most common ailment it younger children and theyare predisposed to more severe complications because of their poorly developed immunity.[9] Aprat from dehydration, electrolyte disturbances are one of the major concerns among the children.[5] Electrolyte homeostasis in the body especially in the central nervous system is essential for normal function. Both hyponatremia and hypernatremia are associated with risk of seizures. While derangement in K^+ levels results in muscle paralysis and fatal arrhythmias.[16]

In present study a marked electrolyte changes are observed among the pediatric patients attending hospital with complaints of loose motions and vomiting. We found that 47.87% of the blood samples were hyponatremic however hypernatremia was recorded in 5.45%. As far as K^+ levels are concerned, 56.36% of children were hypokalemic while we have only one sample showing hyperkalemia (0.306%). Research work conducted by Shah et al. in 57 children with diarrhea has shown that disturbances of Na^+ and K^+ occurvery commonly in such patients. Inthis study hyponatremia is seen in 56% and 10% have hypernatremia, while K^+ levels in 46% are noted below the cut-off value and hyperkalemia is observed in 10% children.[17]Our study reveals seasonal association of electrolyte changes similar seasonal pattern of electrolyte variation is seen in the work of Swingler et al.[11]

Swinlger's team showed that prevalence ratio of severe hypokalemia (potassium < 2mmol/l) in the summer as compared with winter months 18(7.2%vs. 0.4%) and severe hyponatremia (sodium >160mmol/l) of 0.08(0.4% vs. 5%).The difference was as much as 12 folds between summer and winter month. Similarly seasonal variation in potassium levels was as much as 18 folds.Similar seasonal chnges have been reported from other countries as well.

Our Study has several limitations; firstly, due to a small number of patients; the study in underpowered to determine the electrolyte changes in exact pattern. A larger sample size is needed to adequately document this observation. Secondly, very little research work has been done to see climatic effect on the complications of diarrhea and we don't have enough reference to approve or disapprove the final results.

Each organism has its unique pathogenic

mechanism and it is very likely, that having its own impact on body resulting in its specific pattern of complications. One cannot exclude the possibility of this seasonal pattern of pathogens confounding the association of serum electrolytes with seasons.

Management of a patient of diarrhea is not only bases on rehydration but correction of electrolyte disturbances as well. Oral rehydration solution (ORS) is a corner stone in this aspect but using uniform composition either standard WHO ORS or low osmolar ORS through the year is not able to tackle all the problem.[17] So it is debatable that different formulations of rehydration solution should be used in different seasons to fulfill the requirements of patients.

We need a larger and systematic study to appropriately address the issue and better data collection regarding the other climatic factors, which may act as bias. It requires simultaneously collection of blood and stool samples for culture to exactly point out the etiological agents occurring in each season.

Table I.(a) Serum level of Sodium in patients of diarrhea:

Months	Sample	Mean	S.D.	95% C.I.	
Dec – 09	37	142	4.308	140.61	143.69
Jan – 10	45	139.84	3.861	138.714	140.974
Feb – 10	38	138	4.937	136.43	139.57
Mar – 10	33	135	2.716	134.07	135.93
Apr – 10	55	137.94	5.244	136.555	139.335
May – 10	47	130	2.596	129.26	130.74
Jun – 10	35	124	1.328	123.56	124.44
Jul – 10	40	122.87	1.0905	122.535	123.215

S.D. standard deviation. C.I. confidence interval.

Table I.(b) Serum level of Sodium in patients of diarrhea:

Months	Sample	Mean	S.D.	95% C.I.	
Dec – 09	37	3.8	0.3808	3.677	3.923
Jan – 10	45	3.916	0.5736	3.748	4.084
Feb – 10	38	3.7	0.6005	3.509	3.891
Mar – 10	33	3.5	0.3976	3.364	3.636
Apr – 10	55	3.4	0.3049	3.319	3.481
May – 10	47	3	0.2874	3.918	3.082
Jun – 10	35	3.3	0.3985	3.168	3.432
Jul – 10	40	3.1	0.3987	2.976	3.224

S.D. standard deviation. C.I. confidence interval.

CONCLUSION:

In present study we have observed serum electrolytes disturb significantly during diarrhea and definite seasonal fluctuation exists for it. However, current research also demands larger prospective trial including parallel diagnostic work to confirm the exact etiology of diarrhea in each season. Management of diarrhea patients requires careful review of electrolyte formulation being prescribed as per patient demand in each season.

Abbreviations

ORS: Oral Rehydration Solution
WHO: World Health Organization
Na^+: Sodium
K^+: Potassium

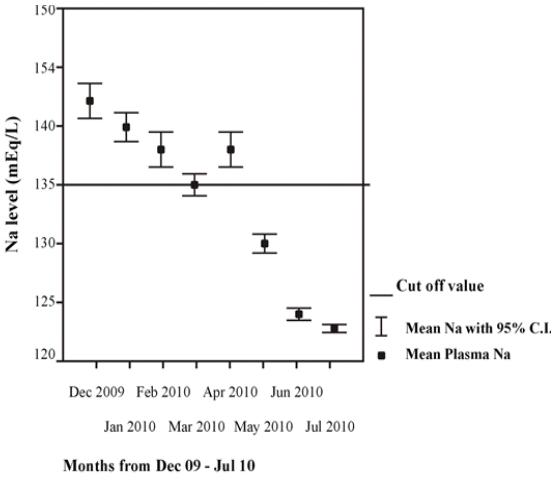

Figure (i) Mean Serum Na^+ level (with 95% C.I.)

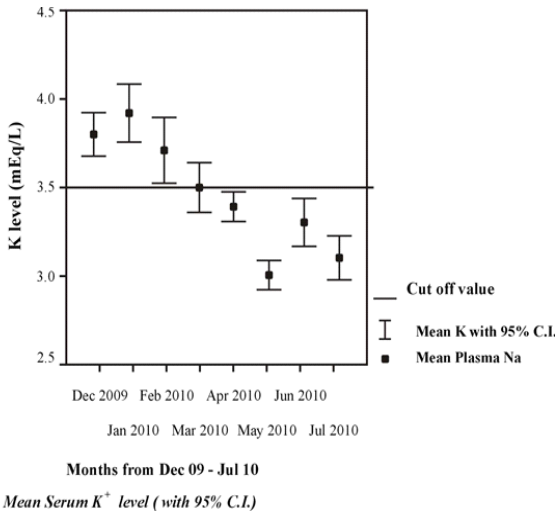

Figure (ii) Mean Serum K^+ level (with 95% C.I.)

Table (ii) Na and K Mean with± standard deviations and P-value

Palsma Electrolytes (mEq/L)	Mean for winter season (=153)	Mean for summer season (n= 77)	P–Value
Na^+	138.862 ± 4.725	129.672 ± 7.008	0.000
K^+	3.744 ± 0.523	3.206 ± 0.378	0.000

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One of the companions of Imam fell ill. Imam Ali called upon him and thus advised him: "Be thankful to Allah. He has made this illness a thing to atone your sins because a disease in itself has nothing to bring reward to anyone, it merely expiates one's sins and so far as reward is concerned, one has to earn it with his good words and good deeds. The Almighty Lord grants Paradise to his creatures on account of their piety and noble thoughts".

Whoever warns you against sins and vices is like the one who gives you good tidings.

Hazrat Ali (Karmulha Wajhay)