PREVALENCE AND RISK FACTORS OF HYPOTHERMIA AT ADMISSION TO NEW BORN UNIT IN KENYATTA NATIONAL HOSPITAL

BY

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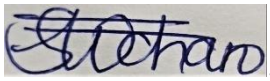
DECLARATION

This dissertation is my original work and has not been published elsewhere or presented for a degree in any other university.

Signed:…… …  …. ….Date:……09/11/21…..

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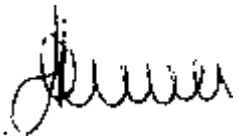
Signed:…  ……. Date:…09/11/2021……..

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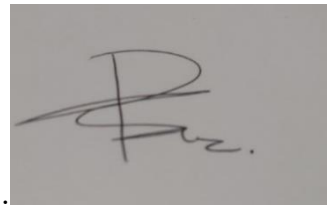
Signed:……  …… Date:…09/11/2021……

ABBREVIATIONS

WHO-World health organization

KDHS-Kenya demographic health survey

KNH-Kenyatta national hospital

NBU-New born unit

UNICEF-United nations children's fund

MOH-Ministry of health, Kenya

BVM-Bag valve mask

TBA-Traditional birth attendant

OPERATIONAL DEFINITION

Hypothermia: In this study, neonatal hypothermia will be defined as axillary temperature <36.5ºC and further subclassified into: Mild hypothermia when axillary temperature is 36.0º-36.4ºC, moderate hypothermia when axillary temperature is 32.0ºC-35.9ºC and severe hypothermia when axillary temperature is <32ºC(1)

Inborn: Newborn born in the study hospital (KNH)

Outborn: Newborn born outside the study hospital

Warm chain: Set of ten interlinked procedures that when carried out maintains the newborns thermoregulation

Neonate/newborn: Infant within the first 28days of life

Adequate clothing: Infant covered in two or more clothing and the head must be covered

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ABSTRACT

Background: World health organization (WHO) defines neonatal hypothermia as axillary temperature <36.5ºC. Neonatal hypothermia is a common problem that coexists with other health problems like severe neonatal sepsis, asphyxia, and prematurity. Neonatal hypothermia leads to decreased cardiac output, decreased cerebral blood flow and has been associated with increased risk of neonatal mortality and morbidity in low and middle-income countries. Neonatal hypothermia is preventable if measures are put in place to identify and bridge the gaps in the warm chain that is used for thermoprotection of the newborn.

Objective: To determine the prevalence and risk factors of hypothermia at admission to the newborn unit in KNH. We also sought to determine the neonatal outcome(mortality) of hypothermic neonates at 28 days of life and to assess the capacity to prevent neonatal hypothermia under the warm chain in KNH

Methodology: A Cross-sectional study conducted in the newborn unit, labour ward and maternity theatre in KNH. All neonates being admitted to NBU-KNH were recruited and their axillary temperature taken. Consecutive sampling was done until the sample size was achieved. Risk factors were abstracted from the KNH NBU transfer form to the newborn data abstraction tool. The newborns were followed up for 28 days to determine their outcome (mortality or discharge). A warm chain assessment checklist was used to assess the maternity theatres, labour ward and NBU admission room. This was done on the same day of the week for the 2 months that the study was ongoing.

Data management and analysis: Data was entered and checked for errors daily in Microsoft excel sheet. Cleaned data was analysed by STATA version 13. Clinical characteristics that were continuous (birth weight, temperature) were analysed and presented using means and standard deviation, as well as medians. Categorical data (gender) was analysed and presented as

frequencies and proportions. Tables and graphs were used to present the results. Statistical significance was considered when the p value <0.05

Results: The prevalence of neonatal hypothermia was 67.2%. The mean birth weight was 2400g (±998.0). More than half of the neonates (54.1%) were males. About 83.2% of all the neonates admitted were less than 1-day old at the time of admission. The mean gestational age was 35.3 weeks (±4.39). Most of the newborns (76.2%) were inborn (newborns born in KNH) and 70.9% of the admitted newborns had received resuscitation after birth. Maternal factors were not associated with neonatal hypothermia. In multivariable logistic regression, age <1day (p=0.002), gestation<37weeks(p=0.001) and very low birth weight(p=0.003) were found to be significant as risk factors for neonatal hypothermia at admission. Newborns admitted with hypothermia were 2 times more likely to die (AOR 2.34, 1.15-4.76) p=0.011. The NBU admission room had better compliance (88%) compared to labour ward and maternity theatre (50% and 60% respectively)

Conclusion: The prevalence of neonatal hypothermia was 67.2%. Gestational age <37 weeks, age<1 day old and very low birth weight were independent factors associated with hypothermia. Therefore, attention is needed for thermal care of preterm newborn and newborns who require admission on their 1st day of life. There should be enhancement of thermal protection principles of warm chain.

CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

1.1 Background

World Health Organization(WHO) describes neonatal hypothermia as axillary temperature below 36.5°C(1)

It further classifies hypothermia into 3 categories(1)

- cold stress or mild hypothermia: 36.0 to 36.4 °C (96.8 to 97.5° F)
- moderate hypothermia: 32.0 to 35.9 °C (89.6 to 96.6° F)
- severe hypothermia: below 32 °C (<89.6° F).

UNICEF released a report indicating that in 2018, 2.5 million children died in the first 28 days of life(2) In the 2019 report of levels and trends in childhood mortality by UNICEF, it is predicted that 52 million under-5 will die between 2019 and 2030 and almost half of them will be newborns (3) This really raises the alarm for urgent, sustainable measures to be taken to try and reduce neonatal deaths (4) In a systematic review and meta-analysis by Beletew et al, he found the pooled prevalence of neonatal hypothermia in East Africa to be 57.2% (95%CI 39.5-75) (5) Kenya Demographic Health Survey (KDHS) 2014 reported neonatal mortality at 22 per 1000 live births(2) Since neonatal deaths make up over 41 percent of deaths below 5 years, (6)the struggle to attain the Sustainable Development Goals(SDG) target on reduction of newborn mortality to less than 12 per 1000 live births requires a decrease in neonatal mortality. Neonatal hypothermia is an associated factor for neonatal morbidity and mortality in low and middle resource settings like Kenya(7,8)

The causes and predisposing factors for neonatal hypothermia generally include:

Failure to observe the **warm chain**, prematurity/low birth weight, infection, abandonment, serious congenital defects and malnutrition(9)

WHO defines the warm chain as a series of interconnected procedures to be followed at birth and during the next few hours and days in order to reduce heat loss in all newborns(1) the 10 measures that make up the warm chain to which if one is not implemented exposes the neonate to neonatal hypothermia include(1): warm delivery room, immediate drying, skin to skin contact, early breastfeeding, bathing and weighing postponed, appropriate clothing/bedding, mother and baby together, warm transportation, warm resuscitation, training and awareness raising(1,10,11). Other special risk factors include infants with asphyxia and those born to mothers receiving anesthetic drugs during delivery(12)

A study done by Alebachew in 2019 found that neonatal hypothermia increases neonatal mortality by 80% for every 1º Celsius drop of body temperature(13) A systematic review done by Lunze et al on the global burden of neonatal hypothermia found case fatality rates for newborn hypothermia to range from 8.5%-52%.(14)

Maintaining normal body temperature is extremely important for a neonate to survive thus interventions to prevent neonatal hypothermia will possibly influence neonatal mortality to decrease(1) In view of the above, it is important to establish the burden of neonatal hypothermia in KNH as well as its associated risk factors. This data will form a basis for evidence-based interventions to deal with the risk factors thus allowing for better neonatal outcomes at KNH.

1.2 Neonatal thermoregulation

For normal thermoregulation to occur there has to be a balance between generating heat and losing heat. Body heat generation depends on body weight but its loss depends on body surface area(15)A newborn is not able to maintain its own thermoregulation since heat production function is underdeveloped(10). This heat production is increased through increase of the metabolic rate and increased oxygen consumption(15) This increase of metabolic rate and oxygen will increase in a healthy feeding newborn(14), a sick newborn is unable to increase his

metabolic rate and has an increased oxygen consumption rate. Other mechanisms of heat production include non-shivering thermogenesis-this is where there is metabolism of brown fat.(10)

There are few mechanism by which the newborn may lose heat, they include(1,10,15,16)

a.) Evaporation- heat loss through the newborns' skin e.g. from evaporation of amniotic fluid
b.) Conduction-baby loses heat to cold objects that they are in contact with e.g. weighing scale, cold mattresses
c.) Convection-if newborn is exposed to cooler surrounding as long as there is air movement
d.) Radiation-heat loss from baby to cold objects within the room e.g. cold walls, windows

Heat loss can cause a reduction in temperature by 2-4ºC in 10-20 minutes(1,12,13) Neonates are particularly prone to neonatal hypothermia due to amniotic fluid evaporation after birth, large surface area compared with its weight, decreased subcutaneous fat and immature physiology(16). In addition the newborn has a larger head compared to its body so 75% of body heat loss can be from an uncovered head(12) Lack of preventive measures to avoid hypothermia causes the neonates body temperature to drop rapidly after its birth(10) It is therefore paramount to take steps to protect the newborns thermoregulation

1.3 Prevalence of hypothermia

Globally a systematic review conducted in 2013 by *Lunze et al* found the prevalence of neonatal hypothermia in hospital based research ranging from 32-85%.(1,13,14,16–21) This range was associated with the different definitions of hypothermia that was used in different studies between 35.0°C and 36.5°C and the climatic differences(14,18). Many studies have used WHO

cut offs for hypothermia but also many other studies have had different cut offs from 36ºC and others 35ºC(16) This has led to under reporting of the prevalence of hypothermia.

Onalo et al did a review in sub-Saharan Africa and noted that neonatal hypothermia was still a major problem in sub-Sahara Africa with its prevalence at a point of admission ranging from 21%-85%(10)

Sodemann et al used a definition of hypothermia as <34.5ºC and found the prevalence of hypothermia within 12 hours of delivery to be 8.1%(17) In the same study it was also noted that hypothermia was associated with a 4.8(95% CI: 2.90–8.00) times increase in mortality from 0 to 7 days(17). WHO defines hypothermia and its cut offs but does not mention when the temperature is to be taken.

