RISK FACTORS FOR SEVERE DEHYDRATION AND HYPOVOLAEMIC SHOCK IN CHILDREN PRESENTING TO KENYATTA NATIONAL HOSPITAL WITH ACUTE GASTROENTERITIS

Research dissertation in partial fulfillment of a Masters degree in Paediatrics and Child Health, University of Nairobi.

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DECLARATION

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LIST OF ABBREVIATIONS

ETAT – Emergency Triage, Assessment and Treatment

GoK – Government of Kenya

NHIF – National Health Insurance Fund

KNH – Kenyatta National Hospital

ORS – Oral Rehydration Solution

ORT – Oral Rehydration Therapy

PEU – Paediatric Emergency Unit

WHO – World Health Organisation

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ABSTRACT

Background: Dehydration is the most frequent and dangerous complication of acute gastroenteritis which accounts for millions of deaths each year in young children, mostly in developing countries. There remains much to be learned about the factors that place a child at a particular risk of dying of diarrhoea due to dehydration or the differences between the majority of mild and self-limited episodes and those that may lead to death. Identification of these risk factors would help in predicting the children with acute gastroenteritis who are more likely to develop severe dehydration/hypovolaemic shock and therefore likely to die.

Objective: To determine the risk factors for severe dehydration and hypovolaemic shock in children aged 2-36 months presenting to Kenyatta National Hospital with acute gastroenteritis.

Methods: The study applied a cross-sectional comparative design. A total of 214 children aged 2-36 months with acute gastroenteritis during the study period was identified and a questionnaire administered to their guardians with regard to the clinical profile, socio-demographic factors and the guardian's practices during the diarrhoeal episode. Seventy-six (76) had severe dehydration/ hypovolaemic shock while one hundred and thirty eight(138) had no or some dehydration.

Study Outcome: Multivariate analysis by logistic regression was done to determine which factors are risks for severe dehydration/ hypovolaemic shock in children with acute gastroenteritis.

Findings: The socio-demographic risk factor for severe dehydration and hypovolaemic shock in children presenting to KNH with acute gastroenteritis is living in a mud floor house. The clinical risk factors are longer duration of diarrhoea, vomiting everything and presence of co-morbidity. Similarly, stoppage of (breast)feeding by the guardian during the course of the illness is a risk factor. The provision of ORS and Zinc reduce the risk of severe dehydration and hypovolaemic shock in the same population.

INTRODUCTION/LITERATURE REVIEW

Acute gastroenteritis accounts for millions of deaths each year in young children, mostly in developing countries[1]. Dehydration, which may be associated with electrolyte disturbance and metabolic acidosis, is the most frequent and dangerous complication[1].

Worldwide, 3-5 billion cases of acute gastroenteritis and nearly 2 million deaths occur each year in children under 5 years[1].Of the childhood deaths in developing countries in 1993, about 23% resulted from diarrhoea[2]. Dehydration caused by severe diarrhea is a major cause of morbidity among children in Kenya[3]. At Kenyatta National Hospital, gastroenteritis accounted for about 18%(2,260) of admissions to peadiatric wards in 2007. In the same year, one thousand one hundred and sixty one(1,161) cases of dehydration due to gastroenteritis were admitted of whom 225(19.4%) died[4]. This high case fatality rate is however partly explained by the presence of co-morbidities which may not have been picked at admission by the clinician or not entered into the records during data collection, or not incorporated in the final diagnosis.

Severely dehydrated or shocked children usually need intravenous fluids and hospital admission. Given that the mean cost for each admission using the NHIF rates is Ksh. 16,556 the economic loss is enormous[5].

There remains much to be learned about the factors that place a child at a particular risk of dying of diarrhoea due to dehydration or the differences between the majority of mild and self-limited episodes and those that may lead to death[6]. Identification of these risk factors would help in predicting the children with acute gastroenteritis who are more likely to develop severe dehydration/hypovolaemic shock. This would inturn be useful especially at developing community advocacy messages and in closer follow up of this children to reduce child mortality.

There are no studies which have specifically looked at the risk factors for severe dehydration/ hypovolaemic shock in children with acute gastroenteritis. The few studies done have dealt with risk factors for ‘dehydrating diarrhoea’ or ‘life-threatening diarrhoea’. In these studies one group of children consisted of those with severe dehydration and moderate dehydration while the other consisted of those with no dehydration. There is no mention of hypovolemic shock but it is important to note that at the time these studies were done the World Health Organisation had not classified shock seperately from severe dehydration. It

follows therefore that cases of hypovolaemic shock would have been among those classified as severe dehydration.

Child-related factors that have been shown to be associated with dehydrating diarrhoea are age and nutritional status. In a study done in a metropolitan area of Porto Alegre, Brazil, in infants aged less than 12 months the risk of dehydrating diarrhoea was significantly higher in the first 9 months of life, and in those aged 12-23 months the risk was again greater in younger children(12-17months)[7] . Another study done in the same country found out that the risk of moderate and severe dehydration decreased sharply with age and was approximately twenty times greater in the first two months of life than in the period 9-11 months[8] . There was however no significant variation in the risk with age during the second year of life. In the same study, the higher birth orders were associated with greater risks since children with three or more older siblings were twice as likely as first borns to develop moderate or severe dehydration.

