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**FACTORS CONTRIBUTING TO NEONATAL DEATHS IN HOSPITALS OF
RWANDA**

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ABBREVIATIONS

ANC	Antenatal Care
CDC	Centers for Diseases Control and Prevention
CHW	Community Health Worker
CI	Confidence intervals ()
CPAP	Continuous Positive Airway Pressure
CPR	Cardiopulmonary resuscitation
DHU	District Health Unit
GIS	Geographic Information System
GoR	Government of Rwanda
HMD	Hyaline membrane disease
HMIS	Health Management Information System
ICD	International Classification of Diseases
IRDS	Infant respiratory distress syndrome
IMR	Infant Mortality Rate
IUGR	Intrauterine Growth Restriction
LBW	Low Birth Weight
LMICs	Low- and Middle-Income Countries
MCH:	Maternal and Child Health
MDG 4:	4 th Millennium Development Goal
MDG 5:	5 th Millennium Development Goal
MMH :	Meters of Mercury high-Respiratory distress syndrome
MNCH:	Maternal, Newborn and Child Health
MoH	Ministry of Health
NGO	Non-Government Organization
NIH	National Institutes of Health
NMR	Neonatal Mortality Rate
OR	Odds Ratio
PHSDP	Primary Health Services Development Program
PNC	Post Natal Care
RDHS	Rwanda Demographic Health Survey
SBR	Stillbirth Rate

TBA	Traditional birth attendant
U5MR	Under-five Mortality Rate
UNICEF	United Nations Children’s Fund
USA	United States of America
VLBW	Very low birth weight
WHO	World Health Organization

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ABSTRACT

Background: Rwanda has achieved remarkable progress in improving health outcomes and the health status of its population in the past decades, specifically great strides have been made to improve maternal and child health. In order to sustain these achievements and continue along the path to achieve better results and attain sustainable development goal (SDG) 3 target 3.2, strategies for reducing neonatal deaths must be put in place.

Objective: To identify contributory factors to newborns deaths in hospitals of Rwanda with view to improve outcomes of admitted newborns.

Methods: This retrospective study was carried out in 25 hospitals of Rwanda. The population of study was made by newborns admitted in neonatology services from January the 1st to December 31st 2017 and the sample consisted of 792 for both cases and controls. Relevant perinatal information both about the mother and newborn was obtained through obstetric or copies of referral forms and admission files attached on deaths audit reports.

Findings: The most common causes of admission were prematurity (36.5%), birth asphyxia (35.8%), neonatal infection (26%), respiratory distress syndrome (21%) and low birth weight (20%). Risk factors for neonatal death identified include among others extreme and severe prematurity (OR=13.08, [5.01-34.19]) and (OR=4.64, [3.05-7.06]) respectively, critical and low APGAR scores (OR=7.39, [3.97-13.77]) and (OR=2.12, [1.63-2.76]), respiratory distress syndrome (OR=3.38, [2.54-4.51]), severe and moderate hypothermia (OR=3.61, [2.59-5.04]) and (OR=1.79, [1.33-2.41]), low birth weight (OR=1.69, [1.29-2.23]), admitted from outside the hospital (OR= 1.91, [1.40-2.61]), two ANC visits or less (OR=1.93, [1.45-2.57]) and multiple pregnancy (OR=1.69, [1.14-2.49]).

Conclusion: Some factors of neonatal mortality reflect poor prenatal and perinatal health services in health facilities. Hence, there is a need to improve the quality of perinatal and neonatal services to prevent avoidable neonatal deaths.

Key word: Neonatal deaths, New-born, Antenatal care.

CHAPTER I: INTRODUCTION

I.1. Definition of key terms

CPAP or Continuous Positive Airway Pressure: is a treatment that uses mild air pressure to keep the airways open. CPAP typically is used by people who have breathing problems. CPAP also may be used to treat preterm infants whose lungs have not fully developed.

Foetal death (stillbirth): Foetal death is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy; the death is indicated by the fact that after such separation the foetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles.

Gestational age: The duration of gestation is measured from the first day of the last normal menstrual period. Gestational age is expressed in completed days or completed weeks.

Infant mortality rate: Number of deaths during the first year of live per 1,000 live births in a given year or period.

Low birth weight: Birth weight of less than 2,500 g (up to and including 2,499g), irrespective of gestational age.

