# INCIDENCE, RISK FACTORS AND NEONATAL OUTCOMES OF UNEXPECTED TERM NEWBORN ADMISSIONS AT KENYATTA NATIONAL HOSPITAL

PRINCIPAL INVESTIGATOR:
DR. AMANDA EZINNE OCHWANDO KENYA
H58/6823/2017
DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY,

A RESEARCH DISSERTATION SUBMITTED IN PARTIAL FULFILMENT FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE, IN DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY, FACULTY OF HEALTH SCIENCES, UNIVERSITY OF NAIROBI.

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## DECLARATION

This thesis is my original work and has not been presented for the award of a degree in any other university.

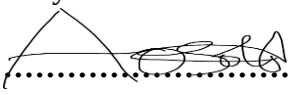
**Signature..**  **Date**: 10/06/2023

**Dr. Amanda Ezinne Ochwando Kenya,**

## CERTIFICATE OF SUPERVISION

This dissertation has been submitted with our approval as university supervisors:

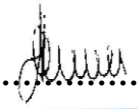
**Dr. Alfred Osoti, MBChB, MMed (Obs & Gyn), MPH, PhD**
Senior Lecturer, Department of Obstetrics and Gynaecology, Faculty of Health Sciences, University of Nairobi.

**Signature:**  **Date: 10.06.23**

**Dr. Allan Ikol, MBChB, MMed (Obs & Gyn) UoN**
Consultant,Obstetrician and Gynaecologist,Departmentof Obstetrics and Gynaecology, Kenyatta National Hospital.

**Signature:**  **Date:** 10/06/2023

**Dr. Jalemba Aluvaala, MBChB,MMed(Paeds&Child Health), PhD**
Lecturer, Department of Paediatrics and Child Health, Faculty of Health Sciences, University of Nairobi. Consultant Paediatrician, Kenyatta National Hospital.

**Signature:**  **Date**:10/06/2023

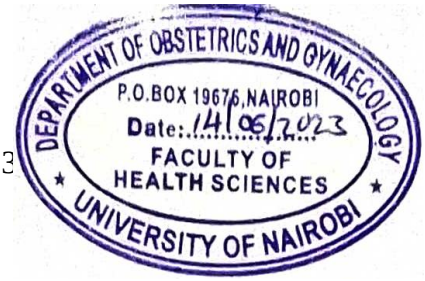
# CERTIFICATE OF AUTHENTICITY

This is to certify that this dissertation is the original work of **Dr. Amanda Ezinne Ochwando Kenya,** MMed student registration Number **H58/6823/2017** in the Department of Obstetrics and Gynaecoloy, Faculty of Health Sciences, University of Nairobi.

This dissertation has not been presented in any other university for award of a degree.

**Professor Eunice J. Cheserem, MBChB, MMed (Obs/Gyn), PGDRM, Fell. Gyn/Oncol**
Associate Professor and Chair, Department of Obstetrics and Gynaecology, Faculty of Health Sciences, University of Nairobi.

**Signature:** ..... **Date:** 14/06/23



## DEDICATION

This thesis is dedicated to all mothers and their babies.

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This work would not have been accomplished without the grace of the Almighty God.

I sincerely thank my parents for all the sacrifices they made to see me come this far, and for their undying love and support.

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**ABBREVIATIONS**

| | |
|---|---|
| AMA | Advanced maternal age |
| ANC | Antenatal clinic |
| ARM | Artificial rupture of membranes |
| BMI | Body mass index |
| BPP | Biophysical profile |
| CS | Cesarean section |
| DM | Diabetes Mellitus |
| EDD | Estimated date of delivery |
| FBS | Fasting blood sugar |
| FGR | Fetal growth restriction |
| GA | Gestational age |
| GDM | Gestational diabetes |
| GH | Gestational Hypertension |
| Hb | Haemoglobin |
| HIV | Human immunodeficiency virus |
| Hx | History |
| IOL | Induction of labour |
| KNH | Kenyatta National Hospital |
| LBW | Low birth weight |
| LGA | Large for gestational age |
| LNMP | Last normal menstrual period |
| MAS | Meconium aspiration syndrome |
| MSL | Meconium-stained liquor |
| NBU | Newborn Unit (including NICU) |
| NCU | Neonatal Care Unit |
| NHS | National Health Service |
| NICU | Neonatal Intensive Care Unit |
| NU | Neonatal units (NBU and NICU) |
| PGD | Pregestational diabetes |
| pH | Acidity or alkalinity of a solution |
| PTB | Preterm birth |

| | |
|---|---|
| PROM | Premature rupture of membranes |
| PSH | Pregnancy-specific hypertension |
| RBS | Random blood sugar |
| RDS | Respiratory distress syndrome |
| SGA | Small for gestational age |
| SPSS | Statistical Package for Social Scientist |
| TOLAC | Trial of labour after cesarean section |
| TTN | Transient tachypnea of the newborn |

## OPERATIONAL DEFINITION OF TERMS

**Active phase of labour:** Cervical dilatation of at least 4 cm [1].

**Case-control study:** This type of study is designed to help determine if an exposure is associated with an outcome (i.e., disease or condition of interest). To do so, first the cases (a group known to have the outcome) are identified, then the controls (a group known to be free of the outcome). After this, the investigators look back in time to learn which subjects in each group had the exposure(s), comparing the frequency of the exposure in the case group to the control group.

**Case:** In this study, the cases were all term neonates ($37^{+0}$ – $41^{+6}$ gestational age) admitted to the NICU between 1 January and 31 December 2019. The mother of each case is referred to as a **mother-case**.

**Chorioamnionitis:** An intra-amniotic infection. For the purposes of this study, chorioamnionitis was based on maternal fever of 38°C or greater with supporting clinical evidence including fetal tachycardia, uterine tenderness, and mal-odorous infant [2].

**Control:** Term neonates ($37^{+0}$ – $41^{+6}$ gestational age) who were not admitted to NBU/NICU at KNH during the study period. The mother of each control is termed **mother-control**.

**Early neonatal outcomes:** Outcomes occurring from birth to 6 days of age [3].

**Expected term newborn admission:** When NBU/NICU admission is anticipated following an antenatal diagnosis.

**Fetal compromise:** Antepartum or intrapartum fetal distress as evidenced by abnormal fetal heart rate (fetal tachycardia < 110 or fetal bradycardia > 160 beats/minute, auscultated intermittently using a pinard or hand-held Doppler), pathological cardiotocograph (fetal tachycardia, fetal bradycardia, reduced variability (less than 5

bpm), decelerations of the fetal heart rate (early, late or variable)), abnormal biophysical profile (BPP ≤4) on ultrasound, or abnormal flow (absent or reversed end-diastolic flow) on umbilical artery Doppler velocimetry. [4] [5] [6][7].

**Fetal heart rate irregularities:** Fetal tachycardia, fetal bradycardia, reduced variability (less than 5 bpm), or decelerations of the fetal heart rate (early, late or variable) [4] [5].

**First stage of labour:** The period of time from the onset of labour to full cervical dilatation [1].

**Grand multiparity:** A woman delivering after the 28$^{th}$ week of gestation, after five or more previous viable pregnancies [8].

**Great grand multiparity:** A woman delivering after the 28$^{th}$ week of gestation after ten or more previous viable pregnancies [8].

**Incidence:** The frequency or number of new occurrences of a health problem (clinical condition) in a population of susceptible individuals who were initially free of that condition before the time period being examined [9].

**Interpregnancy interval:** The duration of time from her last delivery to the time a woman is not pregnant between one live birth or pregnancy loss and the next pregnancy [10].

**Latent phase of labour:** Labour with cervical dilatation of ≤ 3 cm [1].

**Mother-case:** A mother who was selected for the study to represent 'a selected case', where the 'selected case' is her unexpected term neonate admitted to the neonatal unit.

**Multiparity:** A woman undergoing her second to fourth delivery (International Federation of Gynecology and Obstetrics, 1993) [11].

**Nested case–control (NCC):** a variation of a case - control study in which cases and controls are drawn from the population in a fully enumerated cohort. Usually, the exposure of interest is only measured rather than the full cohort design. The nested case–control study can be analyzed using methods for missing covariates. Commonly, 1 - 4 controls are selected for each case [12]. In this study, 2 controls will be selected for each case.

**Normal labour:** The spontaneous onset of regular, painful uterine contractions associated with the effacement and progressive dilatation of the cervix and descent of the presenting part – with or without a 'show' or ruptured membranes [1].

**Nulliparous:** A woman delivering after the $28^{th}$ week of pregnancy after no previous viable pregnancy [8].

**Parity:** The number of previous pregnancies of >28 weeks [8].

**Partograph:** A form that has been established as the gold-standard labour monitoring tool universally [13].

**Preeclampsia with severe features:** Systolic blood pressure of at least 160 mmHg, diastolic blood pressure of at least 110 mmHg, platelet count less than $100 \times 10^3$ per μL, liver transaminase levels two times the upper limit of normal, a doubling of the serum creatinine level or level greater than 1.1 mg per dL, severe persistent right upper-quadrant pain, pulmonary edema, new-onset cerebral or visual disturbances, or any evidence of end-organ dysfunction [14] [15].

**Second stage of labour:** The period of time between full cervical dilatation and time of birth of the newborn [1].

**Term newborns:** A neonate born between $37^{+0}$ to $41^{+6}$ weeks gestation [16].

**Uncontrolled diabetes:** Diabetes whereby the patient is on medication for the disease but blood sugar levels remain above the recommended (HBA1C > 6.5%, persistent FBS of >7.1 mmol/L, or persistent RBS of >11.1 mmol/L) [17].

**Unexpected term newborn admissions:** Neonates born at term who had no pre-existing conditions or antenatal clinical concerns, and whose admission to a neonatal unit was not anticipated [18].