Further, low body weight, regardless of age, was found in Brazil to be strongly associated with the risk of severe dehydration[9]. Low body weight was found to be superior to more complex anthropometric indices, including weight for age, weight for length or length for age, and also to early signs and symptoms during the diarrhoea episode.

The socio-demographic factors of the guardian which studies have shown to be risk factors for severe disease in terms of dehydration include family income and maternal education level. In a case-control study in Dhaka, Bangladesh, income in the uppermost quartile of the study population, independently of maternal education, was associated with 41% reduced risk of severe disease(dehydration) compared to the lowest quartile. In addition, after adjusting for family income, 7 or more years of school education was associated with 54% reduced risk of severe disease as indicated by presence of dehydration[10]. Based on the concept that socio-economic variables operate through a set of proximate variables it is contended that maternal education, independently of economic power through its impact on disease from acute diarrhoea, favourably influences child survival[10].

In contrast, the study in Brazil did not find family income, maternal education and employment as risk factors of severe dehydration in acute gastroenteritis[8].

Guardians' practices may also determine the degree of dehydration due to acute gastroenteritis. In Bangladesh, withdrawal of breastfeeding by mothers during diarrhoeal episode was shown to be associated with a substantially increased risk of dehydration compared with those who did not stop breastfeeding[6]. Compared with infants who are exclusively breastfed, bottle-fed infants are at a higher risk of dehydrating diarrhoea[7]. Partially breastfed infants were at intermediate levels of risk. Furthermore, compared with those still breastfeeding, children who stopped in the previous 2 months are more likely to develop dehydrating diarrhoea[7]. In Brazil, children who were not breastfed were three times more likely to become dehydrated than those who received breastmilk but no other milk[8]. Dehydrating diarrhoea in these studies meant diarrhoea with moderate or severe dehydration.

In terms of the clinical profile of the child,the diarrhoeal duration on the day of attendance to hospital, frequency of stool per day,vomiting by the child, oral rehydration therapy and drugs given at home and nutritional status have been shown to be significantly associated with dehydration[11]. Vomiting in particular has been shown to be a significant risk factor[11,12,13]. It has been shown that many mothers stop the use of oral fluids completely when children vomit[11], despite the fact that vomiting does not prevent successful oral rehydration therapy. Drugs given at home increase the risk for dehydration, and infact have been shown to prolong the duration of diarrhoea and put the child at risk again of developing dehydration[11].

Locally, Gitau in a study of factors associated with late hospital presentation, found out that symptoms of cough and diarrhoea were likely to be associated with presentation later than 3 days and that caretakers of children with late presentation were likely to have explored other options first[14]. In addition he reported use of herbal medicine by 5% of the children and this was associated with marked likelihood of late presentation. Similarly, Tailer reported that 33.5% of all patients presenting with acute diarrhoea presented after four days since onset of diarrhoea[15]. This makes duration of diarrhoea before presentation one of the potential risk factor for severe dehydration/shock to be studied.

Tailer also found that while 68.9% of the caretakers had heard of ORS only 11.1% used it during the diarrhoeal episode. Migiro reported that 11.3% of the children had been given ORS by their caretakers as opposed to 53.6% who had received salt-sugar solution. In the same study 25.6% of children had received drugs without supplemental fluid therapy.These practices need to be studied to

see if they are risk factors for severe dehydration/ shock in children with acute gastroenteritis.

Finally, Migiro found out that a greater proportion of malnourished children had moderate dehydration as compared to children with normal weight.[16] However, severe dehydration was more in well nourished children than in malnourished children with acute diarrhoea. Noteworthy though is that one of the exclusion criteria was those children who appeared very ill thus potentially excluding cases of severe dehydration and shock.

STUDY JUSTIFICATION

Severe dehydration and hypovolaemic shock due to acute gastroenteritis accounts for most of the deaths due to acute gastroenteritis yet it is preventable. Information on associated risk factors, which is currently deficient, would be important for advocacy at community level by focussing on them to reduce child mortality.

Since all children who present with severe dehydration/shock are subsequently admitted, the identification of the associated risk factors at community and lower-level facilities would reduce the number of children admitted at Kenyatta National Hospital hence reduce congestion in its pediatric wards.

Further,the ability to identify,early on, episodes of gastroenteritis at highest risk of leading to severe dehydration/hypovolaemic shock would enable health workers to recognize potentially severe cases, treat them appropriately and keep them under closer surveillance. This would reduce cases of severe dehydration/hypovolaemic shock from acute gastroenteritis and hence lower its associated mortality.

STUDY OBJECTIVES:

BROAD OBJECTIVE:

To determine the risk factors for severe dehydration and hypovolaemic shock in children aged 2-36 months presenting to Kenyatta National Hospital with acute gastroenteritis.

