**UNIVERSITY OF NAIROBI**

# PREVALENCE, RISK FACTORS AND OUTCOMES OF NEONATAL DEHYDRATION AMONG 13 HOSPITALS IN KENYA

**BY**

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**A DISSERTATION SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH IN PARTIAL FULFILMENT OF REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF PUBLIC HEALTH OF THE UNIVERSITY OF NAIROBI.**

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## DEDICATION

This dissertation is dedicated;

To my beloved husband **Rono Kirui** for his financial and moral support.

To my parents **Mr. David Rotich and Mrs. Alice Rotich** for their constant encouragement and motivation throughout my studies.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **BMI** | Body Mass Index |
| **CI** | Confidence Interval |
| **IQR** | Inter-quartile Range |
| **CIN** | Clinical Information Network |
| **CS** | Caesarean Section |
| **DHIS** | District Health Information System |
| **ICC** | Intra-class Correlation Coefficient |
| **KEMRI** | Kenya Medical Research Institute |
| **MoH** | Ministry of Health |
| **OR** | Odds Ratio |
| **REDCap** | Research Electronic Data Capture |
| **SDGs** | Sustainable Development Goals |
| **USA** | United States of America |
| **WHO** | World Health Organization |

## OPERATIONAL DEFINITION OF TERMS

| | |
|---|---|
| **Ankyloglossia** | A congenital oral anomaly whereby a band of tissue (frenulum) tethers the tongue thereby decreasing mobility, causing difficulty in breastfeeding, speech articulation, and other mechanical tasks. |
| **Dehydration** | Loss of salt, water or extracellular fluid |
| **Hyperbilirubinemia** | Is a condition whereby there is a build-up of bilirubin in blood causing yellow discoloration in the skin and eyes. |
| **Hypernatremia** | An electrolyte problem that indicates a rise in serum sodium concentration to values exceeding 150mmol/l. |
| **Intracranial haemorrhage** | Bleeding within the skull. |
| **Neonate** | A child between the age of 0 and 28 days. |
| **Neurological sequelae** | Complications involving the central nervous system that include cognitive, sensory and motor defecits arising from a previous disease. |

**ABSTRACT**

**INTRODUCTION**

**Background Information** - Neonatal deaths currently contribute nearly 50% of under-five deaths and identification of causes of neonatal mortality is a priority. There are concerns that dehydration is a common problem in sick neonates, but few studies have documented the burden of dehydration, partly because of difficulty in making clinical diagnosis. In the neonatal period, dehydration has less pronounced clinical signs and this may lead to missed or mis-diagnosis leading to adverse outcomes and increasing cost of care.

**Study significance**- This study described the outcomes in neonates admitted with dehydration thereby informing policy on the need for local clinical guidelines on diagnosis of dehydration in newborns. This study also sought to investigate neonatal and maternal risk factors for dehydration thereby highlight at risk patients that are most vulnerable to neonatal dehydration for early recognition and prompt treatment in efforts to reduce fatality.

**Study Objectives-** The objectives of this study were to quantify the burden of neonatal dehydration among Kenyan hospitals, describe the outcomes of neonates presenting with dehydration, and to identify the risk factors of dehydration that can be obtained from routine hospital data.

**METHODS**

**Study design** – This was a cross-sectional analytic study.

**Study Area**- This study was conducted across 13 county (first-referral level) hospitals in Kenya participating in a clinical information network (CIN).

**Data Collection Procedures** - Data were abstracted from medical files of neonates admitted to pediatric wards of these 13 Kenyan hospitals within a 1year period (December 2015-November 2016). Newborns aged less than 28 days were identified from the CIN database and 65 patients randomly selected from each hospital from a list of unique identifiers. Medical notes for selected patients were reviewed by trained clerks located in each hospital and data were abstracted into a specially designed survey tool and synched to a central server.

**Data analysis** – Newborns fulfilling a defined criterion for neonatal dehydration were identified from review of medical notes. Well babies and those admitted for accommodation were excluded. Inverse probability weighting was used to determine the prevalence of neonatal dehydration for the 13 hospitals. The adverse outcomes of neonatal dehydration were determined by calculating the proportion of neonates fulfilling case definition of neonatal dehydration who experienced undesirable outcomes upon discharge. The Risk factors for neonatal dehydration were identified using mixed effects logistic regression.

## RESULTS

**Study Population** - A total of 810 neonates fulfilled criteria for inclusion.

**Dehydration Prevalence** - The overall prevalence of neonatal dehydration was 16.7 % (132/810, 95% exact binomial CI [13.9 – 19.6%]) and it varied across study hospitals (range 7.8% to 26.6%). Dehydration presented alongside other conditions (comorbidities), the most common were sepsis, jaundice and pneumonia. Laboratory results for serum sodium and renal function tests for dehydration were rarely available even though tests were requested.

**Outcomes of Neonatal Dehydration** – The major outcomes experienced by dehydrated patients (n=132) were; renal failure in 4(3%) of dehydrated newborns, neuro-disability/sequelae in 1 patient (0.8%) and mortality in 8(6%). A majority, 97(73.5%) were normal (in good health) upon discharge.

**Risk Factors of Neonatal Dehydration** - This study identified neonatal age (Odds Ratio (OR) 0.5, 95% Confidence Interval (CI) [0.31-0.75]) and parity (OR 1.61, 95% CI [1.01-2.5])) as important risk factors for neonatal dehydration. There was minimal variation in outcome (dehydration) across study hospitals and the intra- class correlation coefficient was 1.7%.

## CONCLUSION

The study findings indicate that neonatal dehydration is common in neonates admitted across hospitals in Kenya with proportions varying across hospitals. Main adverse outcomes experienced by dehydrated neonates in this study were kidney injury, neurologic sequelae and mortality. Age less than one week and being born to primiparous mother, were found to be significant risk factors of dehydration. Lactation support and training is recommended for primiparous mothers and mothers with neonates in their first week of life.

## RECCOMENDATIONS

1. Guidance for diagnosing dehydration that includes weight loss determination and laboratory examination should be included in the national paediatric guidelines.
2. Lactation support including practical training on proper breastfeeding techniques should be provided especially to first time mothers and more attention should be accorded to babies in their first week of life.
3. A study reviewing detailed medical records with improved documentation is needed.

# CHAPTER ONE: INTRODUCTION

## 1.0 Introduction

This chapter gives an introduction of this research. It contains background information on neonatal dehydration, statement of the problem and justification of the study. The research objectives, research hypotheses, and the limitations of the study are also outlined.

## 1.1 Background

Dehydration has been reported as a common cause for hospitalization in the first month of life ( Koklu et al., 2007; Moritz et al., 2005; Tarcan & Tiker, 2005; Simiyu, 2003; Laing, & Wong, 2002; Escobar et al., 2002; Manganaro, Mamì, Marrone, & Marseglia, 2001; Oddie et al., 2001) and a significant predictor of in-patient death (Simiyu 2003). Dehydration generally refers to loss of water and salt or extracellular fluid (Finberg, 2002). It may be classified clinically based on signs as 'severe', 'some', or no dehydration, or based on serum sodium levels/abnormalities, into isonatraemia, hyponatraemia, and hypernatremia (Finberg, 2002).

Globally, there are few reports on the burden of dehydration from an overall perspective. A study carried out in the United states reported an incidence of 1.2 to 3.4 per 1000 live births (Escobar et al., 2002) while another in the Netherlands which included newborns up to 3 months of age found an incidence of 58 per year per 100,000 live births (Pelleboer et al., 2009). To the best of my knowledge there is limited evidence on the burden of neonatal dehydration in Low and Middle income countries (LMICs), however a recent study in India found an incidence rate of 6.45% in a 3-

month period (Shah & Bakul, 2018). A local study that focused on all causes of morbidity and mortality among neonates admitted to the paediatric ward at one of the national hospitals in Kenya (Kenyatta National Hospital) revealed that dehydration was among the top six diagnoses contributing 14% of neonatal admissions. (Simiyu, 2003).

Dehydration in the neonatal period -first 28 days- has less pronounced clinical signs (Manganaro et al., 2001) and can be difficult to recognize clinically (Mortazavi, Sakha, & Nejati, 2009). Neonates are a vulnerable group to hypernatremic dehydration, which is an electrolyte abnormality indicating serum sodium values above 150mmol/l and is the most commonly reported type of dehydration among neonates ( Lavagno et al., 2016; Davanzo et al., 2013; Ergenekon, Unal et al., 2007; Koklu et al., 2007; Moritz et al., 2005; Tarcan & Tiker, 2005; Oddie et al., 2001). Newborns presenting with hypernatremic dehydration have better preserved extracellular volume and thus less pronounced signs of dehydration (Moritz & Ayus, 2002). The Kenya paediatric protocol, a locally adapted World Health Organization (WHO) guidance, only provides national guidelines for diagnosis of dehydration in children above one month of age. Misdiagnosis of dehydration can increase the cost of care due to misuse of health resources managing other erroneously presumed diagnosis. Furthermore, unrecognized dehydration could cause avoidable mortality (Tregoning & Schwarze Jr, 2010).

Dehydration has been suggested to be a cause of preventable acute kidney injury in the first month of life (Ahmed et al., 2014; Unal et al., 2008), cerebral hemorrhage, intracranial hemorrhage, (Paul, Phillips, Widome & Hollenbeak, 2004), vascular thrombosis (Pringle et al., 2011), and death (Shah & Bakul 2018). Neurological problems at 24 to 36 months post-discharge (Unal et al., 2008) among newborns previously admitted with dehydration have also been reported. However, clinical

outcomes for children admitted with dehydration in Kenyan hospitals or similar settings in Africa in the absence of clear guidelines for diagnosing dehydration in neonates are unknown.

Dehydration in newborns is thought to result from poor breastfeeding or lactation failure which may be propagated by several neonatal, maternal and health system related factors. The design of this study was retrospective therefore, it only focused on neonatal and maternal risk factors as it was presumed that hospital related factors may not have been captured upon admission. Neonatal risk factors include; preterm births, birth order (first born babies), infant birth weight and illness. Dehydration occurs among preterm or small for gestational age babies (Escobar et al., 2002) due to prematurity of sucking reflex (Laing & Wong, 2002) however, delivering a large infant is stressful for both mother and baby and has also been associated with a delayed onset of lactation (Champman & Pirez, 1999) that may also lead to dehydration. First born babies are also more vulnerable to dehydration (Escobar et al., 2002; Manganaro, MamÃ, Marrone, Marseglia, & Gemelli, 2001). These babies' mothers have been reported to lack breastfeeding experience and may have problems with positioning the baby and breast attachment hindering successful lactation (Manganaro et al., 2001). Conditions other than feeding difficulty have been found amongst dehydrated newborns. Escobar et al (2002) found other illnesses such as sepsis and meningitis in 5% of the neonates in their study population. Sick neonates are sensitive to fluctuations in fluid volume associated with these disease processes and dehydration occurs when high volumes of water losses are inadequately replaced (Powers, 2015). Maternal factors reported to predispose newborns to dehydration include maternal age greater than 35 years, maternal obesity, caesarean birth and long duration of labor. Babies born to mothers who have had caesarean section experience a delay in initiation of

breastfeeding as compared to those of vaginal birth (Escobar et al., 2002; Manganaro et al., 2001). Mothers with Body Mass Index (BMI) above 27kg/$m^2$ have been found to experience a delay in onset of lactation as compared to mothers with lower BMI (Dewey et al., 2003). Labour duration greater than 14 hours has also been shown to be stressful for both mother and baby leading to delayed lactation onset (Dewey et al., 2003). A majority of the risk factors described above are from studies in developed countries, factors predisposing newborns to dehydration may vary in Sub Saharan Africa due to contextual and health system differences.

In Kenya, the neonatal mortality rate is 22 deaths per 1000 live births compared to 16 deaths per 1000 live births in infants above one month of age (Kenya National Bureau of Statistics, 2014). With the end of the Millennium Development Goals (MDGs), a new era characterised by sustainable development goals (SDGs) represents a renewed commitment by UN member states to end preventable deaths of newborns and children under 5 years of age by 2030, with all countries aiming to reduce neonatal mortality rate to as low as 12 deaths per 1000 live births and under 5 mortality to at least as low as 25 deaths per 1000 live births (United Nations, 2015). Efforts to reduce neonatal mortality will have to address causes of neonatal mortality and morbidity including dehydration.

### 1.2 Statement of the research problem

There are very few studies in low and middle-income countries that report on the burden of neonatal dehydration that can support decision making on formulation of strategies aimed at preventing and mitigating neonatal dehydration. The setting for this study was 13 Kenyan hospitals that are part of a Clinical Information Network whose aim is to collect standardized routine hospital data to create an evidence base for informed

decision making (Ayieko et al., 2017). Paediatricians within this network reported anecdotally an increasing number of newborns being admitted to paediatric wards for neonatal dehydration and suggested that the prevalence of dehydration be estimated as an initial step to better understand the rise in admissions.