## LIST OF TABLES AND FIGURES

## LIST OF TABLES



## LIST OF FIGURES

**TABLE OF CONTENTS**

## ABSTRACT

**Background:** Whilst admission to neonatal units (NBU) is usually thought of in terms of congenital anomalies and prematurity, admission of term neonates, though unexpected, is not rare. The proportion of term newborns admitted to newborn units annually is approximately 5-18%, and most of these are unexpected. The incidence of term newborn admissions to neonatal units in Kenya is currently unknown. Globally, factors associated with admission of term neonates include extremes of maternal age, minority ethnicity, low socioeconomic status, operative mode of birth, elective delivery before 39 weeks, maternal hypertension and maternal diabetes. There are limited local and regional studies on the burden of and risk factors for unexpected term newborn admissions. This study used hospital data and records to determine the incidence and describe the risk factors of unexpected term newborn admissions to neonatal units, as well as the neonatal outcomes.

**Objective:** To determine the incidence, risk factors, and early (one week) neonatal outcomes of unexpected term newborn unit (NBU) admissions at Kenyatta National Hospital (KNH).

**Methods:**

*Study Design:* This was a descriptive, hospital-based study comprising 2 components: an incidence study and a nested case-control study to evaluate the risk factors for NBU admission.

*Study Population:* All term ($37^{+0}$ – $41^{+}6$), live-born neonates born at KNH between Jan 1st 2019 – Dec 31st 2019 and the mothers of those newborns. A case was a term neonate admitted to NBU/NICU during the study period. The mother of a case was a mother-case. A control was a term neonate who was born during the study period and was not admitted to NBU/NICU. The mother of a control was a mother-control.

*Study Site:* Kenyatta National Hospital.

*Sample Size:* A sample size of 50 cases and 100 controls was used.

*Data Collection:* Data was collected using a data extraction form, from files of the identified cases and selected controls.

*Data Analysis:* Data was analysed using the Statistical Package for Social Sciences version 23 (SPSS). The incidence of unexpected term newborn admissions was determined by getting the total of all unexpected term newborn admissions taken as a

proportion of all the term live-born neonates born at the KNH during the study period and reported as a percentage. Comparison of the maternal sociodemographic and clinical characteristics, as well as neonatal characteristics were done with the use of Pearson Chi-square test. Neonatal outcomes were reported as frequencies and proportions. Univariate and multivariate analysis with the use of logistic regression was performed on the antepartum and intrapartum risk factors, maternal and clinical characteristics, and neonatal characteristics. Crude and adjusted Odds Ratio with their 95% confidence interval were reported. All statistical tests were considered to be significant where the p-value < 0.05.

**Results:** Of the 10,315 term neonates born at KNH during the study period, 1,729 (16.76% (95% CI: 16.05%, 17.50%)) were unexpected term admissions. The median length of stay was 5.0 (IQR 3.0 – 6.5) days and 26% of neonates remained admitted after 1 week. The death rate within 1 week was 2%. In the fully adjusted model, the factors associated with the highest odds for term admission included: maternal comorbidities (aOR3.4 [95% CI: 1.04, 11.2]), antenatal Hb <10 g/dl (aOR3.0 [95% CI: 0.9, 10.8]), thin MSL (aOR11.5 [95% CI: 2.2, 59.5]), elective CS (aOR41.2 [95% CI: 7.0, 241.2]) and emergency CS (aOR4.3 [95% CI: 1.4, 13.3]). An identified protective factor was delivery in late term.

**Conclusion:** This study contributes to the currently limited understanding of term, neonatal admission rates as a marker of obstetrical care quality. The incidence of unexpected term neonatal admissions at KNH is on the higher end of the worldwide range. Mothers at risk should receive augmented antenatal care to attenuate term neonatal admission. The crucial contributing factors should be earmarked and analysed further over a longer timeframe with a multi-disciplinary team to reduce the rate of admissions and enhance quality of care.

**Key words:** unexpected, term newborn admissions, risk factors, NBU, NICU, KNH

## CHAPTER ONE: INTRODUCTION

Newborn units (NBU) and neonatal intensive care units (NICU) give care to newborns who are born premature, unwell or who need to be observed after birth. These units are a very busy part of a hospital, with most running at full capacity [19]. Although these units offer life support to neonates, admission may culminate in risks for the admitted newborns as well as their families, including a financial burden [20], interruption of establishment of breastfeeding , as well as mother-infant bonding [21].

Infants who begin their lives in the medicalized environment of a neonatal unit have the potential for great divergence in long-term health outcomes. For instance, infants of similar gestational ages who have comparable courses of medical care in the NICU may have very different outcomes [22]. This variability occurs despite fairly standardized protocols and regimented care-giving practices.

Beyond mere states of health or illness, infants who require NICU after birth are exposed to adverse experiences that differ from what healthy newborns encounter [23]. The adversities many NICU infants endure include intense and chronic experiences of stress, pain and parent separation.

In a 2015 cross sectional study of neonatal units of 22 public hospitals in Kenya, Aluvaala et al. found that referral level hospitals in Kenya are poorly prepared to ensure newborn survival; and although most essential supplies were available, some major inadequacies were evident, for example, only 5 out of 14 facilities had an area assigned for providing kangaroo care, and only 10 out of 22 facilities could do blood cultures [24].

Neonates at risk of admission to NBU or NICU are those subjected to situations with increased odds of adverse outcomes, and who are more likely to have higher morbidity and mortality than average.

Term admission refers to admission of neonates who were delivered at term ($37^{+0}$ - $41^{+6}$ weeks gestation). Unexpected term admission refers to term, singleton, non-anomalous, liveborn infants without any prior risk for NBU or NICU admission, but who end up admitted to these units [25]. These admissions are adverse perinatal outcomes and require investigation [26].

In obstetrics, anticipating mothers who will require auxiliary care more than routine maternal and newborn care is not easy. Mothers without any antenatal risk factors and their neonates may encounter unanticipated complications during or after labour. Several studies have been done to determine the risk of unexpected maternal and neonatal adverse outcomes among pregnancies without predetermined antenatal risk factors [27].

Some factors linked to increased risk of term newborn admission to neonatal units worldwide include maternal age, low socioeconomic status, minority ethnicity, nulliparity, maternal diabetes and hypertension, small and large for gestational age (SGA and LGA), induction of labour (IOL), no trial of labour, prolonged second stage of labour, meconium stained liquor (MSL), chorioamnionitis, nuchal chord, placental abruption, presence of a uterine scar, operative mode of birth, elective delivery prior to 39 weeks via cesarean section (CS) or vaginally, placental abruption, and operative mode of delivery [12], [13], [14], [15].

The most common indications for admission identified in these studies include; respiratory distress, non-bilious vomiting, congenital abnormalities, hyperbilirubinemia, hypotonia, and suspected sepsis [29], [63].

Unidentified confounders and extrinsic factors, for example, availability of NBU/NICU beds, may limit the potential for unanticipated term newborn admissions to truthfully reflect the quality of obstetrical care. However, unexpected term neonatal admissions and unanticipated perinatal complications have been suggested as neonate-focused quality metrics for intrapartum care by the; Society for Maternal-Fetal Medicine in 2016, National Quality Forum for Perinatal and Reproductive Health in 2018, and California Maternal Quality Care Collaborative in 2018 [25]. Worldwide, unexpected term admissions represent a significant portion of NICU and NBU admissions, and are major contributors to workload.

The timely identification of risk factors, followed by appropriate interventions, may modify the effects of unexpected admission of term newborns to neonatal units. Therefore, the aim of this study is to determine the incidence, risk factors and early neonatal outcomes of unexpected term newborn admissions at KNH.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

Whilst admission to NBU is commonly considered in terms of congenital anomalies or prematurity, available literature indicates that admission of term newborns (born at ≥37 weeks of gestation), though unanticipated, is not uncommon [29].

Some term admissions may be indicated even if all appropriate measures have been taken, e.g., for a baby needing surgical intervention due to a congenital anomaly. Other admissions may represent effective execution of improvement programs, such as stillbirth reduction programs. Some neonates need antibiotics or phototherapy for jaundice, although newborns with these conditions who are well may be managed without being separated from their mothers in a transitional care setting.

Worldwide, approximately 5–18% of term newborns are admitted to NICU yearly, with most of these being unexpected [28]. There were 48,000 term newborn admissions in England, 2013. By 2015 this number had increased to 54,821 even with a fall (3.6%) in the term live births [19]. The numbers appear to be much higher in Kenya. The proportion of term newborn admissions in KNH is currently unknown, however, a 2015 audit of neonatal care services of 22 public hospitals in Kenya found that 50% (44%-56%) of the neonates admitted were term [24], although 55% of neonates in the study did not have documented gestation by dates.

The risk factors associated with term newborn admission include; operative mode of delivery [30], [31], elective delivery before 39 weeks via CS or vaginal delivery [32], maternal hypertension and diabetes, maternal age, minority ethnicity and low socioeconomic status [33]. As the gestational age increases beyond 40 weeks gestation, risks to the mother as well as the baby have been found to increase [34], [35]. Excessive weight gain of the mother and obesity has also been linked to adverse perinatal outcomes at term [36], [37]. The use of instruments during delivery has also been implicated in term neonatal admission to NICU [38], [39].

In low-to-middle-income countries, the neonatal period has long been neglected, leading to a steady neonatal mortality rate, despite considerable advancements of child care and survival in the last few decades [40]. Neonatal mortality has not been an indicator but has been included in the wider term of infant mortality. The causes of

death in the neonatal period have been grouped as "neonatal causes", not further specified, despite the range of interventions needed in different situations, sometimes leading to death [41].

It is necessary to put more emphasis on using current data to identify the segment of the population where programs need to be strengthened in order to achieve the goal of reducing neonatal mortality. This study therefore attempts to contribute to research that have used hospital-based data and records to examine the factors linked to unexpected term newborn admission to neonatal units.

