CAUSES AND CONSEQUENCES OF SODIUM IMBALANCES IN THE FIRST WEEK OF LIFE IN VERY LOW BIRTHWEIGHT INFANTS

BY

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STUDENT NUMBER: 695463

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

DECLARATION

I, Ngwako Innocent Ramaboea, 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.

Signed:  at Johannesburg on 25

day of MAY 2018.

DEDICATION

My wife, Mary Mahlodi Ramaboea and our two sons Tshegofatso and Lefa, without whom this would never have been possible.

ACKNOWLEDGMENTS

Professor Daynia Ballot, MBChB; FC Paed; PhD
My supervisor, for her guidance, assistance, patience and support at all times

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LIST OF ABBREVIATIONS

BPD -bronchopulmonary dysplasia

ECF-extracellular fluid

CMJAH- charlotte Maxeke Johannesburg academic hospital

CPAP- continuous positive airway pressure

HMD- hyaline membrane disease

ICF-intracellular fluid

IVH- intraventricular haemorrhage

IWL-insensible water loss

Na- sodium

PDA- patent ductus arteriosus

NEC –necrotizing enterocolitis

NVD- normal vaginal delivery

REDCAP- research electronic data capture

ROP- retinopathy of prematurity

SGA-small for gestational age

SVT- surfactant

VLBW-very low birth weight

Causes and consequences of sodium imbalances in the first week of life in very low birthweight infants.

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Abstract

Background. Sodium imbalance is common in the first week of life in very low birth weight (VLBW) infants and may be associated with poor outcome.

Objectives. To determine the incidence and outcomes of both hypo and hypernatraemia in VLBW (500g – 1500g birth weight) infants in the first week of life.

Methods. This was a retrospective cross sectional descriptive study evaluating sodium abnormalities in VLBW (500g – 1500g) infants in the first week of life. Subjects included all VLBW infants born at Charlotte Maxeke Johannesburg Academic Hospital between the 1st January 2013 and the 31st July 2013. The causes and complications associated with sodium abnormalities sodium abnormalities and their outcomes were reviewed.

Results. Sodium imbalances were found in 29.1% (85/292) VLBW infants. Hypernatraemia was present in 27.1 % (79/292) and hyponatraemia in 2.0 % (6/292). There was no difference in birth weight or gestational age between hyponatraemic and hypernatraemic VLBW infants. Within the hypernatraemic VLBW infants, mortality was significantly increased in much smaller and more preterm infants ($p<0.001$) and in higher sodium levels ($p<0.005$). The main causes of hypernatraemia was insensible water loss through skin (73.9% of babies born via normal vaginal delivery) and respiratory (60% of babies on CPAP). The outcome of the sodium abnormalities was high mortality rate in patients with hyponatraemia as compared to patients with hypernatraemia.

Conclusions. Hypernatraemia is common in the first week of life in VLBW infants. Prevention of prematurity and measures to prevent sodium abnormalities should be implemented at birth, especially in very small preterm infants to decrease mortality and morbidity.

Background

Sodium is required to maintain extracellular tonicity and positive sodium balance is a prerequisite for growth.

Fluids and electrolytes management in very low birth weight infants (VLBWI) birthweight <1500g is critical in the first week of life and needs to be managed appropriately to prevent morbidity and mortality. Whether plasma sodium increases or decreases depends, therefore, on the magnitude and direction of change in total body sodium and water. This information is often difficult to obtain in preterm infant, the cause is not always evident and the wrong treatment may be prescribed. Sodium balance is determined by the intake or loss of both sodium and free water. The sodium requirement in VLBW infants is 3-5 mmol/kg of sodium per day and their fluid requirements may go up to 200ml/kg/day[3]. This is affected by weight, degree of prematurity and size for gestational age [3-5].