Available economic data from the United States of America suggests that the hospital readmission for neonatal dehydration cost approximately 118.70 dollars per admission (Paul, Phillips, Widome & Hollenbeak, 2004). By extension to our setting, this would substantially increase the economic burden on families of newborns admitted with dehydration and pose a strain on health resources.

Neonatal dehydration is thought to be common among sick hospitalized neonates, but the magnitude of the problem, outcomes and predisposing factors in low income countries like Kenya are unclear. Neonatal dehydration is a potentially manageable condition and timely management has potential to reduce mortality and morbidity in affected neonates. This study investigates the above issues to contribute knowledge that would be useful in attempts to further reduce neonatal mortality, which has showed comparable slower decline (compared to mortality in older children) over the last decade.

### 1.3 Justification of the study

Efforts to reduce national neonatal mortality and eventually achieve the SGD goal three (ensure healthy lives and promote wellbeing for all ages) will have to address major causes of neonatal mortality and morbidity. Dehydration is thought to be a major contributor of neonatal morbidity and mortality in hospitalized children but there are few studies in low and middle income settings. This study was done in 13 hospitals involved in a clinical information network in Kenya and investigated the burden of

neonatal dehydration in sick neonates. It also sought to investigate neonatal and maternal risk factors for dehydration thereby highlighting at risk patients that are most vulnerable to neonatal dehydration for early recognition and prompt treatment in efforts to reduce fatality. This study also described the outcomes in neonates admitted with dehydration thereby informing policy on the need for local clinical guidelines on diagnosis of dehydration in newborns.

### 1.4 Research questions

1. What is the prevalence of dehydration among neonates admitted in CIN hospitals?
2. Are neonatal factors (gestational age, current age, birth weight, sex, mode of delivery and illness) related to dehydration in newborns admitted in CIN hospitals?
3. Are maternal factors (maternal age, labor duration, parity and maternal conditions affecting breastfeeding) predictors of dehydration in neonates admitted in CIN hospitals?
4. What are the outcomes in newborns admitted with dehydration in CIN hospitals?

### 1.5 Objectives of the study

#### 1.5.1 Broad objective

To estimate the prevalence of neonatal dehydration, describe clinical outcomes in sick neonates admitted with dehydration, and to identify the risk factors of dehydration using routine data from 13 Kenyan hospitals.

### 1.5.2 Specific objectives

1. To estimate the prevalence of neonatal dehydration across 13 hospitals in Kenya over a one-year period (December 2015-November 2016) using routinely collected hospital data.
2. To describe the outcomes in newborns admitted with dehydration in 13 Kenyan hospitals within a one-year period using routine hospital data.
3. To identify the neonatal and maternal risk factors for neonatal dehydration across13 Kenyan hospitals using routine hospital data**.**

## CHAPTER TWO: LITERATURE REVIEW

### 2.0 Introduction

This review of the literature focuses on studies conducted on neonatal dehydration in both developed and developing countries. The main aspects of the review cover definition of dehydration, causes, diagnosis, burden, clinical outcomes and risk factors of neonatal dehydration.

### 2.1 Dehydration definition

Dehydration generally refers to the loss of water whilst in physiology and medicine, it means a loss of water and salt or extracellular fluid (Finberg, 2002). Dehydration may be classified based on signs as 'severe', 'some', or no dehydration, or based on serum sodium levels/abnormalities into isonatremia, hyponatremia, and hypernatremia (Finberg, 2002). Isonatremic dehydration refers to sodium of 130 to 150 mEq/L (130 to 150 mmol/L), indicating loss of water and solutes in equal proportions. It mostly occurs in patients with secretory diarrhoea where the solute concentration of the diarrhoea is the same as the plasma solute concentration. Hyponatremic dehydration occurs when losses from diarrhoea are replaced with hypotonic fluids, resulting in sodium concentration of less than 130 mEq/L (130 mmol/L). Hypernatremic dehydration on the other hand indicates a high proportion of water loss compared to solutes, resulting in serum sodium greater than 150 mEq/L (150mmol/L). This reflects water loss in excess of solute loss. This is common in viral gastroenteritis, such as that caused by rotavirus, and in neonates with inadequate breastfeeding in whom diarrheal and insensible water losses are inadequately replaced (Powers, 2015) .

The most common cause of hypernatremic dehydration in neonates is low volume intake of breast milk (Laing & Wong, 2002). Poorly fed infants are less likely obtain a

high sodium content from a small volume of breast milk, therefore hypernatremia is thought to be associated with water deprivation and secondary accumulation of sodium in an attempt to maintain circulating volume (Caglar et al., 2006). This type of dehydration may be missed and its severity under-estimated by clinicians leading to under-diagnosis of dehydration (Livingstone et al., 2000). In a study carried out by Moritz et al (2005), dehydration was rarely recorded as an admission diagnosis for newborns in this study population, the neonates were mostly admitted with presumed sepsis or jaundice before laboratory tests for dehydration were carried out.

**2.2 Diagnosis of dehydration**

In infants, dehydration may be diagnosed by taking historical points from adult care givers when assessing fluid volume status. Paediatricians may inquire on the number of wet diapers (indicating frequency of urination), normal tearing state, history of ability to take fluids, (Porter et al., 2003) , if an infant has been vomiting or having diarrhoea (Goldman et al., 2008), if a baby can drink/breastfeed vigorously or not (King et al., 2003). Physical examination includes skin turgor (Fayomi et al., 2007), sunken fontanel (Kiesler and Ricer, 2003), cardiovascular compromise (delayed capillary refill time, weak pulse volume) ( Shavit et al., 2006), dry mucus membranes and ill general appearance (Porter et al., 2003) . Decreased Skin turgor is checked by pinching small skin folds on lateral abdominal wall and measuring the time it takes for the skin to return from a folded state to normal (Fayomi et al., 2007), while measurement of capillary refill time involves the examiner compressing a superficial capillary bed and noting the time it takes for normal colour to return after pressure is released (Shavit et al., 2006). Clinical diagnosis of more severe forms of dehydration in neonates involves looking out for dry mucosa which may also be as a consequence of other pathological conditions (Liang & Wong, 2002).

Assessment of reduced skin turgor is a good indicator in older children may be misleading in neonates since their skin is generally has reduced elasticity. Sunken eyes may also be difficult to ascertain since they generally have smaller eyes. Weight loss of greater than 10% of birth weight in the first week of life and infrequent urination are sensitive markers of dehydration in newborns (Moritz et al., 2005). The neonates body mass may be measured every day (Liang & Wong, 2002; Livingstone et al., 2000) but this is time consuming and may be impractical (Pelleboer et al., 2009), especially in the developing world where doctor- patient ratios are wanting. Assessment of volume of urine output may also be difficult with modern disposable diapers (Liang and Wong, 2002).With a growing water deficit, signs of circulatory failure also occur, such as peripheral vasoconstriction (the skin becomes cold and marble-like) and a slow refill of cutaneous capillary bed following pressure on the earlobe and nail plate – the capillary refill time becomes longer. These signs, however, may also be affected by the ambient temperature, therefore, they must be interpreted with caution (Kieliszczyk et al., 2016).

Very mildly dehydrated patients may be managed without laboratory determinations, but it is wise to confirm clinical impressions in moderate losses and always in severe illness (Finberg, 2002). Laboratory testing is mostly required only for children with greater than 10% dehydration in need of intravenous fluid repletion (Powers, 2015) . Sodium, chloride, bicarbon-ate, and urea nitrogen determinations are the most essential (Finberg, 2002). Vega and Avner (1997), found that assessment of serum bicarbonate is one of the most sensitive tests to help determine the degree of dehydration; values less than 17 mEq/L (17 mmol/L) can be used to differentiate moderate-to-severe dehydration from mild dehydration, obtaining a serum bicarbonate can improve the accuracy of predicting serious dehydration. Measurement of serum sodium in moderate – severe dehydration is important since it determines the type and speed of repletion

(Powers, 2015). The measurement of blood urea nitrogen (BUN) or serum urea concentration is usually used as an indicator of pre-renal uraemia and dehydration, urea nitrogen level give a rough estimate of renal compromise (Finberg, 2002).

### 2.3 Burden of neonatal dehydration

Dehydration has been found to be common in newborns admitted to hospitals in developed countries over the decades. An old study in Canada by Lee et al (1995) reported an incidence rate of 0.58 per 1000 live births while another in the United States of America by Edmonson et al (1997) which was a nested case control study carried out over a 4 year period reported an incidence of 1.7 per 1000 live births. In both studies the increase in hospital admissions due to dehydration were attributed to a decreased lengths of hospital stay by mothers after delivery. Escobar et al (2002) also carried out a case control study across 11 hospitals in the United States and found an incidence of 2.1 per 1000 live births (range 1.2-3.4 per 1000 live births). Another study carried out in the Netherlands (Pelleboer et al., 2009) among breast fed infants up to three months of age found an incidence of 58/year/100,000 breastfed infants. These differences in incidence could be due to the variation in case definition across the studies, differences in prevalence of risk factors for dehydration and differences in health system interventions to prevent dehydration.

There is limited evidence on the burden of neonatal dehydration in low and middle income countries (LMICs). A study by Simiyu (2003) reported on all causes of mortality among newborns admitted at the paediatric ward of one of the national referral hospitals in Kenya pointed out that dehydration was among the top six diagnoses at (14%). A recent study carried out in India (Shah & Bakul, 2018) found an incidence rate of 6.45% within a 3 month period.

Findings from high-income settings cannot be directly extrapolated due to potential differences in prevalence of predisposing conditions and other contextual differences, therefore the magnitude of dehydration hospital admissions reported by studies from developed nations may not reflect the burden in LMICs and specifically Kenya. Examples of population and health system differences include the fact that many developed countries have most citizens on medical insurance or the state fully covers health care costs. Kenya has an insurance uptake of 17.1%. (MOH, 2013), with a majority of families funding their health care. Again, developed countries have higher literacy levels and readily accessible support services. The first few days after delivery are critical in training first time mothers on lactation and allowing for time for full milk flow to occur and where necessary, fluid supplementation is often given. Newborns in low income countries like Kenya may be at risk of experiencing dehydration during this early days and may not be hospitalized early enough due to health cost concerns.

### 2.4 Risk factors for neonatal dehydration

Several maternal and neonatal factors have been identified to predispose newborns to dehydration;

#### 2.4.1 Neonatal Factors

These include; gestational age, sex, birth weight, anatomical abnormalities, preterm babies and ill infants.

##### 2.4.1.1 Premature Infants

Low birth weight/ premature neonates have been reported to be at risk of dehydration. Escobar et al., (2002), found that infants born less than 39 weeks gestation were 2 times more likely to be rehospitalised for dehydration than term babies. Preterm infants have

less developed sucking ability (Laing & Wong, 2002) because of complications arising from their immaturity and their mothers have also been found to experience delayed onset of lactation (Chapman & Perez-Escamilla, 1999).

#### 2.4.1.2 A Neonates' Sex

Similar proportions of male and female infants have been reported among dehydrated patients (Shah & Bakul, 2018). Studies that have investigated sex (male or female) as a risk factor for neonatal dehydration have found that it is not a significant predictor (Boskabadi et al., 2010; Escobar et al., 2002)

#### 2.4.1.3 Infants with Anatomic Abnomalities

Infant anatomic abnormalities such as ankyloglossia (tongue tie), cleft lip and palate and ankyloglossia may interfere with infant suckling and predispose to dehydration (Livingstone et al., 2000; Power & Murphy 2004).

#### 2.4.1.4 Ill infants

Conditions other than feeding failure have been found amongst dehydrated neonates (Shah & Bakul 2018; Escobar et al., 2002) these include meningitis, jaundice, and sepsis. Sepsis is often accompanied by signs such as fever and lethargy which increase water loss and predispose infants to dehydration (Moritz et al., 2005). Jaundice has also been shown to a sign of insufficient lactation (Moritz et al., 2005).

### 2.4.2 Maternal Factors

Cesarean delivery, primiparity, breast anomalies or breastfeeding problems, excessive pregnancy maternal body weight, delayed first breastfeeding, no previous breastfeeding experience and low maternal education have been reported to predispose neonates to dehydration.

### 2.4.2.1 Primiparity

Majority of cases of neonatal dehydration in previous studies are from primiparous mothers (Edmonson et al., 1997; Escobar et al., 2002; Caglar et al., 2006; Oddie, Craven, Deakin, Westma & Scally, 2013). A nested case control study by Escobar et al. (2002) which was carried out across 11 hospitals in the United States reported that newborns from primiparous mothers were 5.5 times more likely to be re-hospitalised for dehydration as compared to those from multiparous mothers. First-time mothers and mothers with no breastfeeding experience require more reassurance and practical advice in the technique of breast-feeding and intensive support on how to correctly position the child and attach it to the breast (proper latching) for successful lactation (Laing & Wong, , 2002; Livingstone et al., 2000). Breastfeeding-associated hypernatremia among infants born to first-time mothers is thought to be related to the fact that primiparous women produce significantly less milk than multiparous women during the first postpartum week (Ingram, Woolridge & Greenwood, 2001). Primiparity may also represent a compounding factor because these mothers lack experience and fail to recognize dehydration early (Livingstone et al., 2000). However Manganaro et al (2001) found no significant difference between dehydrated and non-dehydrated children born of primiparous and multiparous mothers. This study attributed dehydration to a negative breastfeeding experience with previous children rather than parity.

