SHORT REPORT

Seasonal plasma electrolyte fluctuations in childhood diarrhoea

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A retrospective analysis of routinely collected data from a diarrhoea rehydration unit found clinically meaningful parallel seasonal variation in plasma sodium and potassium concentrations. The prevalence of severe hypokalaemia was 7.2% and 0.4% in February and August respectively, and of severe hypernatraemia 0.4% and 5.0% respectively. These unexpected findings need prospective confirmation and exploration in other settings.

A clinical impression of a sudden increase in the prevalence of severe hypokalaemia in children admitted to a diarrhoea rehydration unit in 1997 prompted an analysis of routinely collected laboratory data. The purpose of the exploratory analysis was to confirm the sudden increase and to identify temporal and geographic associations with a view to identifying a possible source. This report describes seasonal patterns of plasma sodium and potassium concentrations that were unexpectedly identified in this analysis.

METHODS

Patients and setting

The study population consisted of children admitted to the short stay diarrhoea rehydration unit of the Red Cross Children's Hospital in Cape Town. The rehydration unit is a public sector facility serving mostly children from working class or indigent backgrounds, the great majority of whom are referred directly from primary care facilities. Children requiring intensive care or in whom diarrhoea is not the main clinical problem are admitted elsewhere. Median age of admitted children is 9.5 months, and around one third are underweight for age. Approximately 50% are <5% dehydrated, 30% are 5-10% dehydrated, and 20% are >10% dehydrated (unpublished routinely collected data). Rotavirus is identified in one third of patients in whom pathogenic organisms are identified (singly or in combination), and enterotoxigenic *Escherichia coli*, enteropathogenic *E coli*, and *Cryptosporidium* in approximately one fifth each (D Colman, unpublished data). At the time of the study there was a relatively low prevalence of human immunodeficiency virus infection in Cape Town, with 4.4% of women attending public sector antenatal care being infected.¹

It was not policy to routinely measure electrolytes on admission, but testing facilities were easily accessible and frequently used. Childhood diarrhoea in Cape Town has a seasonal incidence, peaking in February and March. Oral rehydration therapy is widely used in ambulatory patients, either with prepacked sachets to make up fluid containing 64 mmol/l of sodium and 20 mmol/l of potassium, or a salt and sugar solution containing a similar concentration of sodium and no potassium.

Data collection and analysis

Sodium and potassium values of specimens sent from the rehydration unit from August 1995 to July 1997 were obtained from the hospital laboratory service's electronic database. This period was chosen because it represented the first two years for which electronic data were available. The first record for each patient in the two year period was included in the analysis. The sampling process thus excluded repeat admissions and tests requested from other sites before admission.

After strong seasonal associations were found in the a priori analysis of severe hypokalaemia, the analysis was extended to include hypernatraemia, and mean concentrations of both electrolytes. Hypokalaemia was taken as below 3.5 mmol/l (severe below 2.0 mmol/l) and hypernatraemia as above 150 mmol/l (severe above 160 mmol/l).

RESULTS

Records of a first laboratory specimen were identified in 3759 (40.2%) of 8936 children admitted during the period under review. Seven sodium and eight potassium values were missing. The monthly proportion of children with hypokalaemia peaked during the busy summer season (February) and that of hypernatraemia in winter (August). Table 1 shows a post hoc comparison of hypokalaemia and hypernatraemia in February and August. The prevalence ratio of severe hypokalaemia in February compared with August was 19 (95% CI 2.6 to 135) and of severe hypernatraemia 0.08 (95% CI 0.02 to 0.36). There was a clear seasonal variation of mean potassium and sodium concentrations, with peaks in the winter and troughs in summer (fig 1). The difference between monthly mean peak and trough potassium concentrations was 0.80 mmol/l (95% CI 0.55 to 1.06) and sodium 6.0 mmol/l (95% CI 4.4 to 7.5). The proportion of admitted patients who had electrolytes

Table 1 Electrolyte disturbances by month of year

Month	Hypernatraemia		Hypokalaemia	
	>150 mmol/l	>160 mmol/l	<3.5 mmol/l	<2.0 mmol/l
February 1996/97 (n=489)	12 (2.5%)	2 (0.4%)	287 (58.7%)	35 (7.2%)
August 1996/97 (n=259)	28 (10.8%)	13 (5.0%)	76 (29.01%)	1 (0.4%)
Prevalence ratio (95% CI)	0.23 (0.12 to 0.44)	0.08 (0.02 to 0.36)	2.0 (1.6 to 2.5)	19 (2.6 to 135)

Figure 1 Mean plasma potassium and sodium concentrations (with 95% CI) and percentage of admissions tested, by month of year.

measured ranged by month from 30.8% to 66.0%, with no clear seasonal pattern in the proportion of patients tested (fig 1).

DISCUSSION

A seasonal fluctuation in the prevalence of hypernatraemia, with higher concentrations in winter, has been reported from Egypt² and the USA,^{3,4} suggesting that factors operative in this

study are widespread. However, in a Medline search (search strategy available from the authors) we found no previous reports of seasonal variation in potassium concentrations.

The parallel variation in potassium and sodium concentrations was clinically meaningful, with the prevalence of severe hypokalaemia and severe hypernatraemia varying 10- to 20-fold with season. These findings in a resource poor country have potential public health importance. Identification of factors contributing to these variations could inform community level interventions to prevent severe electrolyte disturbances in settings where diarrhoea is a leading cause of childhood mortality. One possible cause of the fluctuations is a seasonal variation in the incidence of one or more enteropathogens causing large electrolyte losses. Enterotoxigenic and enteroinvasive *E coli* (ETEC and EIEC) both have a seasonal incidence with a summer peak.^{5,6} ETEC and rotavirus are the commonest pathogens in Cape Town; ETEC is the commonest organism in summer and rotavirus in winter (D Coltman, unpublished data).

The unexpected findings of this exploratory and partially post hoc analysis require confirmation in prospective studies in different settings, and investigation of the determinants of any variation. Such a study has commenced in Cape Town.

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REFERENCES

- 1 **Department of Health**, Republic of South Africa. Seventh national HIV survey of women attending antenatal clinics of the public health services, October/November 1996. *Epidemiological Comments* 1996/1997;**23**:4-16.
- 2 **Fayad IM**, Hirschhorn N, Abu-Zikry M, *et al*. Hypernatraemia surveillance during a national diarrhoeal diseases control project in Egypt. *Lancet* 1992;**339**:389-93.
- 3 **Bruck E**. Seasonal incidence of hypertonic dehydration in diarrhoea of infants. Experience in Buffalo from 1954 to 1967. *Am J Dis Child* 1969;**118**:582-4.
- 4 **Finberg L**. Hypernatremic (hypertonic) dehydration in infants. *N Engl J Med* 1973;**289**:196-8.
- 5 **Ram S**, Khurana S, Khurana SB, *et al*. Seasonal fluctuations in the occurrence of enteroinvasive *Escherichia coli* diarrhoea. *Indian J Med Res* 1990;**91**:258-62.
- 6 **Sack RB**, Svennerholm AM. Prevalence of toxin types and colonization factors in enterotoxigenic *Escherichia coli* isolated during a 2-year period from diarrhoeal patients in Bangladesh. *J Clin Microbiol* 2000;**38**:27-31.