HYPERNATRAEMIC DEHYDRATION IN ACUTE GASTROENTERITIS

A DESCRIPTIVE AUDIT OF THE PRE HOSPITAL MANAGEMENT AND PREDISPOSING FACTORS IN CHILDREN

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand Johannesburg, in fulfilment of the requirements for the degree of Master of Medicine in the branch of Paediatrics

Johannesburg, 2017

DECLARATION

I, Shenaaz Banoo Ghulam Hoosain declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the branch of Paediatrics, in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Shenaaz Banoo Ghulam Hoosain

12 June, 2017

DEDICATION

To my family

PUBLICATIONS AND PRESENTATIONS ARISING FROM THIS STUDY

I have presented at the University of the Witwatersrand Paediatric research day during the year 2015. I have presented at the South African Paediatric Association and South African Association of Paediatric Surgeons Congress held during September 2016. I'm currently in the process of identifying and submitting to the appropriate journals.

ABSTRACT

Introduction: Diarrhoeal illness is a major contributor to morbidity and mortality in children under five years. Hypernatraemia is a serious electrolyte disturbance associated with diarrhoea. There is a paucity of data of the incidence and possible risk factors of hypernatraemia in acute gastroenteritis amongst the paediatric population in South Africa.

Objective: To document the incidence of hypernatraemia in children admitted with diarrhoea and any associations between hypernatraemia and potential risk factors.

Method: This study used a prospective cross - sectional convenience sample of children between the ages of one and 24 months, who were admitted for diarrhoea complicated by dehydration. Caregivers were interviewed and demographic, clinical and laboratory variables were obtained.

Results: A total of a 125 children were included into the study. Fifty one of the 125 children (41%) had hypernatraemia. Their serum sodium levels ranged between 154 and 171 mmol/l. Age below one year ($p< 0.001$) and severe dehydration ($p = 0.003$) were risk factors for hypernatraemia in the univariate analysis but only infancy remained significant after the multivariate analysis (Odds ratio 10.6, 95% CI: 3.5 – 32.6, $p<0.001$). Three patients demised and all were part of the hypernatraemic group (6% vs. 0%, $p = 0.24$). Hypernatraemia was significantly associated with neurological deficits (14% vs. 0%, $p = 0.013$).

Conclusion: This study illustrated a high incidence of paediatric hypernatraemic dehydration, which has not been reported in other studies. An age of less than one year old was a statistically significant risk factor.

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ABBREVIATIONS

1. CEO - Chief Executive Officer
2. Commercially available powder - oral rehydration therapy dispensed as commercially available powder sachets
3. IMCI - Integrated Management of Childhood Illnesses
4. ORS - Oral Rehydration Solution (refers to both the commercially available powder and homemade sugar and salt solution)
5. ORT - Oral Rehydration Therapy (refers to the method employed to rehydrate the child, which is, per os)
6. REDCap - Research Electronic Data Capture
7. ReSoMal - Rehydration Solution for the Malnourished as recommended by the World Health Organisation
8. SADHS - South African Demographic and Health Survey
9. SSS - Sugar and Salt Solution
10. 'Turnitin' - Plagiarism detection software
11. WHO - World Health Organisation

1.0 INTRODUCTION

1.1 Epidemiology of diarrhoeal illness

Worldwide acute diarrhoea is the "second leading cause of death", contributing to the high under five mortality rate.(1, 2)There are approximately two billion cases of diarrhoeal illness per year.(1)

Annually, death occurs in 1.9 million children younger than five years of age with diarrhoea.(1)This accounts for 18% of the global mortality rate among children under the age of five years.(1)Seventy eight percent of these deaths occur in developing countries.(1)

In South Africa, during the year 2007, diarrhoeal disease was the leading cause of death in children between one and four years of life.(3)A higher diarrhoeal incidence, morbidity and mortality rate occur in children younger than five years of age (especially during infancy) as compared to children older than five years of age.(1)

1.2 Contributing factors and complications of diarrhoea

The high incidence of diarrhoeal disease is attributed to infection, non-hygienic water supply, poor sanitation, low rates of breast feeding and inadequate nutrition.(1, 2)

In 2005, 17% of the world's population lacked a safe water supply while 42% relied on pit latrines.(4)Consequently this population is affected by the vicious cycle of diarrhoeal illness and malnutrition with impaired childhood development.(1, 4)

Diarrhoea impairs weight and height gain leading to malnutrition.(1, 4)The processes by which this is brought about include anorexia, protein and nutrient losses, increased catabolic demands and impaired absorptive function.(4)Malnourished children have a greater incidence, longer duration and increased severity of diarrhoeal episodes. In addition, malnutrition causes impaired innate and adaptive host immune responses, predisposing the child to further gastrointestinal infections.(4)

Repeated exposure to diarrhoeal illness thus predisposes to malnutrition, which creates a vicious cycle between diarrhoea being worsened by and worsening malnutrition.(2, 4, 5)Fifty three percent of the deaths due to diarrhoeal illness (5.6 million) are associated with malnutrition.(4)On average, a child less than five years will experience three episodes of diarrhoeal illness per year.(1)

Each one of these episodes of diarrhoea may result in dehydration and electrolyte disturbances. This may be potentially fatal if it is complicated by shock, metabolic acidosis and electrolyte imbalances such as hypernatraemia.(5-8)

1.3 Hypernatraemia and Diarrhoeal illness

One of the most serious electrolyte disturbances diagnosed in patients with diarrhoea in hospital is hypernatraemia, which is defined as a serum sodium level greater than 145 - mmol/l.(6, 7)It is found more frequently in infancy and during the winter months.(7-9)

The body's thirst mechanism and its ability to produce a concentrated urine via antidiuretic hormone usually protects against hypernatraemia.(7)Hypernatraemia occurs due to increased sodium intake in conjunction with inadequate water intake, frequently with a background of a pathological condition causing increased water loss.(6, 7)

1.4 The Incidence of Hypernatraemia

Nazer (1991) indicated an incidence of 15.7% of hypernatraemic dehydration in infants with acute gastroenteritis.(8) In a recent South African study, 16% of the study population with diarrhoea (ages between 20 days and 64 months) presented with hypernatraemic dehydration.(10)

1.5 Contributing factors and complications of hypernatraemic dehydration

Extra-renal losses of water via the gastrointestinal tract secondary to infectious or osmotic diarrhoea, insufficient breastfeeding, incorrectly prepared formula and ingestion of salt

have all been implicated as causes of hypernatraemia.(6, 9, 11)Furthermore, incorrect preparation of the oral rehydration solution (ORS) could lead to increased ingestion of salt.(11)

Neurological manifestations include irritability, lethargy, coma, hypertonia, hyperreflexia and seizures.(6, 7)Hypernatraemia can lead to irreversible encephalopathy secondary to complications such as venous sinus thrombosis with cerebral infarction, intracranial haemorrhage or cerebral oedema due to rapid rehydration.(6, 7, 9)Infants with hypernatraemia have worse outcomes when compared to older children. They may develop long-term neurological damage and suffer a high mortality rate between 40 and 70%.(6, 9)

1.6 Oral Rehydration Therapy

Oral rehydration therapy (ORT) is the mainstay treatment of dehydration secondary to diarrhoea.(1, 5, 12)It is effective in rehydration of "all acute infectious dehydrating diarrhoeal disease of infancy and childhood, irrespective of the age or aetiological agent".(5)The World Health Organization's (WHO) implementation of the use of ORS worldwide has resulted in a decrease in mortality rate from acute diarrhoeal disease.(1, 4, 5)

The majority of caregivers will give ORS at home prior to seeking the help of a health care provider.(10)Previously, during the year 1975, the WHO recommended that the solution should contain 90mEq of sodium in one litre of water (311mOsm/l) and this also applied to the home made sugar and salt solution (SSS).(12-14)However, since the year 2002, the WHO recommends a lower osmolarity (245mOsm/l) solution containing 75mEq/l sodium which is more effective in children with acute non-cholera diarrhoea and provides a lower risk of causing hypernatraemia.(13, 14)

Malnourished children are protein deficient with a low plasma albumin concentration. This may cause a decrease in the plasma volume resulting in a low cardiac output and hypotension.(15)Consequently, a decrease in glomerular filtration rate occurs resulting in decreased peritubular hydrostatic pressures.(15)This in turns stimulates the renin-angiotensin-aldosterone system leading to increased sodium and water retention.(15)

Alternative hypothesis of increased anti diuretic hormone release, increased permeability of the leucocytes cell membranes and the direct regulation of the sodium potassium ATPase pump activity by vandanium may all lead to increasing sodium efflux from the sodium pump causing excessive sodium retention.(15)

Usually, the 2002 WHO ORS does not cause hypernatraemia if correctly used. However, in the severely malnourished child, accumulation of sodium may occur owing to the fluid and electrolyte shifts from the high sodium content of the oral rehydration solution.(12, 15)Thus the WHO advocates for a300mOsmol/l oral rehydration solution (ReSoMal) with a lower sodium content (40mmol/l) for children with severe acute malnutrition.(12, 16)

As per the Integrated Management of Childhood Illnesses (IMCI) protocol, the homemade SSS is emphasised in the initial treatment of mild to moderate diarrhoea, and this may successfully treat up to 90% of patients.(10, 17, 18)Thus in South Africa we expect that caregivers should be aware of the solution and employ it frequently.

