

BACKGROUND AND AIMS

Electrolyte disorders are frequent in severely malnourished children who require hospitalization. Hypokalaemia is particularly prevalent, and is associated with increased mortality. (1) (2) Therapeutic milks (F75 and F100) are formulated to address electrolyte disorders, with F75 used to stabilize children during the crucial first hospital days when critical hypokalemia is most likely.

Through the use of point-of care electrolyte measurement devices, we aimed to document the prevalence of electrolyte disorders, including hypokalemia, and the factors associated with critical hypokalemia at hospital admission. We further describe the changes in serum K⁺ over time in children presenting at hospital with an initial serum K⁺ <3.0 mmol/l receiving standard nutrition therapy with F75 with or without rehydration, and children receiving F75 and intravenous (IV) and/or oral K⁺ correction

METHOD

Serum electrolytes were measured at admission to hospital for severely malnourished children with vomiting or diarrhea using a point-of-care laboratory device in 5 inpatient units in Niger, Chad and Nigeria between July 2017 and July 2019. For most children with [K⁺] <3.0 at admission, electrolyte measurements were repeated every 24h until K⁺ > 3.0. All children received F75. Those who were not dehydrated received IV (1.0 mmol/kg over 3h) or oral (3 mmol/kg over 24h) K⁺ until serum K⁺ > 3.0.

RESULTS

We conducted point of care electrolyte testing in 761 severely malnourished children hospitalised with diarrhea in 5 hospitals in 3 countries

There was a high prevalence of life-threatening electrolyte disturbances

- 20% of children had critical hypokalemia of less than 2 mM/L upon admission.
- 35% of children had hyponatremia of less than 130 mM/L upon admission; among these it was severe in 56 children at less than 120. Hyponatremia was significantly associated with mortality. Hyponatremia was 25x more prevalent than hypernatremia.

Oral potassium correction shows promise for addressing critical hypokalemia

Severe hyponatremia resolved in 94% of children who received Lactated Ringers and/or low osmolarity oral rehydration salts (ORS) plus therapeutic milk, whereas it resolved in only 50% children given therapeutic milk and/or Resomal.

Table 1: Initial serum potassium and sodium levels

Electrolyte distribution	n	%
Sodium		
Normal value [135,145]	244	32.1
Hypонатremia		
Mild [130,134]	229	30.2
Moderate [120,129]	211	27.7
Severe < 120	56	7.4
Hypernatremia		
Mild [145,149]	10	1.3
Moderate [150,159]	7	0.9
Severe ≥ 160	4	0.5
Potassium		
Normal Value [3.5,5.5]	232	30.5
Hypokalemia		
Mild [3.0,3.4]	105	13.8
Moderate [2.5,2.9]	118	15.5
Severe [2.0,2.4]	88	11.6
Critical < 2.0	152	20
Hyperkalemia		
Mild [5.6,5.9]	47	6.2
Moderate [6.0,6.4]	8	1.1
Severe ≥ 6.5	11*	1.4

*only 3 confirmed by a 2nd sample

Table 2: Evolution of potassium blood levels

Serum potassium	Standard (F75 +/- Resomal)				Standard + K ⁺ (IV and/or po)			
	Before		After		Before		after	
	r%	n	r%	n	r%	n	r%	n
K ⁺ <2	32	29.4	7	6.4	79	56	9	6.4
K ⁺ [2-3]	48	44.0	14	12.8	58	41.1	32	18.4
K ⁺ [3-5.5]	23	21.1	79	72.5	4	2.8	89	67.2
K ⁺ >5.5	6	5.5	9	8.3	0	0	11	8

Table 3: Evolution of sodium blood levels

Serum sodium	Without infusion or ORS				With infusion or ORS			
	Before		After		Before		after	
	n	%	n	%	n	%	n	%
Na ⁺ <120	10	5.6	5	2.8	17	23.6	1	1.4
Na ⁺ [120,130]	61	34.3	39	21.9	29	40.3	20	27.8
Na ⁺ [130,145]	106	59.6	126	70.8	25	34.7	45	62.5
Na ⁺ >145	1	0.6	8	4.5	1	1.4	6	8.3

Table 4: Factors associated with critical hypokalemia at initial electrolyte measure, n=761

Characteristics		K <2	K >2	Multivariate	
				N (%)	N (%)
Breastfeeding	Yes	58 (16)	304 (84)	Ref	
	No	61 (24.2)	191 (75.8)	1.63 (1.07,2.49)	0.023
Duration diarrhea before admission	< 5 days	58 (15.1)	325 (84.9)	Ref	
	≥ 5 days	91 (24.9)	275 (75.1)	1.73 (1.13,2.64)	0.012
Natremia	≥ 130	62 (12.6)	432 (87.4)	Ref	
	<130	90 (33.7)	177 (66.3)	3.5 (2.29,5.34)	<0.001

Table 5: Factors associated with hyponatremia

Characteristics		Na <130	Na >130	Multivariate	
				N (%)	N (%)
Death (n=X)	Cured	221 (33.4)	441 (66.6)	Ref	
	Died	34 (51.5)	32 (48.5)	2.32 (1.36,3.95)	0.013
Traditional medicine	No	193 (33.6)	381 (66.4)	Ref	
	Yes	26 (65)	14 (35)	3.38 (1.67,6.86)	<0.001
Duration diarrhea before admission	< 5 days	114 (29.8)	269 (70.2)	Ref	
	≥ 5 days	149 (40.7)	217 (59.5)	1.57 (1.11,2.23)	0.011

CONCLUSION

Critical hypokalemia affected 20% of children upon admission of which one third failed to correct with F75/Resomal alone. Oral potassium supplementation in addition to F75 is feasible, shows promise even in children with critical hypokalemia and should be further investigated.

Severe hyponatremia (Na⁺ < 120 mmol/L) is 14 times more prevalent than hypernatremia and is not accounted for in standard nutrition protocols. The current West African generic SAM protocol incorrectly emphasizes risk of hypernatremia and ignores an apparently more serious risk of hyponatremia.

This study raises important questions for improving inpatient care for severely malnourished children:

- Would patient outcomes improve if low osmolar ORS is used instead of Resomal for fluid replacement?
- Can F75 be reformulated to more efficiently correct critical electrolyte, vitamin and mineral imbalances?

Ethical Review Board: Not required for secondary data analysis from routine data obtained from de-identified patient files.

REFERENCES

- 1: Talbert A, et al. Diarrhoea Complicating Severe Acute Malnutrition in Kenyan Children: PLOS ONE. 2012.
- 2: Daly K, Farrington E. Hypokalemia and Hyperkalemia in Infants and Children: Pathophysiology and Treatment. Journal of Pediatric Health Care 2013
- 3: Hiffler L et al. Thiamine content of F-75 therapeutic milk for complicated severe acute malnutrition: time for a change? Ann NY Acad Sci. 2017