## 2.2 Antepartum Risk Factors for Unexpected Term Newborn Admissions

### 2.2.1 Maternal Risk Factors

Some of the maternal risk factors linked to unexpected term newborn admission include low or advanced maternal age (AMA) (>35 years), being unmarried, low socioeconomic status, and low level of education.

Over the last few decades, pregnancy at AMA has become commonplace. AMA has been identified as a risk factor for gestational diabetes (GDM) [42], gestational hypertension (GH), preeclampsia [43], SGA infants [44], late preterm delivery and CS [45]. All the above risk factors increase the odds of neonatal admission [46].

Adolescents (10-19 years) are also vulnerable to adverse perinatal outcomes [47].

A low education level as well as AMA have been linked to fetal death and other adverse perinatal outcomes in some studies [48], [49]. Neonates born to families of lower socioeconomic status are also at increased risk of poor outcomes [35], [48].

Marital status also plays a role; current theories that link marital status and birth outcomes include an absence or paucity of security, stability, and socio-psychological support in the relationship for women who are not married [50]. Studies have shown that compared to married mothers, single mothers are more prone to preterm birth, low birth weight and perinatal deaths [51], however, a retrospective case-control study in 2005 in Israel which included 304 women found that unmarried and married women had almost the same pregnancy outcomes on mode of delivery, Apgar score, and length of gestation [52]. However, a systematic review revealed that being unmarried (single or cohabiting) is associated with markedly higher odds of and preterm birth (PTB),

SGA births, low birth weight (LBW); which would all result in neonatal admissions [53].

The Apgar score is a quantitative expression of an infant's physiological condition and is used immediately after birth. It is taken at 0, 5, and 10 minutes post-delivery. It has been in use for more than 60 years. It includes 5 signs; colour, heart rate, reflex irritability, muscle tone and respiration, which are each scored 0-2 points and summed up. The highest possible score is 10. A "low" score is generally considered to be <7. This scoring system, however, has limitations and should not be used alone to diagnose birth asphyxia or predict neurological morbidity. Some components of the Apgar score, such as colour and reflex irritability, are subjective and may be influenced by numerous factors such as gestational age, maternal anaesthesia, congenital malformations, and birth trauma. Due to this, a low score cannot predict morbidity or mortality for any individual infant [54] [55]. There have been no studies at KNH on the utility and/or limitations of the Apgar score.

### 2.2.2 Pregnancy Risk Factors

Pregnancy-related risk factors associated with unexpected term newborn admission include: nulliparity/grand multiparity, interpregnancy time interval (IPI), gestational age >40 weeks, multiple gestation, chronic/gestational hypertension, pre-gestational diabetes (PGD), GDM, maternal malnutrition, maternal obesity, SGA and LGA.

Parity is often classified into 4 groups: nulli-parity, multiparity, grand parity, and great grand multiparity. It is not clear whether this classification of parity is appropriate in terms of pregnancy outcomes. In the medical literature, parity is either regarded as a continuous or a dichotomous variable [56]. In this study, parity will be analysed both as a continuous variable as well as in the 4 groups. Nulliparous women have increased odds of experiencing a prolonged 2$^{nd}$ stage of labour and therefore NICU admission [57]. Some studies, however, found that nulliparity is not a risk factor for poor perinatal outcomes and only leads to increased maternal morbidity and the rates of cesarean section [19]. Mothers and babies of nullipara and grand multipara (parity 5-8) are at higher risk [56], but this may be ameliorated by satisfactory socioeconomic and healthcare conditions [11].

According to a retrospective cohort study by DeFranco et. al in 2015, IPI length is a significant contributor to neonatal morbidity, independent of gestational age at birth. In this study, the frequency and adjusted odds of neonatal morbidity was lowest following IPI of 12 to <24 months (4.1%) compared to shorter IPIs of <6 months (5.7%) [58]. A meta-analysis of retrospective studies done in 2006 by Conde-Agudelo found that IPIs shorter than 18 months and longer than 59 months are significantly associated with increased risk of adverse perinatal outcomes [59].

Postterm pregnancy is an independent risk factor for perinatal morbidity even in singleton pregnancies with no other antenatal risk factors [60]. Seven percent (7%) of pregnancies reach postterm, which is defined as a pregnancy progressing beyond 42 weeks gestation (294 days or EDD + 14 days [61]) [62]. Many studies have linked postterm pregnancy to neonatal morbidity including; macrosomia, meconium aspiration syndrome (MAS), oligohydramnios, and fetal birth injury [63], [64], [65], [66], [67] all of which increase the odds of neonatal admission.

Multiple gestation, which is defined as the carrying of more than one fetus in a single pregnancy, has been found to be a leading risk factor for poor pregnancy outcome [68], [69], [70]. This is disproportionately true in low resource countries such as Kenya, as evidenced by a 2010 prospective multicentre study done by Marete et al. [71]. Up to half of women with a twin pregnancy will reach term (37 weeks gestation) and beyond. The risk of neonatal morbidity and mortality with twin pregnancies has been shown to rise with increasing gestational age [7]; and often elective delivery is carried out at this time, thus increasing the risk of admission to neonatal units.

Pre-pregnancy hypertension, gestational hypertension, and preeclampsia are well established features of high-risk pregnancies [72], [25]. At delivery, gestational age and birth weight are the main factors linked to admission of neonates born to mothers with preeclampsia [73].

Uncontrolled maternal diabetes (PGD or GDM) affects fetal growth, and readiness for extrauterine life. Some conditions commonly diagnosed in newborns born to mothers with diabetes mellitus (DM) type 1 and 2 include fetal macrosomia, infant respiratory distress syndrome (RDS), hypoglycemia, hypocalcaemia, hypomagnesaemia, hyperviscocity, polycythemia, and cardiomyopathy. The most frequent indications for admission of these babies are hypoglycemia and RDS [74]. Type 1 DM also increases the risk of preterm birth, preeclampsia and CS [75].

Hypoxic composite neonatal morbidity occurs more frequently in small for gestational age newborns while traumatic composite neonatal morbidity occurs more frequently with large for gestational age newborns, among women with uncomplicated term pregnancies [76], thus increasing their risk of neonatal admission.

Maternal nutrition has a major part to play in influencing the health and growth of the fetus and neonatal outcomes and is a significant modifiable risk factor. Maternal under-nutrition, including anemia and various micronutrient deficiencies [77] has been shown to result in poor neonatal outcomes such as fetal growth restriction (FGR), preterm birth (PTB) and low birth weight (LBW) [78]. On the other end of the spectrum, obesity (BMI >30) and inordinate weight gain in pregnancy have been linked to neonatal morbidity including primary CS, macrosomia, FGR and neonatal admission to NICU [79]. The Institute of Medicine guidelines recommend a total weight increase of 5-24.5 kg depending on starting weight [80].

In several studies, a low number of antenatal clinic (ANC) visits has been linked to maternal and perinatal complications. A longitudinal ecological study done by Nilson et al. between 1994 and 2004 in Brazil showed that higher number of antenatal visits lead to lower indexes of low birth weight [23]. Other studies show that poor antenatal care is a main factor associated with fetal death. In 2016 in Istanbul, Turkey, Eken et al. did a retrospective observational study involving 3607 neonates admitted to NICU for 2 years and found that babies born to mothers who had <7 ANC visits had a 1.3 higher risk of hospitalization [81]. There is therefore a need to enhance antenatal care, especially in vulnerable women [41].

### 2.3 Intrapartum Risk Factors

A case-control study by Burgess et al. which included 100 NICU and 100 non-NICU admissions born between 34-42 weeks gestation in 2015 in New York, USA showed that the intrapartum risk factors for admission to NICU are; induction of labor (IOL), elective and emergency CS, prolonged 1$^{st}$ and 2$^{nd}$ stage of labour, preterm labour, maternal fever, nuchal chord, late decelerations and fetal tachycardia. Protective factors include active labour and vaginal delivery [82].

Evidence suggests that induction of labour (IOL) may not make a difference (if at all) to the number of neonates admitted to NICU [83]. A retrospective cohort study done

by Darney et al. using 2006 data in California, USA also suggests that elective IOL is linked to reduced odds of CS compared to expectant management, irrespective of gestational age and parity, and is also not a risk factor for NICU admission [84]. In 2013, in Lausanne, Switzerland, Baud et al. did a retrospective study whereby medical records of 5090 patients that underwent IOL between 1997-2007 for either medical or elective reasons were reviewed, revealing that their neonates did not have higher odds of admission to NICU [27].

At 40 weeks gestation, neonates born via operative mode of birth have an increased risk of admission to NICU, as opposed to with those whose vaginal birth was unassisted [30]. In terms of CS timing, a 2018 prospective cohort study by Pirjani et al. in Tehran, Iran which included 2086 term singleton pregnancies scheduled for CS found that elective CS at 38–39 weeks gestation has been linked to higher odds of NICU admission and transient tachypnea of the newborn (TTN), compared to elective CS done after 39 weeks gestation.

In 2005, a cohort study by Bailit et al. in Chicago, USA compared active phase and latent phase low-risk nulliparous patients (6,121 and 2,697 respectively) and found a higher risk of CS among the patients admitted in latent phase of labor than those admitted in active labour [85], although it is not clear whether intrinsic abnormalities of parturition led to presentation in pre-active phase followed by clinical intervention, or whether early presentation and early clinician intervention resulted in abnormalities of labour. Maternal and perinatal outcomes may be improved by postponing admission till patients are in the active phase of labor, thus leading to reduced admissions to neonatal units.