SPECIFIC OBJECTIVES:

1. To determine the clinical and socio-demographic risk factors for severe dehydration and hypovolaemic shock in children with acute gastroenteritis seen at Kenyatta National Hospital.

2. To determine guardians' practices which are risk factors for severe dehydration and hypovolaemic shock in children with acute gastroenteritis seen at Kenyatta National Hospital.

RESEARCH QUESTION:

What are the risk factors for severe dehydration and hypovolaemic shock in children aged 2-36 months presenting to Kenyatta National Hospital with acute gastroenteritis?

METHODOLOGY:

STUDY DESIGN

This was a hospital based cross-sectional comparative study.

STUDY AREA

The study subects were recruited from the pediatric emergency unit(PEU) of the Kenyatta National Hospital, a national referral and teaching hospital located in Nairobi, Kenya. The PEU serves as the emergency reception for all sick children less than 13 years of age who present to this hospital.

On average 5,000 children are attended to at the PEU every month.
Kenyatta National Hospital has an inpatient bed capacity of 1,868 beds out of which 240 are in the four pediatric general wards where those with severe dehydration and shock are admitted after rescucitation at the PEU.

STUDY POPULATION

Children aged between 2-36 months presenting with acute gastroenteritis at the PEU and the pediatric wards at the Kenyatta National Hospital.

INCLUSION CRITERIA

1. Children aged 2-36 months with acute gastroenteritis, where acute means a duration of 7days or less from the onset of diarrhoea and/or vomiting.
2. Informed consent to participate in the study provided by the guardian.

EXCLUSION CRITERIA

1. Children whom informed consent was not given.
2. Children with bloody diarrhoea.

SAMPLING METHOD

All children aged 2-36 months who were brought to KNH Pediatric Emergency Unit with a report of the child having diarrhoea (i.e the guardian gave a history of watery or loose stool without any visible blood in the past 24 hours) for 7 days or less during the study period was considered for inclusion in the study. Every of such a child was sequentially recruited throughout the study period. The study period was March to May 2010.

One group consisted of children with severe dehydration or hypovolaemic shock and another group consisted of children with some or no dehydration. The classification of the patients depending on the degree of dehydration was as per the Government of Kenya Basic Paediatric Protocal guidelines as shown in Appendix 1.

STUDY PROCEDURE

The principal investigator or one of the two research asistants was stationed at the Paediatric Emergency Unit and enrolled the children who met the study criteria. This was during the study period of three months which ran from March to May 2010.

A structured questionnaire as shown in Appendix 3 was administered to the guardian after the child had been attended to by the clinician at the unit. The clinician would either be a paediatric resident or a clinical officer with higher diploma in paediatrics. All the clinicians and nurses in the Paediatric Emergency Unit have undergone a one-week training in Emergency Triage, Assessment and Treatment (ETAT) of sick children. In this course they are, among other things, trained on assessment and classification of children with acute gastroenteritis as per the GoK basic Paediatric Protocal guidelines.The principal investigator and the research assistants have also had this training.

Priority was given to rescucitation of the children with severe dehydration and hypovolaemic shock . Consent was sought once the child was stable and the questionnaire then administered.

Questions asked on clinical profile inluded the duration of illness before presentation, frequency of diarrhoea, presence/absence of vomiting, frequency of vomiting, and presence/absence of fever.
Socio-demographic variables included the child's age, sex, birth order, birth interval; the guardian's relationship to the child, the guardian's level of education, family income and housing conditions.

The variables on the guardian's practices included the type of facility/ practitioner first visited, whether or not ORS was given, whether other type of fluid/drug was given, and breastfeeding/feeding practices during the illness.
The degree of dehydration was assessed and recorded.
Weight, length/height were also taken and the corresponding weight-for-height z-score checked in the relevant WHO chart.

SAMPLE SIZE CALCULATION

Sample size was calculated according to the following formula:

$$n = \frac{Z^2 \alpha_{/2} PQ}{D^2}$$

Where:-

n = the minimum sample size.

$Z\alpha/_2$ = 1.96, the standard normal deviate at the required confidence level (95%).

α = Statistical significant level (0.05).

P = the proportion in the target population estimated to have characteristic being measured (Prevalevance of Severe Dehydration in patients with acute gastroenteritis , = 4.3%[17]).

Q = 1-P.

D = precision with which to measure prevalence, set at plus or minus 5% (0.05).

At 95% confidence interval, $Z\alpha/2$ at 1.96 and Prevalence of 4.3% based on a study by Migiro S. of 1988 the minimum sample size for the study was to be 64 participants for the group consisting of severe dehydration/hypovolaemic shock. At least a similar number was to consist of the group with no or some dehydration and thus a total number of at least **128** participants.

DATA MANAGEMENT AND ANALYSIS

The collected data was kept in a safe place for data entry process. After cross checking the questionnaires for any missing entries a data base was designed in MS Access which allowed the the data to be cleaned.On completion of the data entry exercise the data was exported to a stastistical package(SPSS- Version 15.0) for analysis and for inferential statistics.