Hypernatraemia is defined as plasma sodium level of >145 mmol/l [I(6)]. In VLBW infants insensible water loss(IWL) and renal immaturity are the major contributing factors of hypernatraemia[7]. Factors affecting IWL in VLBW infants are increased respiratory rate, surgical malformations (gastroschisis and omphalocoele), increased body temperature, use of radiant warmer and phototherapy[6]. Complications of hypernatraemia are probably due to dehydration and hypernatraemia is associated with an increased incidence of chronic lung disease (CLD), patent ductus arteriosus(PDA), necrotizing enterocolitis(NEC)[8]and intraventricular haemorrhage(IVH)[7]. Very severe hypernatraemia is associated with poor neurological outcome[8]. More emphasis in fluid and electrolytes therapy in VLBW infants should be put on the prevention of excessive insensible water loss rather than replacement of insensible water loss.

Hyponatraemia is defined as plasma sodium <130 mmol/l [6, 8]. Water retention may be a more important cause of hyponatraemia in the VLBW infant than sodium losses [1, 9]. Hyponatraemia may be due to excessive fluid and water /salt administration (iatrogenic) or due to impaired tubular sodium reabsorption[10, 11]. Hyponatraemia is associated with delayed growth and poor neurodevelopmental outcome[13], increased risk of PDA, BPD, IVH, NEC[14] and neurosensory hearing loss [15].

The present study aims to review sodium imbalance in VLBW infants seen in Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) in Johannesburg, South Africa.

SUBJECTS AND METHOD:

The study was a retrospective cross sectional descriptive study evaluating sodium abnormalities in VLBW infants in the first week of life (birthweight between 500g to 1500g). All VLBW infants born at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) between 1st January 2013 and 31st July 2013 were eligible for inclusion. Those VLBW infants who were admitted after 48 hours of life, those who died at birth and those with major congenital abnormalities were excluded.

Study objectives were

1. To determine the incidence of both hypo and hypernatraemia in VLBW infants at CMJAH

2. To identify complications and mortalities associated with these sodium abnormalities.

Data was collected from a neonatal computer database kept for the purpose of clinical audit. Clinical and demographic data was collected on discharge for each VLBW infant by the attending medical staff. The data was verified against hospital records. Data was managed using Research Electronic Data Capture (REDCAP) hosted by the University of the Witwatersrand[16]. A copy of the laboratory result sheet is kept with each neonatal summary.

The plasma sodium level results for the first seven days of life were obtained for each study infant from the laboratory result sheet. All VLBW infant were cared for according to unit protocols and blood was drawn for sodium measurement at the discretion of the attending physician. There was no information available on fluid intake, type of incubator (e.g. radiant warmer), cardiovascular status or whether the baby was covered in plastic. A plasma sodium level above 145 mmol/l was considered as hypernatraemia and plasma sodium level less than 130 mmol/l was considered as hyponatraemia. Data collected for each infant studied included gestational age, birthweight, maternal steroid administration, admission temperature, phototherapy, IVH, use of CPAP, mechanical ventilation, PDA and NEC. Grading of IVH was according to Papile [17]. The presence of NEC was defined as either grade two or three using modified Bell's classification[18]. Outcomes were recorded as either death or survival/hospital discharge.

Statistical analysis.

Data was described using standard statistical methods. Continuous variables were described using mean with standard deviation (SD) or median with range, depending on the distribution of the data. Categorical variables were described using frequencies and percentages. Comparison between different groups (survivor's vs non- survivors and hypo- vs hypernatraemia) was done using Chi square or Fisher's exact test for categorical variables. Unpaired t tests or non-parametric tests were used to compare continuous variables as appropriate. Only valid cases were analysed (i.e. missing information was excluded for each variable). Analysis was done using SPSS version 24(IBM, USA)