### 2.4.2.2 Caesarean Delivery

Evidence suggests that babies born through caesarean section are at risk of developing dehydration (Caglar et al., 2006; Manganaro et al., 2001) due to a stressful delivery experience (Chapman & Perez-Escamilla, 1999) and newborn status that may have prompted operative delivery. Furthermore, early hospital discharge after birth among

Caesarean mothers has been reported to be associated with dehydration. Escobar et al (2002) found that caesarean born infants discharged less than 48 hours after birth were 4.5 times more likely to be rehospitalised for dehydration than those who stayed longer in hospital.

#### 2.4.2.3 Maternal Education

Some authors have reported that mothers with low education status are more likely to have dehydrated neonates (Edmonson et al., 1997; Manganaro et al., 2001). However Neifert et al (2001) argued that mothers may be well educated but still fail to recognise dehydration especially in hypernatremic dehydration where lack of clinical signs may disguise the underlying dehydration. Escobar et al (2002) found no difference in maternal education between s cases of dehydration and controls in a study carried out across 11 hospitals in the United States.

#### 2.4.2.4 Duration of labour

A long duration of labour greater than 14 hours has been linked to delayed onset of lactation (Dewey et al., 2003). Long duration of labour increases levels of stress to a newborn and its mother releasing the hormone cortisol, which has been shown to contribute to delayed onset of lactation (Chapman & Perez-Escamilla, 1999)

#### 2.4.2.5 Maternal Body Weight

Maternal obesity or a body mass index (BMI) greater than 27kg/$m^2$ contributes to impaired lactation. Although the causal pathway is unclear this is thought to result from several mechanisms including higher steroid hormone levels in obese women (Ahmed et al., 2014). There may also be infant difficulty in positioning onto the breast of obese women and less ability to perceive breast fullness, such mothers require lactation guidance and support to successfully establish breastfeeding (Dewey et al., 2003).

#### 2.4.2.6 Maternal Breast Complications

Structural and functional changes take place in the breast during gestation and after birth, milk production naturally increases in the first four days after birth (Neville & Morton, 2001). Mothers whose breasts did not adequately change in size during pregnancy (mammogenesis) develop primary lactation failure (Caglar et al., 2001). Mothers with flat, inverted or big nipples fail to latch appropriately even though their breasts can produce sufficient milk (Caglar et al., 2006). Flat or inverted nipples are associated with sub-optimal infant breastfeeding and with delayed onset of lactation and have been found more commonly among mothers of dehydrated neonates. Other maternal breast conditions that have been reported to cause breast-feeding difficulties include previous breast surgery, cracked or painful nipples, systemic maternal illnesses, and perinatal complications (Neifert et al., 2001). Women with these breast conditions could benefit from additional support for breastfeeding until the newborn is able to latch on effectively (Caglar et al., 2006).

### 2.5 Outcomes of dehydration

Serious complications following dehydration have been reported including; acute renal failure or acute kidney injury (Ahmed et al., 2014; Unal et al., 2008), intracranial haemorrhage (Korkmaz et al., 2000), multiple cerebral infarctions and seizures (Unal et al., 2008), and death (Shah & Bakul, 2018).

A study in the United States found no adverse outcomes among newborns rehospitalized for dehydration (Escobar et al., 2002). This was attributed to infants enduring a much shorter duration with dehydration (less than 5 days) before rehospitalization. Another study in 2007 by the same authors found no adverse neurodevelopment outcome among children followed up for 5 years. These authors highlight that these findings were from an insured population with no challenges to

immediate hospitalization. A recent study in India reported that out of 28 dehydrated infants over a 3 month period 2 died ( mortality rate 7.14%) while 92.3% of the case patients were discharged in good health. Mortality in this set of patients was thought to have been caused by septic shock and renal failure (Shah & Bakul, 2018).

Serious complications have also been reported to occur in children with preventable hypernatremic dehydration. Unal et al (2008) reported on hospital outcomes in 169 newborns with hypernatremic dehydration hospitalized within a 3 year period. The most common adverse outcome in this study population was acute kidney injury in 82.8% of the newborns, brain oedema occurred in 5.2%, intracranial haemorrhage in 3.6% of these newborns and 2(1.2%) neonates died. In cases of hypernatremic dehydration, if high sodium serum concentrations are corrected quickly during rehydration, there is a risk of osmotic changes in the brain that could lead to celebral oedema (Ergenekon et al., 2007). A prospective study in Turkey by Ergenekon et al (2007) assessing long term outcomes in newborns previously admitted with hypernatremic dehydration found the only adverse outcome of hypernatremic dehydration to be delayed neurological development which occurred in 2 of 28 patients included in that study.

# CHAPTER THREE: METHODOLOGY

## 3.0 Introduction

This chapter elaborates methods, materials and procedures that were undertaken in conducting this research. It gives details on the study area, study design, study population, case definition of dehydration for the study, selection criteria of the participants, sampling method and sample size determination. Study variables, data collection techniques/methods and tool/instrument, data processing and analysis conducted, minimization of errors and bias, and ethical considerations are also highlighted.

## 3.1 Study Area

The study was conducted in 13 hospitals in Kenya which are part of the Clinical Information Network (CIN), which is a collaboration between KEMRI Wellcome Trust, the Kenyan Ministry of Health (MoH), University of Nairobi, Kenya Paediatric Association, and county hospitals that are distributed across the country. The study was undertaken in; Busia, Embu, Kakamega, Karatina, Kerugoya, Kiambu, Kisumu East, Kitale, Machakos, Mama Lucy, Mbagathi, Nyeri and Vihiga level five hospital. The purpose of CIN is to collect standardized routine hospital data on paediatric care given for common childhood illnesses in Kenya that can support informed decision making on adoption of evidence-based interventions, improvement of the quality of care and ultimately, support for pragmatic intervention trials designed by all stakeholders including frontline health workers (Tuti et al., 2005). Annual meetings are conducted among stakeholders to discuss data quality, potential research areas and to train paediatricians on various aspects of scientific research. During the 2016 annual meeting, paedetricians mentioned that they had noted an increase in number of neonates

admitted to paediatric wards with dehydration. It was therefore agreed that a survey be carried out within the network to generate preliminary data on these rise in admissions.

### 3.1.1 Hospital selection

During establishment of the Clinical Information Network, the Ministry of Health purposefully selected 12 counties based on desire for a wide geographical coverage. To be considered for selection, a hospital had to have at least 1000 general paediatric admissions per year (Ayieko et al., 2016). Routine hospital data is collected from 13 hospitals in Kenya mentioned above and Mbale hospital, however this study left out Mbale hospital since it refers all its newborns to Vihiga hospital which is part of the CIN. It was also thought that this study would be feasible because documentation of clinical and demographic characteristics has improved as a result of regular feedback (Irimu et al., 2018).

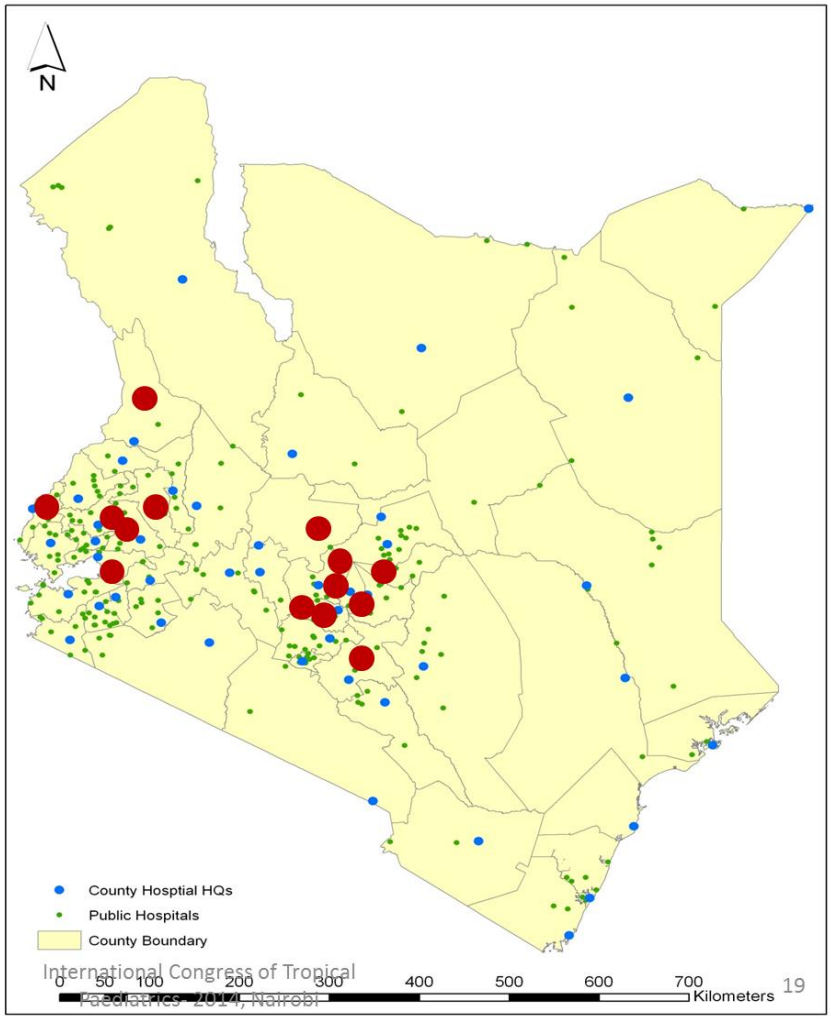


**Figure 1: Location of CIN Hospitals; Study Sites.**

### 3.2 Study Design

This was a cross sectional analytical study. The rationale for using this design was that both prevalence and risk factors for neonatal dehydration can be estimated. Data were abstracted from inpatient medical records of newborns below 28 days of age admitted within a one year period**.**

### 3.3 Study Population

#### 3.3.1 Target Population

This study targeted all neonates admitted to paediatric wards of Kenyan public hospitals. The results of this study can be generalized to this population.

#### 3.3.2 Source Population

This population consisted of all neonates admitted during a one-year period (December 2015 to November 2016) to paediatric wards of 13 hospitals that are part of CIN in Kenya. The population was identified from the CIN database.

### 3.4 Eligibility Criteria

#### 3.4.1 Inclusion Criteria

All medical files of newborns aged less than 28 days admitted in paediatric wards of CIN hospitals between December 2015 and November 2016 were included in this study.

#### 3.4.2 Exclusion Criteria

Neonates admitted for reasons not related to their own health (for accommodation), for instance those whose mothers were receiving medical care or those that were well but had been abandoned in hospital were excluded from this study. Newborns admitted to dedicated newborn units were not included as their data were not captured.

### 3.5 Study Case Definition

There is no locally accepted or universally adopted case definition for neonatal dehydration. For this study, literature was reviewed, and a case definition agreed on by the pediatricians involved in CIN (researchers and hospital pediatricians) through a modified Delphi process whereby several suggestions were made, discussed and a final definition agreed upon.

### 3.5.1 Case Definition for Neonatal Dehydration

For this study, a neonate was considered dehydrated if they had any of the following characteristics documented in their medical notes;

- Where a child had a diagnosis of dehydration;
- Where patients in their first week of life had a weight loss of more than 15% for term babies and more than 20% for preterm babies.
- Where a child had a Urea, Electrolyte or Creatinine test above the set range for normal values plus weight loss. Urea values above 10mmol/l, sodium values above 150mmol/l, and creatinine values above 80µmol/L were considered as upper limit (Gowda et al., 2010). Creatinine levels were only considered for children above 2 days of age since earlier levels may reflect maternal values.
- Where a child received extra fluids or feeds during their hospital stay but was not on phototherapy. This was ascertained by considering-≥20% of the recommended total volume of fluid given per kilogram body weight per day. This allowed for measurement error introduced by differences in weighing scales and multiple personnel taking patients' weight across study sites. For this study term babies while detecting cases of dehydration were defined as those born after 34 weeks gestation.
- Any child given a fluid bolus at any point of hospital stay was considered dehydrated.

### 3.6 Sampling Method and Sample Size Determination

#### 3.6.1 Sample Size Determination

The minimum number of files reviewed was determined using a single population proportion formula by (Daniel, 1999) suing the following assumptions;

The prevalence of neonatal dehydration in Kenyan hospitals has not been documented in the past therefore a 50% estimate was used for sample size calculation.

$$N = \frac{Z^2 p(1-p)}{d^2}$$

**Where;** $\mathbf{Z^{2=}}$ Z statistic for the desired level of confidence of the prevalence estimates set at (95%) for this study.

**p=** Expected prevalence of neonatal dehydration

$\mathbf{d^{2=}}$ The precision of the estimate (margin of error) set at 5% for the prevalence estimate.