The duration of the first stage of labor also has a major influence on term neonatal admission. Several studies have found a positive correlation between longer length of first stage of labour and higher odds of neonatal morbidity [86], [87]. Therefore, procedures aimed at reducing the length of the first stage of labor may indirectly lower the occurrence of adverse perinatal outcomes and admission of term neonates. One such procedure to reduce the length of the first stage of labor is timely augmentation with oxytocin [88]. In a randomized control trial, Hinshaw et al. found that early use of oxytocin resulted in decreased time to delivery, without impacting neonatal morbidity, maternal morbidity, or the number of CS [88]. A Cochrane review in 2008 done by Bugg et al. involving patients with primary dysfunctional spontaneous labour at term

had similar results [40]. Although few studies have been done to support routine amniotomy, it is a procedure that is used to shorten duration of labor.

A second stage of labor ≥240 min, regardless of the mode of birth, is a risk factor for admission to newborn units. Several studies have shown that prolonged second stage of labor is associated with adverse maternal and perinatal outcomes [89], [22]. However, a 2004 retrospective cohort study done by Cheng et al. in San Francisco, California, involving 15,759 nulliparous term births between 1976-2001 showed that prolonged 2$^{nd}$ stage of labour of >1 hour is linked to maternal morbidity but not poor perinatal outcomes [19].

Premature rupture of membranes (PRzOM) can lead to several pregnancy complications including; cord compression, prolapsed cord, abruption placenta leading to fetal distress, and rarely, infection [90]. An international retrospective multi-centre term PROM study done by Seaward et al. in 1998 in United Kingdom, Israel, Australia, Sweden, Denmark and Canada showed that some predictors of newborn infection in babies born in the setting of PROM include; clinical chorioamnionitis, positive maternal group B streptococcus status, 7-8 vaginal digital examinations, 24-<48 hours from rupture of membranes to active labour, ≥48 hours from rupture of membranes to active labour, and maternal antibiotics before delivery [91].

A 1999 retrospective cohort study done by Alexander et al. on "chorioamnionitis and the prognosis for term infants", involving 101,170 term infants showed an increased risk for umbilical artery pH of ≤7.0, Apgar scores at 5 minutes of ≤3, sepsis, intubation, pneumonia, convulsions, and MAS [2].

The significance of meconium in amniotic fluid/meconium-stained liquor (MSL) is widely debated. The incidence is 1-18% worldwide. It is traditionally thought of as an indication of fetal distress as a result of hypoxia. Recently, it is being acknowledged as a demonstration of a normally-maturing gastrointestinal tract. Globally, it is still considered a risk factor for poor neonatal outcomes. Studies have shown a positive association between Apgar score and MSL. According to a prospective cohort study done by Qadir et al. in 2016 in Kashmir, India, involving 300 labouring women, fetal heart rate (FHR) anomalies are diagnosed more frequently with thick meconium than with thin meconium [92].

Several studies have demonstrated that adverse neonatal outcomes, including admission to neonatal units, are increased in women who undergo trial of labour after cesarean section (TOLAC) vs scheduled CS [93], [94].

Placental abruption has been linked to a higher risk of NICU admission, RDS, newborn resuscitation, apnea, stillbirth, asphyxia, and neonatal mortality [95]. Smoking has been found to be a significant preventable cause of placental abruption [96].

Nuchal cord is whereby the umbilical cord is wound $360^0$ around the neck of the fetus [97]. The prevalence is about 6-37% globally and increases with increasing gestational age [98]. A study by Ayore et al. in 2018 in Nairobi, Kenya involving 436 parturients found that nuchal cord prevalence at KNH was 28.7% and the odds of neonatal resuscitation were higher in the group with nuchal cord than in the group without, although nuchal cord was not found to be associated with other adverse neonatal outcomes such as MSL, low Apgar score, or NICU admission [99]. In 2005, in Zurich, Switzerland, a retrospective cohort study by Schaffer et al. involving 17,644 deliveries between 1995-2004 showed that admission of term and postterm babies with nuchal cords was not required more frequently, and that routine nuchal cord evaluation via ultrasound is not mandatory when admitting for delivery [100]. However, a 2018 cross-sectional study in Sewagram, India done by Tayade et al. which included 116 women with nuchal cord in labour demonstrated that nuchal cord led to a two-fold risk of CS, a two-fold risk of MSL, and a three-fold risk of abnormal FHR patterns In the study by Tayade et al., more newborns with nuchal cord had Apgar scores <7 and NICU admissions were also more frequent in babies with nuchal cord versus those without [101].

## 2.4 Conceptual Framework

The conceptual framework for the study is illustrated in Figure 1 below.

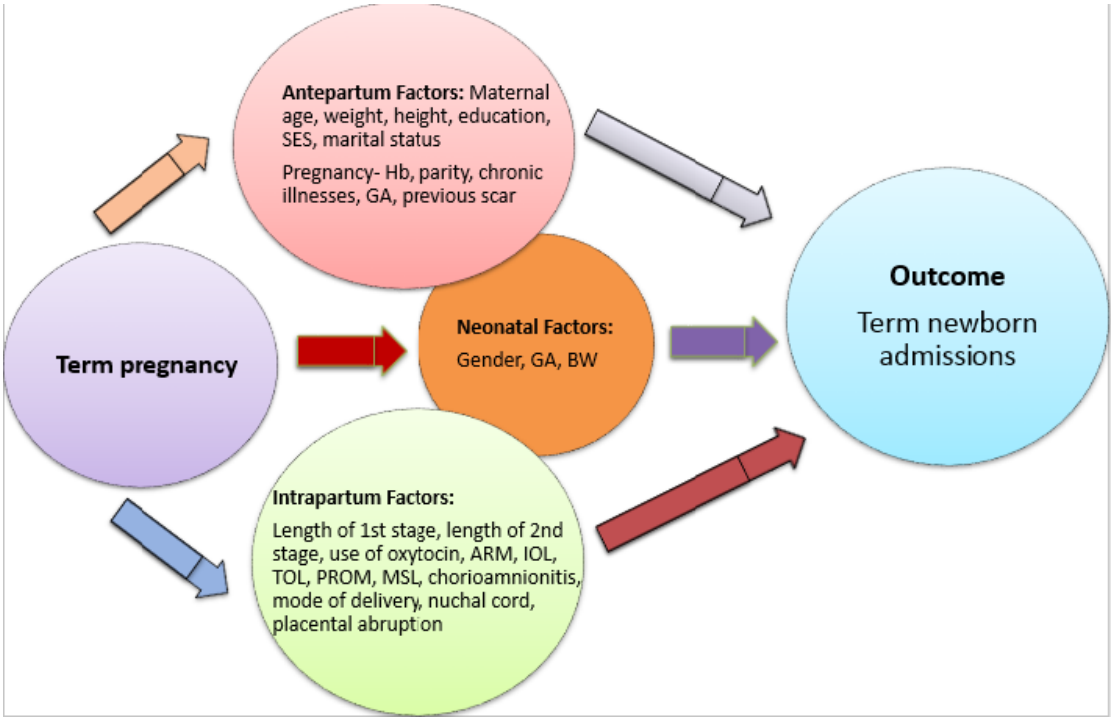


**Figure 1:** Conceptual Framework

### 2.5 Study Justification

Most studies on neonatal health in low-to-middle-income countries have focused on neonatal mortality rather than morbidity. However, to reduce neonatal mortality, it is important to examine the factors linked to with neonatal morbidity.

Admission of neonates to newborn units may be an indicator of morbidity that can be used to design and implement programs to improve survival of newborns.

There are limited local and regional studies on the burden of and risk factors for unexpected term newborn admissions.

Early identification of risk factors, with appropriate interventions, can modify the effects of unexpected term newborn admission to neonatal units. This study will inform strategies aimed at reducing unexpected term NBU admissions and their outcomes at KNH and nationally. The outcome will be an enhanced family experience, by ensuring babies are not separated from their families, and a general decrease in the load on our healthcare system.

## 2.6 Research Question

What is the incidence, risk factors, and early neonatal outcomes of unexpected term newborn admissions at KNH?

## 2.7 Study Objectives

### 2.7.1 Broad Objective

To determine the incidence, risk factors, and early neonatal outcomes of unexpected term newborn admissions at Kenyatta National Hospital.

### 2.7.2 Specific Objectives

Among mothers and their term neonates delivered at KNH between 1st Jan 2019 – 31st Dec 2019, to;

**Primary Objectives**

1. Determine the incidence of unexpected term newborn admissions
2. Determine the early (one week) neonatal outcomes of unexpected term newborn admissions

**Secondary Objectives**

3. Describe the antepartum risk factors for unexpected term NBU admissions
4. Describe the intrapartum risk factors for unexpected term NBU admissions

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1 Study Design

This was a descriptive, hospital-based study comprising 2 components; an incidence study to determine the incidence of unexpected admissions of term newborns at KNH

as well as the early (one week) neonatal outcomes of these newborns, and a nested case-control study to evaluate the antepartum and intrapartum risk factors for term newborn admission.

The study was a review of term neonatal admissions ($37^{+0}$ – $41^{+6}$ weeks gestation) between 1st January 2019 – 31st December 2019. The study period of 1 year was chosen because this was the first study of its kind at KNH that would provide baseline data for future studies on trends of term newborn admission over time.

### 3.2 Study Area

This study was carried out at Kenyatta National Hospital health records. KNH is a national teaching, referral and research hospital in Nairobi, Kenya which has existed since 1901. It accepts patients from other facilities locally and regionally for specialized healthcare. Majority of Kenyans seek healthcare in this hospital, and the patient turnover is high.

There is an Accident and Emergency Department, 22 outpatient clinics, 50 wards, and 24 theatres (16 of which are specialized). There are 1800 beds, 209 of which are in the private wing. The hospital is in service of an average of 80,000 inpatients and > 500,000 outpatients annually.

The Department of Reproductive Health comprises antenatal clinics, antenatal wards, maternity theatre, adult Intensive Care Unit, NBU, and gynaecology-oncology wards. The labour ward has 2 theatres and 32 beds. The unit serves between 60-120 patients daily, averaging 1400 patients per month.