Approximately ninety percent of caregivers are aware of the homemade SSS while two different studies illustrate that up to 80% utilise it as initial management in an attempt to treat the diarrhoea.(10, 17)This implies that caregivers should prepare it correctly, although the same South African studies illustrate that the homemade SSS is often mixed incorrectly.(10, 17)

The commercially available powder of ORT is relatively easier to prepare than the home made SSS since only the correct amount of water needs to be added. On the other hand, this needs to be purchased at a pharmacy or obtained from a health care facility. In addition, parents could still make an over-concentrated solution by adding too little water.

The homemade SSS is easily accessible and cheaper as ingredients from the household are used and there is no need to visit a health care professional. The use of this solution is therefore promoted in South Africa. Clearly, given the varying sizes of teaspoons and utensils available in the household, there is a greater chance of incorrect preparation as it requires measuring accurate amounts of salt, sugar and water.

Many studies found that caregivers failed to prepare the commercially available powder of ORT or the homemade SSS correctly.(10, 17, 19)One danger of incorrect preparation is producing a hyperosmolar hypernatraemic solution resulting in potentially life threatening hypernatraemic dehydration.(17, 20)

A study by Erasmus et al (1981), demonstrated that, 70% of South African mothers prepared a hyperosmolar homemade SSS with a sodium concentration greater than 150mmol/L.(21)It was also demonstrated that glucose was added according to taste which also increased the osmolality of the solution.(21)

In South Africa, caregivers tend to add one or more teaspoons of salt into the homemade SSS.(10, 17)However, Cooke et al (2013) could not demonstrate a correlation between hypernatraemia and incorrectly prepared homemade SSS.(10)Most importantly, when parents are counselled regarding correct preparation of the homemade SSS, a decrease in hypernatraemic dehydration is evident.(20)

1.7 Feeding practices and Hypernatraemia

South Africa has a low rate of exclusive breast feeding. During the year 2003, 8%of infants younger than six months were exclusively breast fed.(22)The rate of exclusive breast feeding decreases after a few months with only one percent of infants between four and six months old being exclusively breast fed.(22)Breast feeding has a low risk of causing hypernatraemia once the neonatal period is completed as mature milk has lower concentrations of sodium and by this time mothers have usually established adequate

breast feeding.(23)Exclusive breast feeding prevents diarrhoea and continuation of breast feeding until two years of age has shown to have a positive effect on the mortality and morbidity from diarrhoeal illness.(1)

Formula feeding has a higher risk of causing hypernatraemic dehydration.(23)It can be prepared inaccurately with an increase amount of powder to water content.(23)The concentrated formula feed and diarrhoea will then stimulate thirst creating a vicious cycle by providing more concentrated formula feeds than water.(23)

1.8 Traditional medications and Hypernatraemia

In South Africa, majority of the community will seek the help of a traditional healer before accessing Western health care services.(24-26)This is associated with traditional beliefs but can also be attributed to fewer staff in the health system, poor access to clinics, or long waiting times.(24-26)This is compounded by the fact that there are approximately triple the number of traditional care practitioners available compared to health care professionals.(24-26)

The reasons for consulting the traditional healer include 'ibala' a Zulu word for a capillary nevus found at the nape of an infant's neck.(26, 27) Other reasons include 'inkaba' or abdominal cramps and 'inyoni' the vulnerability of the infant to paranormal phenomenon which cause disease in all infants. The perception is that if 'ínyoni' is not treated it will lead to diarrhoea and a sunken fontanelle thus it is treated with 'muthiwenyoni'.(26, 27)This could be fatal if a child is being given 'muthiwenyoni' in the face of severe dehydration or shock and not accessing urgent health care.

One of the common cultural practices for perceived constipation, is to administer 'enemas' per rectum to infants. This is done in an attempt to, 'clean the baby out', in order to cool the baby down or to provide protection by eradication of the harmful evil powers.(26, 27)The other reason for its use includes the healing of ‘inkaba' which is thought to be an internal wound caused by the severance of the umbilical cord.(26, 27)Easily accessible components such as 'Sunlight Soap', traditional Zulu remedies and water are contained in the 'enemas'.(26, 27)

Orally administered traditional medications are used to treat colic or perceived abdominal cramps in infants.(27)'Gripe water' is one of the common non prescribed medications administered to infants.(27)

Dippenaar et al (2005)found that up to 24% of caregivers use 'enemas' and 'muthi' as initial management of diarrhoea in their children, prior to seeking health care services.(17) This was emphasised in other studies which demonstrated a high incidence of orally or rectally administered traditional medications used in children less than one year of age.(26-28)The use of traditional medications can result in poisoning.(29) It may cause gastrointestinal, renal and hepatic toxicity. It frequently presents with vomiting, diarrhoea and abdominal pain.(29)This ultimately leads to electrolyte abnormalities including hyperkalaemia, hypokalaemia and hypernatraemia.(11, 25)

1.9 Rationale for current study

Hypernatraemic dehydration in children is a common medical problem in South Africa.(10)Many contributing factors have been implicated in the development of hypernatraemic dehydration, including, the use of traditional medications, insufficient water intake and incorrect preparation of the ORS and formula feeds.(6, 9, 11, 28)

The aim in the management of hypernatraemia includes correcting both the sodium level and the depleted intravascular volume.(7) Rapid rehydration, the use of hypotonic intravenous fluids, and a rate of sodium level correction of greater than 1mEq/hr can lead

to cerebral oedema followed by seizures, encephalopathy and long term neurological manifestations.(7)

The author has observed a high incidence of hypernatraemia in children with dehydration secondary to acute gastroenteritis during her medical practice. Currently there is limited research regarding hypernatraemic dehydration amongst the paediatric population in South Africa. A better understanding on the causative factors is necessary. Is it part of the diarrhoeal disease process or is it brought on by modifiable factors?

Thus, this study set out to document the incidence of hypernatraemia in children admitted with diarrhoea to an urban hospital and any associations between hypernatraemia and the potential risk factors.

2.0 MATERIALS AND METHODS

2.1 Study design

This was a prospective cross - sectional study.

2.2 Study population

2.2.1 Inclusion criteria

Any child between the ages of one and 24 months, who was admitted for a diarrhoeal illness complicated by dehydration, during the six month period from April to September 2014, was included into the study. As the study sought to investigate pre-hospital risk factors for the development of hypernatraemia, laboratory based serum sodium levels taken on the day of admission were used.

2.2.2 Exclusion Criteria

Children who were admitted with dehydration and/or hypernatraemia secondary to aetiologies other than acute gastroenteritis were excluded. This would have excluded patients with chronic gastro-enteritis, intra-renal renal failure, iatrogenic causes of hypernatraemia, feeding problems, Bartter syndrome and meningitis, from entering the study. In addition, children whose caregivers refused to participate in the study and those who had no laboratory sodium levels done were excluded.

2.3 Sampling method

A convenience sample was used.

2.4 Study site

The study was conducted at Rahima Moosa Mother and Child Hospital. This is a secondary level urban paediatric hospital in the public sector. This hospital accepts referrals from its paediatric outpatient department, surrounding primary health care clinics, primary and district hospitals, general practitioners and self-referrals.

2.5 Study Procedure

At the study site, the children are admitted to the infectious disease ward if they are dehydrated secondary to acute gastroenteritis and they have failed a trial of oral rehydration therapy administered at the paediatric outpatient department or casualty.

Newly admitted children meeting the inclusion criteria were identified on a daily basis. Caregivers of children who fulfilled the inclusion criteria were invited to be part of the study and sign an informed consent document after being counselled about the study (Appendix D).

The investigator then proceeded to interview the caregivers and complete the questionnaire (Appendix E).On the questionnaire sheet a specific study number was recorded. On a separate sheet the study number was documented with the patient's name and file number which was only accessible to the author. This maintained confidentiality and allowed blinding of the participant's information.

Data collected included age, gender and anthropometry of the patient. The serum sodium level, as determined by the local National Health Laboratory Service, at presentation for admission to hospital was recorded. The type of feeds and ORS given at home, prior to presenting to the study site was documented.

The degree of dehydration was assessed clinically. Previously, three levels of dehydration namely; mild (3-5%), moderate (6-9%) and severe (>10%) were used to classify dehydration.(30)Recent guidelines, including the WHO IMCI protocol, take on a similar but simpler classification of dehydration where three levels of dehydration are defined.(18)This comprises of "No Dehydration", "Some Dehydration" and "Severe Dehydration".(18, 30)

The WHO IMCI classification of dehydration is commonly utilised and familiar to health care workers in South Africa. Thus, in this study these guidelines were used to classify the severity of dehydration(Table 2.5).(18, 30)

If the investigator interviewed the caregiver on the day of admission, then the severity of dehydration was obtained from the medical records and confirmed by clinical examination

of the child. However if this was not possible then the severity of dehydration was obtained from the medical records.