Neonatal death: A neonatal death is defined as death of a live birth during the first 28 days of life. Early neonatal death: death occurs during the first 7 days of life. Late neonatal death: death occurs after the 7th day but before 28 completed days of life.

Neonatal mortality rate: Number of deaths during the first 28 completed days of live per 1,000 live births in a given year or period.

Neonatal period: Commences at birth and ends 28 completed days after birth. Early neonatal period commences at birth and ends seven completed days after birth. Late neonatal period: Commences after seven days and ends 28 completed days after birth.

Perinatal period: Commences at 22 completed weeks (154 days) of gestation age (the time when birth weight is normally 500 g), and ends seven completed days after birth. Briefly perinatal is the health of women and babies before, during and after birth.

Perinatal mortality: the statistical rate of foetal and infant death, including stillbirth, from 28 weeks of gestation to the end of the neonatal period of 4 weeks.

Pre-term: Less than 37 completed weeks (less than 259 days) of gestation.

Skilled birth attendance: Delivery in the presence of a skilled birth attendant, with at least midwifery skills, in an environment that includes availability of equipment, drugs, and referral transportation and communication systems. Neonatal mortality is death among live births during the first 28 completed days of life; it may be subdivided into early neonatal deaths, occurring the first seven days of life, and late neonatal deaths after the seventh day but before 28 completed days of life.

Under-five mortality rate: Number of deaths during the first five years of live per 1000 live births in a given year or period.

I.2. Background of the study

Worldwide four million infants die in the first 28 days of life each year. Three quarters of these neonatal deaths occur in the first week of life, and more than one quarter occurs in the first 24 hours after birth (25). In developing countries, neonatal deaths occur at a rate of about 17 per 1,000 births and early infant deaths at a rate of nine per 1,000 live births even when women receive antenatal care and deliver in hospitals prepared to handle obstetrical and birth complications. One of the millennium Development Goals (MDG-4) was to reduce child mortality by up to two thirds by 2015. Overall, substantial progress was made towards achieving this MDG. The number of under-five deaths worldwide has declined from 11.7 million in 1990 to 6.9 million in 2011. While that translates into 14,000 less children dying every day in 2011 than in 1990, it still implies the deaths of 19,000 children under age five every day in 2011 (25).

Trends in mortality show that neonatal mortality is declining less rapidly compared to infant and child mortality so that the proportion of neonatal deaths among under-five deaths has increased 7% since 1990 to 2011 from 36% to about 43% (25).

In Sub-Saharan Africa, Rwanda is one of few countries that achieved MDG4 to reduce the under-five mortality rate by two-thirds in the period between 1990 and 2015(1). According to DHS 2014-2015, the under-five mortality was 50 per 1,000 live births and neonatal mortality rate was 20/1,000 LBs meaning that 40% of all under-five deaths occurred during the first month of life.

In Sub-Saharan African countries, the main causes of neonatal mortality are similar but rank differently, namely preterm delivery, birth asphyxia and neonatal infections. Neonatal mortality is known to occur because of poor maternal health, adverse social conditions, and inadequate care during pregnancy, delivery and immediate post-partum period(3).

According to 2014 HMIS report, 24,939 new-borns have been admitted in different health facilities in Rwanda. Including 22,953(92%) in district hospitals, 1,622(6.5%) in referral hospitals, 297(1.2%) in private clinics and 67(0.3%) in health centres(5). According to the same source, 3,049 newborns died representing a fatality rate of 12.2%. Among 3,049 neonatal deaths, 2,716 (89.1%) occurred in District hospitals and 262(8.6%) in two referral hospitals, meaning that referral and district hospitals accounted for 97.7% of all neonatal deaths which occurred in Rwanda in 2014.

In contrast to high health facility neonatal fatality rate, out of 51053 children aged from 28 days to 5 years admitted during 2014, the total number of 1039 deaths were recorded leading to fatality rate of 2%. Likewise, health facility neonatal mortality rate accounted itself around 75% of the total under five deaths occurred in health facilities in 2014. Results from neonatal death audit in 2014 revealed that the main biological causes of neonatal deaths were birth asphyxia and their complications (39%), prematurity related causes (32%), neonatal infections (11%), congenital abnormalities (8%) and other causes (10%)(5).