This department handles about 17,000 deliveries annually, overseen by several consultants and senior house officers (SHO). The labour ward unit comprises; 20 midwives, 2 SHOs (one monitoring the critical patients), 2 SHOs manning the theatre and 2 consultants during any given 12-hour period.

The Newborn Unit accepts babies from the labour ward, maternity theatres, and from provincial and private hospitals as referrals. It comprises 2 sub-units: NBU and NICU. The NBU serves all unwell neonates while NICU receives the critical cases.

15-20 neonates are admitted to KNH NBU daily, and approximately 30% of these admissions are term babies, i.e., about 4-6 term neonates are admitted per day.

## 3.3 Study Population

The study population was all term, live-born neonates born at KNH during the study period (1st January – 31st December 2019) and their mothers. For the purpose of determining the incidence of unexpected term newborn admissions at KNH, the overall number of registered term live-born neonates who fulfilled the inclusion criteria was abstracted from health records department to constitute the denominator.

## 3.4 Recruitment

### 3.4.1 Inclusion Criteria

Mothers who delivered at KNH at term ($37^{+0}$ - $41^{+6}$ weeks gestation) and their neonates were included in tis study.

### 3.4.2 Exclusion Criteria

The exclusion criteria for neonates and their mothers was:

a) Neonates born before arrival at KNH
b) Multiple gestation
c) Fetal congenital anomalies requiring admission
d) Newborns admitted for observation e.g. Rhesus negative, mother critically ill
e) Preeclampsia with severe features, uncontrolled diabetes with evidence of fetal compromise

## 3.5 Variables

The primary outcome was recorded admission to either NBU or NICU at KNH. The independent variables were antepartum and intrapartum risk factors associated with the admissions. All variables were predefined and categorized in the data set.

### 1.6 Incidence Study

The records of all the term neonates admitted to KNH NBU from 1st January to 31st December 2019 were reviewed and the unexpected term neonatal admissions established. The neonates fitting the description of unexpected term newborns ($37^{+0}$-$41^{+6}$ weeks gestation) constituted the incidence. The early (one week) neonatal outcomes were determined from this group of admissions (Objectives 1 and 2).

The incidence was the number of new cases of unexpected term newborn admissions at KNH in the year beginning 1st January 2019 – 31st December 2019. This number constituted the numerator. All the term live-born neonates born at KNH during the study period who fulfilled the inclusion criteria constituted the denominator.

### 1.7 Nested Case-Control Study

In a case control study, the intention is to compare the exposure to pre-determined factors in the patients with the outcome of interest (cases - unexpected term admissions) to patients who do not have the outcome (controls - term newborns who were not admitted). This component of the study was nested within the incidence study.

The records of the cases were accessed through KNH health records department. The controls were accessed through the records of their mothers which are also found through KNH health records department, in the register of all deliveries for each month of every year. The files of the mothers contain information about the babies who were not admitted in the same month as each case (including the events surrounding labour). For each case, the date of birth was noted. From the records of all deliveries on that day, 2 controls whose neonates were not admitted were randomly selected and their files were reviewed. The information in these files include the gender, weight, time of birth, and outcome of the newborn, as well as details of intrapartum events such as induction of labour, meconium-stained liquor and duration of each stage of labour (using the partograph).

In order to achieve Objectives 3 and 4, information (neonatal, antepartum and intrapartum factors) from the files of the mothers whose newborns were admitted were compared to the mothers whose newborns were not admitted.

### 1.7.1 Sample Size for Incidence Study

This was calculated using OpenEpi™ Version 3 software

n = [DEFF*Np(1-p)]/ [(d2/Z21-α/2*(N-1)+p*(1-p)]

Applying this in the calculator gave a sample size of **246** (least expected incidence)

Where;

DEFF*= design effect= 1

N= population size= 1000000

p= Hypothesized % frequency of outcome factor in the population in this case 20% (5-18% according to Spain et al., 2015)

d= confidence limits as % = 5

Z= Standard normal deviation (1.96) corresponding to 95% confidence interval

α= normal standard deviation at 95% CI with 0.05 level of significance

### 1.7.2 Sample Size for Case-Control Study

Sample size for the case-control was calculated using the difference in proportions - Fleiss JL (with CC) formula (OpenEpi™) as outlined below. The following assumptions will be considered during the calculation:

$$n = \left(\frac{r+1}{r}\right)\frac{(\bar{p})(1-\bar{p})(Z_{\beta}+Z_{\alpha 2})^2}{(p_1-p_2)^2}$$

n= sample size in case group

r= ratio of controls to cases, 2:1

$\bar{p}$ = variability (standard deviation)

$p_1$= proportion of cases 55.42% (generated by OpenEpi™)

$p_2$= proportion of controls 30.3% (Al-Wassia et al. [102] [33])

$Z_{\beta}$= power of the study 80%= 0.80

$Z_{\alpha}$= normal standard deviation at 95% CI= 1.96 with 0.05 level of significance

$p_1$- $p_2$= effect size (difference in proportions)

Odds ratio to be detected= 2.86 (the odds ratio of operative delivery (highest odds ratio in the study) detected by Borg et al. [29])

The software gives a sample size of **150 with 50 cases and 100 controls.**

## 1.8 Sampling Method

### 1.8.1 Sampling Method for Incidence Study

Consecutive sampling was used for the incidence study.

### 1.8.2 Sampling Method for Cases

Since 50 cases were required within 12 months, 50/12 = 3.5. Therefore, 4 cases were selected per month in 2019. The sampling interval was calculated for each month depending on the number of days in that month. For example, Feb 2019 had 28 days. 28/4 = 7. The first term neonate to be admitted on every $7^{th}$ day was selected, starting from a random starting point in the month (between $1^{st}$ and $7^{th)}$. The random starting point for February was Feb $5^{th}$. Therefore, the first term newborn who was born on $5^{th}$, $13^{th}$, $20^{th}$, and $27^{th}$ who fulfilled the inclusion criteria were chosen. The same was done for every month in 2019.

### 1.8.3 Sampling Method for Controls

The mother-controls (mothers of term neonates not admitted) were selected directly from the register of deliveries. Two (2) mother-controls were randomly selected and matched by date of delivery to each mother-case.

## 1.9 Sampling Procedure and Recruitment of Participants

The recruitment process was done by the principal investigator (PI). The list of mothers who delivered in each month of the year 2019 was found in the register of all deliveries at KNH health records. These records included the file numbers of the mothers.

The term neonates admitted to NBU were identified by reviewing all the NBU admissions at KNH during the study period and selecting those who were born at term and met the inclusion criteria. This information was available in the form of NBU

admission books for every month of the year 2019 at health records department. 50 of these selected as cases, as described in Section 3.8.2 above.

For each case, the date of delivery was noted and 2 controls were randomly selected from the register of deliveries whose babies were not admitted and met the inclusion criteria.

Figure 2 below summarizes how this process was done.

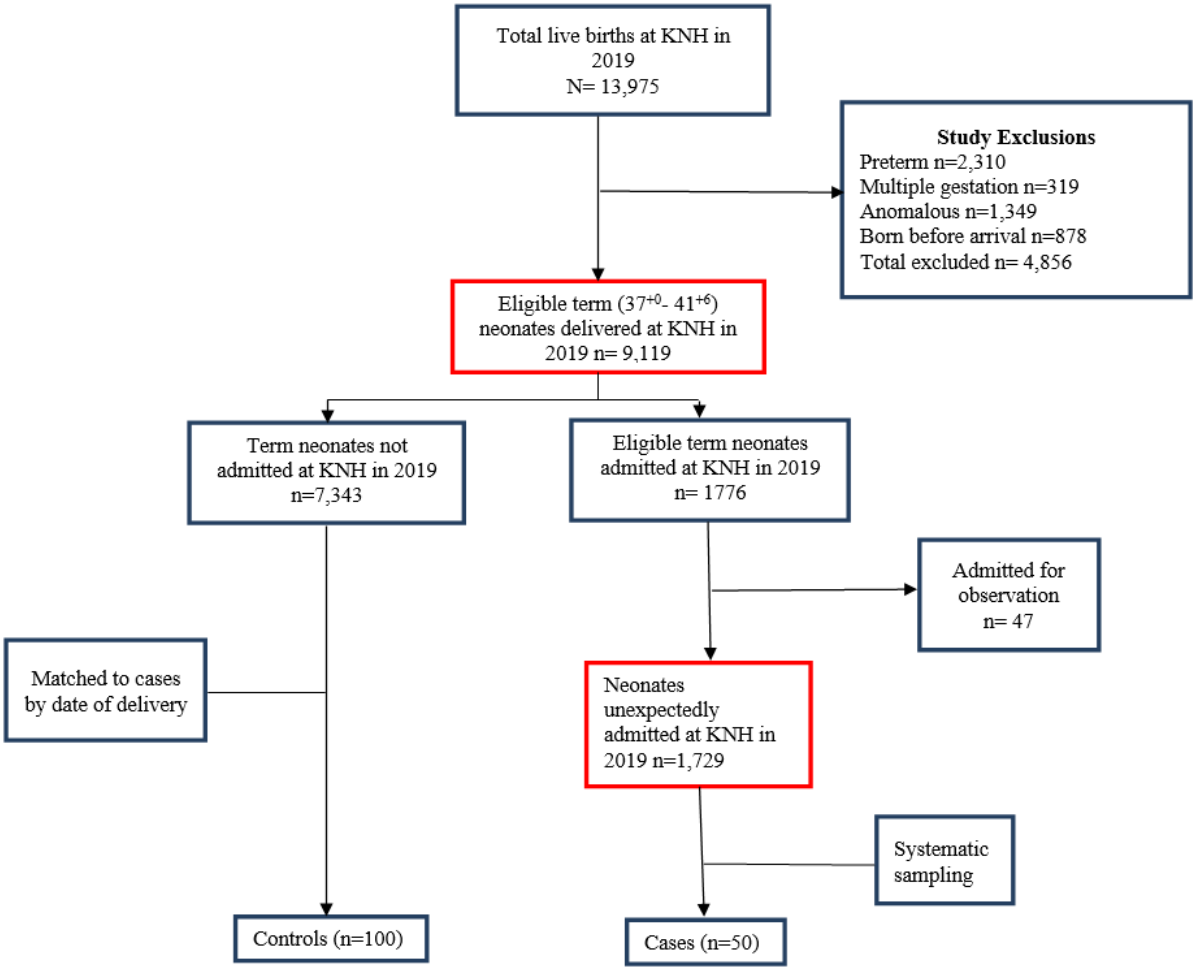


**Figure 2:** Study Flowchart of Recruitment Process

## 1.10 Study Personnel

After being permitted by the relevant authorities, the PI introduced the research assistant to the nurses in charge of the Department of Reproductive Health, NBU, and KNH health records department. The PI oriented the research assistant in the afore-

mentioned units and availed all necessary materials. The PI and one research assistant collected data. The research assistant was chosen from a group of Reproductive Health clinical officers trained in accurate collection of data and confidentiality. The PI regularly monitored and supervised the research assistant during the data collection period and ascertained data was collected daily and backed-up.