Table 2.5 WHO IMCI Classification for dehydration(18)

Severe Dehydration	**Two of the following signs:** • Lethargic or unconscious • Sunken eyes • Not able to drink or drinking poorly • Skin pinch goes back very slowly
Some Dehydration	**Two of the following signs:** • Restless, irritable • Sunken eyes • Drinks eagerly, thirsty • Skin pinch goes back slowly
No Dehydration	Not enough signs to classify as some or severe dehydration

The caregivers were also questioned about the use of alternative/traditional/other medications or whether other fluid intake was continued during the illness. The caregiver characteristics were included. In this study the South African Demographic and Health Survey (SADHS) was used as a guideline to classify the level of education.(22) 'No schooling' was defined as no formal educational training received. 'Schooling' included anyone who completed grade 1 to grade 12. 'Tertiary education' was defined as any undergraduate/postgraduate studies done after grade 12.

In addition the method of preparation of the formula feeds and the ORS was documented. Short-term outcome of patients (neurological deficit) at the time of discharge was documented. Neurological deficits were defined as any clinical change in neurological function that was not present in the well child as per the clinical history, which included, long tract signs, seizures and feeding difficulties.

Study data was collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of the Witwatersrand.(31)

Children whose caregivers refused to participate in the study were excluded. In addition children who were admitted and discharged over a weekend or public holiday were excluded depending on the availability of the investigator. Children who were admitted for overnight observations but did not have laboratory sodium levels done were also excluded.

A record was kept of the number of children admitted with gastroenteritis who were not recruited by the investigator over the same period of time.

2.6 Statistical analysis

As per the variables recorded on the questionnaire, descriptive statistical methods were employed. Anthropometric z-scores were calculated using the WHO Anthropometry program.(32)

We compared all variables recorded on the questionnaire sheet based on the serum sodium level on admission. This was analysed using STATA in three comparative groups which included isonatraemia, hyponatraemia and hypernatraemia. The aim of this study was to find out the reason we have so many children presenting with hypernatraemic dehydration in acute gastroenteritis. The hyponatraemia group was excluded when analysing the potential risk factors. Thus, only the isonatraemic and hypernatraemic groups were compared for risk factors.

Categorical variables were compared using chi square tests or Fisher's exact tests where appropriate. Normally distributed continuous data were described as means and the Student's t-test were used. If these data sets were skewed then they were described as medians and the Wilcoxon rank-sum tests/Mann Whitney U test was used. P-values below 0.05 were accepted as significant. A multivariate regression analysis was done including all risk factors with p-values below 0.1.

2.7 Funding

All research expenses were covered solely by the author.

2.8 Ethics approval

This study was approved by the University of the Witwatersrand Ethics and Research Committee. The Ethics Clearance number is M140205 (Appendix A). Permission to conduct the study at the hospital was obtained from the Chief Executive Officer and Head of the Paediatric department at the study facility (Appendix B & C).

3.0 RESULTS

3.1 Study Population

The total number of children potentially fulfilling the inclusion criteria admitted during the study period was 219. Ninety four of the 219 children (43%) were not included in the study either because they were admitted over a weekend or public holiday, or it was an overnight admission with no laboratory serum sodium level done, or the parents refused participation.

Four parents refused participation in the study. Of these, two children had hypernatraemia. One of the children with hypernatraemic dehydration whose parents refused to be part of the study subsequently demised.

A total of a 125 children were included into the study. Fifty one (41%) of the 125 children had hypernatraemia, 49 (39%) had isonatraemia, and 25 (20%) hyponatraemia. The serum sodium levels in the hypernatraemic group ranged between 154 and 171 mmol/l (Figure 3.1).

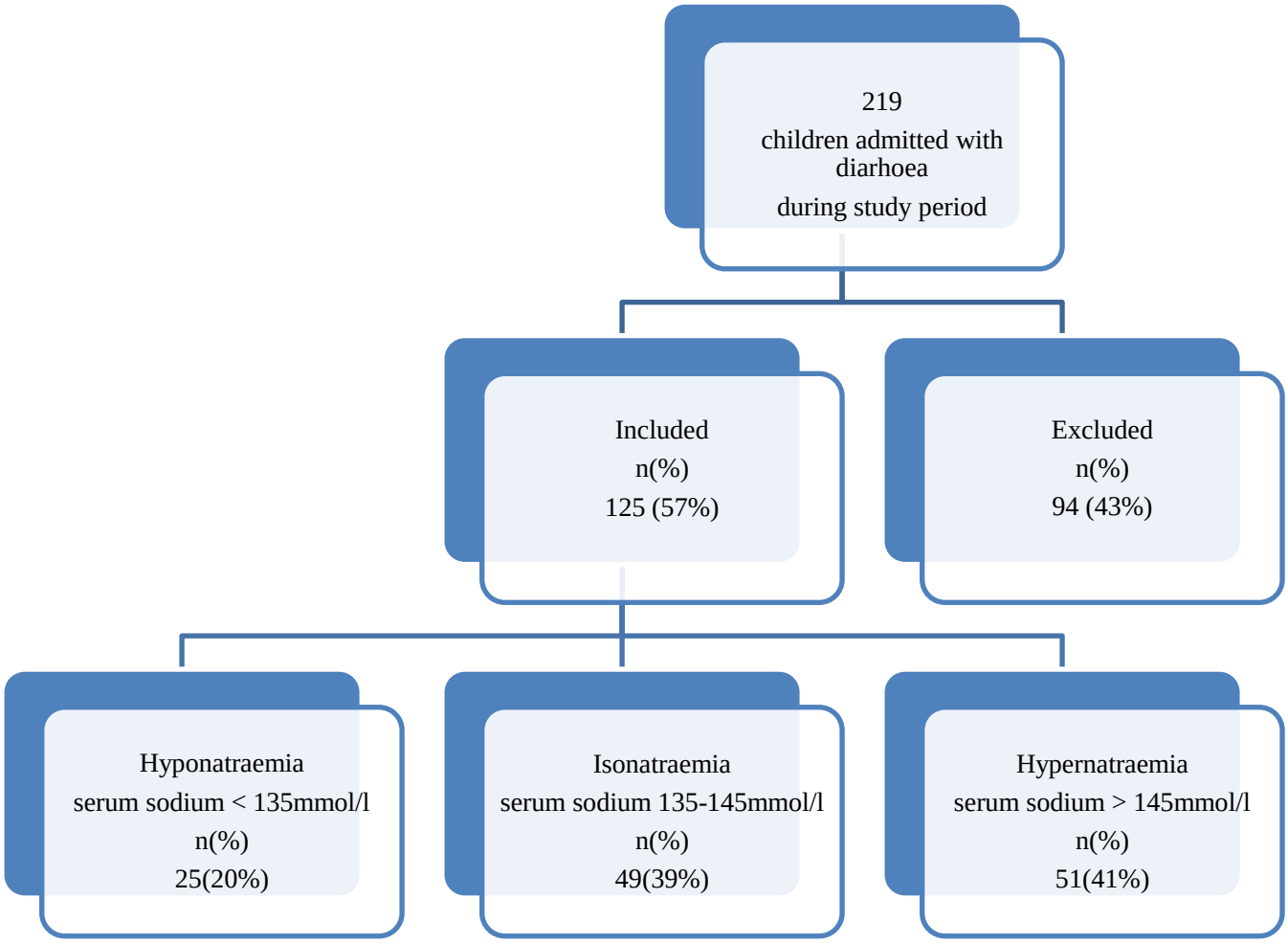

Figure 3.1 Study Population

3.2 Demographic Data

Over half of the total children were male (71/125; 57%). Twenty six of the 51 (51%) hypernatraemic children were male (Table 3.2). The median age of all children was 8 months (Range: 1 to 23 months). There was a significant difference between the age of the hypernatraemic and isonatraemic children (median age 5 vs. 12 months, Wilcoxon rank-sum (Mann-Whitney) test p <0.001) (Figure 3.2.1& Table 3.2). The primary caregiver was either the mother or grandmother. The median caregiver age was 28years for both the hypernatraemic and isonatraemic groups (Wilcoxon rank-sum test, p = 0.50). The level of education of caregivers was fairly similar between groups (Table 3.2).