Univariate analysis was used to examine whether there was any significant association between potential risk factors above and severe dehydration/hypovolaemic shock by logistic regression.

Multivariate analysis was done for statistically significant risk factors by logistic regression.
Odds Ratios(OR) and its associatted 95% confidence interval(CI) was employed to assist in determining the factor(s) that is/are associated with severe dehydration/hypovolaemic shock.

P-value of less than 5% was considered to be statistically significant.

ETHICAL CONSIDERATIONS:

- Informed consent was sought from parents/guardians
- Permission to carry out the study was sought and received from the KNH Research and Ethical committee. The approval letter is attached as Appendix 4.
- Participants did not incur any extra cost for the study
- Resuscitation and stabilization of children with shock and severe dehydration took precedence over administration of the questionnaire.

RESULTS.

A total of two hundred and fourteen (214) children who met the inclusion criteria during the study period were enrolled into the study. Seventy- six (35.5%) were in the severe dehydration/ hypovolaemic shock group while one hundred and thirty-eight(64.5%) had no or some dehydration.This distribution is depicted in Table 1 below.

Table 1: Distribution as per hydration status.

Hydration Status	**Frequency (%)**	**Cumulative Frequency(%)**
Shock	19 (8.9)	
Severe dehydration	57 (26.6)	76(35.5%)
Some dehydration	76 (35.5)	
No dehydration	62 (29.1)	138(64.5%)

The baseline child and guardian characteristics were as shown in Table 2 below. The mean age of the children was 11 months while that of the guardians was 26 years.There was a slight predominance of the girl child constituting fifty-nine (59%). Most of the guardians were female, making up ninety-seven (97%), with all of them being the mother to the child.

Table 2: Child and guardian socio-demographic characteristics

Variable	**Mean (IQR)/ Frequency (%)**
Child characteristic	
Age months (children)	11.0 (7.0-15.0)
Weight (kgs)	7.7 (6.5-9.1)
Height/length(cm)	68.0 (63.0-75.0)
Sex Male	88 (41.1)
Female	126 (58.9)
Guardian characteristic	
Age (years)	26.0 (24.0-28.3)
Sex Male	7 (3.3)
Female	207 (96.7)
Number of rooms in the household	2.0 (1.0-2.0)
Transport to first facility visited(Kshs)	50.0 (30.0-80.0)
Family income (Kshs /month)	6,000 (3000-10000)
Education level: Lower primary	3 (1.4)
Upper primary	58 (27.1)
Secondary	100 (46.7)
Tertiary	49 (22.9)
None	4 (1.9)
Relationship to child: Mother	207 (96.7)
Father	6 (2.8)
Other relative	1 (0.5)
Family house floor: Mud	21 (9.8)
Cement	193 (90.2)
Source of drinking water	
Piped	200 (93.5)
Borehole	11 (5.1)
Protected well	1 (0.5)
Water vendors	2 (0.9)
Method of water treatment	
Chlorination	54 (25.2)
Boiling	120 (56.1)
Untreated	40 (18.7)

The baseline clinical characteristics of the children at presentation is as shown in Table 3 below. Most of the children (81.3%) presented with both diarrhoea and vomiting while the remainder presented with diarrhoea only. Amongst the children who presented with vomiting, one hundred and fourteen (65%) of them were reported to have been vomiting everything. Further, one hundred and twenty-seven (59%) were reported to have had refusal to (breast)feed. Sixty- one (61) of the children constituting about twenty-eight percent (28%) had cormobidity which included upper respiratory tract infections, epilepsy, pnemonia, heart disease,cerebral palsy, rickets and malnutrition,

Table 3: Baseline Clinical characteristics of the children

Variable	**Mean (IQR)/ Frequency (%)**
Diarhoea duration (Hours)	72.0 (48.0-91.5)
Diarhoea motions/24 hrs	4.0 (3.0-5.0)
Vomiting: Present Absent	174 (81.3) 40 (18.7)
Vomiting (duration in hours)	48.0 (31.5-96.0)
Vomiting (bouts/24hrs)	4.5 (3.0-6.0)
Vomiting everything Yes No	 114 (65.5) 60 (34.5)
Refusal to feed /breastfeed Yes No	 127 (59.3) 87 (40.7)
Presence of fever Present Absent	 167 (78.0) 47 (22.0)
Co-morbidity Yes No	 61 (28.5) 153 (71.5)

The guardian's practices during the duration of the illness is as shown in Table 4 below.

Table 4: Guardian practices during the duration of the illness.