I.3. Problem statement

Although both the neonatal death audit and HMIS provide some descriptive information on neonatal deaths in Rwanda, they do not allow identifying factors contributing to neonatal deaths since they collect information from only deceased newborns. A clear understanding of the factors contributing to neonatal deaths in hospitals is important to guide the development of evidence-based health interventions to prevent neonatal deaths in Rwanda.

Given the lack of countrywide studies conducted with that purpose, this study was conducted with the aim of investigating factors contributing to neonatal deaths in hospitals of Rwanda.

I.4. Objectives of the study

I.4.1. General objective

The general objective of the study was to determine factors contributing to neonatal deaths in hospitals of Rwanda.

I.4.2. Specific objectives

1. Determine case fatality rate of the main causes of neonatal deaths in hospitals of Rwanda.
2. Identify factors associated with neonatal mortality in hospitals of Rwanda.

CHAPTER II: LITERATURE REVIEW

II.1. Non-risk factors

Globally there has been a considerable decline in under-five and infant mortality in the past two decades(25). However, neonatal mortality remains relatively unchanged especially in developing countries. Worldwide four million infants die in the first 28days of life each year: The neonatal period. Three quarters of these neonatal deaths occur in the first week of life, and more than one quarter occurs in the first 24 hours after birth. The estimated 3.2 million stillbirths per year globally are not part of this mortality. Almost all of neonatal mortality is observed in developing countries and mostly in babies who are born at homes. The highest neonatal mortality rates are seen in Sub-Saharan Africa(3). In Asia, the average rates are lower but this region accounts for over 60% of the estimated global total, mainly because of the large population and high fertility rate.

II.1.2. AGPAR Score

Apgar is a quick test performed on a baby at 1 and 5 minutes after birth. The 1-minute score determines how well the baby tolerated the birthing process. The 5-minute score tells the health care provider how well the baby is doing outside the mother's womb.

Normally a doctor, midwife, or nurse does the Apgar test. The provider examines the baby's: Breathing effort, heart rate, muscle tone, reflexes, and skin color.

Each category is scored with zero, one, or two, depending on the observed condition.

Breathing effort: If the infant is not breathing, the respiratory score is 0, If the respirations are slow or irregular, the infant scores 1 for respiratory effort, If the infant cries well, the respiratory score is two.

Heart rate is evaluated by stethoscope. This is the most important assessment: If there is no heartbeat, the infant scores 0 for heart rate, If heart rate is less than 100 beats per minute, the infant scores 1 for heart rate, If heart rate is greater than 100 beats per minute, the infant scores 2 for heart rate. A study conducted in Brazil, revealed that, the Apgar of 7-10 indicate normal baby, 4-6 indicate mild to moderate and 0-3 severe respiratory depression. Further, the findings of the same study highlighted that infants who were small for their gestational

age presented a higher risk of neonatal death and a low five-minute Apgar score over the entire gestational age range(5).

Muscle tone:

If muscles are loose and floppy, the infant scores 0 for muscle tone, If there is some muscle tone, the infant scores 1, If there is active motion, the infant scores two for muscle tone.

Grimace response or reflex irritability is a term describing response to stimulation, such as a mild pinch:If there is no reaction, the infant scores 0 for reflex irritability, If there is grimacing, the infant scores 1 for reflex irritability, If there is grimacing and a cough, sneeze, or vigorous cry, the infant scores two for reflex irritability.

II.1.3.Resuscitation

Cardiopulmonary resuscitation (CPR) consists of the use of chest compressions and artificial ventilation to maintain circulatory flow and oxygenation during cardiac arrest (see the images below). Although survival rates and neurologic outcomes are poor for patients with cardiac arrest, early appropriate resuscitation involving early defibrillation and appropriate implementation of post cardiac arrest care lead to improved survival and neurologic outcomes.

A study conducted in Zambia concluded that among 89 of the 54 babies who needed resuscitation, 65% (n=35) died and 35% (n=19) were discharged alive while 33 babies who did not need resuscitation, 58% (n=19) died and 42% (n=14) were discharged alive(3).