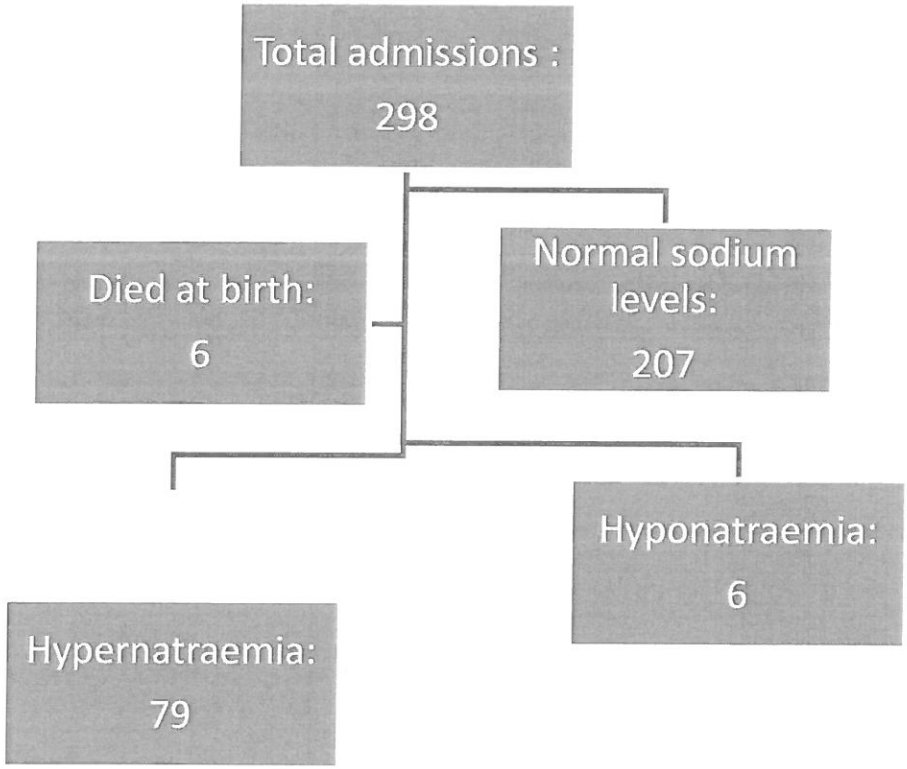
ETHICS CLEARANCE:

The study was considered and cleared by the Human Research Ethics Committee of the University of the Witwatersrand (Clearance number M120926)

RESULTS

There were a total of 298 VLBW infants admitted within the study period. A total of 85 VLBW infants (29.01%) had sodium abnormalities and were included in the study (see Figure 1). A total of 79 patients (27.01%) had hypernatraemia while 6 patients (2 %) had hyponatraemia. None of the patients had congenital abnormalities. Six patients died before blood was drawn for urea and electrolytes. A total of 207 of VLBW infants had normal serum sodium levels in the first week of life

Figure 1: Selection of study subjects



Neonatal characteristics

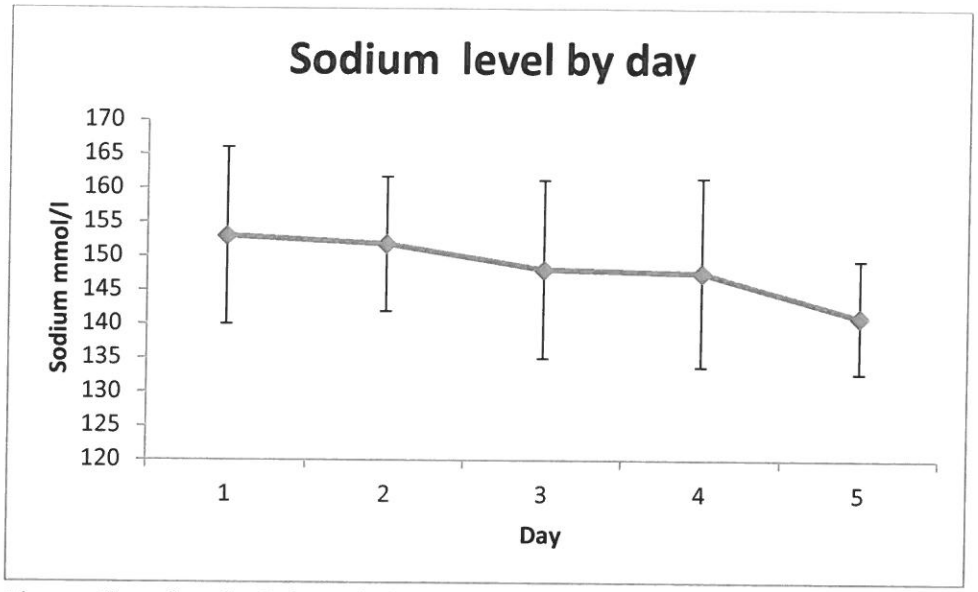
The birth weight considered in this study was for babies born with the birthweight of 500g to 1500g. The mean birth weight was found to be 1058.5g (SD 293.7) and mean gestational age was found to be 28.7 weeks (SD 2.5). Other demographic and clinical characteristics are shown in Table 1. Overall survival was 64.7%. The majority of VLBW infants were treated with phototherapy and NCPAP.