Manji conducted a study in Muhimbili in Tanzania and found the prevalence of point of admission neonatal hypothermia to be 22. 4% with associated factors including gestational age, inadequate clothing on the newborn and delivery by caesarean section.(22) The relative risk of death was 3.3(22)

In a retrospective survey done in Kenyatta National Hospital on morbidity and mortality of low birth weight infants, one of the top causes for admission included hypothermia at 27.2% among the 533 low birth weight infants(10,23) The study further noted that Some incidents such as apnoeic attacks, hypothermia and birth asphyxia have been associated with death greater than 80%(23)

Neonatal hypothermia is actually a problem that is often ignored and it should be considered as an admission diagnosis as the risk of mortality is higher.

Table 1: Prevalence of neonatal hypothermia studies done in some countries in Africa

STUDY COUNTRY	AUTHOR AND YEAR	STUDY OUTCOMES	SAMPLE SIZE	DEFINITION OF HYPOTHERMIA USED	PREVALENCE
Nigeria	*Ogunlesi et al, 2008*(21)	Prevalence at admission	150	Axillary temperature <36.5ºC	62%
Ethiopia	*Demessie et al,* 2018(25)	Prevalence and associated risks at admission	356	Axillary temperature <36.5ºC	64%
Tanzania	Manji & Kisenge, 2003(22)	Prevalence at admission	1632	Axillary temperature <36.5ºC	22.4%
Ethiopia	*Ukke et al, 2005*(36)	Prevalence and risk factors	346	Rectal temperature <36.5ºC	50.3%
Kenya	Simiyu, 2004(23)	Morbidity among low birth weights	533	Not mentioned	27.2%

1.4 RISK FACTORS FOR NEONATAL HYPOTHERMIA

There are many factors that have been associated with neonatal hypothermia. They can generally be classified into: Neonatal, maternal and environmental factors(13,14,16,24). Below is a summary table with the associated risk factors for neonatal hypothermia. (Table 2)

Table 2: Summary of risk factors of neonatal hypothermia

Neonatal (physiologic)	**Maternal**	**Behavioural**	**Environmental**
Birth weight (low birth weight, extreme low birth weight, normal weight)	Number of pregnancies	Skin to skin contact	Place of delivery (Home, TBA, hospital-inborn or outborn)
Gestation (<28weeks, 28-32weeks, 32-37weeks, >37 weeks)	Mothers age	Early breastfeeding	Time of delivery (daytime, night time)
Resuscitation needed	Pregnancy type (single, twin)	Immediate drying	Mode of transportation to NBU (incubator, KMC, carried by health worker)
Diagnosis on admission	Complications during pregnancy (Bleeding, hypertension, premature rupture of membranes, infections)	Newborn wrapping Cap wearing	

1.4.1 Neonatal (physiologic) factors

Prematurity is a significant risk for neonatal hypothermia because of underdeveloped physiology, transepithelial water losses and decreased subcutaneous fat, which complicates the lives of these fragile neonates (9,11). A study done by Demissie in Ethiopia found that the odds of a preterm newborn getting hypothermia was 4.8 times more likely (25) than in a term infant. Preterm newborns were found to have a higher incidence of hypothermia at 82.5% compared

to term babies who were at 54.5%(21). In East Africa, Beletew et al found the odd of neonatal hypothermia among preterm to be 4.01 (95% CI: 3.02-5.00)(5)

Neonates born with low birth weight due to whatever reason-maternal, maternal socioeconomic status or demographic characteristics are more prone to neonatal hypothermia. A review done in Africa on the prevalence of neonatal hypothermia and its associated factors by Beletew et al found the odds of neonatal hypothermia among low birth infants to be 2.16 (95% CI:1.03-3.29)(5)

During resuscitation radiant heaters are used to conserve heat, the newborn is placed under the radiant heater during resuscitation and oxygen can be administered if needed. The baby can also be observed while naked. Instances where a resuscitaire is not available baby should be completely covered except for the face and upper chest(1) This minimizes heat loss from convection; reducing the risk of hypothermia. *Zayeri et al* noted neonatal hypothermia to be in 28.9% of the 104 neonates who received resuscitation(26)

Neonatal hypothermia exists with other comorbidities like infections which cause 36% of all neonatal deaths and perinatal asphyxia accounting for 23% (14) *Manji et al* in Tanzania found that 60.8% of the children with asphyxia had hypothermia(22)

1.4.2 Maternal factors

Neonates resulting from multiple pregnancy were noted to have 1.65 odds of developing hypothermia(26)

The parity of the mother seems to be associated with neonatal hypothermia. In a research done in Ethiopia found that64% of the mothers of recruited newborns were multiparous(13)

1.4.3 Behavioral factors

Immediate drying should be done right after delivery while the baby is on the mother's chest or abdomen, if this is not possible the baby should be placed on a pre- warmed cloth on a bed.

Skin to skin reduces risk of hypothermia, mothers' chest or abdomen is the best surface for the baby because it is clean and has the correct temperature (1) A study done by *Alebachew Bayih et al* found that 74.7% of the newborns with hypothermia did not have skin to skin contact with their mothers(13)

Appropriate clothing and bedding should always be maintained on a newborn. Newborns usually require 2 or 3 more layers of clothing than adults(1). Preterm infants would require heavier clothing including a cap and the baby to be kept in a warmer room. A study done in Ethiopia found that 48.6%(n=403) of the neonates with hypothermia had proper wrapping that is wrapping the body and head while 53.6% of the neonates wore caps(13) In Tanzania a study showed that only 67% (n=366) of the hypothermic neonates had appropriate clothing(22)

Early onset of breastfeeding-occurring in the first hour of delivery as recommended by WHO ensures that the newborn gets calories to generate body heat(1). A study conducted in Zambia reported an increased risk of neonatal hypothermia by 7.5 times in neonates who had long time before initiation of breastfeeding(19,27)comparison to those who had early initiation within an hour. Similarly, another study that was conducted in Southern Nepal found that there was a 1.5 times increased risk of neonatal hypothermia in infants with delayed breastfeeding as compared to those with early initiation(8,19). In a systematic review in East Africa on neonatal hypothermia and associated risk factors by Beletew et al, it was found out that the odd of neonatal hypothermia among infants with prolonged periods before breastfeeding was 2.83(95% CI: 1.398-4.26)(5)

Bathing the newborn immediately after birth should be avoided as it drops the newborns body temperature. WHO recommends postponing bathing of the newborn to the second or third day of life. Blood, meconium and vernix can be wiped off immediately after birth. Tasew et al in a study conducted in Ethiopia on determinants of hypothermia on neonates found the odds of

neonatal hypothermia among neonates bathed within 24 hours to be AOR = 10.06; 95% CI (3.86, 26.22)(28)

1.4.4 Environmental factors

Neonates born via caesarean section are at risk of neonatal hypothermia either from the temperatures of the theatre or from the anesthetic drugs used. In a study done in Tanzania 60.7% of the children who were born via caesarean section were hypothermic. However there was no association found between home deliveries and hypothermia (22) KDHS2014 reported that only 61% of deliveries occur in hospitals(2). Homes with no heating equipment could easily render the newborn hypothermic despite the ambient temperature in Sub-Sahara Africa ranging between 20-30ºC but with diurnal variations(10)hence the time of delivery influences newborns body temperature.

Newborns who are outborn (born not in the study hospital) are prone to neonatal hypothermia probably due to many reasons including the mode of transportation to receiving facility, time of delivery and knowledge of health care providers on thermal protection in the referral facility. A study in Nigeria found that outborn babies had higher incidence of hypothermia at 64.4%(21)

Night time delivery seems to be having an association with neonatal hypothermia maybe due to the health care provider to patient ratio being low and partly due to the drop of room temperatures at night(5) Beletew et al found the odds of neonatal hypothermia during night time delivery in East Africa to be 2.46(95% CI:1.22-3.70)(5)

Warm transportation of the newborn from one area to another needs to be upheld at all times as the newborn can become hypothermic despite the thermal care prevention methods that had been taken immediately after birth(1). Mothers' skin to skin contact may be used in setting where a warm incubator is not available. Transporting a neonate from the delivery area to NBU

was noted to have an influence on body temperature. A study conducted in Ethiopia by Bayih et al on neonatal hypothermia and associated factors within six hours of delivery found that newborns who were not kept war during transportation from delivery area to NICU had thrice the higher odds of developing neonatal hypothermia in comparison to the neonates who had been kept warm during transportation (AOR = 3.18, 95% CI: 1.84, 5.48)(13). Children who arrived at the NBU in Muhimbili one and half hours later from the time of transfer were found to be hypothermic in contrast to those who were received within an hour.(22)

1.5 Signs and effects of neonatal hypothermia

The early clinical signs of hypothermia include: feet getting cold before the body, decreased suckling, weak cry and lethargy(12). If hypothermia persists the newborn will get to severe hypothermia and may exhibit: bright red colour on face and extremities, shallow irregular breaths, sclerema of the skin, bradycardia(1,12). This is very dangerous for the infant and appropriate steps should be taken immediately to rectify the hypothermia. There is little information on the effects of hypothermia on the newborn and studies in this area have been based on newborns undergoing therapeutic hypothermia(10,29,30)

Prolonged hypothermia predisposes the newborn to increased risk of infection, growth impairment and higher chances of mortality(1,10,12). There is decreased metabolism by 6% in every degree Celsius drop(10) A study conducted by Omene et al on heat loss of infants in the delivery room found hypoglycaemia to be present in the infants with hypothermia(10,31) although in other studies -Reueler et al on pathophysiology of hypothermia, noted that hypothermia inhibits insulin release therefore causing hyperglycaemia in some neonates.(32) Wong et al noted that failure to protect one from stress induced hypothermia causes a surge in catecholamines leading to hyperglycaemia(33) Calculated feeds and frequent checking of the glucose level should be considered in the management as hypothermia is being corrected.