Variable	Frequency (%)
Child breastfeeding before illness: Yes	193 (90.2)
No	21 (9.8)
Breastfeeding stopped after illness: Yes	78 (36.4)
No	136 (63.6)
Feeding frequency during illness	
Increased	4 (1.9)
Decreased	210 (98.1)
Fluids given at home before facility	
ORS	32 (15.0)
Water	134 (62.6)
Home-made salt/sugar solution	37 (17.3)
None	11 (5.1)
Drugs given at home	
None	111 (51.8)
Herbal medicine	6 (2.8)
Antibiotics	15 (7.0)
Anti-motility	10 (4.7)
Analgesics	70 (32.7)
Anti-malaria	2 (0.9)
Health facility first visited	
Private clinic	82 (38.3)
Private hospital	9 (4.2)
KNH	99 (46.3)
KNH revisit	6 (2.8)
City council health centre	13 (6.1)
Non-conventional practitioner	2 (0.9)
Other	3 (1.4)
Provided ORS by time of arrival: Yes	138 (64.5)
No	75 (35.5)
Provided zinc by time of arrival:	
Yes	50 (23.4)
No	153 (71.5)
Not known	11 (5.1)

Among the one hundred and ninety-three (90%) of the children who were still breastfeeding before the illness, seventy-eight (36.4%) had breastfeeding stopped during the course of the gastroenteritis. One hundrend and fifteen(53.7%) of the guardians had sought medical care elsewhere before presenting to Kenyatta National Hospital with most of them, eighty-two (71.3%), having been to a private clinic. Only thirty-two (15%) of the guardians had given ORS at home with majority(62.6%) having given plain water.

On univariate analysis, as shown in Table 5 below, children with hypovolaemic shock and severe dehydration were not significantly different in age from those presenting with some or no dehydration (P=0.140). The guardians of children with shock and severe dehydration were younger (median age of 25 years) and the family income was lower (median income of Kshs 6000) compared to those with some or no dehydration; P=0.035 and 0.001 respectively. Further, children with hypovolaemic shock or severe dehydration were more likely to have come from a family house with mud floor (22.4%) compared to 2.9% of those presenting with some or no dehydration (P<0.001).

Table 5: Child and guardian socio-demographic characteristics associated with severe dehydration and hypovolaemic shock

Variable	Dehydration		P value
	Shock and Severe	Some and None	
Child characteristics:			
Age (months)	10.0 (6.0-15.0)	11.0 (7.0-15.0)	0.140
Weight/height z-score:			
Median to -1	61(80.3%)	118(85.5%)	0.514
-1 to -2	7(9.2%)	13(9.4%)	
-2 to -3	3(3.9%)	3(2.2%)	
> -3	5(6.6%)	4(2.9%)	
Sex: Male	37 (48.7%)	51 (37.0%)	0.095
Female	39 (51.3%)	87 (63.0%)	
Guardian characteristics:			
Age (years)	25.0 (23.0-28.0)	26.0 (24.0-29.0)	0.035
Family income (Kshs/month)	4000 (2500-8000)	6000 (4000-11000)	0.001
Number of rooms	2 (1.0-2.0)	2.0 (1.0-3.0)	0.184
Cost of transport to first facility	40.0 (20.0-100.0)	50.0 (30.0-80.0)	0.337
Sex: Male	2 (2.6%)	5 (3.6%)	0.696
Female	74 (97.4%)	133 (96.4%)	
Education level			
None	3 (3.9%)	1 (0.7%)	0.147
Lower primary	1 (1.3%)	2 (1.4%)	
Upper primary	25 (32.9%)	33 (23.9%)	
Secondary	35 (46.1%)	65 (47.1%)	
Tertiary	12 (15.8%)	37 (26.8%)	
Relationship to child: Mother	74 (97.4%)	133 (96.4%)	
Father	1 (1.3%)	5 (3.6%)	0.253
Other	1 (1.3%)	0 (0.0%)	
Family house floor: Mud	17 (22.4%)	4 (2.9%)	<0.001
Cement	59 (77.6%)	134 (97.1%)	
Source of drinking water			
Piped	69 (90.8%)	131 (94.9%)	0.464
Borehole	5 (6.6%)	6 (4.3%)	
Protected well	1 (1.3%)	0 (0.0%)	
Water vendors	1 (1.3%)	1 (0.7%)	
Water treatment			
Chlorination	20 (26.3%)	34 (24.6%)	0.896
Boiling	43 (56.6%)	77 (55.8%)	
Untreated	13 (17.1%)	27 (19.6%)	

Most of the clinical characteristics of the children, as shown in Table 6 below, were asssociated with severe dehydration and hypovolaemic shock on univariate analysis.These included the duration of diarrhoea, number of bouts of diarrhoea, presence and duration of vomiting, vomiting everything, refusal to (breast)feed, presence of fever, and presence of co-morbidity.

Table 6: Clinical characteristics associated with severe dehydration and hypovolaemic shock in acute gastroenteritis.