### 1.11 Measurements

The gestational age was determined using the best obstetric estimate. The first trimester ultrasound (up to and including $13^{+6}$ weeks gestation) was used for gestational dating, as this is the most accurate, according to ACOG, 2017. If this ultrasound was not available, the first day of last normal menstrual period (LNMP) was used, if known. If the ultrasound was unavailable and LNMP unknown, the gestational age was determined by consistently measured symphisio-pubic fundal height [103].

### 1.12 Data Collection, Analysis and Presentation

A pre-coded, pre-tested data extraction form was used to collect data. The same form was used for both the cases and controls. All data relevant for the study was obtained from the mothers' and neonates' medical records (files) retrieved from KNH health records department and entered into the data extraction forms. Data was cleaned and stored in a USB flash drive and was only accessible to the PI and statistician.

Data was analysed using the Statistical Package for Social Sciences version 23 (SPSS). The incidence of unexpected term newborn admissions was determined by getting the total of all unexpected term newborn admissions taken as a proportion of all the term live-born neonates born at the KNH during the study period and reported as a percentage. Comparison of the maternal sociodemographic and clinical characteristics as well as neonatal characteristics were done with the use of Pearson Chi-square test. Neonatal outcomes were reported as frequencies and proportions. Univariate and multivariate analysis with the use of logistic regression was performed on the antepartum and intrapartum risk factors, maternal and clinical characteristics, and neonatal characteristics. Crude and adjusted Odds Ratio with their 95% confidence

interval were reported. All statistical tests were considered to be significant where the p-value < 0.05.

Data was presented in the form of tables, charts and graphs.

## 1.13 Control of Biases and Errors

Data was keyed into a computer and cross-checked to ascertain validity. The trained research assistant was given a tutorial for the study, with definitions of the terms used in the data extraction form.

## 1.14 Ethical Considerations

The study approval was attained from the University of Nairobi and the KNH Ethical Review Committee (ERC). Institutional approval was obtained from the KNH Scientific and Research department as well as the Department of Obstetrics and Gynecology. A waiver for individual consent from participants was obtained from ERC. No identifying data was used, and all data gathered was only used for research purposes, with no exceptions.

# CHAPTER FOUR: RESULTS

## 4.1 Incidence of Unexpected Term Newborn Admissions

During the study period of January 1st – December 31st, there were 13,975 total live births at KNH. Of these neonates, 2,310 neonates were excluded due to being preterm, 319 neonates were excluded due to being multiple gestation, 1,349 were excluded due to having anomalies requiring admission, and 878 were excluded due to being born before arrival. Of the 9,119 newborns who remained, 1,227 were admitted to NBU/NICU, 47 of whom were excluded due to being admitted for observation. Those left (1,729) were considered to be admitted unexpectedly, giving an incidence of 18.96% (1729/9119) (95% CI: 18.17%-19.78%).

## 4.2 Description of Participants

### 4.2.1 Maternal Socio-Demographic Characteristics

The mean maternal age was 27.78 (SD 6.31) years with majority (77%) being within the age bracket of 20-34 years. Most mothers were married (84%) and had attained post-primary level of education (68%). Majority of mothers were unemployed (52%).

**Table 1:** Comparison of socio-demographic characteristics among mothers of term neonates admitted and not admitted to NBU/NICU at KNH between Jan 1st 2019 and Dec 31st 2019 (N=150)

| **Maternal Characteristic** | **Cases (n=50)** | **Controls (n=100)** | **p-value** |
|---|---|---|---|
| **Age (years),** *n (%)* | | | |
| <20 | 4 (8.0) | 9 (9.0) | 0.052 |

| | | | |
|---|---|---|---|
| 20 – 35 | 35 (70.0) | 83 (83.0) | |
| >35 | 11 (22.0) | 8 (8.0) | |
| **Marital status,** *n (%)* | | | |
| Married | 45 (90.0) | 82 (82.0) | 0.200 |
| Single | 5 (10.0) | 18 (18.0) | |
| **Education,** *n (%)* | | | |
| Primary | 15 (30.0) | 28 (28.0) | 0.961 |
| Secondary | 19 (38.0) | 40 (40.0) | |
| Tertiary | 16 (32.0) | 32 (32.0) | |
| **Employment,** *n (%)* | | | |
| Employed | 11 (22.0) | 27 (27.0) | 0.042 |
| Unemployed | 24 (48.0) | 60 (60.0) | |
| Self-employed | 15 (30.0) | 13 (13.0) | |

### 4.2.2 Neonatal Characteristics

Majority of the newborns (73.3%) were ≥39 weeks gestation and had normal birth weight (88%). Most of the newborns (52.7%) were male.

**Table 2:** Comparison of characteristics among term neonates admitted and not admitted to NBU/NICU at KNH between Jan 1st 2019 and Dec 31st 2019 (N=150)

| **Neonatal Characteristic** | **Cases (n=50)** | **Controls (n=100)** | **p-value** |
|---|---|---|---|
| **Gestation (weeks),** *n (%)* | | | |
| Early term ($37 – 38^{+6}$) | 19 (38.0) | 21 (21.0) | **0.001** |
| Full term ($39 – 40^{+6}$) | 28 (56.0) | 45 (45.0) | |
| Late term ($41 – 41^{+6}$) | 3 (6.0) | 34 (34.0) | |
| **Birth weight,** *n (%)* | | | |
| Low BW (<2.5kg) | 4 (8.0) | 1 (1.0) | 0.079 |
| Normal BW (≥2.5kg -<4.0kg) | 42 (84.0) | 90 (90.0) | |
| Macrosomia (>4.0 kg) | 4 (8.0) | 9 (9.0) | |
| **Gender,** *n (%)* | | | |
| Male | 32 (64.0) | 47 (47.0) | **0.049** |

| | | |
|---|---|---|
| Female | 18 (36.0) | 53 (53.0) |

### 4.3 Early Neonatal Outcomes

68% of the newborns were admitted to NBU while 32% were admitted to NICU. The median length of stay (LoS) was 5.0 (IQR 3.0 – 6.5) days. The minimum LoS was 1 day, and maximum was 28 days. 26% of newborns remained admitted after one week and the death rate within one week was 2%. This is illustrated in Figure 3.

The various indications for admission are presented as a percentage of the total unexpected term admissions in Table 4.

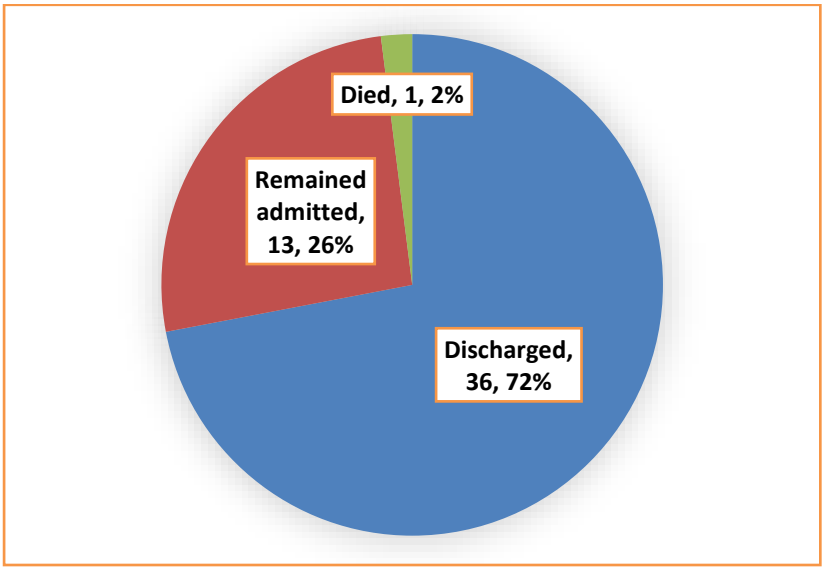


**Figure 3:** Pie chart showing one-week outcome of term neonates admitted unexpectedly at KNH between Jan 1st 2019 and Dec 31st 2019 (N=50)

**Table 3:** Indication for admission of term neonates at KNH between Jan 1st 2019 and Dec 31st 2019 (N=50)

| **Diagnosis** | **Percentage (%) N=50** |
|---|---|
| Respiratory distress syndrome | 38% |
| Birth Asphyxia | 20% |
| Neonatal Sepsis | 16% |
| Meconium Aspiration Syndrome | 6% |
| Transient Tachypnoea of the Newborn | 4% |

| | |
|---|---|
| Hypoglycemia | 2% |
| Others | 10% |
| Unknown | 4% |

## 4.4 Risk Factors for Unexpected Term Newborn Admissions

### 4.4.1 Antepartum Risk Factors

Majority of mothers (62%) were multiparous and had an inter-pregnancy interval of ≥12 months (59.3%). 67.3% of mothers in the study had attended ≥4 ANC visits and 91.3% had an antenatal haemoglobin (Hb) of ≥10 g/dl. Maternal comorbidities were present in 12.6% of mothers.