Hypothermia also has an effect on the heart-at first due to the stimulation of the sympathetic nervous system there is increased cardiac output but when cold injury is prolonged there is decreased cardiac output, bradycardia and arrhythmias maybe experienced(10)

There is also metabolic acidosis noted due to increased oxygen consumption leading to pulmonary vasoconstriction thereby enhancing tissue hypoxia which will cause peripheral vasoconstriction and anaerobic metabolism and cause the neonate to have metabolic acidosis

In blood hypothermia causes an increase in haematocrit and viscosity due to sequestration in capillaries(10,30,33) with a decrease in platelet levels and increased bleeding time and clotting time(10,29)

Hypothermia depresses the CNS proportionally to the degree of hypothermia, by reducing cerebral blood flow therefore reducing cerebral metabolism(10,34). Hypothermia also causes the blood pH to increase while the partial pressure of carbon dioxide decreases affecting vascular tone(34)

Due to the decreased cardiac output there is decreased blood flow to the intestines causing decreased motility which will eventually lead to distension of the stomach and lumen loops(10,32)

1.6 Neonatal outcomes(mortality)

Although previous studies did not find a direct causal relationship between hypothermia and mortality, higher risk of death of 3.3 in hypothermic neonates compared to the normothermic infants was found by Manji et al. Similarly *Mullany et al* noted the relative risk of death in mild hypothermic babies was 1.70; 95% CI (1.23-2.35),and moderate hypothermia (RR, 4.66; 95% CI, 3.47-6.24]), and severe (RR, 23.36; 95% CI, 4.31-126.70]) (35) than normothermic babies. In Kigali Urbuto et al in a study on prevalence, risk factors and outcomes of neonatal

hypothermia at admission found a higher risk of mortality in hypothermic neonates with an adjusted OR 1.89(18)

1.7 Conceptual framework

Several authors have studied associated risk factors of hypothermia and found links with neonatal hypothermia as shown in table 3.

Table 3: Studies that have grouped risk factors of neonatal hypothermia

Author	**Title of the study**	**Year**
Kumar et al(16)	Neonatal hypothermia in low resource settings: a review	2009
Seyum et al(24)	Proportion of neonatal hypothermia and factors among newborns	2015
Ukke et al(36)	Prevalence and factors associated with neonatal hypothermia on admission to NICU in southwest Ethiopia	2019
Bayih et al(13)	Neonatal hypothermia and factors within 6 hours of delivery	2019
Beletew et al(5)	Prevalence of neonatal hypothermia and factors in East Africa: a review	2020

All the factors namely: neonatal/physiologic, maternal, behavioural and environmental do affect newborns thermoregulation and impact on the newborns morbidity and mortality (figure 1)

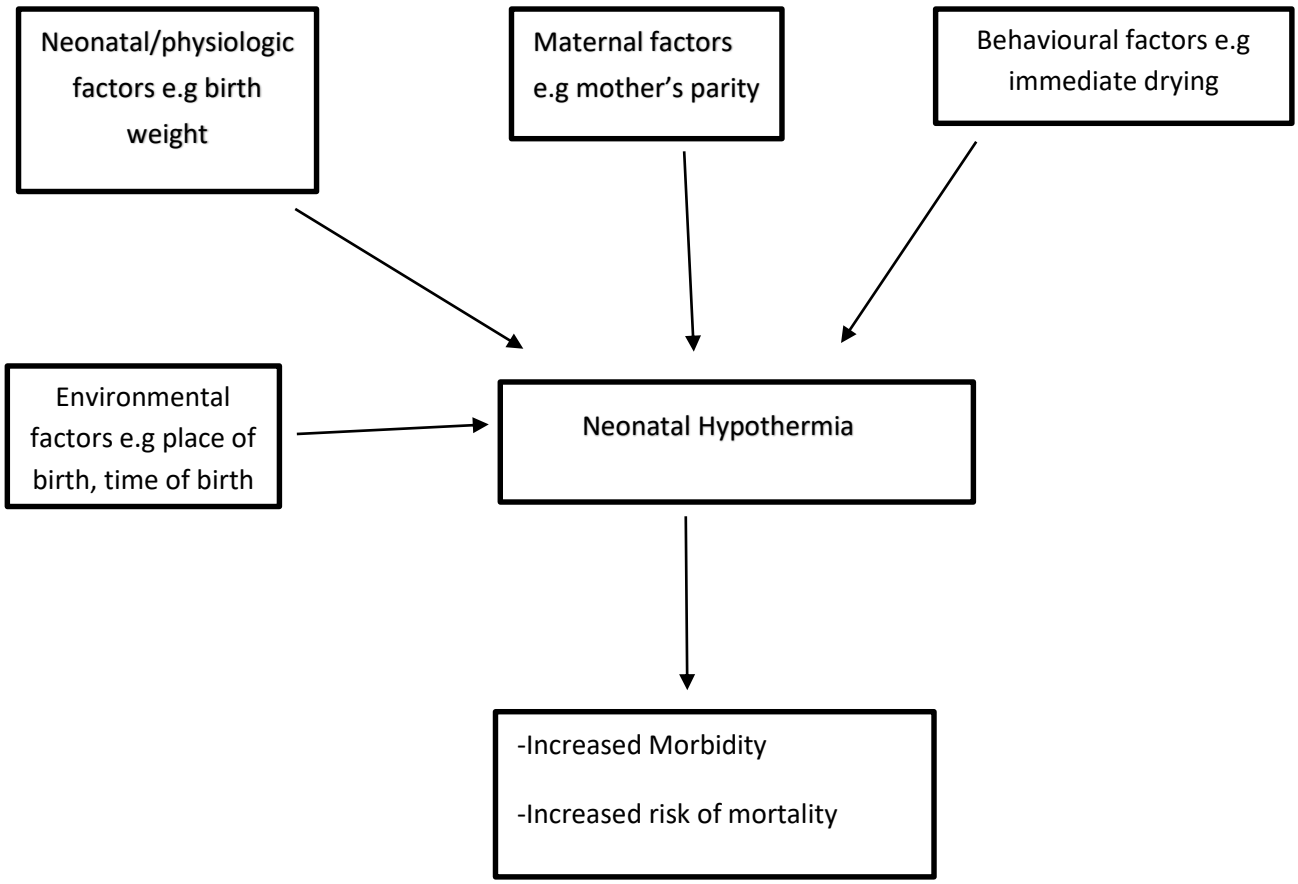

Figure 1: Conceptual framework on risk factors of neonatal hypothermia and its possible effects

1.8 Study justification and utility

- Neonatal hypothermia is a common problem with a prevalence in resource limited settings varying from 32-85%(14) This range is noted to be very wide and might be due to the different cut off points in temperature for the definition of neonatal hypothermia, the different cultural practices surrounding newborns and environmental factors including climatic changes.

- The early signs of neonatal hypothermia mimic several neonatal conditions like neonatal sepsis, meningitis, preterm births and asphyxia- If neonatal hypothermia is not considered as an early diagnosis and appropriate action taken then cold injury sets in

and predisposes the newborn to decreased cerebral metabolism, decreased cardiac output, increased bleeding tendencies and increased risk of death.

- Sustainable development goal No.3.2 aims to end preventable deaths of newborns and children under 5. Neonatal hypothermia exists as a comorbidity alongside other severe neonatal infections, preterm births and asphyxia. It is an associated factor increasing morbidity and mortality among neonates. It is therefore important to understand its burden and associated risk factors in our setup.
- Despite WHO publishing guidelines including thermal protection as one of essential requirements of the neonate, there is paucity of knowledge of neonatal hypothermia burden and its risk factors in our setting. It is paramount to have regular assessment of the burden of neonatal hypothermia for improved preventive interventions throughout the country both in health care facilities and communities where the newborn will be living. This study intends to find the prevalence and its associated risk factors of neonatal hypothermia at a point of admission to newborn unit. The results from this study may be used to strengthen thermoprotection measures of the newborn and provide better service delivery upon detection of neonatal hypothermia.

CHAPTER 2. RESEARCH QUESTION AND STUDY OBJECTIVES

What is the prevalence of neonatal hypothermia at admission to newborn unit in KNH?

What are the risk factors and outcomes(mortality) of neonatal hypothermia?

2.1 PRIMARY OBJECTIVE

To determine the prevalence of neonatal hypothermia at admission to NBU in KNH

2.2 SECONDARY OBJECTIVES

- To assess the neonatal/physiologic (birth weight, gestation, need for resuscitation, diagnosis at admission), maternal (pregnancy type, pregnancy complications, number of pregnancy) and environmental (place of delivery, time of delivery) risk factors for neonatal hypothermia at admission to newborn unit in Kenyatta National Hospital
- To determine the neonatal outcomes(mortality) of hypothermic neonates at 28 days of life in newborn unit in Kenyatta National Hospital
- To assess the capacity to prevent neonatal hypothermia under the warm chain in KNH

CHAPTER 3: METHODOLOGY

3.1 Study Design

This was a cross sectional study

3.2 Study Setting

The study was carried out in Kenyatta National Hospital (KNH)which is the only national referral hospital serving people in Nairobi and its environs and also receiving referrals from all over the country.

KNH newborn unit has more than 100 babies at a particular time, with approximately 10 admissions per day. KNH NBU admits both inborn and outborn patients. The unit has a NICU with 6 bed capacity. The unit is run by neonatologists, neonatology fellows, paediatric residents and neonatal nurses.

Assessment of capacity to prevent neonatal hypothermia was done in labour ward, maternity theatre and NBU admissions room in KNH. These are the areas where newborns are delivered in KNH and then transported to NBU where they are received in the admissions room for further management.

Labour wards and maternity theatres are situated on ground floor of the hospital while the newborn unit is located on first floor. The pathway from maternity theatre and labour ward which are adjacent to each other to the newborn unit include: open corridors of approximately 120 metres and closed corridors of approximately 130 meteres.

3.3 Study population

The target population of the study included all newborns that were being admitted to the NBU in KNH

3.3.1 Inclusion criteria:

All neonates being admitted to NBU in KNH during the study period whose parents gave consent to participate in the study.

3.3.2 Exclusion criteria

No neonate was excluded

3.4 Sample size

Calculated sample size was got using a previous study by Manji *et* al done in Tanzania whose prevalence of neonatal hypothermia at admission was 22.4%. Using Fisher's formula, the sample size was calculated as follows:

$n=Z^2xp(1-p)/e^2$

$1.96^2x0.224\ (0.776)/0.05^2$

n=268

Z=confidence interval at 95%, standard value 1.96

P=prevalence of hypothermia in neonates 22.4% from a study by Manji et al in Tanzania

e=precision at 5%

n=sample size

3.5 Sampling method

Consecutive sampling was done until the sample size was achieved.

3.6 Study variable

i) Dependent Variable-Neonatal hypothermia

ii) Independent variable-

- Neonatal factors-birth weight, gestational age, resuscitation done or not done, gender, newborns diagnosis at admission

- Maternal factors-parity, mother's age, pregnancy type (singleton or multiple), complications during pregnancy
- Environmental factors-Place of delivery, time of delivery, mode transportation to NBU

3.7 Study tools

3.7.1 KNH NBU transfer form

This is a KNH validated form(KNH/NBU/005) filled by clinicians transferring the neonates for admission to NBU KNH, both inborn and outborn newborns. It contains neonatal factors (date of birth, time of birth, gestation at birth, whether resuscitation was done or not), Maternal factors (mother's age, parity, pregnancy type-singleton or multiple pregnancy, complications during pregnancy). It also contains environmental factors (place and time of delivery, time of admission to NBU). This information was abstracted from the KNH NBU transfer form (KNH/NBU/005) (appendix 4) and entered into a data collection tool.