Table1: Demographics and clinical characteristics.

Variable*	Total
Gender	
Male, n/N (%)	47/85 (55.3)
Female, n/N (%)	38/85 (44.7)
Place of birth	
Inborn, n/N (%)	72/85(84.7)
Out born, n/N (%)	13/85(15.3)
Initial temp mean (SD)	35.5 ^{0}C (1.5)
Steroids n/N (%),	53/84(62.4)
NVD, n/N (%),	44/83(51.8)
CPAP, n/N (%)	62/85(72.9)
Phototherapy, n/N (%)	56/85(72.9)
SVT, n/N (%)	61/85 (71.8)
Outcome	
Survived n/N (%)	55/85(64.7)
Died n/N (%)	30/85(35.3)
PDA, n/N (%)	8/85(9.4)
NEC 2/3, n/N (%)	5/85(5.9)
IVH grade 1, n/N (%)	6/85(7.1)
grade 2, n/N (%)	7/85(8.2)
grade 3, n/N (%)	2/85(2.4)
grade 4, n/N (%)	1/85(1.2)
HMD, n/N (%)	77/85(90.6)
ROP, n/N (%)	6/85(7.1)
Sepsis, n/N (%)	2/85(2.4)
Metabolic acidosis n/N (%)	4/85(4.7)
Hyperglycaemia n/N (%)	23/85(27.1)

*PDA =patent ductus arteriosus, NEC =necrotizing enterocolitis, IVH= intra ventricular haemorrhage, HMD= hyaline membrane disease, ROP =retinopathy of prematurity. NVD= normal vaginal delivery, CPAP= continuous positive airway pressure, SVT= Surfactant

Figure 2: Sodium Levels by Day of Life



The sodium level of the whole group is shown in Figure 2. There was a decline in sodium levels over the first five days of life.

Hypernatraemia vs. Hyponatraemia

Table 2: Comparison between VLBW infants with hypernatraemia and hyponatraemia

Variable	Hyponatraemia	Hypernatraemia	P value
Died	5/6 (83.3%)	25/79 (31.6%)	0.019
NEC	4/6 (66.7%)	1/79 (1.3%)	<0.001
Antenatal steroids	4/5 (80%)	27/79 (34.2%)	0.06
NCPAP	2/6 (33.3%)	60/79 (75.9)	0.043

Table2 compares the causes and outcome between babies with hypernatraemia and hyponatremia. NEC and high mortality in babies with hyponatraemia.