Having an antenatal Hb of <10 g/dl and having maternal comorbidities were found to be statistically significant antepartum risk factors for unexpected term newborn admission. Delivery in late term (gestational age 41 – $41^{+6}$) was found to be a protective factor against admission.

**Table 4:** Crude and adjusted odds of term neonatal admission for antepartum characteristics (N=150)

| **Antepartum characteristics** | **Cases (n=50)** | **Controls (n=100)** | **cOR (95% CI)** | **p-value** | **aOR (95% CI)** | **p-value** |
|---|---|---|---|---|---|---|
| **Parity*** | | | | | | |
| Nulliparous | 21 (42.0) | 36 (36.0) | 1.3 (0.6 – 2.6) | 0.476 | 1.5 (0.7 – 3.1) | 0.338 |
| Multiparous | 29 (58.0) | 64 (64.0) | Reference | | Reference | |
| **Inter-pregnancy interval (months)+** | | | | | | |
| 6 to <12 months | 3 (6.0) | 1 (1.0) | 7.3 (0.7 – 73.1) | 0.092 | 4.1 (0.4 – 45.2) | 0.247 |
| 12+ | 26 (89.7) | 63 (98.4) | Reference | | Reference | |
| **No. of ANC visits*** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| <4 | 15 (30.0) | 34 (34.0) | 0.8 (0.4 – 1.7) | 0.623 | 1.0 (0.4 – 2.2) | 0.911 |
| ≥4 | 35 (70.0) | 66 (66.0) | Reference | | Reference | |
| **Antenatal Haemoglobin (g/dl)*** | | | | | | |
| <10 | 8 (16.0) | 5 (5.0) | 3.6 (1.1 – 11.7) | **0.032** | 3.0 (0.9 – 10.8) | 0.085 |
| ≥10 | 42 (84.0) | 95 (95.0) | Reference | | Reference | |
| **Maternal comorbidities*** | | | | | | |
| Present | 9 (18.0) | 10 (10.0) | 2.0 (0.7 – 5.2) | 0.170 | 3.4 (1.04 – 11.2) | **0.042** |
| Absent | 41 (82.0) | 90 (90.0) | Reference | | Reference | |
| **Gestation (weeks)*** | | | | | | |
| Early term (37 – $38^{+6}$) | 19 (38.0) | 21 (21.0) | 1.5 (0.7 – 3.2) | 0.347 | 1.4 (0.6 – 3.1) | 0.419 |
| Full term (39 – $40^{+6}$) | 28 (56.0) | 45 (45.0) | Reference | | Reference | |
| Late term (41 – $41^{+6}$) | 3 (6.0) | 34 (34.0) | 0.1 (0.04 – 0.5) | **0.003** | 0.1 (0.03 – 0.4) | **0.001** |

*Adjusted for all variables except inter-pregnancy interval, $^{+}$Adjusted for all variables

### 4.4.2 Intrapartum Risk Factors

Most of the mothers in the study (55.3%) were admitted in active labour. 77.3% had trial of labour with no uterine scar while 18% had trial of labour with uterine scar. 4.7% of mothers had no trial of labour. 13.3% of mothers underwent induction of labour. PROM was present in 20% of mothers, with most being ≤18 hours (66.7%). Chorioamnionitis was present in only 2.7% of mothers. 20.6% of mothers had MSL during labour, with most (51.6%) having thick MSL. Placental abruption was a rare occurrence (3.3%). About half of the mothers in the study (50.7%) underwent cesarean section, most of which were emergency (73.7%). Nuchal cord was present in only 2.7% of deliveries.

The only statistically significant intrapartum risk factors were thin MSL and cesarean delivery, with elective cesarean showing a higher risk of admission than emergency cesarean.

**Table 5:** Crude and adjusted odds of term neonatal admission for intrapartum events (N=150)

| **Intrapartum events** | **Cases (n=50)** | **Controls (n=100)** | **cOR (95% CI)** | **p-value** | **aOR (95% CI)** | **p-value** |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **Admitted in** | | | | | | |
| Active phase of labour | 22 (44.0) | 61 (61.0) | Reference | | Reference | |
| Latent phase | 17 (34.0) | 30 (30.0) | 1.6 (0.7 – 3.4) | 0.250 | 1.5 (0.5 – 4.4) | 0.423 |
| Not in labour | 11 (22.0) | 9 (9.0) | 3.4 (1.2 – 9.3) | **0.018** | 0.7 (0.1 – 3.9) | 0.639 |
| **Trial of labour** | | | | | | |
| Labour with no uterine scar | 34 (68.0) | 82 (82.0) | Reference | | Reference | |
| Labour with uterine scar | 9 (18.0) | 18 (18.0) | 1.2 (0.5 – 3.0) | 0.682 | 0.5 (0.1 – 2.0) | 0.357 |
| No trial of labor | 7 (14.0) | 0 (0.0) | - | | - | |
| **Induction of labour** | | | | | | |
| Done | 8 (16.0) | 12 (12.0) | 1.4 (0.5 – 3.7) | 0.498 | 2.2 (0.6 – 8.3) | 0.226 |
| Not done | 42 (84.0) | 88 (88.0) | Reference | | Reference | |
| **PROM** | | | | | | |
| Present ≤18 hours | 5 (10.0) | 15 (15.0) | 0.7 (0.2 – 2.0) | 0.462 | 0.9 (0.2 – 3.5) | 0.858 |
| Present >18 hours | 5 (10.0) | 5 (10.0) | 2.0 (0.5 – 7.3) | 0.295 | 1.4 (0.2 – 10.5) | 0.721 |
| Absent | 40 (80.0) | 80 (80.0) | Reference | | Reference | |
| **Chorioamnionitis** | | | | | | |
| Present | 3 (6.0) | 1 (1.0) | 6.3 (0.6 – 62.4) | 0.115 | 8.4 (0.5 – 137.5) | 0.135 |
| Absent | 47 (94.0) | 99 (99.0) | Reference | | Reference | |
| **MSL** | | | | | | |
| Present (thick) | 5 (10.0) | 11 (11.0) | 1.2 (0.4 – 3.7) | 0.769 | 0.8 (0.2 – 3.1) | 0.755 |
| Present (thin) | 12 (24.0) | 3 (3.0) | 10.4 (2.8 – 39.3) | **0.001** | 11.5 (2.2 – 59.5) | **0.004** |
| Absent | 33 (66.0) | 86 (86.0) | Reference | | Reference | |
| **Placental abruption** | | | | | | |
| Present | 3 (6.0) | 2 (2.0) | 3.1 (0.5 – 19.4) | 0.220 | 1.1 (0.1 – 12.0) | 0.930 |
| Absent | 47 (94.0) | 98 (98.0) | Reference | | Reference | |
| **Mode of delivery** | | | | | | |
| CS (elective) | 17 (34.0) | 3 (3.0) | 32.5 (8.1 – 129.6) | **<0.001** | 41.2 (7.0 – 241.2) | **<0.001** |
| CS (emergency) | 22 (44.0) | 34 (34.0) | 3.7 (1.6 – 8.5) | **0.002** | 4.3 (1.4 – 13.3) | **0.012** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Vaginal delivery | 11 (22.0) | 63 (63.0) | Reference | | Reference | |
| **Nuchal cord** | | | | | | |
| Present (1) | 1 (2.0) | 1 (1.0) | 2.0 (0.1 – 32.3) | 0.632 | 1.3 (0.1 – 28.7) | 0.854 |
| Present (2) | 0 (0.0) | 1 (1.0) | - | | - | |
| Present (3) | 0 (0.0) | 1 (1.0) | - | | - | |
| Absent | 49 (98.0) | 97 (97.0) | Reference | | Reference | |

# CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

## 5.1 Discussion

Unexpected admission of a term neonate may be used as an indication of avoidable harm that may have taken place during the antenatal, intrapartum, or postnatal stage. Admission to NBU results in separation of the baby from the mother which may result in breastfeeding and bonding challenges. This separation can also negatively affect the mother's mental health [21]. Furthermore, it increases the load on the healthcare system as regards staff to patient ratios, financial cost, and bed availability [20][24]. Ensuring that mother and neonate are kept together should be the goal from the beginning, as it enhances short and long term health outcomes for both.

The incidence of unexpected term newborn admissions in the current study was found to be 18.96%. This is on the higher end of the global range (5-18%) reported by Spain et al., 2015 [28]. Other studies done in similar teaching hospitals as KNH have shown much lower incidences, such as that done in Saudi Arabia by Al-Wassia et al., 2017 [102] (4.7%) and that done in Malta by Borg et al., 2018 [29] (5.2%). Most recently, a retrospective cross-sectional study including multiple hospitals in the United States done in 2019 by Clapp et al. reported an incidence of 2.9% - 11.2% [25]. However, it is important to note that the primary outcome of interest in these previous studies was newborn admission to NICU and did not include those admitted to other units such as NBU, while the present case included neonates admitted to both NBU and NICU.

The mean length of stay (LoS) of admitted newborns in the current study was 5.9 ± 5.3 days, with 28% remaining admitted after one week and 2% dying within the week. This is longer than the LoS reported in the UK by Thankappen et al., 2014 (4.7 days) [104]. In Malta, Borg et al., 2018 reported a longer mean LoS (8.8 days) [29]. However, in the United States, Clapp et al., 2019 reported a similar death rate of <1% [25].