3.7.2 Newborn data abstraction tool

This is a modified validated newborn data abstraction tool (appendix 5) that is used by MOH in partnership with KEMRI in hospitals. It was used to collect information that was being abstracted from the KNH NBU transfer form. It has neonatal, maternal and environmental factors associated with neonatal hypothermia.

3.7.3 Warm chain assessment checklist

This checklist (appendix 6) was adopted and modified from MOH's clinical Service Review and Supervision -Neonatal Tool. It focused on the capacity to prevent neonatal hypothermia. It was used to assess labour ward, maternity theatre and NBU admission room in KNH. It entails components that should be in the specific wards to maintain thermoprotection of the newborn e.g. source of heat, warm resuscitaire, more than 2 towels and a cap in each delivery packs. All

tools were pretested on eligible patients to make sure that the language used was clear and understood to both the research assistant and the principle investigator. Corrections were done before actual data collection started.

3.8 Screening, recruitment and enrolment to the study

All neonates being admitted to NBU- KNH had their body temperature measured and recorded as part of vital signs taken at admission by the principal investigator or pre-trained research assistant. In this study there was a single reading of temperature measurement- this was at the point of admission of the neonate. The neonates were examined and management initiated by the clinician on duty. Parents of participants were informed about the purpose of the study and allowed to ask questions for clarification. The questions were answered satisfactorily and then informed consent was obtained. Post admission data was abstracted from KNH-NBU transfer form to the newborn data abstraction tool. The neonates were followed for early neonatal outcomes (death or discharge) for upto 28 days. This process was repeated till the sample size was achieved.

3.9 Study procedure

i) hypothermia and its risk factors component:

The principal investigator with the help of research assistants recruited the neonates. Before recruitment into the study, informed consent was obtained from the parent/guardian by the principal investigator or research assistant. Consent form was available in English and Kiswahili. Neonates who were participating in the study were allocated unique serial numbers 1…n. The parents/guardians were educated on the data collection process. The neonates' axillary temperature was taken as follows: the neonate was put in supine or lateral position; thermometer was cleaned with 70% methylated ethyl alcohol. The bulb of the thermometer was placed in the middle of the axilla and the arm held down on the side of the infant firmly but

gently for five minutes to allow the body temperature to settle. The temperature was then recorded. The clinician was informed of the neonates that were found to be hypothermic and were immediately managed according to the ministry of health newborn guidelines(9).The PI/ research assistant abstracted data post admission from KNH-NBU transfer form onto the data collection tool. In cases where there was missing data from the KNH-NBU transfer form, the principal investigator who is part of the clinical team working in NBU endeavoured to find the missing elements and filled it in the transfer form, enhancing clinical decision making. Axillary temperature was used because of its safety, better hygiene and the fact that it is less invasive. It is also the standard of care in KNH and it is recommended by WHO as it has been found that there is no sufficient difference between temperatures taken at the axillar and the ones taken rectally. A study by McCarthy et al on comparison of rectal and axillary temperature measurements noted that axillary temperature was sensitive for detecting rectal hypothermia.(37) The neonates were followed up for 28 days of life to determine neonatal outcomes(mortality or discharge)

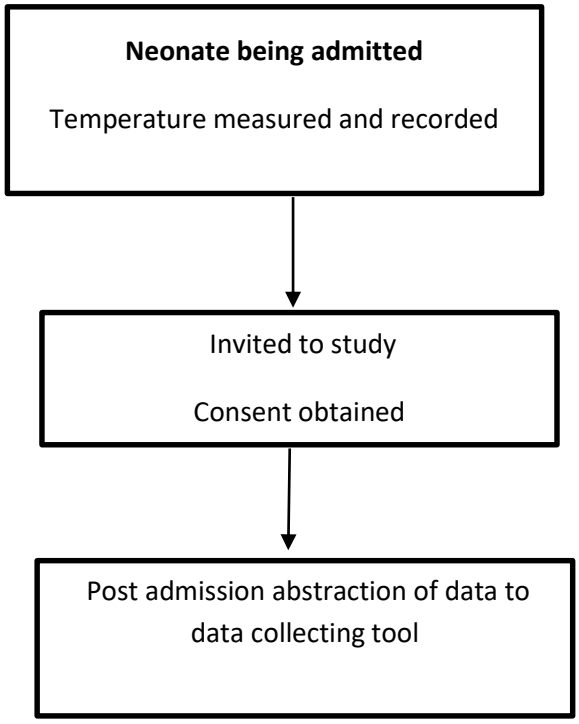

Figure 2: Flow chart demonstrating the study procedure

ii) Warm chain assessment

The principal investigator used a validated checklist to assess labour ward, maternity theatre and NBU admission room. This assessment occurred weekly on the same day and time during the study period to provide context to the prevalence of hypothermia. When the principal investigator found one or more of the components missing, the clinical team was informed immediately to prevent any possible neonatal hypothermia.

3.10 Quality assurance of data

A calibrated digital thermometer was used (Nuvita 1015) whose range is 32.0-43. 9ºC.It has an accuracy of ±0.1 °C. It is ISO certified 13485.

The research assistants were qualified nurses and clinical officers working in the paediatric unit. The principal investigator offered a training to all NBU staff and research assistants on proper technique of taking the body temperature to ensure temperatures are always taken correctly. In addition, the research assistants were trained on ethical considerations necessary in this research, obtaining informed consent, taking body temperature and abstracting relevant data from KNH-NBU transfer form to the newborn data abstraction tool. They were supervised by the principal investigator and the head nurse of the new born unit.

The data collection tool and warm chain assessment check list were pre-tested at the same time in eligible patients to determine internal reliability.

3.11 Data management and analysis

Data was obtained by the principal investigator or research assistant from the newborn data abstraction tool and warm chain assessment checklist and uploaded in a password protected excel sheet.

Data entered was checked for errors daily. Cleaned data was analysed by SPSS. Afterwards Clinical characteristics that were continuous (birth weight, temperature) were analysed and presented using means and standard deviation. Categorical data (gender, warm chain assessment) was analysed and presented as frequencies and proportions. Tables and graphs were used to present the results. Statistical significance was considered when the p value <0.05

3.12 Ethical considerations

Ethical approval was sought from KNH-UoN Ethics and Research Committee before commencing the study. Confidentiality was maintained throughout the study by all parties involved-principal investigator, research assistants and the study institution. We used serial numbers for identification and not patients' names. The personal identifiers were recorded only on consent forms, which will not be shared with third party without formal authorisation by the KNH-UoN Ethics and Research committee. Clinician attending to the neonate was notified of any neonate that was found with hypothermia and management according to the Kenya neonatal guidelines on management of hypothermia was initiated promptly. The management of hypothermia generally includes: immediate rewarming by radiant servocontrol mode or servo-controlled incubators with set skin temperature at 36.5°C and a skin probe fixed securely, initiating intravenous fluids or feeds via nasogastric tube, correction of any acid base derangement and thereafter 30 minutes monitoring of vital signs. Each participant got a fair chance of selection into the study. Study participants were explained to fully the benefits involved in the study together with the study procedures. Participants were then asked to voluntarily choose whether or not to participate and those who agreed were given an informed consent to sign. There was no monetary benefit to the participants.

CHAPTER 4: RESULTS

4.1 Description of study participants

Neonatal Characteristics:

A total of 268 neonates were studied. These comprised of 205(76.2%) inborn neonates, 60(22.3%) and 4(1.5%) were born at home. Majority of the babies (224; 83.2%) presented within the first 24hours while the rest (45;16.8%) presented to hospital more than 24 hours later. There were 146 (54.3%) males and 123 (45.7%) females (Table 4)

Table 4: Description of neonatal characteristics

Variable	Frequency(n=268)	Percent
Age in Days		
1 day	223	83.2
>1	45	16.8
Sex		
Male	145	54.1
Female	123	45.9
Birth weight		
<1000g	13	4.8
1000 – 1499g	39	14.5
1500- 2499g	87	32.4
>= 2500g	139	48.3
Mean birth weight (±SD)	2440(±998.0)	
Gestation age		
<28 weeks	12	4.46
28-31 weeks	48	18.22
32-36 weeks	78	29
≥37 weeks	130	48.33
Place of birth		
Out born (Referrals)	64	23.8
Inborn (KNH)	204	76.2
Mode of delivery		
Assisted	1	0.4
Breach	5	1.8
CS	123	46.1
SVD	139	51.7
Resuscitation[1]	190	70.9
Yes		
No		
Time of day		
Day	178	66.5
Night	90	33.5

[1]Resuscitation included: the need for BVM or chest compression

The approximate gestational agevaried from 23 to 42 weeks. Majority of the neonates being more than 37 weeks (130;48.33%). The birth weight varied between 500g and5kg with a mean body weight of 2440(±998.0). Among the 268 neonates who had been admitted 190(70.9%) had received resuscitation immediately after birth. The most common admission diagnosis was preterm and low birth weight at 30%, followed by newborn respiratory distress syndrome at 29% while the least at 2% was congenital anomalies. Two hundred and twenty-eight (85.1%) of the pregnancies were singleton pregnancies while 40(14.9%) were multiples (Table 4)

Maternal characteristics:

A total of 258(95.9%) of the mothers attended antenatal clinic and received tetanus toxoid vaccine. Pre-eclampsia was the leading pregnancy complication at 38% of the total 77 pregnancies that had complications followed by hypertension in pregnancy at 29% with the least being eclampsia and diabetes mellitus each being at 9% (Table 5)

Table 5: Description of maternal characteristics

Variable	**Frequency (n=268)**	**Percent**
ANC Visit		
Yes	257	95.9
No	11	4.1
Tetanus vaccine received		
Yes	256	95.9
No	12	4.1
Parity		
Primigravida	104	39
Multipara	164	61
Types of pregnancy		
Singleton	228	85.1
Multiples	40	14.9

The leading diagnosis at admission was prematurity with low birth weight at 121episodes followed by birth asphyxia at 120 episodes. Congenital abnormalities and neonatal jaundice had the least episodes at admission at 10 and 13 episodes respectively. (figure 3)