This was then adjusted by a design effect (DE) to account for the fact that prevalence of neonatal dehydration may differ from site to site and case notes of infants managed for neonatal dehydration in one CIN hospital may be more similar than those managed in the other CIN hospitals (cluster effect) leading to similar outcomes in a study site (Macfarlane, 1997). A design effect of 2 is adequate for most surveys. This was inflated further by 10% to account for missing and incomplete hospital records and the final figure divided by number of clusters to obtain the number of files to be reviewed per hospital. With regard to the above formula and all necessary adjustments, a sample size of 845 files was

considered sufficient for this study, 65 files were reviewed for each of the 13 hospitals.

### 3.6.2 Sampling Method

Stratified sampling was employed for this study with each of the 13 hospitals considered as separate strata. An equal number of medical files were then drawn from each hospital using simple random sampling technique to select inpatient numbers from an existing CIN database at the KEMRI Wellcome Trust headquarters. Differences in hospital admission rates (hospital size) was controlled for in analysis by inverse probability weighting to increase precision of estimates.

## 3.7 Study variables

Variables in this study included those for defining dehydration as per the study case definition, those that described the health condition of neonates upon discharge and predictor variables that were potential neonatal and maternal risk factors of dehydration (neonates' age, gestation, gender, delivery mode, maternal age, parity, breastfeeding anomalies and duration of labor). These variables were measured in one of the three different types (nominal, ordinal or continuous) as illustrated in **Table I**.

**Table I: Study variables and their measurements**

| Variable type | Measurement |
|---|---|
| Hospital ID(nominal) | This indicated the medical facility where the newborn whose medical record was included in the study was admitted. This was either of the 13 CIN hospitals; Mama Lucy, Mbagathi, Kitale, Kakamega, Kerugoya, Embu, Kiambu, Nyeri, Busia, Kisumu East, Machakos, Karatina and Vihiga hospitals. |
| **Neonatal, Maternal and Clinical characteristics** | |
| Age (continuous) | Captured in days |
| Gender (nominal) | Recorded as a binary variable; male or female |
| Gestation (continuous) | Captured in weeks |
| Birth weight (continuous) | Recorded in kilograms |
| Mode of delivery (nominal) | Captured in 3 levels either; spontaneous vaginal delivery, assisted vaginal or caesarean delivery |
| Time to first breastfeed after delivery (continuous) | Recorded in hours |
| Fever (nominal) | Recorded as a binary variable; Yes or No |
| Difficulty feeding | Captured as a binary variable; Yes or No |
| Difficulty breathing | Captured as a binary variable; Yes or No |
| Abnormalities affecting breastfeeding (nominal) | This was categorized into 6 levels; Ankyloglossia, Candidiasis, Respiratory Distress Syndrome, Others or None. |
| Maternal age (continuous) | Captured in years |
| Parity/live births (continuous ) | The absolute number was captured |
| Maternal conditions affecting breastfeeding (nominal) | Either of the following options was recorded; Breast/nipple pain, hypoplastic breast, mastitis, flat/inverted nipples, other or none |
| Duration of labor (continuous) | Captured in hours |
| **Information on outcomes of dehydration** | |
| Presence of discharge/death summary (nominal) | Either Yes or No was entered |
| Outcome at discharge (nominal) | This was captured in either of 7 levels; Alive, Dead, Renal replacement therapy, Neuro-disability, Gangrene, brain damage and other. |
| Discharge diagnosis (nominal) | This was left open ended, the different diagnosis recorded were coded during analysis. |

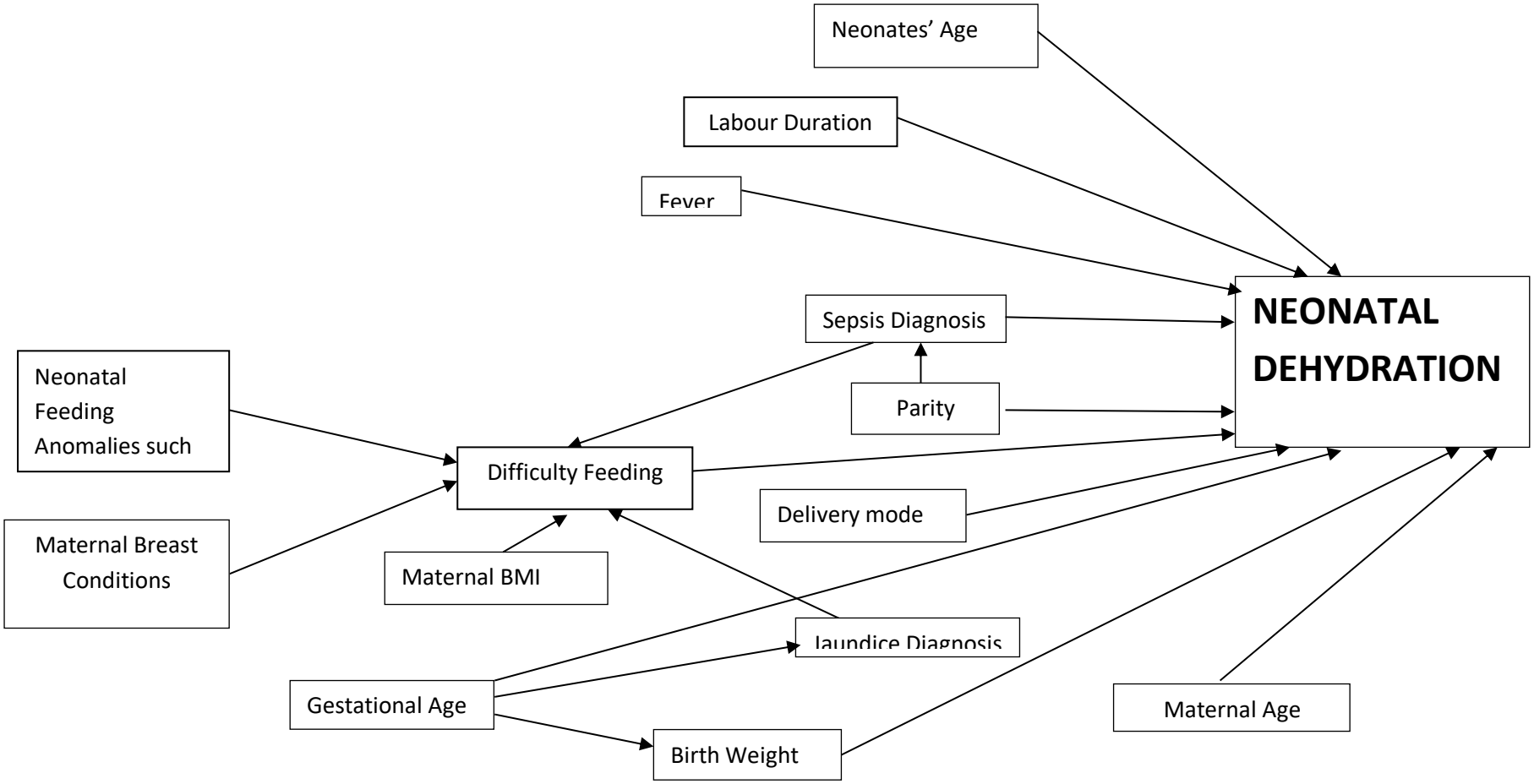


**Figure 2: Conceptual Framework-** Causal diagram for factors thought to influence occurrence of dehydration among newborns admitted to CIN hospitals**.**

### 3.8 Data Collection Procedure

Data clerks who had previous training and experience on data extraction from medical records (who also extract routine hospital data for the CIN database) assisted in collecting data for this survey. A detailed standard operating procedure (SOP) elaborating every field in the data collection tool was availed to guide the data entry process. This manual (SOP) contained all the variable names and a brief elaborate definition of the variable and alternative forms it may appear in the medical files to be reviewed. This was followed by a two-day pilot of the study tool where ambiguous fields were noted and additional medical language used by clinicians in reviewed files that the data clerks could not comprehend were added and explained in the SOP. The study tool and SOP were amended accordingly.

Inpatient numbers were sampled from the CIN database at the Kemri Wellcome Trust headquarters were sent to health records officers in respective hospitals to assist in retrieving the selected files. A survey tool developed in REDCap software (Research Electronic Data Capture) was deployed for online data entry from the study sites and data synchronized to a central server located at the Kemri Wellcome Trust daily. The retrieved files were then reviewed by the CIN data clerks and data entered to the online tool (Appendix A).

Errors in data entry were checked in real time by validation checks built into RED Cap. At the end of the data collection process, data from the 13 sites were further checked for potential additional errors at a central location using a script developed in R statistical software. Data clerks were asked to make any corrections by referring clerks back to the medical files.

### 3.9 Data Analysis

Data were first cleaned, and the degree of missing observations for each variable ascertained. Continuous variables were summarised using median and inter-quartile range while for discrete variables, proportions were computed.

The prevalence of neonatal dehydration and its associated 95% exact binomial confidence interval was estimated. Prevalence was determined by calculating the proportion of patients meeting the case definition of neonatal dehydration for the study. Each hospital specific prevalence obtained above was multiplied by the sampling weight of that hospital to obtain a weighted prevalence estimate. The overall pooled prevalence was also weighted and 95% confidence intervals calculated.

The outcomes of patients who met the case definition for dehydration for the study were determined by describing their health condition upon hospital discharge. Co-morbidities, history of illness, demographic characteristics and the clinical care they received were also described for these patients.

Risk factors for neonatal dehydration were identified using mixed effects logistic regression. The outcome variable was dehydration while explanatory variables were drawn from the study conceptual framework.

It was noted that some potential predictors had missing observations, for instance; sex had 1.4% of observations missing, age had 0.5%, delivery mode had 4.9%, parity had 40.6%, gestational age had 46% missing observations, maternal age had 48% while labour duration was most affected with 83% missing data. The mechanism of missing observations was examined to ascertain if data was missing at random, missing completely at random or missing not at random mechanisms. Thereafter, the above predictor variables imputed under the assumption that data was missing at random to

allow for complete case analysis (Madley-Dowd et al., 2019). However, duration of labour was excluded from imputation since it was missing by a huge extent. Imputation was carried out using the Multivariate imputation by Chained Equations (MICE) package in R software (Azur et al., 2011).

Considering that neonates from one facility were more likely to be similar compared to those from other health facilities, the variable 'hospital' was added as a random effect in risk factor analysis to account for clustering. Univariable analysis was first undertaken to determine the effect of each predictor on dehydration. This was based on the Wald test from the logistic regression and a liberal p- value cut off point of 0.25 (Hosmer, Lemeshow & Sturdivant, 2013). Variables with statistical significance in univariable analysis were entered into a multivariable model. Those with p value higher than the 0.25 cut off but were of known clinical importance to predispose newborns to dehydration were also included in the multivariable model. Variables were eliminated from multivariable analysis at $p>0.05$ only if their exclusion from the multivariable model did not result in more than 30% change in the effects of the remaining variables (Dohoo et al., 2012)

The Intra-class Correlation coefficient (ICC) which is the variation in outcome (dehydration) at the hospital level or correlation of newborns in a hospital in relation to dehydration was obtained by dividing the group variance by the total variance (Dohoo et al 2012). The group variance represented the variation in outcome (dehydration) between hospitals while the total variance was a sum of group variance and error variance.

### 3.10 Ethical Consideration

The KEMRI Wellcome Trust Health Service Unit has ethical approval to collect routine paediatric data from the CIN hospitals for purposes of audit and descriptive analysis (Appendix B). Informed consent was therefore not sought from care givers of the neonates whose files were reviewed. The hospital management in the respective hospitals were given full information on the scope of the survey and health records officers in respective hospitals assisted in retrieving the sampled medical files. The files from which data were abstracted were anonymized by issuing them with unique identifiers during data entry to ensure confidentiality.

### 3.11 Minimization of Errors and Bias

Data clerks who have previously been trained on data abstraction from clinical records assisted in collecting data for this survey. A standard operating procedure (SOP) was provided to guide the data entry process. A pre-test was conducted at one CIN hospital to check if questions in the data collection tools were non-ambiguous and non-repetitive. Inpatient numbers were selected randomly from CIN database to prevent selection bias.

### 3.12 Limitations of the study

Important maternal and hospital related risk factors for neonatal dehydration could not be collected due to the retrospective nature of this study. Selection of study hospitals was non- random therefore prevalence of dehydration may be limited to CIN hospital and not a countrywide estimate.

## CHAPTER FOUR: RESULTS

### 4.1 Study Population

A total of 846 medical files were randomly selected from pediatric wards in the 13 study sites. After excluding 36 files of well babies and children aged >28 days, 810 children were eligible for analysis. **Figure 3** illustrates the patient selection process.