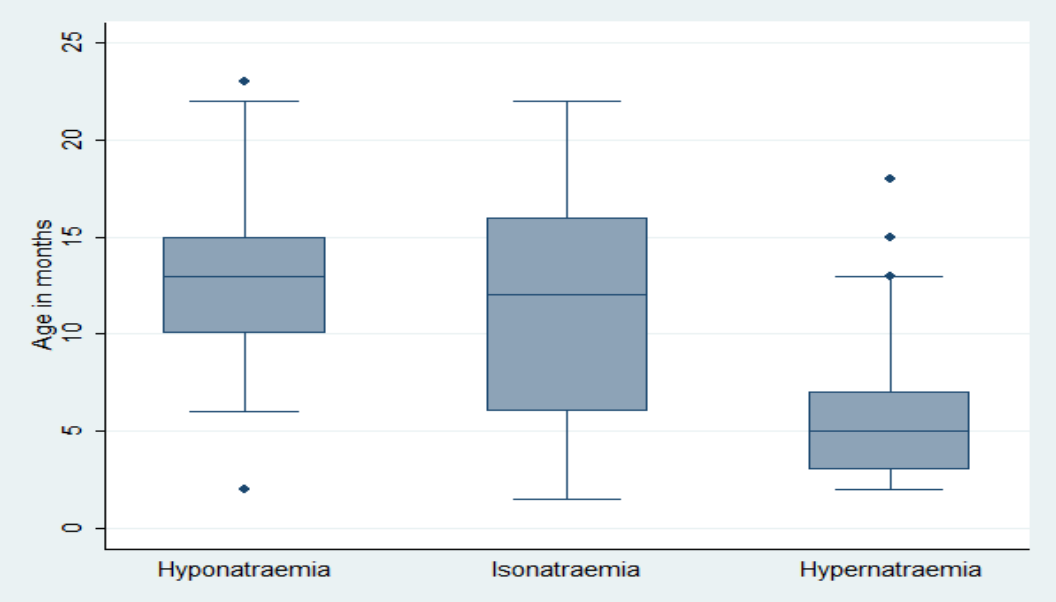

Figure 3.2.1.Age of the children by sodium level

The median z-scores (total population) for weight-for-age was -1.9, length-for-age -0.9 and weight-for-length was -1.8 (Figure 3.2.2).There was no significant difference between the hypernatraemic and isonatraemic groups. A quarter of the children (32/125; 26%) had severe acute malnutrition. Forty eight percent (60/125) were underweight for age (weight-for-age < -2 z-score) which included 23% (29/125) who were severely underweight for age (weight-for-age < -3 z-score). Stunting (length-for-age < -2 z-score) occurred in 29% (36/125) which included 16% (20/125) who were severely stunted (length-for-age < -3 z-score). Wasting (weight-for-length<-2 z-score) was present in 45% (56/125) which included 26% (32/125) who were severely wasted (weight-for-length < -3 z-score) (Table 3.2).

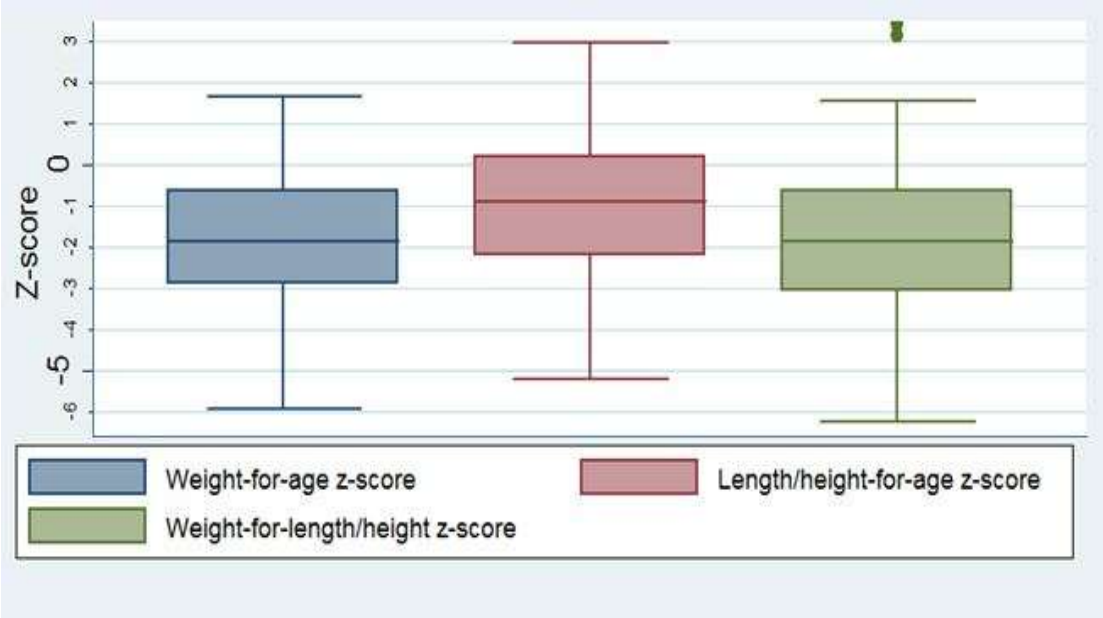

Figure 3.2.2 Anthropometry of the children

Table 3.2 Demographic data

	Hyponatraemia N = 25 (20%)	Isonatraemia N = 49 (39%)	Hypernatraemia N = 51 (41%)	p-value *#
CHILDREN				
Male n (%)	16 (64)	29 (59)	26 (51)	0.41
Female n (%)	9 (36)	20 (41)	25 (49)	0.41
Median age (months)	13	12	5	<0.001
Weight for age (mean z-score)	-2.17	-1.73	-1.8	0.84
Length for age (mean z-score)	-1.26	-1.42	-0.69	0.12
Weight for Length (mean z-score)	-1.95	-1.48	-2.05	0.31
Underweight n (%) (weight/age<-2)	14 (56)	23 (47)	23 (45)	0.83
Stunted n (%) (length/age<-2)	7 (28)	17 (35)	12 (24)	0.31
Wasted n (%) (weight/length <-2)	11 (44)	19 (39)	26 (51)	0.37
CAREGIVERS				
Median age (years)	26	28	28	0.50
Level of education				
1. None n (%)	1 (4)	2 (4)	1 (2)	0.61
2. School n (%)	22 (88)	42 (86)	46 (90)	0.49
3. Tertiary n (%)	2 (8)	5 (10)	4 (8)	0.74

*p-values compare hypernatraemic to isonatraemic group

Chi square tests (categorical data) or Fisher's exact tests (categorical data with cells with an expected value below 5) and Wilcoxon rank-sum tests (continuous data) used

3.3 Risk Factors

Hypernatraemic children were more severely dehydrated (as opposed to "no dehydration" or "some dehydration") than those with isonatraemia, a relationship that was statistically significant (Odds ratio: 3.6, 95% CI: 1.4 – 9.5, p= 0.003) (Table 3.3.1).

Thirty two percent of the children younger than six months (15/47) were exclusively formula fed with 27 %(4/15) not mixing the formula correctly. Of those that exclusively formula fed, 80 %(12/15) presented with hypernatraemia. A total of 10 children (exclusive formula fed and mixed fed) were given over-concentrated formula feeds. Of these children, one had hyponatraemia, two isonatraemia and seven hypernatraemia (Figure 3.3). In infants less than six months, six out of 47 (13%) were exclusively breast fed (Table 3.3.2).

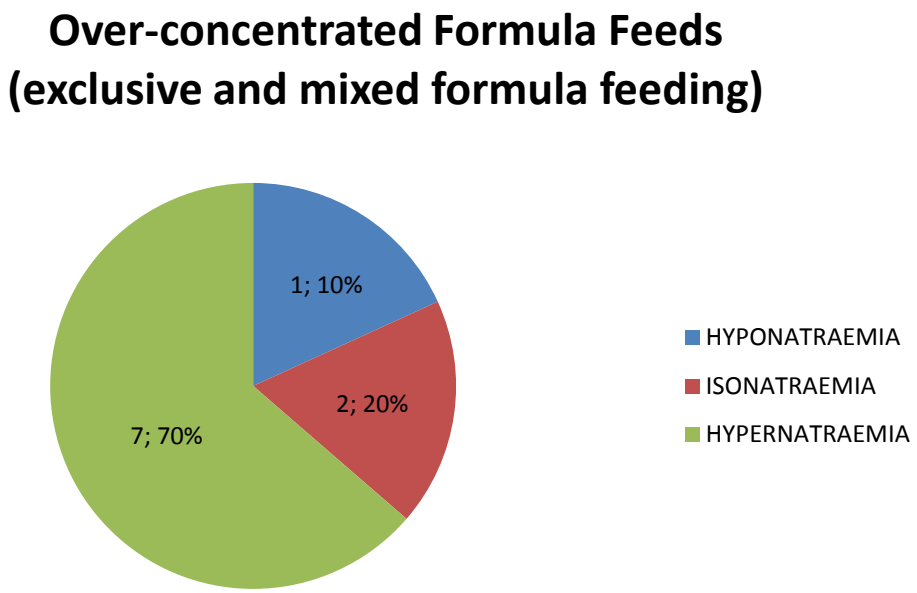

Figure 3.3 Preparation of over-concentrated Formula Feeds (n ;%)

Thirty two of the 125 (26%) children were not given any ORS. While 93 of the 125 (74%) children were given ORS. Twenty two of the 93 (24%) children were given the commercially available powder only, 59 of the 93(63%) were given the homemade SSS

only, while 12 of the 93(13%) children received both the commercially available powder and the homemade SSS.