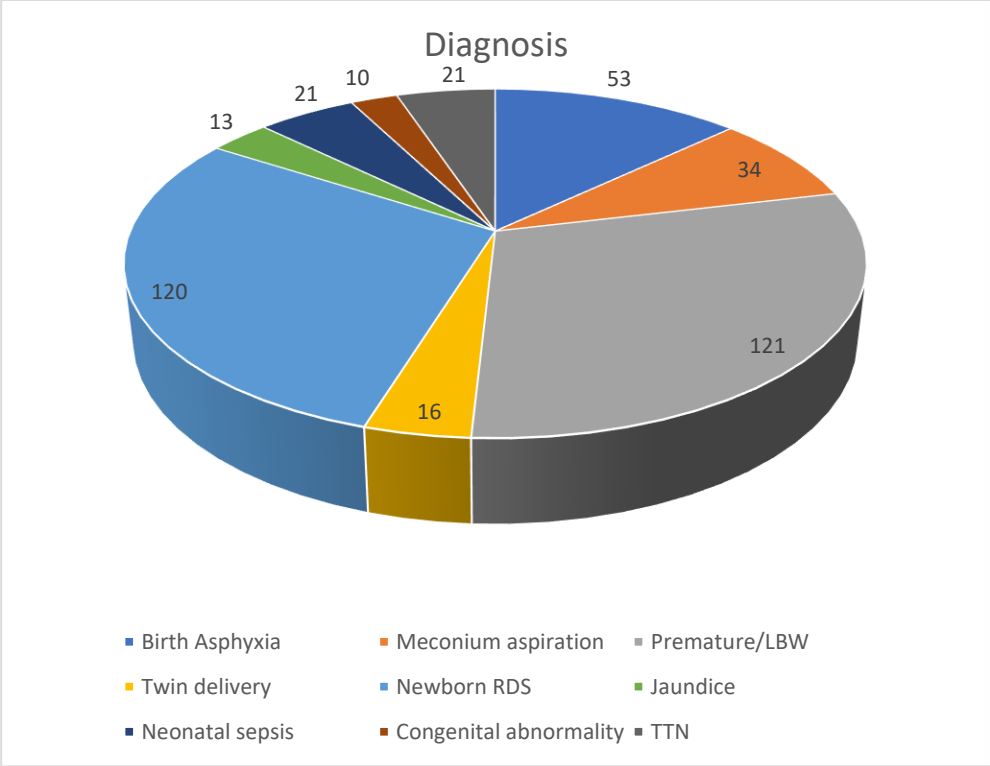

Figure 3: Pie chart showing diagnosis at admission

Note: these are disease episodes not per patient, some patients had more than 1 diagnosis that were captured separately

Newborns who were enrolled to the study were 268. Of these 180(67.2%) were discharged home while 88(32.8%) died. (figure 4)

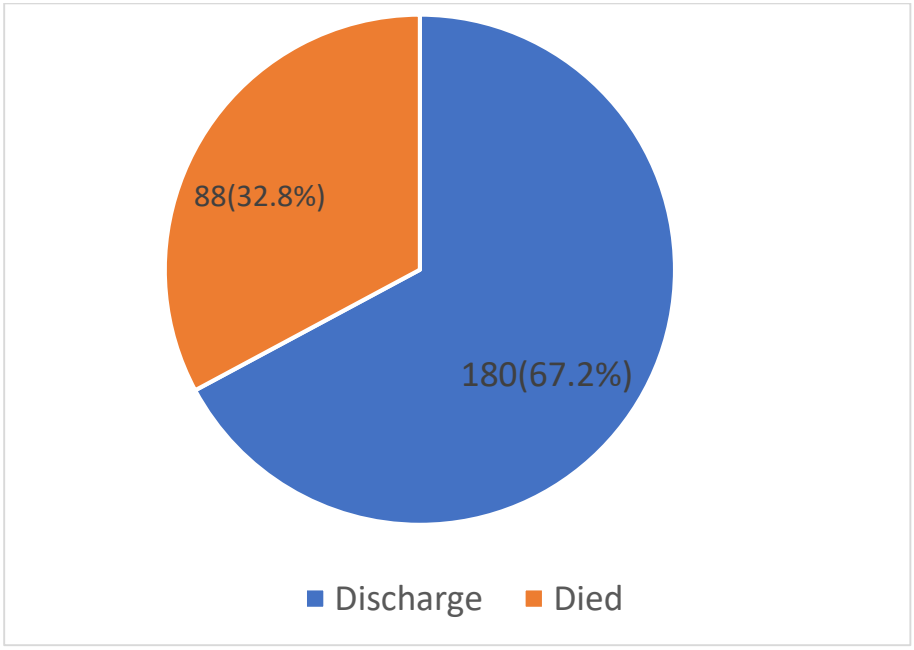

Figure 4: Pie chart showing neonatal outcomes (N=268)

Environmental factors:

Neonates that were admitted during the day(7am-7pm) were 179(66.5%) while those admitted at night(7.01pm-6.59am) were 90 (33.5%). Neonates that were born via SVD were 145(53.9%) while those born via caesarean section were 124(46.1%)

4.2 Prevalence of hypothermia:

The prevalence of neonatal hypothermia in this study was 67.2%(95% CI: 61.2-72.8) The body temperature ranged from 31°C to 39.1°C. Majority of the neonates 126(47%) had moderate hypothermia, 53(19.8%) had mild hypothermia while 1 neonate (0.4%) had severe hypothermia (Table 6)

Table 6: Prevalence of neonatal hypothermia

Temperature	**Frequency**	**Percent**		
Severe Hypothermia (<32°C)	1	0.4	Prevalence of hypothermia	67.2 % (95% CI: 61.2-72.8)
Moderate Hypothermia (32-35.9°C)	126	47.0		
Mild Hypothermia /Cold stress (36°-36.4°C)	53	19.8		
Normal rage (36.5°-37.5°C)	74	27.6		
Fever (>37.5°C)	14	5.2		

4.3 Risk factors of neonatal hypothermia:

On bivariable logistic regression analysis variables that had been found to be associated with hypothermia significantly were admission on the first day of life, birth weight of less than 2500g, gestation less than 37 weeks, newborn respiratory distress syndrome, Jaundice and neonatal sepsis.(Table 7&8) These factors were therefore included in the multiple logistic regression and admission on the first day of life, gestation less than 37weeks and birth weight less than 2500g were found to be significantly associated with neonatal hypothermia. Neonates who were admitted on the first day of life were 30 times more likely to have hypothermia compared to newborns admitted from the second day of life onwards (AOR=30.05, 95% CI: 3.525, 256.256). Those neonates who were <37 weeks' gestation were almost 3 times more likely to have hypothermia than those who were >37weeks gestation (AOR=2.71, 95%CI: 1.534, 4.781). Those newborns whose birth weight was between 1000g to -1499g were 5 times more likely to have hypothermia (AOR=5.11, 95%CI: 1.714, 15.248) while those with birth weight <1000g were twice more certainly to be hypothermic in comparison to neonates with birth weight .2500g (AOR= 2.08. 95%CI: 1.079, 3.998) (Table 9)

Table 7: Neonatal factors associated with hypothermia

Variables	**Hypothermia freq (%)**		**Crude Odds ratio (95% CI)**	**P-value**
	Yes	No		
Age				
1	152 (56.7)	71(26.5)	1.3(0.67-2.53)	**<0.001***
>1 days	28(10.4)	17(6.3)		
Gender				
Male	102(38.1)	43(16)	1.37(0.82-2.28)	0.229
Female	78(29.)	45(16.8)		
Birth weight				
<2500	109(40.7)	30(11.2)	2.97(1.74-5.05)	**<0.001**
≥2500	71(26.5)	58(21.6)		
Gestational age				
<37	108(40.3)	31(11.6)	2.76(1.62- 4.68)	**<0.001***
>37	72(26.9)	57(21.3)		
Resuscitation[1]				
Yes	53(19.8)	25(9.3)	11.13(5.11-24.26)	0.861
No	127(47.4)	63(23.5)		
Time of day				
Day	113(42.2)	65(24.3)	0.6(0.34-1.05)	0.073
Night	67(25)	23(8.6)		
Apgar score 5				
<7	38(14.2)	11(4.1)	1.87(0.91-3.87)	0.09
>=7	142(53)	77(28.7)		
Place of birth				
Referred	40	24	0.762(0.42-1.37)	0.363
KNH	140	64		

[1]Resuscitation included: the need for BVM, chest compression

Table 8: Maternal factors associated with hypothermia

Variables	**Hypothermia freq(%)**			
	Yes	No	Crude Odds ratio (95% CI)	P-value
Pregnancy Complications				
Eclampsia				
Yes	6(2.2)	1(0.4)	3(0.356-25.309)	0.313
No (reference)	174(64.9)	87(32.5)		
Hypertension in pregnancy				
Yes	17(6.3)	5(1.9)	1.73(0.62-4.86)	0.297
No (reference)	163(60.8)	83(31.0)		
PET				
Yes	24(9)	5(1.9)	2.55(0.94-6.94)	0.066
No (reference)	156(58.2)	83(31.0)		
Diabetes mellitus				
Yes	4(1.5)	3(1.1)	0.64(0.14-2.94)	0.57
No (reference)	176(65.7)	85(31.7)		
Type of pregnancy				
Singleton	150(56)	78(29.1)	1.56(0.73-3.36)	0.255
Multiples	30(11.2)	10(3.7)		

Multiple regression analysis was conducted through a forward stepwise analysis and setting the alpha value at 0.15 gave the parsimonious model. Having controlled for confounders age, gestation age, apgar score were included in the model. Age at admission, low birth weight and gestational age are independent predictors of hypothermia having controlled for confounders (table 9)

Table 9: Independent determinants of neonatal hypothermia

Variable	S.E.	Adjusted Odds Ratio	95% Confidence interval		P-value
			(Lower)	(Upper)	
Age group					
Age-day 1 of life	1.093	30.05	3.525	256.256	**0.002**
>1 day of life (Reference)					
Gestation					
<37 weeks	0.29	2.71	1.534	4.781	**0.001**
≥37 weeks (Reference)					
Apgar 5					
<7	0.400	1.83	0.834	4.008	0.132
≥7 (Reference)					
Birth weight					
<1000g	0.334	2.08	1.079	3.998	**0.029**
1000 – 1499g	0.558	5.11	1.714	15.248	**0.003**
1500- 2499g	0.807	2.96	0.609	14.411	0.179
≥2500g (Reference)					
Neonatal sepsis					
Yes	0.557	0.46	0.154	1.364	0.161
No (Reference)					