Mortality within the hypernatraemia group

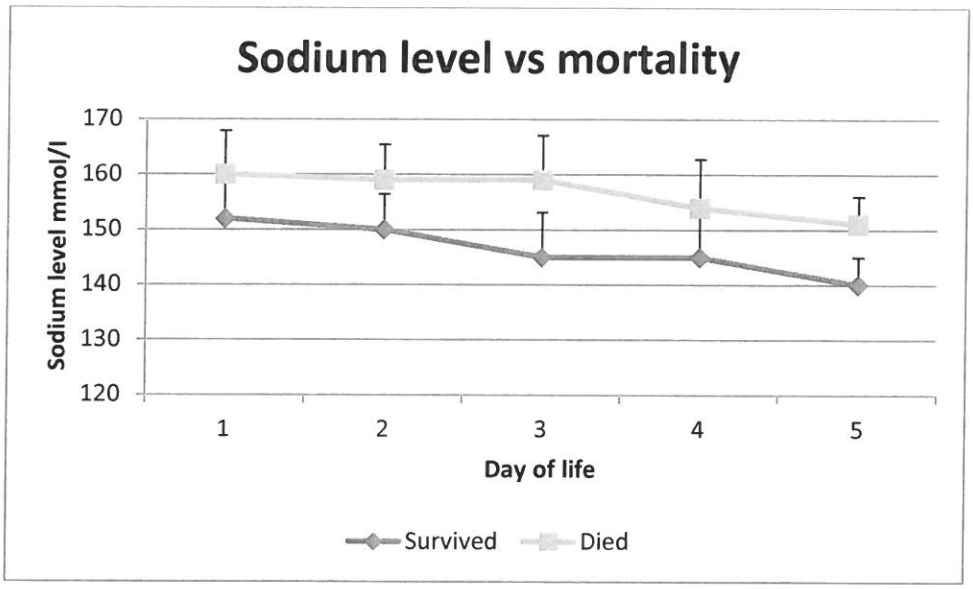
Table 3: Significant associations with mortality within the hypernatraemic group of VLBW infants

Variable	Survived	Died	P Value
Hyperglycaemia	7/54 (13%)	13/25 (52%)	0.001
NEC	2/54 (3.7%)	6/25 (24%)	0.011
Metabolic acidosis	0/54 (0)	3/25 (12.0)	0.029
NCPAP	45/54 (83.3 %)	15/25 (60)	0.024
NVD	21/54 (38.9%)	17/23 (73.9)	0.005

Table 3 summarize the causes, complications and the outcome of babies who developed hypernatraemia.

Outcomes of sodium abnormalities

Figure 3: Sodium level vs mortality in VLBW infants with hypernatraemia



DISCUSSION

The present study found that 28 % of VLBW infants had sodium abnormalities in the first week of life. Hypernatraemia was the most common sodium abnormality, present in 95% of the VLBW infants with sodium abnormalities. Hypernatraemia was present in 26% of all VLBW infants which is in keeping with other reports[20]. Very few VLBW infants in the present study were found to have hyponatraemia in the first week of life. This is in contrast to other reports where hyponatraemia in the first week of life was found to occur in 25% to 65% of VLBW infants in the first week of life and was more frequent in those infants of lower gestational age[9, 11].

Survivors within the hypernatraemia group were significantly heavier than non survivors 1145.0 (SD 204.1) vs 855.6 (SD 189.7) grams) ($p<0.001$) and of more advanced gestational age 29.6 (SD 2.4) vs 26.8 (SD 2.1) weeks) ($p<0.001$). In VLBW infants with hypernatraemia, hyperglycaemia, metabolic acidosis and NVD were significantly associated with high mortality (see Table 3). Sodium levels were significantly higher in those VLBW infants with hypernatraemia who died in comparison to those who survived (see Figure 3). All sodium levels were significantly different at $p<0.005$, apart from the levels on day 4 which were not different. There was no other statistically significant association with mortality for any other variables.