The commercially available powder of ORT were mixed correctly three quarters (16/22; 73%) of the time, while the homemade SSS was mixed correctly only in 37/59 (63%).This difference was not significant (Odds ratio: 0.6, p= 0.29). Caregivers who gave both types of ORS mixed correctly in nine of 12 cases (75%). There was no statistical differences between the hypernatraemic and isonatraemic groups relating to the preparation of any ORS (Table 3.3.3).

Of those that provided additional tap water, 15 (15/49; 31%, p=0.42) was part of the isonatraemic children as compared to 12 (12/51; 24%, p= 0.42) of the hypernatraemic children.

Eleven percent (14/125) of the children received some form of traditional 'muthi' (excluding 'enemas', 'muthiwenyoni' and 'gripe water'). Many children were given traditional oral medications of unknown composition.

There was no difference in use of 'enemas' in the isonatraemic children (4/49; 8%, p=0.71) as compared to the hypernatraemic children (3/51; 6%, p=0.71). 'Muthiwenyoni' administration was equally distributed between hypernatraemic and isonatraemic children (p = 0.52).

One out of 49children with isonatraemic dehydration were receiving nevirapine. In contrast, 3 of the 51 children (2% vs. 6%, p=0.61) with hypernatraemic dehydration were receiving nevirapine.

In addition children were given anti-diarrhoeal and anti-emetic medications from the local clinics or general practitioners. Four of the 125 caregivers (3%) admitted to administrating anti-emetic agents (p = 0.89). While anti-diarrhoeal agents were given to 4 of the 125 children (3%; p = 0.3). However, neither was significantly associated with the development of hypernatraemia.

The hypernatraemic children had a higher usage of 'gripe water' (17/51; 33%) compared to the isonatraemic children (9/49; 18%, p=0.08) (Table 3.3.1).

Table 3.3.1 Risk Factors

	Hyponatraemia N = 25 (20%)	**Isonatraemia N = 49 (39%)**	**Hypernatraemia N = 51 (41%)**	**p-value *#**
MEDIAN AGE IN MONTHS	13	12	5	<0.001
	SEVERITY OF DEHYDRATION (WHO IMCI)			
1. "No" n (%)	11 (44)	23 (47)	7 (14)	<0.001
2. "Some"n (%)	10 (40)	15 (31)	18 (35)	0.62
3. "Severe"n (%)	4 (16)	11 (22)	26 (51)	0.003
	TYPE OF ORAL REHYDRATION SOLUTION			
No ORS given n (%)	10 (40)	11 (23)	11 (21)	0.91
Commercial Powder n (%)	4 (16)	10 (20)	8 (16)	0.51
Homemade SSS n (%)	8 (32)	25 (51)	26 (51)	0.94
Both commercial powder & homemade SSS used n (%)	3 (12)	3 (6)	6 (12)	0.48
	ADJUVANT MEDICATIONS			
1. Traditional 'muthi'n (%)	1 (4)	4 (8)	9 (18)	0.15
2. 'Enema'n (%)	2 (8)	4(8)	3 (6)	0.71
3. 'Muthiwenyoni'n (%)	7 (28)	11(22)	11(22)	0.52
4. 'Gripe Water'n (%)	3 (12)	9 (18)	17 (33)	0.08
5. 'Additional Tap Water' n (%)	10 (40)	15 (31)	12 (24)	0.42
6. Nevirapine n (%)	0 (0)	1 (2)	3 (6)	0.61

*p-values compare hypernatraemic to isonatraemic group

Chi square tests (categorical data) or Fisher's exact tests (categorical data with cells with an expected value below 5) and Wilcoxon rank-sum tests (continuous data) used

Table 3.3.2 Risk Factors - Type of feeding in children under 6 months of age

	Hyponatraemia N = 2 (4%)	**Isonatraemia N = 12 (26%)**	**Hypernatraemia N = 33 (70%)**	**p-value *#**
Exclusive Breast feeding n (%)	1 (50)	2 (17)	3 (9)	0.49
Exclusive Formula feeding n (%)	0 (0)	3 (25)	12 (36)	0.47
Mixed feeding n (%)	1 (50)	7 (58)	18 (55)	0.82
Over concentrated Formula Feeds n (%)	1(50)	2 (17)	7 (21)	0.58

*p-values compare hypernatraemic to isonatraemic group

Chi square tests (categorical data) or Fisher's exact tests (categorical data with cells with an expected value below 5) and Wilcoxon rank-sum tests (continuous data) used

Table 3.3.3 Risk Factors - Preparation of Oral Rehydration Solution

	Hyponatraemia N = 15 (16%)	**Isonatraemia N = 38 (41%)**	**Hypernatraemia N = 40 (43%)**	**p-value *#**
Correctly mixed n (%)	11 (73)	28 (74)	23 (58)	0.13
Over concentrated n (%)	4 (27)	10 (26)	14 (35)	0.41
Too dilute n (%)	0 (0)	0 (0)	3 (7)	0.24

*p-values compare hypernatraemic to isonatraemic group

Chi square tests (categorical data) or Fisher's exact tests (categorical data with cells with an expected value below 5) used

3.4 Multivariate analysis

All risk factors with a p-value below 0.1 were included as dichotomous variables in a logistic regression analysis. All children under a year of age were included into the infant variable, this inferred a higher risk of hypernatraemia (p< 0.001). The other risk factors included in this model were the administration of 'gripe water' (p= 0.08) and the presence of severe dehydration (p= 0.003). After multivariate analysis, only infancy remains a significant risk factor for hypernatraemia (Odds ratio 10.6, 95%CI: 3.5 – 32.6, p<0.001) (Table 3.4).

Table 3.4 Multivariate analysis of risk factors with a p value < 0.1

	Unadjusted p-value	**Odds ratio (95% CI)**	**p-value**
Infancy (age < 12 months)	<0.001	10.6 (3.5 - 32.6)	<0.001
Severe dehydration	0.003	2.3 (0.88 –6.23)	0.09
Gripe water use	0.08	1.3 (0.45 – 3.82)	0.62

3.5 Outcome of children

A total of three children demised and all were part of the hypernatraemic group (3/51 = 6% vs. 0%, p =0.24). Of those who demised, two were severely dehydrated (sodium level 158 & 156 mmol/l respectively) and one had "no dehydration"(sodium level 154 mmol/l).

Seven children were considered to have a neurological deficit at the time of their final outcome. Of these, 5 children were discharged home with the neurological deficit and 2 demised. These children presented with severe dehydration except for one who had "no dehydration". They were all part of the hypernatraemic group with serum sodium levels ranging between 156-170mmol/l. Hypernatraemia was thus significantly associated with neurological deficits (7/51 = 14% vs. 0%, p = 0.013) (Table 3.5).

Table 3.5Outcome of children

	Hyponatraemia N = 25 (20%)	**Isonatraemia N = 49 (39%)**	**Hypernatraemia N = 51 (41%)**	**p – Value *#**
Neurological deficit n (%)	0 (0)	0 (0)	7 (14)	0.013
Demised n (%)	0 (0)	0 (0)	3 (6)	0.24

*p-values compare hypernatraemic to isonatraemic group

Fisher's exact tests (categorical data with cells with an expected value below 5) used

4.0 DISCUSSION

A total of a 125 children were included into the study. Fifty one of the 125 children (41%) had hypernatraemia. Their serum sodium levels ranged between 154 and 171 mmol/l. Three patients demised and all were part of the hypernatraemic group (3/51 = 6% vs. 0%, p =0.24). Hypernatraemia was significantly associated with neurological deficits (7/51 = 14% vs. 0%, p = 0.013). Only infancy remained a significant risk factor for the development of hypernatraemic dehydration after the multivariate analysis (Odds ratio 10.6, 95% CI: 3.5 – 32.6, p<0.001). However severe dehydration (p=0.09) and gripe water use (p = 0.62) were not significant risk factors for developing hypernatraemia.

4.1 Study population

This prospective sample reflects the profile of children admitted for acute gastroenteritis to this urban public sector hospital. There is paucity of data regarding the incidence of hypernatraemic dehydration in acute gastroenteritis outside of the neonatal period.

Over half of the total admissions for acute gastroenteritis during the study period were included into this study (125/219; 57%). Of those who were excluded from the study, majority of the children were overnight admissions for clinical observations without serum

sodium levels been done or refused participation in the study. Thus the author believes that the current sample is a true reflection of the target population.

4.2 Caregiver Characteristics

The primary caregiver was either the mother or grandmother. The assumption is that the younger caregivers who have a poor education background are more likely to mix formula and ORS incorrectly, delay seeking health care, take advice from elders and opt for traditional management of the patients.(27)

However, the mean age and level of education of caregivers in this study were similar between the hypernatraemic, isonatraemic, and hyponatraemic groups. This illustrates the above assumption is inaccurate.