4.4 Outcomes of neonates with hypothermia

Neonates who were admitted with hypothermia and discharged home were 111(41.4%) while the ones who were admitted with hypothermia but died were 69(25.7%) (OR=2.25, 95%CI: 1.25, 4.07) with a p value of 0.007. (Table 10)

Table 10: Association of hypothermia with neonatal outcomes(discharged or mortality)

	Outcome at day 28 Freq (%) N=268		Adjusted Odds ratio (95% CI)	P-value
Hypothermia	Died	Discharged		
Yes	69(25.7)	111(41.4)	2.34(1.15-4.76)	**0.019**
No	19(7.1)	69(25.7)		

Neonates who were admitted with hypothermia were twice more certainly to die in comparison to those admitted with normal temperature (AOR 2.34, 95%CI: 1.15, 4.76) with a p value of 0.019. Other independent factors of mortality included neonates who were resuscitated at birth, meconium aspiration and congenital abnormalities (Table 11)

Table 11: Multivariable logistic analysis of independent factors of mortality

Variables	**S.E.**	**AOR**	**95% CI**		**p-value**
			Lower	Upper	
Hypothermia	0.85	2.34	1.15	4.76	**0.019**
Birth weight	0.61	1.06	0.34	3.29	0.921
Gestation <37weeks	0.88	1.60	0.54	4.71	0.402
Resuscitation	0.9	2.53	1.26	5.07	**0.009**
Meconium aspiration	2.40	4.87	1.85	12.84	**0.001**
APGAR 5th minute	0.65	1.63	0.75	3.56	0.22
Premature/LBWT	1.56	2.77	0.92	8.34	0.071
Congenital abnormalities	23.52	26.99	4.89	148.92	**<0.001**
Pre-eclampsia	1.09	2.39	0.98	5.83	0.056
Neonatal sepsis	1.68	2.74	0.83	9.08	0.098
Outborn deliveries	0.84	2.45	1.25	4.81	0.009

4.5 Warm chain assessment:

In the warm chain assessment, a checklist was used that contained presence of heat source, a wall thermometer, resuscitaire, presence of an overhead heater on the resuscitaire, pre-heated incubators for transporting neonates, presence of open windows or doors which got no mark as they enhance heat loss. In addition to this labour ward and maternity theatre were assessed for presence of 2 towels and a cap in the delivery pack (Table 12)

Table 12: Components of the warm chain that were assessed

Components assessed	Labour wards	Maternity theatres	NBU admitting room
Source of heat	✓	✓	✓
Resuscitaire	✓	✓	✓
Overhead heater on resuscitaire	✓	✓	✓
Presence of incubators	✓	✓	✓
Preheated incubators	×	×	✓
Open windows	–	+	+
Open doors	–	–	–
Wall thermometer	×	×	✓
2 towels in delivery pack*	✓	✓	
Neonatal cap in the delivery pack*	×	×	

Key:

+ absent but positive mark awarded, - Present but no mark awarded

* not assessed in NBU, × Absent

✓ present,

All these variables were each awarded a mark except for open windows and doors but got a mark if the window or doors were closed. The total points scored in the assessed department was divided by total number of points that can be achieved in that department and multiplied by 100 to get the percentage of compliance. For example, labour ward got 5 points out of the

possible 10, then multiplied by 100=50%. This was the score all through the weeks of the study period, so the average remained 50%. The same was done for labour ward and maternity theatre

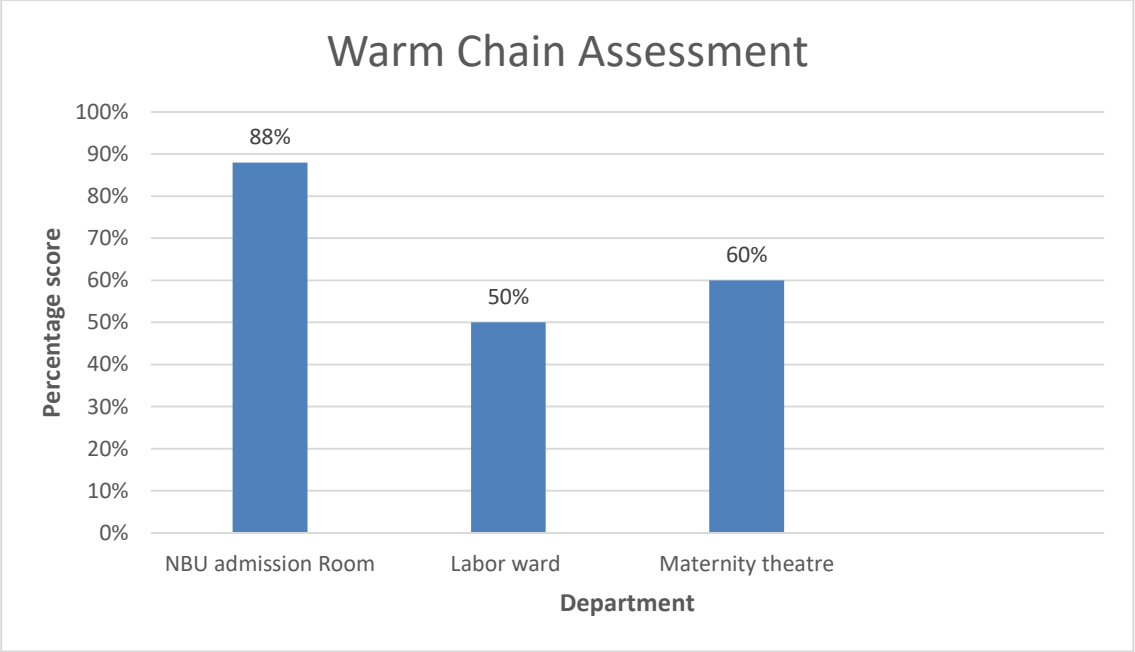

Figure 5: Bar graph showing assessment of warm chain in KNH

NBU admission room had the highest compliance at 88% followed by maternity theatre at 60% and the labour ward at 50%

CHAPTER 5: DISCUSSION

The prevalence of neonatal hypothermia in this study (67.2%) is higher than 22.4% previously reported in Tanzania(22) but similar to a Nigerian study where the prevalence was at 62%(21) and in Ethiopia whose prevalence was 69.8%(24). These studies that were conducted in Africa were similar in their definition of hypothermia. The global burden of neonatal hypothermia ranges from 32-85%(14). This big range could maybe have been due to different definitions of hypothermia ranging from 35°C-36.5°C, different temperature measuring site and the different participants' selection.

The frequency of hypothermia was highest among the neonates who were admitted on their first day of life at 56.7%. Neonates who were admitted within 24 hours of birth were 30 times more likely to have hypothermia (AOR=30, 95%CI 3.525-256.256, p=0.002). This result was higher than the one in a previous study by Demissie et al where newborns who were one day or less in age had twice the odds of having hypothermia compared to the neonates who were older than one day (AOR = 2.26, 95%CI: 1.27, 4.03)(25)This observation agrees with an earlier study by Ogunlensi et al where the incidence of hypothermia among neonates less than 24 hours was 72.4%, n=150 (21) This may reflect that most admissions during the first day of life are due to neonatal problems. Such critical illness in the neonate has been demonstrated to lead to hypothermia (1) Consequently, very sick neonates need extra care to prevent heat loss.

The other factors which showed significant association with neonatal hypothermia at a point of admission were preterm and low birth weight. Preterm had almost 3 times the odds of having hypothermia compared to term babies (AOR 2.71, 95%CI:1.534 - 4.781, p=0.001), while very low birth weight neonates had 5 times the odds of having hypothermia(AOR 5.11 95%CI: 1.714 -15.248 p=0.003) This is also supported by the findings from a review on prevalence of neonatal hypothermia in East Africa by Beletew et al where they found the odds of neonatal hypothermia among low birth infants was 2 times higher than in infants with normal weight (aOR =2.16;

95%CI: 1.03–3.29)(5) and the odds of neonatal hypothermia among preterms to be 4 fold higher than in term neonates (aOR = 4.01; 95%CI: 3.02–5.00)(5). Similarly, in an Iranian study where there was increased risk of hypothermia in low birth weight newborns by about 2 fold OR = exp (0.549) = 1.73 times compared to term neonates (26). In another study in Nigeria where preterms had 1.5 times higher risk of getting neonatal hypothermia. Thirty-three of the preterm babies had hypothermia compared with 60 of term babies (RR = 1.51; CI = 1.21– 1.89) (21). This is attributable to the reality that low birth weight neonates have large surface area compared to their body weight which puts them at a higher risk to get hypothermia (1, 26). Secondly, neonates with low birth weight have diminished thermal insulation secondary to their minimal subcutaneous fat and decreased brown fat (10).

In this study 25.7% of neonates who had hypothermia died compared to 7.1% who had normal temperature (OR=2.25, 95%CI: 1.25, 4.07) with a p value of 0.007. A multivariable logistic analysis established that the odds of death in hypothermic infants was significantly high (AOR 2.34, 95% CI:1.15-4.76) with P=0.019. This high rate of mortality has also been seen in other studies like Ogunlensi found case fatality rate in hypothermic babies to be 37.6% versus 16.7% for neonates with normal temperature (RR=2.26, 95%CI=1.14-4.48)(21) Similarly Manji et al in Tanzania found 33out of 366 hypothermic infants died, while 10 out of 381 normothermic infants died, the relative risk was 3.3(22). This is also similar in a study by Silveira et al that found the odds of mortality in neonates with hypothermia to be 2 times more than in normothermic neonates (OR=2.39, 2.14-2.63)(38) . In Rwanda, Urbuto et al found 26% of hypothermic neonates died versus 9% of normothermic neonates (AOR=1.89, P=0.011)(18) All the studies presented here did not find hypothermia as a direct causality of mortality but the very high incidence of mortality cannot be possibly ignored as the effects of hypothermia are detrimental to a newborn. This high rates of mortality may be due to the tendency of neonates being admitted that are very sick hence having their thermoregulatory mechanisms depressed,

as well as poor transportation techniques and delayed initiation of therapeutic interventions. It was also noted that only 1 out of 180 neonates with hypothermia, had hypothermia as part of the diagnosis.

Warm chain assessment included assessment of presence of resuscitaires, presence of pre-heated incubators for transporting babies, presence of more than two towels in the delivery packs, presence of neonatal cap in the delivery pack, presence of draught free (no open windows or doors) rooms and presence of a wall thermometer. Newborn admission room was compliant in this assessment.