Variable	**Dehydration**		**P value**
	Shock and Severe	**Some and None**	
Diarhoea duration (Hours)	72.0 (48.0-96.0)	48.0 (24.0-72.0)	0.015
Diarhoea (motions/24 hrs)	5.0 (3.0-6.0)	4.0 (3.0-5.0)	0.001
Vomiting: Present Absent	69 (90.8%) 7 (9.2%)	105 (76.1%) 33(23.9%)	0.008
Vomiting duration (Hours)	72.0 (48.0-96.0)	48.0 (24.0-84.0)	0.004
Vomiting bouts/24hrs	5.0 (4.0-6.0)	4.0 (3.0-6.0)	0.009
Vomits everything: Yes No	63 (91.3%) 6 (8.7%)	51 (48.6%) 54 (51.4%)	<0.001
Refusal to feed /breastfeed Yes No	 60 (78.9%) 16 (21.1%)	 67 (48.6%) 71 (51.4%)	 <0.001
Presence of fever Present Absent	 72 (94.7%) 4 (5.3%)	 95 (68.8%) 43 (31.2%)	 <0.001
Co-morbidity Yes No	 36 (51.4%) 34 (48.6%)	 25 (19.5%) 103 (80.5%)	 <0.001

The guardian practices which were associated with severe dehydration and hypovolaemic shock in gastroenteritis were stoppage of breastfeeding during the course of the illness, provision of ORS, provision of Zinc and the type of facility first visited, as shown in Table 7 below.There was, however no statistically significant association with decrease in feeding frequency during the illness, and the type of fluid or drug given at home.

Table 7: Guardian practices associated with severe dehydration and hypovolaemic shock

Variable	**Dehydration**		**P value**
	Shock and Severe	**Some and None**	
Breastfeeding stopped during illness			
Yes	44 (57.9%)	34 (24.6%)	<0.001
No	32 (42.1%)	104 (75.4%)	
Feeding frequency during illness			
Increased	1 (1.3%)	3 (2.2%)	0.653
Decreased	75 (98.7%)	134 (97.8%)	
Fluids given at home			
ORS	12 (16.9%)	20 (15.2%)	0.429
Water	43 (60.6%)	91 (68.9%)	
Home-made salt/sugar solution	16 (22.5%)	21 (15.9%)	
Drugs given at home			
None	32 (43.2%)	77 (55.8%)	0.241
Herbal medicine	3 (4.1%)	3 (2.2%)	
Antibiotics	5 (6.8%)	10 (7.2%)	
Anti-motility	6 (8.1%)	4 (2.9%)	
Analgesics	28 (37.8%)	42 (30.4%)	
Anti-malaria	0 (0.0%)	2 (1.4%)	
Health facility first visited			
KNH	25(32.9%)	80 (59.3%)	0.006
Other health facility	49(64.5%)	55 (40.7%)	
Non-conventional practitioner	2 (2.6%)	0 (0.0%)	
Provided ORS by time of arrival: Yes	34 (44.7%)	104 (75.9%)	<0.001
No	42 (55.3%)	33 (24.1%)	
Provided Zinc by time of arrival: Yes	2 (2.6%)	48 (35.3%)	<0.001
No	68 (89.5%)	85 (62.5%)	
Not known	6 (7.9%)	3 (2.2%)	

On subjecting the potential risk factors identified in univarate analysis to multivariate analysis (see Table 8 below), it shows that mud family house floor is an independent sociodemographic risk factor for severe dehydration/ hypovolaemic shock in acute gastroenteritis.

Duration of diarrhea, vomiting everything and presence of co-morbidity are the clinical factors that independently predicthypovolaemic shock and severe dehydration in children presenting with acute gastroenteritis.

Among the guardian's practices, stopping (breast)feeding increased the risk of shock and severe dehydration ; OR 4.1 (2.0-8.1), p<0.001 while provision of ORS and zinc reduced the risk; OR 0.1 (0.2-0.4), p=0.004 and OR 0.4 (0.2-0.7), p=0.002 respectively.

Tables 8: Multivariate analysis for potential risk factors for severe dehydration/ hypovolaemic shock in acute gastroenteritis.

Variable	OR (95% CI)	P value
Socio-demographic factors:		
Guardian's age	0.9(0.9-1.0)	0.088
Family income	1.0(1.0-1.0)	0.367
Family house floor	9.5(2.6-35.0)	0.001
Clinical factors:		
Duration of diarrhea	1.01 (1.00-1.02)	0.020
Diarrhea motions/24hrs	1.2 (1.0-1.5)	0.092
Duration of vomiting	1.0 (0.98-1.01)	0.293
Vomits bouts/24hrs	1.0 (0.8-1.3)	0.917
Vomiting everything	20.9 (4.3-102.1)	<0.001
Refusal to feed	1.0 (0.3-3.5)	0.992
Presence of fever	4.2 (0.4-42.4)	0.222
Co-morbidity	9.7 (3.3-28.5)	<0.001
Guardian practices:		
Breastfeeding stopped	4.1(2.0-8.1)	<0.001
Provision of ORS before arrival	0.1(0.2-0.4)	0.004
Provision of Zinc before arrival	0.4(0.2-0.7)	0.002

DISCUSSION

In this study the prevalence of children with acute gastroenteritis who presented with severe dehydration and hypovolemic shock was 35.5%. This is three times that reported by Tailer A.[15] in 1988 which was 11%. This may be explained in part by the fact that slightly more than half of the patients seen in this study had been seen in other facilities thus being a population of those who either had severe disease or got wrong management. This study also specifically identified children with hypovolaemic shock in addition to those with just severe dehydration unlike the previous studies. The difference may further be explained by the different criteria used in the classification of children as per their hydration status.