People living in urban areas achieve a higher level of education as compared to those residing in non-urban areas.(22)Despite the fact that this study was conducted in an urban compared to a non-urban area, it demonstrated a high prevalence of caregivers with no

schooling (4/125; 3% of the caregivers had no formal educational training). This is in keeping with the national general population surveys estimating eight percent of the Gauteng adult population having no formal schooling.(22)Despite the high prevalence of poor/no education, this did not appear to predict the presence of hypernatraemia.

4.3 Anthropometry of children

There was no statistically significant difference in growth measurements between the hypernatraemic and isonatraemic groups. A quarter of the children (32/125; 26%) had severe acute malnutrition. Half of the children (60/125; 48%) were underweight for age (weight-for-age < -2 z-score). The age range of children included into this study was 1 - 23 months old. Thus, the percentage of children underweight for age, was higher than that reflected in the average population, as per the National Food Consumption survey of 2005 which demonstrated 10 percent of the population between 1-9 years old were underweight for age.(33)Hypernatraemic children did not have a statistically significant higher percentage of severe acute malnutrition (wasted $p = 0.37$, stunted $p = 0.31$) or of being underweight for age ($p=0.83$) as compared to the isonatraemic children.

In this study the weight on admission, prior to rehydration, was used. This could partially explain the higher percentage of malnutrition obtained. The length of the child is not affected by the dehydration and 29% (36/125) of this study population was stunted. This compares well with the SADHS in 2003 (children under five years of age) and the National Food Consumption survey of 2005 (children 1 - 9 years of age), which demonstrated that27%and 20% of South African children are stunted respectively.(22, 33)It can thus be safely deduced that there is a high rate of malnutrition. These findings depict the susceptibility of the malnourished to gastroenteritis.

4.4 Hypernatraemia and Risk factors

4.4.1 Hypernatraemia

It's important to note that there is a paucity of data regarding the incidence and risk factors of developing hypernatraemia in acute gastroenteritis outside of the neonatal period.

Forty one percent (51/125) of the study population had hypernatraemia. This is a significantly higher incidence than that shown by other studies.(8, 10)As observed by the author, this did not coincide with a higher rate of acute gastroenteritis within the

community. In South Africa, children that present to the public sector setting as compared to the private sector, may have to be more ill to be admitted or to have formal serum urea and electrolytes done. Thus this study might have preselected a sicker population but the author does not believe this completely explains the high incidence.

4.4.2 Demographic data and Hypernatraemia

There were no differences in the proportion of males and females within the hypernatraemic and isonatraemic groups. A statistical difference in the median age between the hypernatraemic and isonatraemic groups was found (median age five vs. 12 months, $p < 0.001$). Being less than one year old remained a significant risk factor for hypernatraemia in the multivariate analysis ($p<0.001$).

This study is comparable to other studies which show a high incidence of hypernatraemia in infants, however those studies included the neonatal population.(6, 8, 9)Possible explanations for the higher incidence in infants include, the inability of an infant's immature kidney in excreting an excess sodium load, the fact that infants cannot express thirst and that they depend on caregivers to provide sufficient and suitable fluids.(9)

4.4.3 Degree of Dehydration and Hypernatraemia

Fayad et al (1992) demonstrated that patients with hypernatraemia present with severe dehydration.(20) This was depicted in this study with 26 of 51 children (51%) with hypernatraemic dehydration being severely dehydrated on admission to hospital ($p = 0.003$). A possible explanation is that hypernatraemia presents in a more complicated form of acute gastroenteritis or at the extreme of the disease process as compared to isonatraemic dehydration. This in turn, could explain the high fatality rate of hypernatraemic dehydration. However after the multivariate analysis this association was no longer significant ($p = 0.09$).

4.4.4 Feeding practices and Hypernatraemia

Only six children less than six months of age were exclusively breast fed (6/47; 13%). This is higher than in the national survey of 2003 which showed that 8% of infants less than 6 months old are exclusively breast fed.(22)The higher rate of exclusive breast feeding in this study could possibly indicate that more mothers in this community, as compared to the rest of the country, opt for breast feeding rather than formula feeding.

Thirty two percent of the children younger than six months (15/47) were exclusively formula fed with 27% (4/15) of caregivers not mixing the formula correctly. Of those that exclusively formula fed, 80 %(12/15) presented with hypernatraemia. A total of 10 children (exclusive formula fed and mixed fed) were given over - concentrated formula

feeds. Of these children, majority presented with hypernatraemia (7/10; 70%). These children lack the protective effect of breast milk in relation to immunity and development of hypernatraemia.(23)

Although the low rate of exclusive breastfeeding and high rate of over-concentrating formula feeds may explain the high incidence of hypernatraemia, no significant associations were found in this study.

4.4.5 Oral rehydration therapy

Seventy four percent (93/125) of the children in this study were given ORS. Of these, 63% (59/93) were given the homemade SSS at home prior to seeking the assistance of a health care provider.

The 2003 SADHS documented that 69% of the population were given ORS, including 37%homemade SSS and 40% commercially available powder.(22)

The high usage of the homemade SSS in this study could be explained by the study population inclusion criteria for age. The SADHS indicated in their study that children less than two years old are more likely to be given the homemade SSS rather than the commercially available powder.(22)On the other hand, it could illustrate the success of the

IMCI program in South Africa depicting an increase awareness and utilisation of the homemade SSS amongst caregivers.

There is no statistical difference between the hypernatraemic and isonatraemic groups relating to the preparation of the ORS. However the commercially available powder (16/22; 73%) is more likely to be prepared correctly as compared to the homemade SSS (37/59; 63%). This study is comparable to the study by Cooke et al, who demonstrated that 18% of caregivers mixed the homemade SSS incorrectly.(10)

Undoubtedly, there is a greater chance of incorrect preparation of the homemade SSS given the varying sizes of teaspoons and utensils available in the household and the fact that one can add a levelled or heaped teaspoon of salt into the homemade SSS. Unfortunately, this question (whether a heaped or levelled teaspoon was used) did not form part of the questionnaire with caregivers. Although it was not a significant risk factor in this study, there is a potential risk of salt poisoning and hypernatraemia with incorrect preparation of the ORS.

This becomes concerning given the high rate of usage of ORS (93/125; 74%) and incorrect preparation (31/93; 33%) illustrated by this study. Therefore, the promotion of the use of the commercially available powder (since it's more likely to be mixed correctly) over the homemade SSS needs to be considered. Commercially available powder will potentially

decrease the amount of incorrect mixing, and it has a regulated amount of potassium, which may be beneficial given the high rate of malnutrition.

4.4.6 Adjuvant management

Although not statistically significant, additional tap water is less frequently given to children within the hypernatraemic group as compared to the isonatraemic group. This could contribute to the hypernatraemia although again not shown to be significant in this study. However, this also illustrates the poor understanding of caregivers regarding the disease process and the importance of fluid intake.

In addition, there was a relatively high use of prescribed anti - diarrhoeal and anti - emetic agents. In this age group the use of these agents is contra indicated and poses its own adverse risk to the participants.(30)

'Gripe water' was more frequently used in the hypernatraemic group (17/51; 33%, p = 0.08) compared to the isonatraemic group (9/49; 18%, p=0.08), although not statistically significant. This effect disappeared completely in the multivariate analysis (p=0.62), suggesting that gripe water use may have been a marker for a younger age group.

An observation has been described between hypernatraemia and nevirapine. Five cases of hypernatraemia as an adverse effect of nevirapine were reported to the Food and Drug Administration between January 2004 and October 2012.(34)Nevirapine was not shown to be a significant risk factor for the development of hypernatraemia in this study. However, only 4 children in this study were being given nevirapine, three of whom had hypernatraemia. This is a small number of cases to detect a causal effect.

4.4.7 Traditional medications

Eleven percent of the children (14/125) in this study received some form of traditional 'muthi'. There was no significant difference regarding traditional 'muthi' exposure between the hypernatraemic and isonatraemic children. However it was shown that many caregivers administered oral or rectal preparations of unknown compositions. This poses the risk of metabolic disturbances including acute poisoning.(29)

In the 2003 SADHS 6.4%received home remedies and herbs while 19.8% received pills/syrups(in a population which was not acutely ill).(22)This study illustrates a higher rate of traditional medication use which becomes concerning as the ingredients used to make these medications are not regulated by a medical board.

The difference in the usage of ‘muthiwenyoni’ and 'enemas' between the hypernatraemic and isonatraemic groups, were not shown to be significant in this study. 'Muthiwenyoni'

and 'enemas' were analysed as separate variables from traditional 'muthi' as they are ubiquitous preparations.

4.5 Outcome of children

All adverse outcomes were found within the hypernatraemic groups confirming the high morbidity and mortality rate in children with hypernatraemia. Neurological deficit ($p=0.013$) was significantly associated with hypernatraemia. Outcomes were based on findings at the time of discharge and thus long term neurological complications could not be ascertained. Follow up of these children, which was outside the scope of this study, would have assisted in defining the long term effects of hypernatraemia on the health care system.