WHO recommends use of radiant heaters to provide warmth locally as it allows for direct observation and free access to the baby (1) This can be used during resuscitation, in the delivery room and when observing the baby while naked. Radiant heaters are effective only if the room temperature is kept high at 25°C

Newborn admission room was the only place of the 5 studied areas that had a wall thermometer for measuring the room temperature, had central heating with controlled room temperatures and had all windows closed at all times. These are all interventions geared towards maintaining a warm environment in a room where the neonate was first received. A study by Russo et al where they implemented a practice plan of maintaining the required delivery room temperature resulted in a significant increase in the delivery room axillary temperature of infants from 36.06 ± 0.65 to 36.61 ± 0.56°C ($P < 0.0001$) and NICU admitting temperature from 36.02 ± 0.81 to 36.70 ± 0.56°C ($P < 0.0001$) at baseline and implementation, respectively. The number of infants with a NICU admission axillary temperature <36°C decreased from 55% to 6% (RR, 0.18; 95% CI, 0.10–0.34; $P < 0.0001$)(39)

All the rooms assessed had access to an incubator for transporting babies from the delivery room, theatre or admitting room to NBU or postnatal wards. But of note only NBU had preheated incubators. WHO recommends transport of newborns to be done in preheated

incubators as the temperature of the newborn fluctuates during transportation due to ambient temperatures or long duration taken on the way(1) A study done by Goldsmit el al on risk factors associated to clinical deterioration during the transfer of sick newborns found that 46% (n=160) of the neonates being transferred arrived to NICU with hypothermia(40)

Labour ward and maternity theatres had atleast 2 towels in the delivery pack but none had a neonatal cap included in this pack. WHO recommends that the newborn should be covered with atleast 2 warm linen and a cap (1) to avoid heat loss. Manji et al in Tanzania found that 33% of neonates who had inadequate clothing(adequate clothing was having two or more items of clothing covering the whole body including the head) had hypothermia compared to the neonates with inadequate clothing who had normal temperatures 5.2%, P=0.000(22)

5.1 Study strengths and limitations:

Strength: There was a training to all NBU staff on the proper techniques of temperature measurements. During the study period all neonates being admitted had their temperature measured and recorded in the proper way.

Limitation: This main limitation of the study is that we were unable to address interventions that were done like immediate drying of the baby, effective and correct skin to skin contact, rooming in of mother and child, early initiation of breastfeeding, skills and qualifications of health care providers working in delivery rooms and postnatal wards-all of which are factors that have a high potential to prevent neonatal hypothermia.

We were unable to follow up the neonates who were discharged home before 28 days of age so as to determine the outcomes within the 28-day period

5.2 Conclusion:

The prevalence of neonatal hypothermia at a point of admission was found to be very high (67.2%) with associated risk factors being a neonate admitted within 24 hours of birth, preterm and low birth weight. Neonatal hypothermia was also greatly associated with mortality.

Departments where the newborn is born had less compliance to warm chain assessment (labour ward-50% and maternity theatre -60%) compared to NBU admission room (88%).

5.3 Recommendation:

The warm chain procedures should be carried out always to prevent neonatal hypothermia from the place of delivery to referral facilities receiving the newborns.

Regular assessment for compliance of warm chain should be carried out so as to be able to provide better preventive services.

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APPENDICES

Appendix 1. Proposed time frame for undertaking the study

Activity	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan 2021
Proposal development and marking											
Ethical clearance											
Data collection											
Data analysis											
Manuscript writing and thesis defence											

Appendix 2. Study budget

Item	**Quantity**	**Unit price(kshs)**	**Total(kshs)**
Supplies			
Pens	10	30	300
Pencils	5	20	100
Box files	3	200	600
Folders	5	50	250
Stapler	1	500	500
Paper punch	1	500	500
Note book	2	150	300
White out pen	1	150	150
Thermometer MT-111	1	11000	11000
Printing and photocopying		10000	10000
Proposal booklets	8	2500	20000
Ethics committee book		2000	2000
Poster	1	3000	3000
Communication			5000
Statistician fee			30000
Research assistant	Approximately 60 days	1000/day	60000
Contingency			30000
Grand total			**173700**

Appendix 3a. <u>Consent Form for Parents/Guardians of Participants</u>

Title of study: Prevalence and risk factors of hypothermia at admission to new born unit in Kenyatta National Hospital**.**

Institution: Department of Paediatrics and Child Health, UON

Principal Investigator: Dr Sharon Ocharo

Supervisors: 1. Dr Jalemba Aluvaala 2. Prof Christine Jowi

Department of Paediatrics and Child Health

University of Nairobi

Ethical Approval: This study has the approval of Kenyatta National Hospital/University of Nairobi Ethical and Research Committee (KNH-UON ERC)

Introduction:

I wish to inform you about a medical research conducted by the above researchers. The purpose of having this discussion with you is to inform you on the aim of this study so that you can make an informed choice on whether to participate. Please feel free to ask any questions regarding any risks or benefits accorded to you for agreeing to participate in this research. We will clarify anything you have not understood. I will ask you to sign the consent form below once you are satisfied. Kindly read through the rest of this form to understand the general principles that apply to all medical researches.

What is this research about?

The purpose of this study is to find out how frequent is hypothermia at the time of admission of neonates to NBU. The findings of this research will enable the clinicians taking care of your child manage them more holistically. This research also aims to find what are the risk factors for neonatal hypothermia.

Procedure

With your permission, I will take information on your gynaecological history and about this current delivery from the medical file and use it in the study. All information obtained will be handled in secrecy. This process will take about 10 minutes.

Are there any risks involved?

There will be no dangers to your health since we shall only take the axillary body temperature which is a routine procedure and ask questions. We will not give you any medicine or perform any procedures on you. None of your rights will be infringed during this research**.**

Benefits

There will be no direct benefits to you, however, the findings of this research will be shared with your doctor so that your illness can be better understood and managed better.

Assurance of confidentiality

All the information obtained from you will be kept in utmost confidence. Your name will not be used or mentioned during handling of the data or in any resulting publication. Serial numbers will be used instead.

What are your rights as a participant?

1. You agree to participate in this research voluntarily.
2. You are free to withdraw from this research at any point without having to explain your reasons.
3. Your refusal to participate in this research will not be held against you and it will not influence the services you are entitled to in this hospital.
4. You can ask a questions that will enable you to clearly comprehend the nature of this research.
5. A copy of this form will be given to you for your records.

Contacts

Should you have any questions about your rights as a research participant, feel free to get in touch with any of the following:

1. Principal investigator :

    - Dr Sharon Ocharo

      Tel 0701095174

      Email sharonocharo@gmail.com

2. Supervisors:

    - Dr. Jalemba Aluvaala

      Tel 0722217034

      jaluvaala@uonbi.ac.ke

    - Prof. Christine Jowi

      Tel 0722293454

      yukojowi@gmail.com

3. The Chairperson, KNH-UON ERC Committee

   Tel 2726300/2716450 Ext 44102

   Email uonknh-erc@uonbi.ac.ke

I now request you to sign the attached consent form below:

CONSENT TO PATICIPATE IN THE STUDY

I have read and have also been clarified to the content on this consent form and I have fully understood. The risks and benefits have been explained to me. I understand that my participation is voluntary and that I am free to withdraw from the study at any point without any loss of benefit or injustice to me. I have also understood that all efforts will be made to keep my personal identification confidential.

Name of participant…… Date……

Signature of participant…….

Researcher's statement

I confirm that I have explained the details of the research to the participant and that he/she has understood.

Name of researcher…… Date…….

Signature of researcher…….

APPENDIX 3b. <u>Kiswahili consent form/ Fomu ya Idhini kwa wazazi/ walezi wa washiriki</u>

Kichwa cha masomo: Ubora wa maisha ya watoto walio na kikohozi sugu katika Hospitali ya Taifa ya Kenyatta.

Taasisi: Idara ya watoto, Chuo Kikuu cha Nairobi

Mtafiti mkuu: Daktari Sharon Ocharo

Wasimamizi: 1. Dkt Jalemba Aluvaala 2. Prof. Christine Jowi

Idara ya watoto, Chuo Kikuu cha Nairobi

Idhini ya maadili: Utafiti huu umeruhusiwa na Kamati ya Maadili na Utafiti katika Hospitali ya Taifa ya Kenyatta na Chuo Kikuu cha Nairobi (KNH-UON ERC)

Utangulizi:

Ningependa kuwajulisha kuhusu utafiti utakaofanywa na watafiti waliotajwa hapo awali. Kusudi la majadiliano haya nanyi ni kuwajulisha nia ya utafiti huu ili muweze kufanya uamuzi bora kushiriki katika utafiti huu. Tafadhali jisikie huru kuuliza maswali yoyote kuhusu hatari au faida utakayopewa utakapo kubali kushiriki katika utafiti huu. Tutafafanua jambo lolote ambalo hamtaelewa. Nitawaomba muweke sahihi kwenye idhini mtakapoelewa kila kitu. Kwa fadhili someni ukurasa uliobakia ili muelewe kanuni za jumla zinazo hitajika katika utafiti huu.

Utafiti huu unahusu nini?

Umuhimu wa utafiti huu ni kugundua joto la chini hupatikana mara ngapi kwa wazaliwa wapya wanapolazwa hospitalini. Matokeo ya utafiti huu yatawawezesha wauguzi wanaowatunza watoto wenu kuwatunza bora zaidi. Utafiti huu pia unaazimia kutafuta sababu zinazoweza kusababisha hili joto la chini.

Utaratibu:

Kwa ruhusa yenu, tutawauliza maswali kuhusu maelezo yenu ya kibinafsi kuhusu maoni yenu katika ustawi wenu kulingana na kikohozi kinachowaathiri. Maoni yote yatakayotolewa yatabebwa kwa usiri. Mchakato huu utachukua kama dakika 20.

Je, kuna hatari zinazohusika?

Ni maswali tu yatakayo ulizwa kwa hivyo hatari yoyote kwa afya yako haitakuwemo kwa kuwa hakuna dawa zitakazopeanwa wala utaratibu utakaofanywa. Utafiti huu utahakikisha kuwa haki zote zimedumishwa.

Faida

Hakutakuwa na faida za moja kwa moja lakini daktari wako atajulishwa kuhusu matokeo ya utafiti huu ili ugonjwa huu ueleweke na utibiwe vyema zaidi.