In the present study, maternal comorbidities and antenatal Hb <10 g/dl were the only statistically significant antepartum risk factors for unexpected term neonatal admission. This is comparable to the study done by Clapp et al. in the US (2019) which found that chronic hypertension and preeclampsia were risk factors [25]. In Turkey, Karaflahin et al., 2007 also found a Hb of ≤8 g/dl to be a risk factor [105]. Other studies found that nulliparity, grand-multiparity, inter-pregnancy interval of < 12 months, and delivery in early term were antepartum risk factors [25][58][56]. The present study did not confirm these findings. This may be due to the relatively small numbers used in the case-control component of the study.

As has been demonstrated in other studies [29][102][82][25], the present study found that MSL and cesarean delivery were intrapartum risk factors for unexpected term newborn admission. However, we found that elective CS carries a higher risk than emergency CS, which is contrary to what other studies [106][107] have found. Several theories attempt to explain the mechanism by which neonates born via elective CS develop respiratory morbidity requiring admission. These include: delayed fetal lung fluid clearance due to reduced thoracic squeeze which occurs during labour, and reduced catecholamine surge [108], as well as iatrogenic prematurity.

The present study found that thin MSL is more strongly correlated with newborn admission than thick MSL. This is contrary to what was found by in India by Kashikar et al., 2021 [109] who found that women with thick MSL had a higher incidence of pathological cardiotocographs than those with thin MSL, although there was no difference in the rate of NICU admission. Other studies demonstrated that chorioamnionitis, placental abruption, trial of labour with uterine scar, admission in latent phase of labour, induction of labour, PROM, and nuchal cord significantly increased the risk of term newborn admission [25][82][102]. As regards these potential

contributing factors evaluated, a reason for not achieving significance may be that small numbers were used in the case-control component of the study.

In our study, we were able to discern the indication for admission for most newborns. Analogous to previous studies [102][29][25], respiratory complications were the predominant causes of newborn admissions, accounting for 62% of unexpected term admissions.

## 5.2 Conclusion

- The incidence if unexpected term newborn admissions at KNH was 18.96%.
- The median length of stay of admitted neonates was 5 days.
- Majority of admitted newborns (72%) were discharged by the $7^{th}$ day and 2% had died.
- Only antenatal Hb of <10g.dl, maternal comorbidities, MSL, and cesarean delivery remained statistically significant risk factors after controlling for confounders.
- Delivery at late term ($41 – 41^{+6}$) was a protective factor against unexpected admission of term neonates.

## 5.3 Recommendations

- There is need to monitor the incidence of unexpected term admissions at KNH and efforts made to enhance antenatal and intrapartum care in order to reduce this incidence.
- Continued progress should be made towards improving neonatal care at KNH.
- Mothers with comorbidities should be monitored closely, even when fetal compromise is not suspected.
- Haematinics should be offered to mothers to maintain a Hb of ≥10 g/dl.
- There should be close monitoring of patients where MSL is detected during delivery.
- Continued efforts should be made towards reducing the rate of cesarean birth at KNH.

- Future studies on emerging trends on this topic should be promoted.

## 5.4 Study Strengths and Limitations

### 5.4.1 Study Strengths

- This is a novel study locally and regionally, providing a guide for future studies to be carried out in other facilities.
- The study site, KNH, has a busy maternity and newborn unit, providing adequate data for analysis.
- Given that the patients in KNH are derived from the community at large, and that it is a national referral hospital, the findings of this study may be generalizable to the country.

### 5.4.2 Study Limitations

- The sample was obtained from a single site, KNH, and could demonstrate patterns and characteristics unique to the facility.
- The retrospective nature of the study exposed it to potential bias due to missing data as a result of gaps in clinical documentation.

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**APPENDICES**

## Appendix I: Data Extraction Form

**Neonate's Form**

| Question Number | Characteristic | Finding | Not known (tick) |
|---|---|---|---|
| 1 | Admitted in | □ NBU<br>□ NICU | |
| 2 | Gender | □ Male<br>□ Female | |
| 3 | Gestational age | □ 37+ _____<br>□ 38+ _____<br>□ 39+ _____<br>□ 40+ _____<br>□ 41+ _____ | |
| 4 | Birth weight (grams) | | |
| 5 | FHR abnormality during labour | □ Present □ Absent | |
| 6 | Apgar score | (i) ___ in 1<br>(ii) ___ in 5<br>(iii) ___ in 10 | |
| 7 | Resuscitation | □ Done<br>□ Not done | |
| 8 | Indication for admission | | |
| 9 | Neonatal complications in the ward | □ Pneumonia<br>□ Sepsis<br>□ Necrotizing enterocolitis (NEC)<br>□ Apnea<br>□ Bronchopulmonary dysplasia (BPD)<br>□ Intraventricular haemorrhage (IVH) | |
| 10 | Length of stay (days) | | |
| 11 | Outcome within 1 week | □ Discharged..... on Day….<br>□ Transferred….. on Day….<br>□ Died…. Day…. | |

| | | | |
|---|---|---|---|
| | | | |

**Mother's Form**

| | | | Not Known(tick) |
|---|---|---|---|
| **Antepartum** | | | |
| Age (years) | | | |
| Weight (kg) | Pre-pregnancy- | 3rd trim- | |
| Marital status | □ Single/separated/divorced/widowed<br>□ Married | | |
| Education level | □ Primary □ Secondary □ Tertiary | | |
| Employment status | □ Unemployed<br>□ Employed as<br>□ Self-employed as | | |
| Parity before delivery | Number……<br>□ Nulliparous[1]<br>□ Multiparous[2]<br>□ Grand-multipara[3]<br>□ Great grand-multipara[4] | | |
| Interpregnancy interval | □ <6 months<br>□ 6- <12 months<br>□ 12- | | |
| No. of prev. vaginal deliveries | | | |
| No. of prev. C/S | | | |
| No. of ANC visits | | | |
| Last antenatal Hb in 3rd trimester (g/dl) | | | |
| Previous hx of chronic hypertension (HTN) | | | |
| Previous hx of preeclampsia | | | |
| Previous hx of pre-gestational diabetes | □ Type 1<br>□ Type 2 | | |

| | | |
|---|---|---|
| Previous hx of gestational diabetes | □ | |
| Previous hx of other chronic illnesses | Namely: | |
| **Intrapartum** | | |
| HIV | □ Yes:<br>o On HAART<br>o Not on HAART<br>□ No | |
| Current chronic HTN without fetal compromise | □ Yes:<br>o On antihypertensives<br>o Not on antihypertensives<br>□ No | |
| Current preeclampsia/eclampsia without fetal compromise | □ Yes:<br>o On antihypertensives<br>o Not on antihypertensives<br>□ No | |
| Current controlled pre-gestational diabetes without fetal compromise | □ Yes:<br>o Type 1<br>o Type 2<br>On:<br>▪ Oral hypoglycemics<br>▪ Insulin<br>▪ Both oral hypoglycemics and insulin<br>□ No | |
| Current controlled gestational diabetes without fetal compromise | □ Yes, on:<br>o Oral hypoglycemics<br>o Insulin<br>o Both oral hypoglycemics and insulin<br>□ No | |
| Other current chronic illnesses without fetal compromise | □ HTN/preeclampsia<br>□ DM/GDM<br>□ HIV | |
| Other chronic illnesses | Namely: | |
| Admitted in: | □ Active phase of labour<br>□ Latent phase of labour<br>□ Not in labour | |

| | | | |
|---|---|---|---|
| Trial of labour (TOL) | □ Done | □ Not done | |
| Length of 1st stage of labour (minutes) | | | |
| Length of 2nd stage of labour (minutes) | | | |
| IOL | □ Done | □ Not done | |
| Oxytocin augmentation | □ Used | □ Not used | |
| Amniotomy | □ Done | □ Not done | |
| No. of vaginal digital examinations before delivery | | | |
| PROM (hours from membrane rupture to active labour) | □ Absent | Present:<br>□ <18 hours<br>□ >18 hours | |
| Use of antibiotics before delivery | □ Used | □ Not used | |
| Chorioamnionitis | □ Present | □ Absent | |
| MSL | Present:<br>o Thin<br>o Thick<br>□ Absent | | |
| Placental abruption | □ Absent | □ Present | |
| Mode of delivery | □ Vaginal delivery<br>□ C/S: indication _____<br>o Emergency<br>o Elective | | |
| Nuchal cord | □ Absent<br>Present, times:<br>□ 1<br>□ 2<br>□ 3<br>□ Unknown number of times | | |

[1]A woman who has never given birth to a baby ≥20 weeks gestation. [2]A woman who has had more than one birth to babies ≥20 weeks gestation. [3]A woman who has had ≥5 births at ≥20 weeks gestation [4]A woman who has had ≥10 birth of babies ≥20 weeks gestation

## Appendix II: Ethical Approval

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

12th March 2021

Ref: KNH-ERC/A/98

Dr. Amanda Ezinne Ochwando Kenya
Reg. No.H58/6823/2017
Dept. of Obstetrics and Gynaecology
School of Medicine
College of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL * APPROVED 12 MAR 2021 KNH/UoN-ERC * P. O. BOX 20723 - 00202 NAIROBI

Dear Dr. Kenya

**RESEARCH PROPOSAL – INCIDENCE, RISK FACTORS AND NEONATAL OUTCOMES OF UNEXPECTED TERM NEWBORN ADMISSIONS TO NEWBORN UNIT AT KENYATTA NATIONAL HOSPITAL (P286/05/2021)**

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 12th March 2021 – 11th March 2022.

This approval is subject to compliance with the following requirements:

a. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d. Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g. Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

Protect to discover

For more details consult the KNH- UoN ERC website http://www.erc.uonbi.ac.ke

Yours sincerely,

PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information Dept. KNH
The Dean, School of Medicine, UoN
The Chair, Dept. of Obstetrics and Gynaecology, UoN
Supervisors: Dr. Alfred Osoti, Dept.of Obstetrics and Gynaecology, UoN
Dr. Allan Ikol, Dept. of Reproductive Health, KNH
Dr. Jalemba Aluvaala, Dept.of Paediatrics and Child Health, UoN