Serum sodium levels reflect water and sodium balance which changed over time after birth. Water loss through the skin in VLBW infants, so called "insensible water loss", is high,

resulting in hypernatraemia[20]. This insensible water loss is high post-delivery in VLBW infants and decreases with increased post-natal age[21]. In the present study it was not possible to evaluate fluid intake or insensible water loss as a possible cause of hypernatraemia as such data was not collected in this study. However, babies who were put on NCPAP (75.9%) had hypernatraemia in the present study. In the study unit, VLBW infants who receive NCPAP are nursed on open resuscitation cribs with overhead radiant warmers which may increase insensible water loss and this may result in hypernatraemia. Hyperglycaemia and metabolic acidosis were significantly associated with mortality in hypernatraemic infants in the present study. Both hyperglycaemia and acidosis could be markers of hypernatraemic dehydration. In VLBW infants with hypernatraemia, the presence of hyperglycaemia increases the risk of early mortality and IVH[22]. Phototherapy increases insensible water loss [27], but was not found to be the case in this study.

There is a strong association between insensible water loss and birth weight [23]. The present study reflected that, there was no statistical significance association between sodium level and birth weight or gestational age. A study conducted in extremely preterm infants also found no association between birth weight and hypernatraemia[5]. Those VLBW infants who died in the hypernatraemia group in the present study, however, were smaller and of lower gestational age than survivors.

This study has shown that low sodium levels were associated with an increased risk of mortality. This should be interpreted with caution due to the low number of subjects, many of whom had NEC, which may be a cofounder. Serum sodium levels were higher in VLBW infants who died within the hypernatraemic group.

Several studies have shown an association between hypernatraemia and IVH [2, 7] however in a study by Hye Jin Lee et al [24] there was no significant association between IVH and hypernatraemia. There was no association between IVH and sodium level in the present study.

In the present study, babies who their mothers received antenatal steroids are likely to develop hyponatraemia as opposed to hypernatraemia (p=0.06). Administration of antenatal steroids and NEC were more frequent in VLBW infants with hyponatraemia (see table 2) Antenatal steroids have been reported to decrease insensible water loss and

decrease the incidence of hypernatraemia[25] PDA[12],and NEC[14], which are all are associated with hypernatraemia in VLBW infants.

STUDY LIMITATIONS

This was a retrospective study and there were low number of hyponatraemia patients reported. There was no information on fluid intake, type of incubator, cardiovascular status or the use of plastic shields which all influence sodium balance. It could not be determined whether sodium imbalance was the cause of death in the present study

CONCLUSION

In conclusion, the present study showed a high incidence of sodium imbalance in VLBW infants in the first week of life. Hypernatraemia was far more common than hyponatraemia. Mortality within the hypernatraemic infants was significantly associated with higher sodium level, lower birth weight and lower gestational age. Measures to prevent hypernatraemia in VLBW infants should be implemented in the first week of life, particularly in very small premature infants.

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Conflict of interest. None

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APPENDIX A: TURN IT IN REPORT

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ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

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2	adc.bmj.com Internet Source	2%

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APPENDIX B: ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Ngwako I Ramaboea

CLEARANCE CERTIFICATE	**M120926**
PROJECT	Sodium Level in Very Low Birth Weight in the First Week of Life
INVESTIGATORS	Dr Ngwako I Ramaboea.
DEPARTMENT	Department of Paediatrics
DATE CONSIDERED	31/08/2012
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 31/08/2012 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Prof D Ballot

DECLARATION OF INVESTIGATOR(S)
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX C:

DATA SHEET

RESEARCH NUMBER	

BABY

BIRTH WEIGHT:	GESTATION(WEEKS):	SEX:	
APGAR	1min:	5min:	10min:

Labour and delivery

Maternal age	Parity	Gravida	Antenatal steroids: Y/N		
Mode of delivery	NVD	Breech	Assisted delivery	Elective C/S	Emergency C/S
Resuscitation	oxygen	BMV	CPR	Intubated	Adrenaline
Place of birth	In born	BBA	Out-born		
Initial temperature					

In ward

Cranial sonar	
Phototherapy	
surfactant	
CPAP	

Sodium level

Day	2	3	4	5	6	7	
NA level							

Outcome

Died	Discharged	Transferred
complications		
Discharge weight		

Protocol

Causes and consequences of sodium imbalances in the first week of life in very low birth weight infants.