Uhakikisho wa Usiri

Habari yote itakayo patikana kwako itahifadhiwa kwenye usiri mkubwa kabisa. Jina lako halitatajwa katika utunzaji wa habari wala katika chapisho lolote. Nambari za kodi zitatumiwa badala yake.

Haki zako kama mshiriki ni zipi?

1. Umekubali kushiriki kwa hiari yako kwenye utafiti huu
2. Unaweza jiondoa kutoka kwenye utafiti huu wakati wowote bila kueleza sasabu za kujiondoa.
3. Kukataa kushiriki kwenye utafiti huu hautatumiwa dhidi yako na hautashawishi huduma unazostahili kupokea hospitalini.
4. Unaweza uliza maswali zitakazokuwezesha kuelewa kwa upana muundo wa utafiti huu.
5. Utapewe nakala ya hati hii ujiwekee.

Mawasiliano

Ukiwa na maswali kuhusu haki zako kama mshiriki wasiliana nasi kupitia njia hizi:

1. Mchunguzi Mkuu:

   Dkt Sharon Ocharo

   Tel 0701095174

   Email sharonocharo@gmail.com

2. Wasimamizi :

   - Dr. Jalemba Aluvaala

     Tel 0722217034

     jaluvaala@uonbi.ac.ke

   - Prof. Christine Jowi

     Tel 0722293454

     yukojowi@gmail.com

2. Mwenyekiti wa kamati KNH-UON ERC

   Tel 2726300/2716450 Ext 44102

   Email uonknh-erc@uonbi.ac.ke

Nakuomba sasa uweke sahihi kwenye idhini hapo chini

IDHINI YA KUSHIRIKI KWENYE UTAFITI

Nimesoma na nikaelezewa yaliyomo kwenye idhini hii na nimeelewa kabisa. Hatari na manufaa yote yameelezewa. Naelewa kuwa kushiriki kwangu ni kwa hiari yangu na nikona uhuru wa kujiondoa kutoka kwenye utafiti huu wakati wowote bila kupoteza manufaa wala haki zozote zangu. Pia nimeelewa kuwa juhudi zote zitachukuliwa kuhakikisha kuwa jambo lolote linaloweza kunitambuluisha litatunzwa kisiri kabisa.

Jina la mshiriki…… Tarehe……

Sahihi ya mshiriki…….

Taarifa ya mtafiti

Ninathibitisha kuwa nimefafanua maelezo yote ya utafiti kwa mshiriki na kuwa ameelewa.

Jina la mtafiti..... Tarehe……

Sahihi ya mtafiti……..

Appendix 4. KNH-NBU transfer form

KNH/NBU/005

Kenyatta National Hospital Newborn Unit Transfer Form

(Complete for neonates from Maternity, Paediatric wards and Referrals in)

Infant's Details									
Name				**Date of transfer to NBU**					
Date of Birth	(dd/mm/yyy)			**Sex**	F☐ M☐		**IP. No**		
Apgar	1m	5m	10m	**Birth Wt**	gms		**Age**	days	hrs
Baby from?	Theatre ☐	Labour ward ☐	Postnatal ward ☐	Paed ward ☐	Referral in☐				
If referral, name of referring facility									
Place of birth?	KNH☐ Home/Roadside ☐Other facility☐								
Reasons for transfer/referral to NBU:									

Mother's details									
Name				**Age**			**IP No.**		
Parity	+		**Gestation(wks)**		**LMP**		**EDD**		
ANC visits	Y☐ N☐ *if yes*	Number of visits			Antenatal US	Y☐ N☐			
Blood Grp	☐A☐B☐AB☐O☐unkn.		**Rhesus**	☐Pos☐Neg ☐unkn.		**VDRL**	☐Pos☐Neg☐unkn.		
PMTCT Status	☐Pos☐Neg☐unkn.		**Mother ARVs**	Y☐ N☐		**Diabetes**	Y☐ N☐	☐unkn.	
TB treatment	Y☐N☐ ☐unkn.		**HTN in Pregnancy**	Y☐N☐	☐unkn	**Eclampsia**	Y☐N☐		
PET	Y☐N☐	**Fever**	Y☐ N☐	**Antibiotics**	Y☐N☐	**APH**	Y☐N☐	**Multiple Pg**	Y☐N☐
Any other maternal condition									
Current Maternal Drugs									

Delivery									
Labour	**1st Stg**	hr	**2nd Stg**	min	**Time of Delivery**		**ROM**	☐ <18h☐ >18h	
Fetal Distress	Y☐N☐	**Meconium**		Y☐N☐	**If yes, Meconium grade?**	☐1	☐2	☐3	
Delivery	☐SVD ☐Vacuum	☐Breech	☐CS	*If CS, type?*	☐Elective	☐Emergency			
Reason for Emergency CS									
BVM Resuscitation?	Y☐N☐	**ECCompressions?**		Y☐N☐	**Res'sc. duration (min)**				
Oxygen?	Y☐N☐	**CPAP?**		Y☐N☐	**Surfactant**	Y☐N☐			
Preventive care given?	**OPV**	Y☐ N☐	**BCG**	Y☐ N☐	**TEO**	Y☐ N☐	**Vit K**	Y☐N☐	**Chlorhexidine**	Y☐ N☐
Brought in by(Name):							**Signature**		
Received on NBU by(Name) :			**Signature**			**Time**		**am/pm**	
.....			.....						

Version August 2019

Appendix 5. Newborn data abstraction tool

Date		**Patients initials**	
Serial no.			

Baby's perinatal details

Baby Name				**Date of Admission**		/ / 20			**IP No.**		E
DOB	**dd mm yy**		**Age**	days	hrs	**Sex**	**F** □	**M** □		**Birth Wt**	• kg
Gest'n	wks		**Temp (^{0}C)**			**Apgar**	1m	5m	10m	**Wt now**	• kg
BBA?	Y □	N □	***..if Yes born where***			home□		Other health facility □			
Delivery	SVD□		Assisted□			Breech□		CS□			
ROM	<18h		>18h								

Mother's details

IP No.	**Mother's age**																
ANC Visits	**Y**	**N**	**LMP**	**dd mm yy**		**EDD**	**dd mm yy**		**TT rec'd**		**Y**	**N**	**E**				
Gravidity			**Parity**			**Bl'd Gp**			**Rh gp**		**+**	**-**	**E**				
Labour	hrs			**Induction / Augmented**	**Y**	**N**	**E**	**Fever**	**Y**	**N**		**Anti-biotics**	**Y**	**N**			
HIV	**+**	**-**	**E**	***if HIV +ve, ARVs given***	**Mother** **Y□ N□ E** □			**Baby** **Y□ N□ E** □									
Pregnancy type				**Singleton□ Multiples□**				**TB treatment Y□ N□**									
Eclampsia Y□ N□				**Hypertension in pregnancy Y□ N□**				**PET Y□ N□**									
Fever Y□ N□				**APH Y□ N□**				**Diabetes mellitus Y□ N□**									
Time of birth								**Time of admission**									

History

Length of illness			days
Fever	**Y**	**N**	**E**
Difficulty breathing	**Y**	**N**	**E**
Apnoeas	**Y**	**N**	**E**
Diarrhoea	**Y**	**N**	**E**
Convulsions	**Y**	**N**	**E**
Partial / focal fits	**Y**	**N**	**E**
High pitched cry	**Y**	**N**	**E**
Difficulty feeding	**Y**	**N**	**E**
Severe vomiting	**Y**	**N**	**E**

Admission Examination

Temp	^{0}C	**Resp Rate**	**/min**	**O_2 Saturation**	**%**	**Pulse**	**/min**	Weak / Norm / E

		Normal	Abnormal			
General Exam	**Appearance**	Well	Sick			E
	Nutrition	Normal	SGA	Large (>4kg)		E
	Jaundice	None	+	+++	NC	E
	Pallor	None	+	+++	NC	E
	Skin	Normal	Bruising	Rash	Severe Pustules	E
	Gestational age(wks)					E
Airway / Breathing	**Cry**	Normal	Hoarse	Weak / absent		E
	Airway	Normal	Stridor	Noisy breathing		E
	Grunting	None	Sustained			E
	Cyanosis	None	Central		NC	E
	Indrawing	None / mild	Severe	Sternal retraction		E
	Chest movement	Symmetrical	Asymmetrical			E
	Breath Sounds	Normal	Crackles			E
Circulation	**Femoral pulses**	Present	Absent			E
	Skin warms at	Hand	Forearm	Elbow	Shoulder	E
	Capillary refill	< 2 secs	2-3 secs	> 3 secs		E
	Heart sounds	Normal	Murmur			E
Disability						
	Abnormal move'nts	None	Jittery	Fitting	NC	E
	Tone	Normal	Floppy	Stiff	NC	E
	Suck reflex / feeding	Normal	Absent / unable		NC	E
	Fontanelle	Normal	Bulging			E
Abdo	**Abdomen**	Normal	Distended	Scaphoid	Large liver	E
	Umbilicus	Normal	Flare / red skin	Pus	Bleeding	E
Congenital Anomaly		Y	N			E

Admission Diagnoses					
Birth asphyxia	☐	***Meconium aspiration***	☐	***Other diagnosis 1 (name below)***	☐
Premature / LBW	☐	***Twin delivery***	☐		
Newborn RDS	☐	***Jaundice***	☐		
Neonatal sepsis	☐	***Meningitis***	☐		
Congenital abnormality	☐				

Appendix 6. Warm chain assessment checklist

Date……. Ward…… Week of assessment……..

No	ITEM	RESPONSE Y-YES N-NO	COMMENTS/OBSERVATIONS
1.	Is there a source of heat?	**Y☐ N☐**	
	If yes to above specify	Radiant heater **Y☐ N☐** Incubator **Y ☐ N☐** Central heating **Y ☐ N☐**	
2.	Is there a resuscitaire?	**Y☐ N☐**	
	If yes to above does it have an overhead heater	**Y☐ N☐**	
3	Are there incubators for transporting babies?	**Y☐ N☐**	
	If yes to above the incubators pre-heated?	**Y☐ N☐**	
4.	Are there more than 2 towels in a delivery pack?	**Y☐ N☐**	
	Is there a neonatal cap in the delivery pack?	**Y☐ N☐**	
5.	Is the room draught free? Are there Open windows?	**Y☐ N☐**	
	Are there open doors?	**Y☐ N☐**	
6.	Is there a wall thermometer?	**Y☐ N☐**	