4.6 Study limitations

A convenience sample attracts potential bias to this study. However it was not possible to collect data on every child due to the lack of the availability of the investigator on a daily basis and a high turnover of patients in hospital. The child's weight on admission was conveniently used for the above reason. This could possibly distort anthropometric results. However as explained previously the child's length should not be affected by dehydration thus giving us a good indication of the degree of malnutrition within the study population.

In retrospect, weighing the child again on discharge could have provided a more accurate estimate of the presence of malnutrition. In addition, weighing the child after rehydration would have provided an accurate estimate of the level of dehydration (mild = 5%, moderate 6 - 9%, and severe > 10 % loss of pre illness body weight).(30)

Replies to the questions on the use of ORS and how it was mixed or how feeds were mixed may have been distorted in order to please the interviewer. In order to limit this, the interviewer stressed the importance of truthful information to yield useful study results.

There is a higher incidence of hypernatraemia during winter months.(8)However, the author did not test for this by doing a year round survey. As observed by the author, there was no increase rate of acute gastroenteritis as compared to previous years or months but it would have been beneficial to have statistical data or references from previous years or months to compare with.

Unfortunately, this study was unable to explain the observed high incidence of hypernatraemic dehydration associated with acute gastroenteritis. There was however an association with infancy (age less than 1 year old).

When comparing to other studies the median age of children included in the studies were similar to this study.(8-10)However the degree of dehydration was not documented in

these studies except for the case report by Elamin et al (2007) in which the patient presented with severe dehydration.(9) Thus there is a possibility that we are admitting younger and more severely dehydrated children compared to other studies. This sampling bias may have contributed to the high incidence of hypernatraemia.

4.7 Study Strengths

This was a prospective study which provided the advantage of collecting comprehensive current data. Given the time frame of the study and that it was a convenience sample, the study achieved an acceptable sample size that could provide vital information. This is the first South African study illustrating the high incidence of hypernatraemia in this unique target population.

5.0 CONCLUSION

This study has illustrated a high incidence of hypernatraemic dehydration in acute gastroenteritis in a South African setting, which has not been reported in other studies. Despite the fact that this study aimed to identify risk factors for the development of hypernatremia, this study could not explain this high hypernatremia incidence. A replication of this study with a larger sample size and over a longer period may provide a greater insight into this condition.

However, this study illustrated that children less than a year old are most likely to have hypernatremia. This information will assist in alerting health care professionals to consider hypernatraemic dehydration and enable a prompt response.

A significant complication is neurological deficit. Thus early counselling of parents regarding the presence of neurological deficits and the possibility of future neurodevelopment delay is important. There also needs to be an emphasis on early initiation of rehabilitation of these children.

Our society is comfortable in utilising both traditional and conventional medicine. There is a trend in the increasing use of traditional, herbal or adjuvant medication.(24, 25) Thus it is essential that the two spheres of medicine (conventional and traditional medicine) work

together in providing safe treatment regimens to patients. Consequently there should be a medical board that regulates the traditional medical practitioners.

The inappropriate prescribing of anti-diarrhoeal and anti-emetic agents by health care professionals to young children is widespread. The indications, complications and correct prescribing points regarding these conventional medication uses in children need to be emphasised to health care professionals through continuous professional development education.

It is promising to see in this study as compared to the national survey of 2003(22), a higher percentage of exclusive breast feeding in infants younger than 6 months old (6/47; 13%). However, the majority of children in this study (less than 6 months old) are exclusively formula fed (15/47; 32%). This study showed that children who are both exclusively or mixed formula fed, are still being fed over-concentrated formula feeds (10/41; 24%). These children lack the beneficial effect of breast milk.(23) Thus greater public health measures regarding promotion of breast feeding or correct preparation of formula feeds are required.

It's encouraging that the IMCI program is becoming successful and more parents are administering the homemade SSS. However, most are mixing it incorrectly often without providing additional fluid intake. Thus the continuation of fluids and food during the diarrhoeal episodes needs to be emphasised. In addition greater public health measures on correct mixing of the ORS need to be conducted.

This study provided vital information in the initial step of investigating hypernatraemic dehydration within the paediatric population. More research into the move to commercially available powder of ORT is needed. It will also be interesting to identify possible gastro-enteric pathogens and their association with hypernatraemia. Further studies are required with a possible larger sample size and over a longer period to explore other aspects and gain a better understanding on hypernatraemic dehydration, its effect on the children and its long term effects on the health care system.

Age less than one year old is a significant risk factor for developing hypernatraemia. Thus, the author recommends, that health care professionals should suspect a potential hypernatraemic state in all infants who present with signs and symptoms of dehydration secondary to acute gastroenteritis and thus rehydrate these children slowly with intravenous fluids containing a higher concentration of sodium until laboratory serum sodium levels become available.

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APPENDIX A - Ethics Clearance Certificate

R14/49 Dr Shenaaz Banoo Ghulam Hossain

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140205

NAME: (Principal Investigator)	Dr Shenaaz Banoo Ghulam Hossain
DEPARTMENT:	Paediatrics Rahima Moosa Mother and Child Hospital
PROJECT TITLE:	Acute Gastroenteritis and Hypernatraemic Dehydration- A Descriptive Audit of the Pre-Hospital Management and Prediposing Factors in Children
DATE CONSIDERED:	28/02/2014
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Tim De Maayer
APPROVED BY:	Professor PE Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	23/04/2014

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

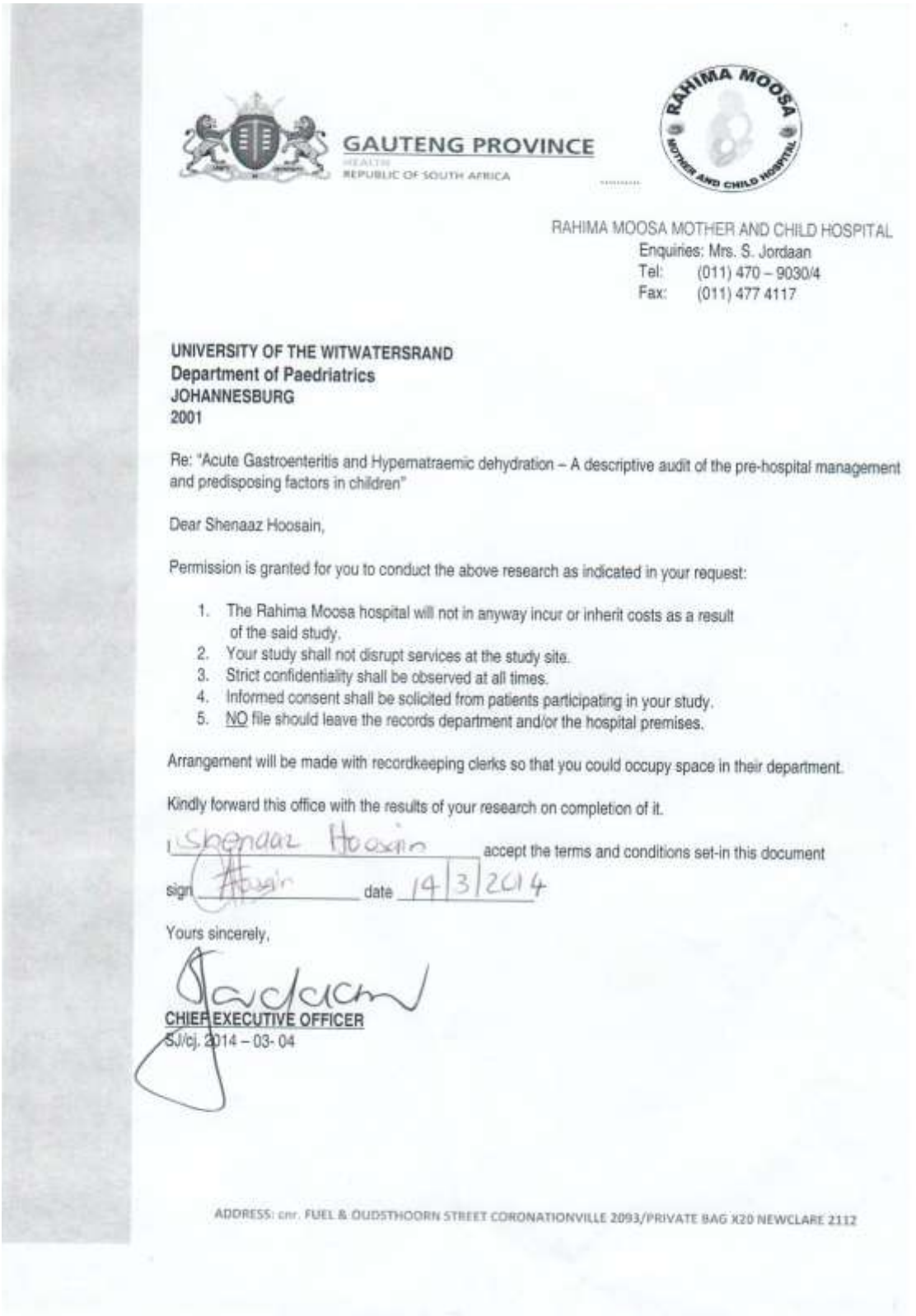
DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.**

Principal Investigator Signature — Date: 26 April 2014

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX B - Permission from the Chief Executive Officer at the study site



GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

RAHIMA MOOSA MOTHER AND CHILD HOSPITAL

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2001

Re: "Acute Gastroenteritis and Hypernatraemic dehydration – A descriptive audit of the pre-hospital management and predisposing factors in children"

Dear Shenaaz Hoosain,

Permission is granted for you to conduct the above research as indicated in your request:

1. The Rahima Moosa hospital will not in anyway incur or inherit costs as a result of the said study.
2. Your study shall not disrupt services at the study site.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.
5. NO file should leave the records department and/or the hospital premises.