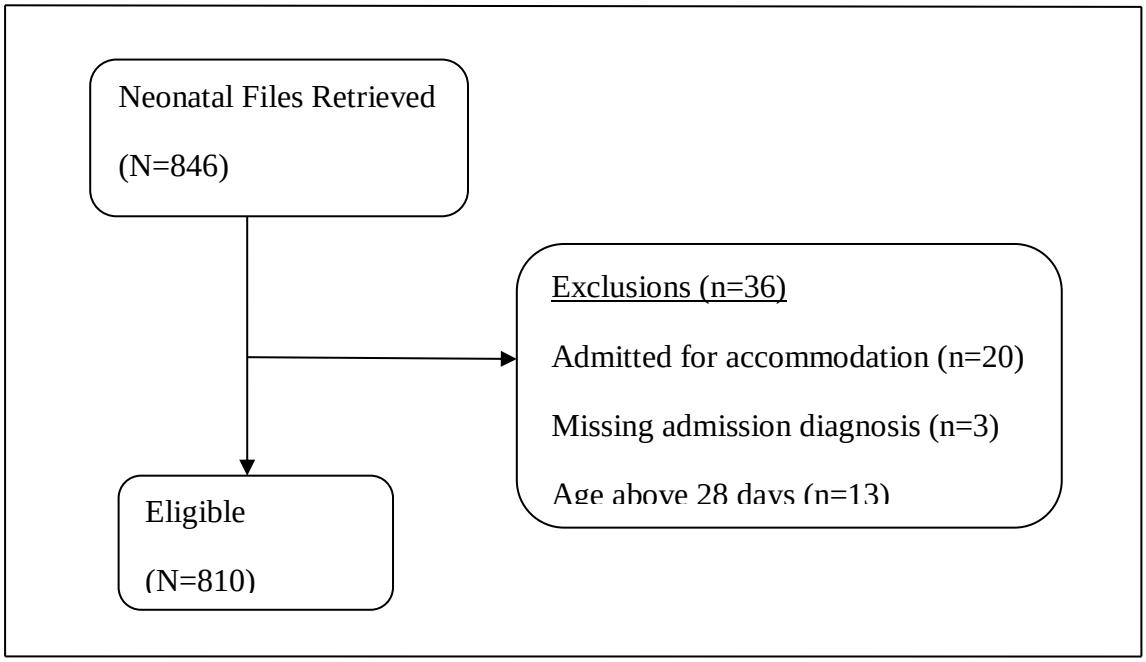


**Figure 3: Patient selection flow diagram**

### 4.2 Characteristics of study population

Majority of the newborns were in their first week of life-63% (508/806); and were mostly term deliveries with normal birth weight 78.6% (574/736). The median age was 5 days (IQR 2-12), median birth weight was 3 kg (range 1.0-4.8 kg) and median length of hospital stay was 5 days (IQR 2-7 days). The median weight at admission was 3kg (IQR 2.5-3.5).

Neonatal descriptive and clinical characteristics were fairly well documented but maternal characteristics that were potential risk factors for neonatal dehydration were

poorly documented. For example, maternal age, duration of labour, antenatal care visits and if a mother was taught how to breastfeed after delivery all had more than 40% missing observations. **Table II** provides a detailed description of the study population.

**Table II: Descriptive characteristics of newborns included in the study.**

| VARIABLE | Value | Frequency n (%) |
|---|---|---|
| **Neonatal Characteristics** | | |
| Age (days) | 0-7 | 508/806 (63%) |
| | 8-21 | 298/806 (37%) |
| Sex | Female | 395/799 (49.4%) |
| | Male | 404/799 (50.6%) |
| Gestation (Weeks) | <28 | 4/438 (0.9%) |
| | 28-34 | 58/438 (13.2%) |
| | 35-37 | 78/438 (17.8%) |
| | >37 | 298/438 (68%) |
| Birth weight (grams) | Extremely Low (<1000) | 0 |
| | Very Low (1000-1500) | 22/730 (3%) |
| | Low (1501g – 2500) | 134/730 (18.4%) |
| | Normal ( >2500) | 574/730 (78.6%) |
| Mode of delivery | Caesarean section | 186/770 (24.2%) |
| | Vaginal | 584/ 770 (75.8%) |
| Place of delivery | Health Facility | 429/488 (88.5%) |
| | Home / On the way to hospital | 56/488 (11.5%) |
| **Maternal Characteristics** | | |
| Labour duration (hours) | < 20 | 131/137 (95.6%) |
| | ≥ 20 | 6/137 (4.4%) |
| Maternal age (years) | <19 | 69/420 |
| | 19 -35 | 312/420 |
| | >35 | 39/420 |
| **Clinical Characteristics** | | |
| Apgar score | < 3 in 5 minutes | 4/307 (1.3%) |
| | ≥ 3 in 5 minutes | 303/307 (98.7%) |
| Feeding difficulty | Yes | 215/789 (27.2%) |
| Breathing difficulty | Yes | 166/785 (21.2%) |
| Fever | Yes | 352/789 (44.5%) |
| Vomitting | Yes | 47/492 (58.5%) |
| Diarrhoea | Yes | 32/789(4.1%) |
| Sepsis | Yes | 474/810 (58.5%) |
| Birth Asphyxia | Yes | 49/810 (6%) |
| Respiratory Distress Syndrome | Yes | 37/810 (4 5%) |
| Jaundice | Yes | 193/810 (23.5%) |
| Prematurity | Yes | 45/810 (5.6%) |

| | | |
|---|---|---|
| Pneumonia | Yes | 29/810 (3.6%) |

### 4.3 Prevalence of Neonatal Dehydration

A total of 132 study patients met the case definition for dehydration in this study, giving an estimated 1 year period (December 2015- November 2016) prevalence of 16.7% with an associated exact binomial CI ranging between 13.9 and 19.6%. Using individual elements of criteria for dehydration, most dehydrated neonates were identified by admission or discharge clinical diagnosis (84, 63.6%), followed by weight loss (53, 40.2%) while use of fluid bolus identified (17, 12.9%), abnormal electrolytes (5, 3.8%) and extra fluids identified only a few cases (2, 1.5%). The prevalence of neonatal dehydration also varied across study sites, with a range of 7.8% and 26.6%, as shown in **Table III.**

Results of laboratory tests for dehydration were unavailable in most of the medical files reviewed (n=810); for example 89(10.9%) had a urea test ordered but only 37/89(41.6%) newborns had urea results available, 75 (9.1%) of the study population had serum sodium test ordered but results were available in 17(2.1%) newborns. Of the newborns with urea results available, 16/37(43.2%) had urea results above 10umol/l while 5(29.4%) of available serum sodium results were above 150 mmol/L. Creatinine was ordered in 82/810 (10%) patients and 15/37(40.5%) of available results were above 80µmol/l after the second day of life.

**Table III: Admissions meeting dehydration definition for the study across study sites**

| Study Site (Hospital) | Number of admissions | Number of files analysed | Number with dehydration | Prevalence of dehydration (unweighted) | Prevalence of dehydration (weighted) |
|---|---|---|---|---|---|
| Busia | 549 | 64 | 11 | 17.2[8.9,28.7] | 17.2[8.4,26] |
| Embu | 978 | 61 | 11 | 18[9.4,30] | 18[8.6,27.5] |
| Kakamega | 1024 | 55 | 6 | 10.9[4.1,22.2] | 10.9[2.8,19] |
| Karatina | 266 | 65 | 12 | 18.5[9.9,30] | 18.4[10.2,26.7] |
| Kerugoya | 1006 | 64 | 17 | 26.6[16.2,39.1] | 26.6[17,37.1] |
| Kiambu | 1701 | 65 | 10 | 15.4[7.6,26.5] | 15.4[6.7,24] |
| Kisumu East | 423 | 64 | 5 | 7.8[2,17.3] | 7.8[1.6,14] |
| Kitale | 1799 | 65 | 13 | 20[11.1,31.8] | 20[10.4,30] |
| Machakos | 1183 | 65 | 14 | 21.5[12.3,33.5] | 21.5[11.7,31.3] |
| Mama Lucy Kibaki | 980 | 62 | 11 | 17.8[9.2,29.5] | 17.7[8.4,27] |
| Mbagathi | 1049 | 63 | 6 | 9.5[3.6,19.6] | 9.5[2.4,16.6] |
| Nyeri | 1125 | 55 | 7 | 12.7[5.3,24.5] | 12.7[4,21.4] |
| Vihiga | 86 | 62 | 9 | 14.5[6.9,25.8] | 14.5[9.8,19.2] |
| **Overall** | **12169** | **810** | **132** | **16.3[13.8,19]** | **16.7[13.9,19.6]** |

In these set of case patients (n=132), dehydration often occurred alongside other diagnoses. The most common overlaps were between dehydration and sepsis in 87(65.9%) newborns, followed by jaundice in 35(26.5%) and pneumonia in 3(2.3%) of the newborns with dehydration. Patients with more than two diagnoses were also observed.

### 4.4 Outcomes of Neonatal Dehydration

The major adverse outcomes experienced by dehydrated neonates (n=132) in this study were; renal failure in 4(3%), neuro-disability/sequelae in 1 (0.8%) and 8(6%) of these case patients died. Other outcomes documented included; referrals for further management 8(6%), 2(1.5%) absconded their hospital stay and 97 (73.5%) in good clinical condition upon discharge

Of the patients who did not have dehydration (n=678), 35 (5.2%) died, 4(0.6%) had neuro-disability, and 2(0.3%) had renal failure.

All four cases of dehydration who experienced renal failure were in their second week of life, all had urea results documented with values above 10mmol/l, median volume 47.54mmol/l, maximum value 112.2mmol/l.

Among the dehydrated children who experienced mortality (n=8), 7(87.5%) were in their first week of life and had birth weight greater than 2.5 kilograms. A similar proportion of male and female non survivors was observed (4, 50%), a majority of these neonates 5(62.5%) had extreme weight loss, all greater than 15% of their birth weight with a median weight loss was 16% (range 0-37.8%). It was also noted that all 8 newborns did not have any urea, creatinine or serum sodium laboratory test results for dehydration documented.

### 4.5 Risk Factors for Neonatal Dehydration

A total of 132 newborns met the dehydration definition for this study. Anatomical abnormalities that could have potentially affected breastfeeding were observed in one case who had cleft palate 2 mothers who had flat/inverted nipples and one other had nipple pain. **Table IV** outlines the characteristics of participants with dehydration alongside those without dehydration.

**Table IV: Descriptive statistics of cases and non-cases of dehydration**

| Variable | Value | Cases (n=132) | Non cases (n=678) |
|---|---|---|---|
| **Sex** | Female | 68/130(51.5%) | 333/677(49.2%) |
| | Male | 62/130(47.7%) | 344/677(51.8%) |
| **Gestation (Weeks)** | < 37 | 2/68(2.9%) | 60/370(16.2%) |
| | ≥ 37 | 66/68(97.1%) | 310/370(83.8%) |
| **Age (Days)** | 0-7 | 99/132(75%) | 409/674(60.7%) |
| | 8-28 | 33/132(25%) | 265/674(39.3%) |
| **Birth weight** | < 2.5 kg | 14/128(10.9%) | 106/610(17.4%) |
| | ≥ 2.5kg | 114/128(89.1%) | 504/610(82.6%) |
| **Delivery mode** | Vaginal | 93/124(75%) | 491/646(76.9%) |
| | Caesarean | 31/124(25%) | 155/646(24.1%) |
| **Duration of labor (Hours)** | < 14 | 20/23(83.3%) | 97/114(85.1%) |
| | ≥ 14 | 3/23(16.7%) | 17/114(14.9%) |
| **Maternal Age (Years)** | <20 | 12/69(17.4%) | 57/351(16.2%) |
| | 20-35 | 52/69(75.3%) | 260/351(74.1%) |
| | >35 | 5/69(7.2%) | 34/451(9.7%) |
| **Parity** | Primiparous | 47/80(58.8%) | 190/401(47.4%) |
| | Multiparous | 33/80(41.2%) | 211/401(52.6%) |
| **Feeding difficulty** | Yes | 58/128(45.3%) | 157/661(23.5%) |
| | No | 70/128(54.7%) | 504/661(76.5%) |
| **Breathing Difficulty** | Yes | 11/130(8.3%) | 155/655(23.7%) |
| | No | 119/130(91.7%) | 505/655(76.3%) |
| **Fever** | Yes | 67/130(51.5%) | 285/659(43.2%) |

| | | | |
|---|---|---|---|
| | No | 63/130(48.5%) | 374/659(56.7%) |
| **Sepsis** | Yes | 87/132(65.9%) | 387/678(57.1%) |
| | No | 45/132(34.1%) | 291/678(42.9%) |
| **Jaundice** | Yes | 35/132(26.5%) | 158/678(23.3%) |
| | No | 97/132(73.4%) | 520/678(76.7%) |

Predictor variables with missing data were imputed under the assumption that data was missing at random. However, labor duration was a potential explanatory variable but was excluded from analysis due to great extent of missing data (83%). A random effects model with hospital but no predictors was then fitted to explore whether dehydration was associated with hospital identity. This model revealed that there was minimal variation in outcome (dehydration) across hospitals with an intra-class correlation coefficient (ICC) of 1.7%. Univariable analysis with hospital retained as a random effect revealed that preterm birth, neonatal age and parity were significantly associated with neonatal dehydration at 25% level of significance (**Table V**).