Table of content:

Glossary:

ECF-extracellular fluid

ICF-intracellular fluid

IWL-insensible water loss

Na- sodium

PDA- patent ductus arteriosus

NEC –necrotizing enterocolitis

SGA-small for gestational age

VLBW-very low birth weight

1. Background:

Sodium is required to maintain extracellular tonicity and positive sodium balance is a prerequisite for growth.

Fluids and electrolytes management in VLBW infants is critical in the first week of life and needs to be managed appropriately to prevent morbidity and mortality. Hyper and hyponatraemia, which occur in preterm infants during the first days after birth, result from changes in total body sodium or total body water or both (26).

Whether plasma sodium rises or fall depends, therefore, on the magnitude and direction of change in total body sodium and water, and as this information is difficult to obtain in preterm infant, the cause is not always evident and the wrong treatment may be prescribed (27).

Sodium balance is determined by sodium intake or loss and free water intake or loss. VLBW babies require 3-5 mmol/kg of sodium per day and fluid requirements may go up to 200ml/kg/day. This is affected by both weight , degree of prematurity and size for gestational age(27)

In utero the foetus consist of is 80-90% water, the baby is immersed in fluid, the lungs are filled with liquid., In VLBW infants the skin is porous and leaking and lacks a keratin layer thus there is a high trans epidermal water loss. The kidneys are also immature so the urine output is high and renal concentrating ability is limited.

After birth, extracellular volume (ECV)-contracts and this is accompanied by net negative sodium and water loss. Loss of this ECV results in physiological weight loss in the first week of life. Term infants are expected to lose 10 % as compared to 15% weight loss in premature neonates. This period is of variable duration, but by the third or fourth postnatal day, sodium and water balance have become positive and remain so until adult life.

The incidence of sodium of sodium abnormalities is variable. Harkay and Scalon reported the incidence of hypernatraemia in preterm infant to be 40% (5). Another study reported the incidence of hyponatraemia was reported to be 24% only whereas 2% was reported on hypernatraemia(28).Whether the preterm infant becomes hypo-or hypernatraemia in the first week of life depends on the early management of the patient.

1.1 Hypernatraemia:

Hypernatraemia is defined as plasma sodium level of >145 mmol/l. Clinically hypernatraemia may present with non-specific signs, including lethargy and irritability.

Hypernatraemia -present with signs of dehydration which could be masked in neonates. Monitoring of fluid balance and serum electrolytes is therefore important.

In VLBW infants hypernatraemia is due to:

1. Insensible water loss(IWL) may be:
   -due to larger surface area to bodyweight ratio.
   - Unkeratinised skin allows loss of water but not loss of sodium.
   -trans epidermal loss results in loss of up to 200ml/kg/day in preterm infants as opposed to term infants who lose 20-40 ml/kg/day

   Factors contributing to insensible loss include phototherapy, incubator humidity, and time of transfer to incubator. Babies born before arrival to the hospital (BBA) are prone to trans epidermal water loss. Certain gastrointestinal abnormalities such as omphalocoele or gastroschisis are cause of fluid loss and hypernatraemia
   The emphasis in fluid and electrolytes therapy in VLBW infants should be on the prevention of excessive insensible water loss rather than replacement of insensible water loss
   Preventative measures include: incubators, plastic barrier, or heat shields.
2. Renal immaturity:
   Immature nephrons and decreased glomerular filtration rate are a major factor in the preterm infant decreased ability to excrete excess fluid and electrolytes loads-(to compensate for high intake of electrolytes although there is ability to regulate to some degree sodium balance by altering sodium excretion.)
   Preventative measure: offer mom in preterm labour prenatal steroids. Prenatal steroids were associated with lower estimated IWL, a decreased incidence of hypernatraemia and earlier diuresis and natriuresis in extremely low birth weight neonates(29).