The mean age of children with acute gastroenteritis was 11 months. This is consistent with previous studies done in the same facility quoted above which found most of the children to be below 24 months with peak of 6-11 months and 5-19 months respectively.

Most of the guardians were of low socioeconomic status as evidenced by a mean family income of 6,000 shillings per month with interquartile range of 3,000 to 10,000 shillings. This is probably explained by the fact that Kenyatta National Hospital is a public facility which is cheaper than the private hospitals. Further evidence of the low socioeconomic status is the average number of rooms per household which stood at two.

Multivariate analysis shows that living in a mud floor house is an independent sociodemographic risk factor for severe dehydration/ hypovolaemic shock in acute gastroenteritis. A similar result was shown by a study by Mahalanabis, D et al in Bangladesh[10]. This is probably an indicator of very low socioeconomic status given that this is in an urban setting. According to the Kenya demographic and health survey 2008-09, most (78%) of urban households have floors made of cement. Low socioeconomic status was demonstrated by Faruque A. et al to be a risk factor for severe dehydration in acute gastroenteritis in Bangldesh[6]. The same study found that mud floor house was an independent risk factor for severe dehydration. The mud floor house being a reflection of very low socio-economic status implies this population is likely to have worse sewage disposal facilities with resultant higher food contamination with sewage.

The clinical risk factors shown in the study to be risk factors for severe dehydration/ hypovolaemic shock in acute gastroenteritis are longer duration of

diarrhoea, vomiting everything and presence of co-morbidity. The comorbidities included upper respiratory tract infections, epilepsy, pneumonia, heart disease, cerebral palsy, rickets and malnutrition. The longer duration of diarrhoea, vomiting everything and presence of some of the co-morbidities like upper respiratory tract infections,pneumonia and malnutrition lead to increased fluid loss hence increasing chances of severe dehydration/ hypovolaemic shock. Some of the co-morbidities for example heart disease, cerebral palsy and malnutrition may contribute towards causing severe dehydration/ hypovolemic shock by reducing oral intake. Unlike the study in Brazil[9] which showed presence of vomiting to be a risk factor for severe dehydration, this study found the mere presence of vomiting not to be a risk factor. However, the presence of vomiting everything was found to be a risk factor.

The results indicate that stoppage of (breast)feeding during the acute gastroenteritis episode is a risk factor for severe dehydration/ hypovolemic shock.This finding is consistent with those of two other studies done in India and Bangladesh by Zodpey, S.P et al[18] and Faruque, A.S et al[6] respectively. Given the increased fluid loss in acute gastroenteritis, stoppage of (breast)feeding would obviously aggreviate the dehydration. The reason given for stoppage of (breast)feeding by the guardians was mostly due to presence of vomiting. For this same reason ORS was also not given which would then compound the problem.

The results also show that the provision of ORS and Zinc each independently reduce the risk of severe dehydration and hypovolaemic shock in acute gastroenteritis. Several studies have demonstrated the importance of ORS in management of gastroenteritis[20,21,22]. Sodium-coupled solute co-transport mechanisms remain intact , allowing for the efficient reabsorption of salt and water. ORS takes advantage of a specific sodium-glucose transporter(SGLT-1) to increase the reabsorption of sodium, which leads to passive reabsorption of water.Similarly, studies have shown that the provision of Zinc not only reduces the severity of acute gastroenteritis but also shortens the duration of diarrhoea[23,24,25]. As an adjunct to ORS, Zinc has the potential to improve management of acute diarrhoea by different mechanisms. These include modulation of ion transport, stimulation of enterocyte growth and differentiation, reduction of intestinal permeability, and positive regulation of oxidative stress and inflammation[27].

Only 15% of the children with acute gastroenteritis had been given ORS at home while only upto 65% had been given ORS by the time of presentation at Kenyatta National Hospital. In the studies by Migiro[16] and Tailer[15] in 1988 it was found that 11.3% and 11.1% of the children who presented with acute gastroenteritis respectively had received ORS at home. More than two decades later we are still stuck at 15%. This means that health education is either not being given to empower the communities or that it is not effective.

Despite the fact that upto 50% of the children had been to another facility or health worker before presenting to Kenyatta National Hospital, only 50(23%) had been given Zinc. There is therefore a big discrepancy between between the provision of Zinc and ORS. This may be explained by lack of knowledge on the importance of provision of Zinc by healthworkers and /or the unavailability of Zinc in the health facilities. Surprisingly, Zinc is not available at the Kenyatta National Hospital pharmacies. A study to establish the reasons for the very low use of Zinc in children with acute gastroenteritis would be useful. A study done in India showed efficacy of zinc-fortified oral rehydration solution in children with acute gastroenteritis[26]. Perhaps exploration of this option would be of value to bridge the gap and simplify management.