The odds of a newborn being admitted to hospital for dehydration was reduced by half in neonates above one week of age, compared to babies in their first week of life ( Odds Ratio (OR) 0.51, 95%CI [0.33-0.78], p 0.02). Preterm births were 1.6 times more likely to be admitted to CIN hospitals for dehydration compared to term babies (OR 1.59, 95% CI [0.85-2.9], p 0.15). Finally, the odds of a baby born of a primiparous mother being admitted for dehydration were 1.5 times higher than those born of multiparous mothers (OR 1.54, 95% CI [0.97-2.42], p 0.06).

**Table V: Univariable analysis of risk factors for neonatal dehydration among newborns admitted to paediatric wards by use of mixed effects logistic regression model with variable *hospital* included as a random effect.**

| VARIABLE | Values | Odds Ratio | 95% CI | | LRT p value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Age (days)[m] | 0-7 | 1.0 | | - | |
| | 7-28 | 0.51 | 0.33 | - 0.78 | 0.002 |
| Gestation (weeks)[n] | <37 | 1.59 | 0.85 | - 2.98 | |
| | >37 | 1.0 | | - | 0.15 |
| Parity [o] | Primiparous | 1.54 | 0.97 | - 2.42 | 0.06 |
| | Multiparous | 1.0 | | - | |
| Delivery mode[p] | Vaginal | 0.93 | 0.6 | - 1.46 | 0.44 |
| | Caesarean | 1.0 | | - | |
| Maternal age (Years) | <20 | 1.0 | | | |
| | 20-35 | 0.78 | 0.31 | - 1.98 | 0.6 |
| | >35 | 0.99 | 0.59 | - 1.65 | 0.97 |

**Variables [m, n, o, p] for inclusion in multivariable analysis.**

Predictors with a two-sided p-value <0.25 (gestation and parity) and those thought to contribute to dehydration by clinical plausibility ( delivery mode ) were entered into a multivariable mixed effects logistic regression model to determine maternal, neonatal and clinical factors significant factors significantly associated with dehydration. Maternal age was excluded from multivariable analysis (p > 25%).

In the multivariable model (**Table VI**), being of age less than one week and being delivered by a primiparous mother were important risk factors of neonatal dehydration.

**Table VI: Multivariable analysis of risk factors for neonatal dehydration among newborns admitted in paediatric wards of CIN hospitals with hospital added as a random effect**

| VARIABLE | Values | Odds Ratio | 95% CI Lower | 95% CI Upper | LRT p value |
|---|---|---|---|---|---|
| Age (days) | 0-7 | 1.0 | - | | |
| | 7-28 | 0.5 | 0.31 | 0.75 | 0.001 |
| Gestation (weeks) | <37 | 1.66 | 0.88 | 3.1 | |
| | >37 | 1.0 | - | | 0.15 |
| Parity | Primiparous | 1.61 | 1.01 | 2.5 | 0.049 |
| | Multiparous | 1.0 | - | | |
| Delivery mode | Vaginal | 1.08 | 0.68 | 1.73 | 0.75 |
| | Caesarean | 1.0 | - | | |

From multivariable analysis, newborns above one week of age had 0.5 lower odds of being rehospitalised for dehydration compared to in their first week of life, (OR 0.5, 95% CI[0.31- 0.75]) controlling for birth order, gestational age, and mode of delivery.

The odds of a first born baby being admitted for dehydration was 1.6 times higher than that of a baby of a higher birth order controlling for age of the neonate, gestational age, and mode of delivery (OR 1.61, 95% CI [1.01 – 2.5]).

# CHAPTER FIVE: DISCUSSION

## 5.0 Introduction

This study sought to determine the prevalence of neonatal dehydration, describe the outcome in neonates with dehydration and to determine risk factors of neonatal dehydration using routine hospital data of newborns admitted in paediatric wards of CIN hospitals within a one-year period. In this chapter, interpretation of study findings in relation to objectives are provided. Comparisons of results with other studies by authors with similar objectives is done to understand where this study lies in the scientific landscape.

## 5.1 Prevalence of Neonatal Dehydration

A reasonably high burden of neonatal dehydration has been reported in high income countries (Pelleboer et al., 2009; Escobar et al., 2002; Lee et al., 1995). This study confirms that the situation is no different in developing nations. In the United States, an incidence of 2.1 per 1000 live births has been reported (Escobar et al., 2002), in the Netherlands, an incidence of 58/year/100,000 breastfed infants was found (Pelleboer et al., 2009), most recently, a study in India documented the incidence rate of neonatal dehydration to be 6.45% (Shah & Bakul., 2018). The prevalence of dehydration was found to be 16.3% (95% exact binomial CI [13.8, 19]). A previous study on general neonatal illnesses in Kenya found that dehydration accounted for 14% of neonatal admissions to paediatric wards (Simiyu, 2003), this proportion falls within the range that we found in our study.

The criteria chosen to identify dehydration did not skew the results since individual elements have been used in various studies, which include weight loss above expected normal (Oddie et al., 2013; Livingstone et al., 2000). In our study population, none of

the children with extreme weight loss had dehydration documented as a diagnosis suspected at admission or discharge indicating possible under-diagnosis. Criterion used to diagnose dehydration was unclear from review of medical notes, this may be because dehydration in the newborn period is difficult to recognize clinically (Laing et al., 2002). Laboratory results for dehydration tests were rarely available despite being ordered in the files reviewed. This study consistently with work from other authors ( Pelleboer et al., 2009; Uras et al., 2007; Moritz et al., 2005), has revealed that laboratory evaluation is not routinely performed in health care settings and this may have also underestimated the prevalence of hypernatremia and neonatal dehydration**.**

Other conditions were observed to occur alongside dehydration in our study patients. Dehydration was observed to mostly overlap with sepsis, pneumonia and jaundice. Other authors have also noted this overlap for instance, Escobar et al (2002) found sepsis and meningitis amongst dehydrated neonates. In this study sepsis and jaundice were the most occurring conditions amongst children with dehydration. Moritz et al (2005) in a study carried out in Pittsburgh USA found that a quarter of the dehydration cases in their study also had jaundice. Jaundice has been shown to be a common feature in neonatal dehydration, (Yaseen et al., 2004; Geiger, Petitti and Yao, 2001), and has frequently been reported to be a sign of insufficient lactation. In another recent study in India, 14.2% of dehydrated newborns in the study had confirmed sepsis. These co-morbidities in our study patients could have potentially led to high rates of water loss predisposing newborns to dehydration.

### 5.2 Outcomes of Dehydration

A relatively low proportion of newborns experienced undesirable outcomes of dehydration upon discharge, a majority (97/132, 73.5%) were in good health. Other authors have also reported high proportions of healthy patients upon discharge with

dehydration. In a retrospective case control study by Escobar et al (2002) in the US, none of the 110 dehydrated participants developed severe consequences of dehydration. This was thought to be due to prompt hospitalization of the studied neonates. Early detection and critical care in management of dehydration is essential for good outcome and failure to diagnose dehydration can have serious consequences (Moritz et al., 2005). In a study carried out in Turkey, only 4 of 158 newborns (2.5%) readmitted with dehydration experienced undesirable outcomes which were signs of shock and seizures (Pelleboer et al., 2009). In a recent study in India (Shah & Bakul, 2018), of 28 patients who had been admitted with dehydration, the proportion of patients who experienced mortality was 7.14%, which is close to what was observed in this study, where 8/132 (6%) of the dehydrated newborns died. It was also reported that of the newborns who experienced mortality in the India study, one death was attributed to renal failure. Renal failure occurred in 4/132(3%) of the newborns in this study. The cause of acute kidney injury (AKI) is multifactorial, birth asphyxia and sepsis are the most associated conditions, however dehydration has also been shown to contribute to development of AKI in newborns who experience weight loss and hypernatremia are at risk if their condition is not recognized and treated early (Livingstone et al., 2000). Neonatal dehydration has also been reported to contribute to neurological sequelae (Koklu et al., 2007), only one child (0.8% of the dehydrated newborns) experienced this in our study.

### 5.3 Risk factors for Dehydration

This study revealed that age of a neonate and parity (borderline significance) are important predictors of neonatal dehydration. Primiparity has consistently been suggested to contribute to dehydration (Caglar et al., 2006; Dewey et al., 2003; Escobar et al., 2002; Livingstone et al., 2000) in babies delivered vaginally who constituted a high proportion of study cases 94/126 (74.6%).First born babies were 1.6 times more

likely to be readmitted for dehydration in CIN hospitals (OR 1.6, 95% CI [1.05- 2.5) controlling for gestation, delivery mode and the newborns' age. The fact that first-time mothers lack breastfeeding experience and therefore require more reassurance and practical advice in the technique of breast-feeding (Laing & Wong, 2002) could explain the significance. Also, primiparous mothers have been thought to produce significantly less milk than multiparous women during the first postpartum week Moritz & Ayus, 2002). A study in the USA similarly found parity to be a significant predictor of neonatal dehydration (Escobar et al., 2002). It reported that neonates born of a first-time mothers 5.5 times higher odds of being admitted for dehydration compared to those born of multiparous mothers. In Turkey, primiparity was also found to be a significant risk factor (LRT p value <0.05) for severe weight loss and hypernatremia (Caglar et al., 2005).

The odds of a newborn above one week of age being admitted for dehydration was halved compared to children in their first week of life. However, other authors have found the age of a newborn to be insignificant in predicting dehydration (Boskabadi et al., 2010). Livingstone et al. (2000) found the mean age at which newborns presented to hospital for dehydration to be 8 days (range 3-14 days) while a study in Kenya (Simiyu 2003) showed that the mean age that neonates generally present for admission to be 9 days (range 4-25). Our study showed that ill newborns admitted in hospital are mostly in their first week of life (75%) and this may explain why early neonatal period was a significant predictor of dehydration in our data.

Caesarean delivery has also been shown to lead to delayed onset of lactation (Dewey et al., 2003), and a leading cause of dehydration from insufficient breastfeeding(Marinelli et al., 2016) . However, mode of delivery was not a significant risk factor for dehydration in this study. Caglar et al (2005) similarly did not find route of delivery to

be a significant factor in predicting neonatal dehydration. Dehydration in caesarean births mainly arises when there are delays to first breastfeeds after birth (Caglar et al., 2006). Also, a study on sick hospitalized newborns in Kenya (Simiyu 2003) pointed out that only 4% of the infants in the study were delivered through caesarean section. In our study CS was also not a common method of delivery as only a quarter of the dehydrated neonates in CIN hospitals were caesarean deliveries, this may have contributed to the lack of statistical significance.

Gestational age was not statistically significant in predicting dehydration in the multivariable model (p=0.11). Preterm babies are unable to suck adequately (Laing & Wong, 2002) and this low intake may predispose them to dehydration. Gabriel et al. (2002) also found gestational age (<39 weeks) to be a significant predictor of dehydration, with preterm births having twice the odds of being readmitted for dehydration compared to term babies. However Koklu et al (2007) did not find a significant difference between dehydration cases and controls in a study in Turkey. The lack of significance in our study could be because preterm births are given special care in Kenyan hospitals and have fluid and feed requirements that were adhered to preventing dehydration, mothers may have been more cautious at home regarding preterm babies fluid requirements.

Findings from this study should be interpreted with caution, data are from routine hospital work and local studies have shown that documentation of patient signs and treatment given to sick newborns is wanting (Aluvaala et al., 2015). For this reason missing data was common in the files reviewed. Poor documentation may have also underestimated prevalence that this study has reported. Dehydration is an acute illness and incidence rate may have been a better measure of dehydration burden. However, due to the retrospective nature of this study and absence of a database or demographic

health surveillance system for all births that would yield the population at risk (denominator) that would allow estimation of incidence rate, and the fact that the setting of this study is a developing health information system (non-electronic), the prevalence of dehydration was the most plausible measure of dehydration frequency. Like all other retrospective studies this study was unable to collect data on important variables that are related to dehydration for instance time that had elapsed from birth to first breastfeed especially to babies who presented in hospital completely unable to feed and on breastfeeding support services given to mothers after delivery.

It is important to point out that this study has revealed that dehydration is of moderate prevalence in Kenyan hospitals and contributes to neonatal morbidity and mortality. It is worth noting that extreme weight loss that has been shown to potentially lead to hypernatremia but is missed by clinicians in routine settings. Serum sodium and renal function tests are ordered but results are rarely available to confirm dehydration. It is not clear from medical records if these tests are available within laboratories of respective hospital at an affordable rate or if missing results are due to poor documentation of medical data in Kenyan hospitals but the former is more likely (Ayieko et al., 2016). This study shows that there is need to screen neonates presenting in the first week of life and those born of primiparous mothers for early rehydration and therefore preventing adverse outcomes of dehydration.

# CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

This chapter outlines the major findings of this study, provides recommendations for mitigating dehydration and highlights areas for further studies in neonatal dehydration.