Complications of hypernatraemia are probably due to dehydration include intraventricular haemorrhage(IVH) , periventricular leukomalacia, cerebral oedema, thrombosis, collapse and severe hyperbilirubimaemia requiring exchange transfusion (26).

1.2 Hyponatraemia:

Hyponatraemia is defined as plasma sodium <130 mmol/l. Hyponatraemia may cause hypotonia, apnoea, and if acute and severe may cause seizures. Hyponatraemia is associated with weight gain. In the first few days after birth hyponatraemia indicate fluid overload rather than sodium deficiency. Chronic sodium deficiency is associated with poor skeletal, tissue growth, and adverse neurodevelopment outcome(30).

Dilutional hypernatraemia due to excessive water intake is the most common cause of hyponatraemia. Water retention may be a more important cause of hyponatraemia in the preterm than losses.

Syndrome of inappropriate ADH (SIADH) has been shown to cause hyponatraemia. SIADH is associated with HIE, PDA, intracranial haemorrhage , pneumothorax and hyaline membrane disease(31). Result show that water retention, often associated with ADH release, rather than negative sodium balance is the main cause of hyponatraemia in sick preterm infants in the first week of life (1).

Complications of hyponatraemia include: pulmonary oedema, PDA, BPD and NEC.

2. Aims and objectives

2.1 Aim: to determine the incidence of sodium abnormalities in VLBW infants in the first week of life as well as the possible causes and consequences of these imbalances.

2.2 Objectives:

1. To determine the incidence of both hypo and hypernatraemia in VLBW infants at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).
2. To identify complications and mortality associated with these sodium abnormalities.

2.3 Justification of the study:

Sodium disturbances are preventable and correctable but if not properly managed may be fatal. Hyponatraemia in the first week of life has been associated with NEC, PDA , chronic lung disease(26), yet, study done by Zuzanna et.al showed that hypernatraemia occur commonly in <27 weeks gestation and was not associated with significant morbidity(5).

3. Methodology:

1. Study design:

   This is a retrospective, longitudinal study whereby we look into the sodium levels in VLBW infants in the first week of life.

2. Study population

   The study will look in to new-born infants born with weight <1500g between 01 Jan 2013-31 July 2013.

3. Measurements:

Data will be collected from computer database kept for clinical audit in neonatal unit. Refer to data sheet as per appendix A.

Demographic details: birth weight, gestational age, gender

Factors contributing to sodium abnormality: phototherapy, hyperthermia, resuscitation, antenatal steroids, mechanical ventilation.

Complications associated with sodium abnormalities: NEC, IVH, PDA, and retinopathy of prematurity (ROP)

Outcome: death or discharged.

Biochemistry results obtained from NHLS data using hospital number

Urea and electrolytes

Date and time to be recorded

Hypernatraemia Na>145

Hyponatraemia Na<130

4. Exclusion criteria:

1. Babies born with major congenital abnormalities incompatible with life will be excluded.
2. Babies born at regional hospitals and transferred to CMJAH after 24 hours will be excluded.

5. Limitations

1. It is a retrospective study so not all information is available. It would have been ideal to get all the files and be able to establish on the management i.e. fluid replacement
2. It will be difficult to establish whether morbidity or mortality can be attributed to Na imbalances

6. Data processing and analysis.

All data collected will be kept by researcher with anonymous study number

Data entry: Information from admission records will be captured in Microsoft Excel spread sheet for data cleaning and coding purposes.

7. Statistical analysis

Categorical variables will be described by frequency and percentages. Continuous data that has a normal distribution will be described using mean and 95% confidence intervals, skewed data will be described by median and interquartile range. Univariate analysis to compare complications between hyper/hyponatraemia groups and to

determine causes of death will be done using odds ratios for categorical data. Continuous data will be compared using unpaired t-test or Mann Whitney test. Multivariate analysis using logistical regression would be used to determine significant predictors of outcome.

8. Ethical considerations.

The data for this study will be collected, analysed and reported only after the WITS human research ethic committee has approved that this study may be conducted.