The strength of this study lies in it being a comparative study with controls.It is also probably the only study that has been done to examine the risk factors for severe dehydration and hypovolaemic shock in children with acute gastroenteritis in Africa. The limitation of the study is that the diagnosis of hypovolaemic shock was based on the history of diarrhoea and vomiting and the presence of clinical signs of shock. It was, therefore, difficult to completely rule out cases of septic shock.

CONCLUSION:

The risk factors for severe dehydration and hypovolaemic shock in children presenting to Kenyatta National Hospital with acute gastroenteris are longer duration of diarrhoea, vomiting everything, presence of co-morbidity, living in a mud floor house and stoppage of breast(feeding) during the course of the illness.

Provision of ORS and Zinc each independently reduces the risk of severe dehydration and hypovolaemic shock in children with acute gastroenteritis.

RECOMMENDATIONS:

Children with acute gastroenteritis who have had a longer duration of diarrhea, are vomiting everything, have a co-morbidity and/or live in a mud floor house should have closer monitoring.

Greater emphasis on advocacy for continued breastfeeding during an episode of acute gastroenteritis in children should be made.

Mechanisms should be put in place to ensure provision of ORS and Zinc in all children with acute gastroenteritis. These include training of health workers and health education to the communities on the use of ORS and Zinc in acute gastroenteritis in children, and stocking Zinc in government health facilities.

Given the big discrepancy between provision of ORS and Zinc in children with acute gastroenteritis and to increase Zinc administration,the supply of Zinc-fortified ORS by the government should be considered.

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APPENDIX 1

Classification of the severity of dehydration in children with diarrhoea[17]

Cold Hands **plus**, weak / absent pulse, and one of:

Capillary refill > 3 secs

Not alert, AVPU < A .....**SHOCK**

Pulse OK but unable to drink plus

Sunken Eyes

Skin pinch ≥ 2 secs?..... **SEVERE DEHYDRATION**

*Able to drink **plus** 2 or more of:*

Sunken Eyes and / or

Skin pinch 1 - 2 secs

Restlessness / Irritability.....**SOME DEHYDRATION**

Not classified above?.....**NO DEHYDRATION**

APPENDIX 2: CONSENT FORM

Participant's serial number……
Date……....

I, …… , being the guardian/ parent of …… give consent for my child to participate in the study on "Risk factors for severe dehydration/ hypovolaemic shock in children 2-36 months presenting to Kenyatta National Hospital with acute gastroenteritis". The procedure and purpose of the study have been explained to me satisfactorily. I understand we can withdraw from the study without any penalty and without compromising the care of the child.

Signed:…….....

Date:…….....

I confirm that I have explained the nature of the study to the parent/ guardian above.

Name:.....

Signed:…….....

Date:…….

APPENDIX 3: QUESTIONNAIRE

Serial No.:

Date:

A:DEMOGRAPHIC DATA(CHILD):

1 Age(months): 2 Weight(kg):

3 Sex : 4 Height/length(cm):

5. Birth order..... 6.Birth interval.....

7.Hydration status: a)shock b)severe dehydration

c) some dehydration d) No dehydration

B. SOCIO-DEMOGRAPHIC DATA(GUARDIAN'S):

1. Age(Years) .....

2. Sex a) male b)female

3. Education level: a) Primary b)Secondary c) Tertiary

4. Relationship to child: a) Mother b)Father c) Other relative

d) Non relative

5. Family size(No. Of children).....

6. Family income (Ksh/ Month)

7. Family house floor a)Mud b)Cement

8. No. Of rooms in family house .....

9.Residence

10.Cost of transport to the first health facility visited(Ksh.) .....

C.CLINICAL PROFILE:

1. Diarrhoea a) Duration(Hours)..... b)Motions/24 hrs.....

2. Vomiting a) Present b) Absent

3. Vomiting a) Duration(Hrs)..... b) Bouts/24hrs.....

4. Vomits everything a) Yes b) No

5. Refusal to feed/breastfeed a) Yes b)No

6. Presence of fever a) Present b) Absent

7. Is another comobidity present? a) yes, Specify .....

b) no

D. GUARDIAN'S INTERVENTIONS/PRACTICES:

1. Child was still breastfeeding before illness a) Yes b) No

2. Breastfeeding stopped during illness a) Yes b) No

3. Feed frequency during illness a) Increased b) Decreased

4. Fluid given at home before visit to first facility a) ORS b) water c) Home made salt/sugar solution

5. Drug(s) given at home a) none b)herbal medicine c)antibiotic d)anti- motility e) analgesic f)anti-malaria

g) other, Specify .....

6. Health facility first visited a)private clinic b)private hospital c) KNH d) KNH(revisit) e)City council health centre f) Non-conventional practitioner

7.ORS provided by time of arrival a) Yes b) No

8. Zinc provided by time of arrival a) yes b) no c)not known