## 6.1 Conclusion

Findings from this study have revealed that neonatal dehydration is a moderately common cause of hospital admission in Kenya with a 1 year period prevalence of 16.3% (95% exact binomial CI [13.8%-19%]). The prevalence significantly varied across hospitals with a range of 7.8% -26.6%.

Using individual case definition elements, the highest proportion of dehydrated cases was identified using the discharge/admission diagnosis (63.6%) followed by weight loss (40.2%) definitions for dehydration. Serum sodium and kidney function laboratory test results for dehydration were rarely available in this set of study patients. Criterion used to diagnose dehydration was unclear from review of medical notes. A relatively low proportion of dehydration cases experienced adverse outcomes upon discharge. The main adverse outcomes were in-hospital death, acute kidney injury/renal failure and neurodisability. A neonates' age and birth order were identified as significant predictors for neonatal dehydration among newborns admitted to CIN hospitals.

## 6.2 Recommendations

Considering the findings and conclusion of the study, the following recommendations were made:

1. Guidance for diagnosing dehydration that includes weight loss determination and laboratory examination should be included in the national paediatric guidelines.
2. Lactation support including practical training on proper breastfeeding techniques should be provided especially to first time mothers and more attention should be accorded to babies in their first week of life to ensure they receive sufficient feeds within this critical period.
3. A study reviewing detailed medical records with improved documentation is needed. This study with key variables documented would highlight other risk factors not included in this study that should be addressed in order to mitigate fatality from neonatal dehydration. Important variables not assessed in this study include; lactation training for mothers, provision of alternative feeds in failed lactation, duration of hospital stay after delivery, duration of labor, maternal BMI, maternal breast problems among others.

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## APPENDICES

## APPENDIX A: PLAGIARISM REPORT

**Turnitin *Originality Report***

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**PREVALENCE, RISK FACTORS AND OUTCOMES OF NEON... *By Beatrice Rotich***

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Pamela J. Mulder, Teresa S. Johnson, Linda C. Baker. "Excessive Weight Loss in Breastfed Infants During the Postpartum Hospitalization", Journal of Obstetric, Gynecologic & Neonatal Nursing, 2010

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# APPENDIX B: QUESTIONNAIRE

## Biodata

Unique ID
_____
(Use format [hosp id][record id] - eg.5100001 for Kiambu record 00001)

Hospital ID
◯ Kiambu
◯ Machakos
◯ Mama Lucy
◯ Mbagathi
◯ Kerugoya
◯ Karatina
◯ Nyeri
◯ Kisumu East
◯ Kakamega
◯ Vihiga
◯ Busia
◯ Kitale
◯ Embu

Patients IPNO
_____
((input -1 for empty))

Document Source
◯ NAR ◯ Free Text ◯ PAR

Date of birth
_____
((for empty date type 1914-01-01)))

Admission Date and Time
_____
((for empty date type 1914-01-01))

Date of discharge/death
_____
((for empty date type 1914-01-01)))

Age documented?
◯ Yes ◯ No

Age(Days)
_____
((input -1 for empty))

Gender
◯ Male ◯ Female ◯ Empty

Referred to hospital?
◯ Yes ◯ No ◯ Empty

Re-admission to this hospital?
◯ Yes ◯ No ◯ Empty

# Baby's History

## 2. Baby's History (Obtain from clinicians admission notes only)

Gestation at birth (weeks)
_____
(No.of weeks ( enter -1 if not recorded))

Birth weight
_____
(in Kgs(Enter-1 if unrecorded))

Weight at admission
_____
(Kgs ( enter -1 if not recorded))

Baby's place of delivery documented
◯ Yes No

Born in this health facility
◯ Yes No

Born on the way to hospital
◯ Yes No Empty

Born where?
◯ Home ◯ Other health Facility
◯ Empty

Mode of delivery
◯ Spontaneous vaginal (SVD)
◯ Assisted vaginal (Includes Forceps,Vacuum)
◯ Breech
◯ Caesarean section (C/S)
◯ Empty

Indication for Caesarean section
◯ Emergency (EM/CS)
◯ Elective
◯ Specific reason for C/S documented
◯ Empty

Time to first breastfeed after birth documented?
◯ Yes ◯ No

Time to first breastfeed after birth
_____

Feeding practice employed before illness documented
◯ Yes ◯ No

Feeding practice employed
☐ Breast milk
☐ Formula
☐ Cow milk
☐ Water
☐ Other

Other feeding practice
_____

Time baby seen documented
◯ Yes ◯ No

Time baby seen
_____

Length of illness(days)
_____
((duration for longest presenting complaint,indicate -1 if unrecorded)))

Fever
◯ Yes ◯ No ◯ Empty

Fever Duration
_____
((indicate in days))

| | |
|---|---|
| Difficulty breathing (DIB) | ◯ Yes ◯ No ◯ Empty |
| Diarrhoea | ◯ Yes ◯ No ◯ Empty |
| Diarrhoea bloody | ◯ Yes ◯ No ◯ Empty |
| Diarrhoea duration | _____ ((indicate in days,enter -1 if empty)) |
| Vomiting | ◯ Yes ◯ No ◯ Empty |
| Difficulty feeding/breastfeeding | ◯ Yes ◯ No ◯ Empty |
| Abnormalities affecting breastfeeding documented | ◯ Yes ◯ No |
| Abnormalities affecting breastfeeding | ◯ Cleft palate<br>◯ Ankyloglossia(tongue tie)<br>◯ Hypotonia<br>◯ Candidiasis<br>◯ Tracheo-oesophageal fistula<br>◯ Respiratory distress syndrome<br>◯ Others |
| History of reduced passage of urine/dry nappies | ◯ Yes ◯ No |
| Convulsions | ◯ Yes ◯ No ◯ Empty |
| Apnoea | ◯ Yes ◯ No ◯ Empty |
| Is there documentation of drugs given to infant before this admission? | ◯ Yes ◯ No |
| Infant drugs | _____ ( For value lookup, Lookup List) |

# Maternal History

## Maternal History (Check the whole of the baby's file for this information)

Mother's age
_____
(( enter -1 if not recorded))

Antenatal visits documented(ANC/ANP)
◯ Yes ◯ No

Number of documented ANC visits
◯ 1
◯ 2
◯ 3
◯ 4
◯ Empty

Gravidity (Number of Pregnancies)
_____
(( enter -1 if not recorded))

Parity live birth(s)
_____
(( enter -1 if not recorded))

Maternal HIV
◯ Positive
◯ Negative
◯ Empty

Maternal Antiretroviral Therapy(ARV/ART/HAART)
◯ Yes ◯ No ◯ Empty

Baby given Antiretroviral Therapy(ARV/ART/HAART)
◯ Yes ◯ No ◯ Empty

Maternal VDRL
◯ Positive ◯ Negative
◯ Empty

Maternal ABO blood group
◯ A
◯ B
◯ O
◯ AB
◯ Empty

Maternal rhesus blood group
◯ Rhesus Negative ◯ Rhesus Positive
◯ Empty

Last normal menstrual period
(LMP)
_____
((for empty date enter 1914-01-01))

Expected date of delivery
(EDD)
_____
((for empty date 1914-01-01)))

Prolonged Rupture of membranes(PROM)
◯ Yes ◯ No ◯ Empty

Maternal conditions affecting breastfeeding
☐ Breast/nipple pain
☐ Hypoplastic breast
☐ Flat/inverted nipples
☐ Mastitis
☐ Breast engorgment

Other maternal conditions

- ☐ Fever/Infection/Chorioamnionitis
- ☐ Diabetes
- ☐ Hypertension (includes Eclampsia,Pre-eclampsia)
- ☐ APH
- ☐ TB treat
- ☐ Obstructed labour
- ☐ Others

Other maternal conditions not listed above

_____

(Check all that apply)

Is there documentation of drugs given to mother? ◯ Yes ◯ No

Maternal drugs?

_____

( Click here for, Lookup List )

Duration of labour (hrs)

_____

(hours( enter -1 if not recorded))

Induction/ Augmented ◯ Yes ◯ No ◯ Empty

Was mother taught how to breastfeed after delivery? ◯ Yes ◯ No ◯ Empty

# Examination

## Vital signs(Check through the entire file for this information)

Temperature(degrees Celsius)
_____
(in degrees celsius to one decimal place (enter -1 if empty))

Respiratory rate- RR (per minute)
_____
((input -1 for empty))

Oxygen saturation measured
◯ Yes ◯ No

Oxygen saturation
_____
(input -1 for empty)

Enter pulse value/Heart rate/HR(per minute)
_____
(indicate per min(input -1 for empty))

## Airway and Breathing

Stridor
◯ Yes ◯ No ◯ Empty

Acidotic breathing
◯ Yes ◯ No ◯ Empty

Cry
◯ Normal ◯ Weak ◯ Hoarse
◯ Empty

Central cyanosis
◯ Yes
◯ No
◯ Not specified
◯ Empty

Indrawing
◯ none/mild ◯ severe
◯ sternum ◯ Empty

Grunting
◯ Yes ◯ No ◯ Empty

Air entry bilateral
◯ Yes ◯ No ◯ Empty

Crackles/Crepitations
◯ Yes ◯ No ◯ Empty

## Circulation

Femoral pulse
◯ Normal ◯ Weak ◯ Empty

Capillary Refill Time (CRT)
◯ X-indeterminate
◯ 2 seconds
◯ 3 seconds
◯ More than 3 secs
◯ Empty

Murmur ◯ Yes ◯ No ◯ Empty

Pallor/Anaemia
◯ none
◯ +(mild/moderate)
◯ +++(Severe)
◯ Not classified
◯ Empty

Skin cold ◯ Hand ◯ Elbow ◯ Shoulder
◯ Empty

## Disability

Can suck/breastfeed? ◯ Yes ◯ No ◯ Empty

Disability (AVPU) ◯ Alert ◯ Verbal response
◯ Pain response ◯ Unresponsive
◯ Other scale ◯ Empty

Bulging fontanelle ◯ Yes ◯ No/flat ◯ Empty

Irritable ◯ Yes ◯ No ◯ Empty

Reduced movement/floppy ◯ Yes ◯ No ◯ Empty

Umbilicus
◯ Clean
◯ Local pus
◯ Pus+red skin
◯ Empty
◯ Other

## General Examination

Skin ◯ Bruising ◯ Rash ◯ Pustules
◯ None ◯ Empty

Jaundice(Yellowness of eyes)
◯ none(0)
◯ +(mild/moderate)
◯ +++(severe)
◯ Not classified
◯ Empty

Gest/Size ◯ Normal ◯ Prem ◯ SGA/wasted
◯ Empty

Abnormalities
☐ Skull
☐ Limbs / Spine
☐ Palate / Face
☐ Genitals / anus
☐ Dysmorphic
☐ None
☐ Empty
(check all that apply)

Thrush ◯ Yes No Empty

Floppy/Inability to suck ◯ Yes No Empty

| | | | |
|---|---|---|---|
| Severe skin pustules | ◯ Yes | No | Empty |
| Femoral pulse | ◯ Yes | No | Empty |
| Severe (Lower) Chest Wall Indrawing | ◯ Yes | No | Empty |

Skin pinch(sec)

◯ Immediate (0)
◯ 1-2 secs
◯ >2 secs
◯ Empty

# Investigations

## 5.Investigations

Haemoglobin (Hb) test ordered at admission ◯ Yes No Empty

Hb results available ◯ Yes No Empty

Hb results _____
(( enter -1 if not recorded))

Type of Hb test ◯ Hb ◯ Hct ◯ Haemogram

Units for Hb results ◯ mg/dl ◯ g/l ◯ % of Hct ◯ Empty

Glucose(RBS)ordered at admission ◯ Yes ◯ No ◯ Empty

Type of glucose test requested ◯ Stick (strip) test ◯ Laboratory ◯ Empty

Glucose results _____
((input -1 for empty))

Glucose test results units ◯ mg/dl ◯ mmol/L ◯ Empty

Bilirubin test ordered ◯ Yes ◯ No ◯ Empty

Bilirubin test results _____
(in micromol/L(input -1 for empty))

Lumber puncture(LP) test ordered ◯ Yes ◯ No ◯ Empty

LP results
◯ dry tap
◯ under pressure
◯ turbid
◯ bloody
◯ clear
◯ Empty

Blood culture ordered ◯ Yes ◯ No ◯ Empty

Chemistry ordered ◯ Yes ◯ No

Chemistry
☐ Na+ K
☐ Urea
☐ Creat
☐ LFTs
☐ Others
☐ Empty

Na+ K results _____

Creat results _____

Urea results _____

Other investigations done

# Babys Admission Diagnoses

Clear primary admission diagnosis? ◯ Yes ◯ No ◯ Empty

Primary admission diagnosis _____
( For value lookup, Lookup List)

Admission diagnosis 1 _____
( For value lookup, Lookup List)

Admission diagnosis 2 _____
( For value lookup, Lookup List)

Admission diagnosis 3 _____
( For value lookup, Lookup List)

Other admission diagnoses ◯ Yes ◯ No

Other admission diagnosis 1 _____
( For value lookup, Lookup List)

Other admission diagnosis 2 _____
( For value lookup, Lookup List)

Other admission diagnosis not listed ◯ Yes ◯ No

Admission diagnoses not listed _____

# Babys Daily Case Notes

## 7. Daily Case Notes (Check all clinicians notes after admission i.e continuation sheets)

Date of first review after admission

_____
(if empty enter 1914-01-01))

Time to first clinicians review after admission?