Arrangement will be made with recordkeeping clerks so that you could occupy space in their department.

Kindly forward this office with the results of your research on completion of it.

I Shenaaz Hoosain accept the terms and conditions set-in this document

sign Hoosain date 14/3/2014

Yours sincerely,

CHIEF EXECUTIVE OFFICER
SJ/cj. 2014 – 03- 04

ADDRESS: cnr. FUEL & OUDSTHOORN STREET CORONATIONVILLE 2093/PRIVATE BAG X20 NEWCLARE 2112

APPENDIX C - Permission from the Head of Paediatric Department at the study site

APPENDIX D - PERMISSION FROM CLINICAL ENTITY

5 February 2014

To : The Department of Paediatrics at the Rahima Moosa Mother and Child Hospital

I am a paediatric registrar, employed by the Rahima Moosa Mother and Child hospital. My training involves a research component which is to complete a Master in Medicine degree.

I would like to conduct by research study at your hospital's paediatric department. The title is Acute Gastroenteritis and Hypernatraemic Dehydration - A descriptive audit of the pre-hospital management and predisposing factors in children.

Patients who meet the inclusion criteria will be identified. Parents, guardians or caregivers will be counselled regarding the study and if they give verbal consent for their child to be a participant an informed consent document will be signed.

The study involves a questioner and examination of patient to weigh the patient , obtain the height of the patient and determine the degree of dehydration. Patient medical records will also be needed to obtain the admission serum sodium level. I request your permission to conduct this study at your hospital between the months of March and August 2014.

My supervisors include Dr Tim DeMaayer and Prof Keith Bolton who are employed as paediatricians at your hospital. The study will be approved by the School of Medicine - Department of Paediatrics and the Committee of Research on Human Subjects – University of Witwatersrand prior to the commencement of data collection.

The research protocol , questioner and informed consent document has been attached. For any queries please contact me or my supervisors.

Thank You

.....

Shenaaz Banoo Ghulam Hoosain, BPharm , MBBCh (Wits)

Tel: 082 3400 817 email: sbghoosain@gmail.com

The Department of Paediatrics at the Rahima Moosa Mother and Child Hospital grant you access to patients medical records and give you permission to conduct the above mentioned study at our department/hospital .

.....

Prof Ashraf Coovadia

APPENDIX D - Informed consent

Consent Form: To be a study participant and allow the use of clinical information

University of the Witwatersrand and Rahima Moosa Mother and Child Hospital

Dear Parent or Guardian

I am Shenaaz Ghulam Hoosain, a doctor working in the paediatric department at Rahima Moosa Mother and Child Hospital. I am doing a study on the increase in salt level in the blood of children with watery/loose stools (diarrhoea) and dehydration.

Your child has been admitted to hospital for watery/loose stools (diarrhoea) and dehydration. Sometimes during this illness the salt level in your child's blood may increase. We are trying to determine factors that may cause an increase salt level in the blood of children with diarrhoea and dehydration. This may help us in providing better care for those with diarrhoea in the future.

If you agree to participate in the study, we would like to ask you a few questions about the treatment you gave to your child and type of feeds, liquids and medications given to your child before admission to hospital. We will also weigh your child with a scale, measure your child's length with a tape measure and examine your child to check how dehydrated he or she is. We will need to ask a few questions about yourself, such as, are you the mother, grandmother or other relation to the child, your age and level of education.

All information given will be confidential and only the investigator will be aware of it. Your child’s name or identity will not be captured, and all your information will be kept anonymous. If you choose not to participate in the study or at any time if you choose to

withdraw consent, it will have no impact on your child's treatment. Nor will participating in the study offer any additional benefit to your child.

I ..... the parent/guardian/caregiver of..... (Patients name) hereby give consent or do not give consent (delete the one which is not applicable) to participate in the above mentioned study for the purposes of research and development.

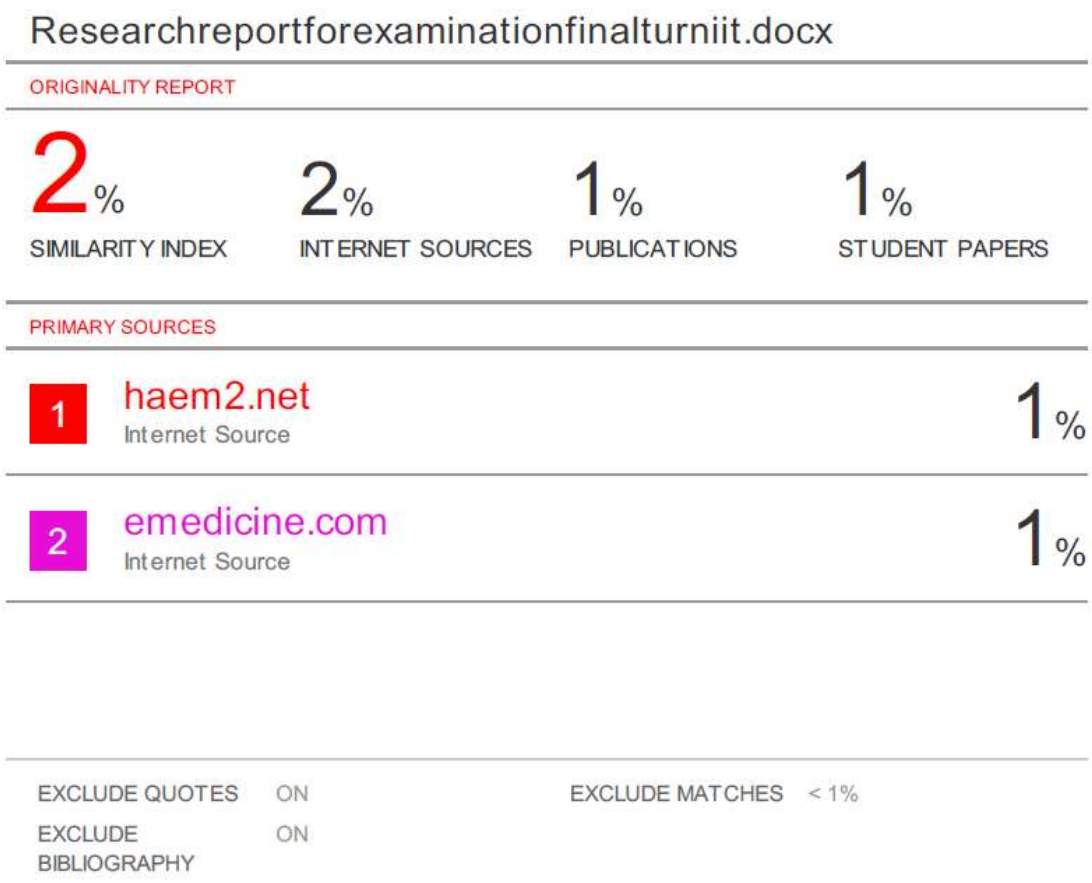
Signature: Witness:

Date: Time:

APPENDIX E - Questionnaire

Study number:	
Gender	☐ Male ☐ female
Age (months)	.....months old
Weight and length	.....kg .....cm
Severity of dehydration as per WHO IMCI criteria	☐ "No" ☐ "Some" ☐ "Severe"
Admission Serum Sodium Level	.....mmol/l
Type of Feeding	☐ Breast feeding ☐ Formula feeding ☐ solids If formula feeding how was it prepared? ....
Type of ORT	☐ none ☐ commercially available powder ☐ homemade SSS How was it prepared?
Other fluid intake	☐ none ☐ water ☐ juice ☐ increased amount of breast or formula feeds ☐ other
Conventional, Alternative or traditional medications used	☐ none ☐ gripe water ☐ enema ☐ muthiwenyoni ☐ other e.g. antibiotics, anti - diarrhoeal agents, Nevirapine, other 'muthi'
Outcome of patient	☐ Discharged home ☐ Died ☐ Neurological deficit
Caregiver characteristics 1. Who is the caregiver 2. Age of caregiver 3. Level of education of caregiver	☐ mother ☐ aunt ☐ grandmother ☐ other ☐ .....years old ☐ School, grade =..... ☐ tertiary ☐ none

APPENDIX F - 'Turnitin' Report



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