- ◯ 0-6 hours
- ◯ >6-12 hours
- ◯ >12-24hrs
- ◯ >24 hours
- ◯ Cant determine from notes

Was child seen by clinician in the last seven days prior to discharge/death?

◯ Yes No

Was the child seen by a clinician in the last 24 hours prior to discharge/death?

◯ Yes No

Number of documented clinician reviews

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10
- ◯ >10

# Drug Treatment

## 8. DRUG TREATMENT (Use data from treatment sheet only and consider only admission treatment)

Is there a treatment sheet in the file? ◯ Yes ◯ No
(CHECK AND ASCERTAIN BEFORE YOU SELECT "NO")

## 8.1 ANTIBIOTICS

1. Benzyl/Crystalline Penicillin(Xpen) prescribed ◯ Yes ◯ No

Date prescribed _____
(if unrecorded enter 1914-01-01))

Route ◯ I.M ◯ I.V ◯ Empty

Dose _____
(amount prescribed per dose ( enter -1 if not recorded))

Units ◯ IU ◯ mg ◯ MU(megaunit) ◯ Empty

Frequency
◯ OD/once a day/24hrly
◯ BD/twice a day/12hrly
◯ TID/TDS/three times a day/8hrly
◯ QID/4 times a day/6hrly
◯ STAT
◯ Empty

Duration (Days) _____
((enter the duration the drug was administered in days) (enter -1 if not recorded))

2. Gentamicin prescribed ◯ Yes ◯ No

Date gentamicin prescribed _____
(if unrecorded enter 1914-01-01))

Route ◯ I.M ◯ I.V ◯ Empty

Dose _____
(mg (enter -1 if not recorded))

Units ◯ mg ◯ Empty

Frequency
◯ Once per day/once daily(OD)
◯ 12 hourly
◯ 8 hourly
◯ 6 hourly
◯ Empty

Duration (Days) _____
((enter the duration the drug was administered in days) (enter -1 if not recorded))

3.Ampicillin ◯ Yes ◯ No

date ampicillin prescribed _____
(if unrecorded enter 1914-01-01))

Route ◯ I.M ◯ I.V ◯ Empty

Dose (milligrams) _____
(milligrams (mg) (enter -1 if not recorded))

Ampicillin units ◯ iv ◯ im ◯ Empty

Frequency
◯ Once per day/once daily(OD)
◯ 12 hourly ◯ 8 hourly
◯ 6 hourly ◯ Empty

Duration (Days) _____
(days ( enter -1 if not recorded))

4.Ceftriaxone ◯ Yes ◯ No

date ceftriaxone prescribed _____
(if unrecorded enter 1914-01-01))

Route ◯ I.M ◯ I.V ◯ Empty

Dose (milligrams) _____
(mg (enter -1 if not recorded))

Frequency
◯ OD/once a day/24hrly
◯ BD/twice a day/12hrly
◯ TID/TDS/three times a day/8hrly
◯ QID/4 times a day/6hrly
◯ STAT
◯ Empty

Duration (Days) _____
((enter the duration the drug was administered in days) (enter -1 if not recorded))

5.Amikacin ◯ Yes ◯ No

Date Amikacin prescribed _____

Frequency
◯ OD/once a day/24hrly
◯ BD/twice a day/12hrly
◯ TID/TDS/three times a day/8hrly
◯ QID/4 times a day/6hrly
◯ STAT
◯ Empty

Duration(Days) _____

5).1% TEO ◯ Yes ◯ No ◯ Empty

Date 1% TEO prescribed _____
(if unrecorded enter 1914-01-01))

Frequency

◯ OD/once a day/24hrly
◯ BD/twice a day/12hrly
◯ TID/TDS/three times a day/8hrly
◯ QID/4 times a day/6hrly
◯ STAT
◯ Empty
(indicate -1 if unrecorded)

Duration(Days)

_____
(indicate -1 if unrecorded)

## 8.2 OTHER TREATMENT

Other drugs prescribed

◯ Yes ◯ No ◯ Empty

Other drugs 1

_____
( For value lookup, Lookup List)

Other drugs 2

_____
( For value lookup, Lookup List)

Other drugs 3

_____
( For value lookup, Lookup List)

Any other drugs

◯ Yes ◯ No

Other drugs

_____

Other drugs

◯ Vitamin K
◯ Paracetamol
◯ Phenobarbitone(Loading)
◯ Phenobarbitone (Maintenance)
◯ Diazepam
◯ Empty

Other drugs not listed above

_____

Gentamicin Given

◯ Yes ◯ No

Zithromax Given

◯ Yes ◯ No

# Supportive Care

## Oxygen and blood transfusion

Oxygen ordered
◯ Yes ◯ No

Flow rate
_____
(litres/min;input -1 for empty)

Route of administration
◯ Nasal Catheter
◯ Nasal prongs
◯ Simple mask
◯ Mask with a reservoir
◯ Other
◯ Empty

Date oxygen prescribed
_____
(if unrecorded enter 1914-01-01))

## CPAP

CPAP done
◯ Yes ◯ No ◯ Empty

Who applied CPAP?
◯ Nurse
◯ Clinical Officer
◯ Clinical Officer Intern
◯ Medical Officer
◯ Medical Officer Intern
◯ Paediatrician
◯ Other
◯ Empty
(Choose One)

Start Date
_____
(if unrecorded enter 1914-01-01)

Start Time
_____

End Date
_____
(if unrecorded enter 1914-01-01)

End Time
_____

Adverse Events
☐ None
☐ Vomiting
☐ Aspiration pneumonia
☐ Nose injury
☐ Eye Injury
☐ Skin injury
☐ Nasal bleeding
☐ Pneumothorax
☐ Other
☐ Empty

CPAP Outcome

- ◯ Death
- ◯ Intubated
- ◯ Referred
- ◯ Discharged (home,well)
- ◯ Alive,in unit,off CPAP
- ◯ Other
- ◯ Empty

## Blood Transfusion

Blood Transfusion Prescribed ◯ Yes ◯ No

First transfusion on admission ◯ Yes ◯ No

Volume of blood _____
(vol in mls)

Duration of transfusion _____
(time in hrs)

Multiple transfusions ◯ Yes ◯ No

## Fluids prescribed at admission

Fluids prescribed at admission using intravenous( I.V) route. ◯ Yes ◯ No

Date Fluid Prescribed _____

IV fluids prescribed

- ◯ Half strength darrows(HSD)
- ◯ Half strength darrows with 5% DW
- ◯ 10% DW(D10W)
- ◯ Normal Saline(NS)
- ◯ Ringers Lactate/Hartmanns(RL)
- ◯ Other
- ◯ 5% DW(D5W)

Total volume of IV fluids _____

Duration of IV fluid prescribed _____
(in hours)

Other fluid ◯ Yes ◯ No

Specify other fluid prescribed

- ◯ Half strength darrows(HSD)
- ◯ Half strength darrows with 5% DW
- ◯ 10% DW(D10W)
- ◯ Normal Saline(NS)
- ◯ Ringers Lactate/Hartmanns(RL)
- ◯ Other
- ◯ 5% DW(D5W)

Total volume of other fluid prescribed _____
((total vol in mls ))

Duration of flow prescribed _____
((time in hrs,if unrecorded fill -1))

Other fluid 2

◯ Yes ◯ No

Specify other fluid 2 prescribed

◯ Half strength darrows(HSD)
◯ Half strength darrows with 5% DW
◯ 10% DW(D10W)
◯ Normal Saline(NS)
◯ Ringers Lactate/Hartmanns(RL)
◯ Other
◯ 5% DW(D5W)

Total volume of fluid 2

_____
(total vol in mls)

Duration of flow_2

_____
(in hours)

## Feeds

Child prescribed with feeds at admission

◯ Yes ◯ No

Date feeds prescribed

_____

Type of feeds prescribed

◯ Expressed Breast Milk (EBM)
◯ Neonatal formula
◯ Cow's milk
◯ Mixed feeding
◯ Other

Time to start feeds(after admission)

◯ < 1 hr
◯ 1-2 hrs
◯ >2hrs
◯ Empty

Feeding route prescribed

◯ NG Tube
◯ Cup and spoon
◯ Empty

Feed Volume

_____
(total vol in mls per feed)

Frequency of administration

◯ hrly
◯ 2hrly
◯ 3hrly
◯ 4hrly
◯ 5hrly
◯ 6hrly
◯ Empty

Date the feeds are initiated

_____
(if unrecorded enter 1914-01-01))

Other feed

_____

Feed/fluid monitoring chart available

◯ Yes ◯ No

## Phototherapy

| | | |
|---|---|---|
| Phototherapy on day of admission | ◯ Yes | No |
| Photo-therapy on any other day | ◯ Yes | No |

# Follow Up Monitoring

**10. MONITORING(look through the entire file for this information)**

Vitals signs chart present ◯ Yes No

Vital signs monitored in the first 48 hours ◯ Yes No

Number of times temp monitored in 48 hrs
◯ 0
◯ 1
◯ 2
◯ 3
◯ 4
◯ 5
◯ 6
◯ 7
◯ 8
◯ 9
◯ 10
◯ >10

Number of times respiratory rate monitored in 48 hrs
◯ 1
◯ 2
◯ 3
◯ 4
◯ 5
◯ 6
◯ 7
◯ 8
◯ 9
◯ 10
◯ >10

Number of times pulse rate monitored in 48 hrs
◯ 1
◯ 2
◯ 3
◯ 4
◯ 5
◯ 6
◯ 7
◯ 8
◯ 9
◯ 10
◯ >10

Oxygen saturation monitored ◯ Yes No

Number of times oxygen saturation monitored in 48 hrs
◯ 1
◯ 2
◯ 3
◯ 4
◯ 5
◯ 6
◯ 7
◯ 8
◯ 9
◯ 10

## Weight Charting

Is the baby's weight charted? ◯ Yes ◯ No

Frequency of charting in last seven days
◯ Daily
◯ Every 2 days
◯ Every 3 days
◯ Once a week

## Fluid Monitoring Chart

Is there a fluid monitoring chart chart? ◯ Yes ◯ No

Frequency of fluid monitoring in first 48hrs
◯ 1 time
◯ 2 times
◯ 3 times
◯ 4 times
◯ more than 4 times
◯ Empty

# Discharge Information

## 11. DISCHARGE INFORMATION

Is there a Discharge/Death Summary? ◯ Yes ◯ No ◯ Empty

Discharge/ Death Date _____
((for empty date type 1914-01-01)))

Discharge weight _____
(in Kgs(Enter-1 if unrecorded))

Outcome of discharge
◯ Alive
◯ Dead
◯ Referred
◯ Absconded
◯ Empty

Date referred _____

Referred where _____

Condition on discharge
◯ Normal
◯ Neuro sequelae/disability
◯ Renal failure
◯ Other
◯ Empty

Other condition on discharge _____

Follow up care
◯ None
◯ Clinics within the hospital(e.g POPC/SOPC)
◯ Other health facilities

## Discharge diagnosis

Clear primary Discharge Diagnosis ◯ Yes ◯ No ◯ Empty

Primary discharge diagnosis _____
( For value lookup, Lookup List )

Discharge diagnosis 1 _____
( For value lookup, Lookup List )

Discharge diagnosis 2 _____
( For value lookup, Lookup List )

Discharge diagnosis 3 _____
( For value lookup, Lookup List )

Any other discharge diagnosis ◯ Yes ◯ No

Other discharge diagnosis 1 _____
( For value lookup, Lookup List )

Other discharge diagnosis 2 _____
( For value lookup, Lookup List )

Other discharge diagnosis not listed ◯ Yes ◯ No

Discharge diagnosis not listed _____

No clear primary discharge diagnosis
☐ Birth asphyxia
☐ Meconium aspiration
☐ Prematurity / VLBW
☐ Twin delivery
☐ Newborn RDS
☐ Jaundice
☐ Neonatal sepsis
☐ Meningitis
☐ Other
(Check all that apply)

## Discharge treatment

Discharge treatment prescribed? ◯ Yes ◯ No

Discharge treatment 1 _____
( For value lookup, Lookup List )

Discharge treatment 2 _____
( For value lookup, Lookup List )

Discharge treatment 3 _____
( For value lookup, Lookup List )

Discharge treatment 4 _____
( For value lookup, Lookup List )

Discharge treatment 5 _____
( For value lookup, Lookup List)

Other discharge treatment not listed ◯ Yes ◯ No

Other discharge treatment _____

Oral Polio vaccine administered during hospitalization ◯ Yes ◯ No

BCG administered during hospitalization ◯ Yes ◯ No