II.1.4.Respiratory distress syndrome (MMH)

Infant respiratory distress syndrome (IRDS), also called neonatal respiratory distress syndrome (NRDS), respiratory distress syndrome of newborn, or increasingly surfactant deficiency disorder (SDD) and previously called hyaline membrane disease (HMD), is a syndrome in premature infants caused by developmental insufficiency of pulmonary surfactant production and structural immaturity in the lungs. It can also be a consequence of neonatal infection. It can also result from a genetic problem with the production of surfactant-associated proteins. IRDS affects about 1% of newborn infants and is the leading cause of death in preterm infants. The incidence decreases with advancing gestational age, from about 50% in babies born at 26–28 weeks, to about 25% at 30–31 weeks. The syndrome is more frequent in males, Caucasians, infants of diabetic mothers, and the second born of premature twins.

IRDS begins shortly after birth and is manifest by fast breathing, more than 60 per minute, a fast heart rate, chest wall retractions (recession), expiratory grunting, nasal flaring and blue discoloration of the skin during breathing efforts.

As the disease progresses, the baby may develop ventilatory failure (rising carbon dioxide concentrations in the blood), and prolonged cessations of breathing (“apnea”). During the first day, the patient worsens and requires more support. During the second day, the baby may be remarkably stable on adequate support and resolution is noted during the third day, heralded by a prompt diuresis. Despite huge advances in care, IRDS remains the most common single cause of death in the first month of life in the developed world. Complications include metabolic disorders (acidosis, low blood sugar), patent ductus arteriosus, low blood pressure, chronic lung changes, and bleeding in the brain. The disease is frequently complicated by prematurity and its additional defects in other organ function.

A study done in Bangladesh revealed that 66% (n=47) of the neonatal deaths, and 34% (n=24) of the babies who were discharged alive, there were signs of respiratory distress only (n=71). The baby who manifested signs of respiratory distress with shock, infection and hypoglycemia (n=1) died(23).

II.1.5. Low birth weight

Low birth weight is a term used to describe babies who are born weighing less than 5 pounds, 8 ounces (2,500 grams). An average newborn usually weighs about 8 pounds. A low-birth-weight baby may be healthy even though he or she is small. However, a low-birth-weight baby can also have many serious health problems.

Low birth weight is most often caused by being born too early (premature birth). That means before 37 weeks of pregnancy. A premature baby has less time in the mother's womb (uterus) to grow and gain weight. Much of a baby's weight is gained during the last weeks of pregnancy.

Another cause of low birth weight is a condition called intrauterine growth restriction (IUGR). This occurs when a baby does not grow well during pregnancy. It may be because of problems with the placenta, the mother's health, or the baby's health. Babies can have IUGR and be:

Full term. That means born from 37 to 41 weeks of pregnancy. These babies may be physically mature, but small.

Premature. These babies are both very small and physically immature.

The findings of the study done in Australia concluded that very low birth weight (less than 2000 g) contributed to 75.6% of the risk of stillbirths and 59.4% of the neonatal deaths. Low gestational age (less than 32 weeks) accounted for 77.7% of stillbirths and 87.9% of neonatal deaths(25).

II.1.6. Severe and moderate hypothermia

Hypothermia among newborns is considered an important contributor to neonatal morbidity and mortality. Children lose heat faster than adults do. Children may also ignore the cold because they are having too much fun to think about it. Moreover, they may not have the judgment to dress properly in cold weather or to get out of the cold when they should.

Babies with hypothermia may look healthy, but their skin will feel cold. They may also be limp, unusually quiet and refuse to feed. Research done by Darmstadt in Denmark concluded that prevention and management of hypothermia reduces neonatal mortality by 18 to 42%. Kangaroo mother care in low birth-weight infants in health facilities reduces the incidence of infections by seven to 75%, and community based pneumonia case management reduces deaths by 18 to 35%

(25).

II.1.7. Conceptual framework

In addition to the direct causes of neonatal mortality and morbidity, there are a number of underlying causes at the family, community and health system levels that also contribute to undermine the health and survival of the newborns. These include inappropriate newborn care and feeding practices, lack of parental knowledge about danger signs of neonatal illnesses, inappropriate care-seeking for neonatal illnesses, poor hygienic/environmental conditions, and inadequate access to obstetric and neonatal health-care services, etc. Then there are social causes at household level, such as poverty, low education and life skills of parents and gender discrimination, among others, and at health system levels such as quality and quantity of health resources available for maternal and newborn health, which affect

neonatal survival. These social causes underpin both the direct and underlying causes of neonatal mortality and morbidity.

The figure below shows how causes at these three levels interact to produce a situation unfavourable for neonatal survival.

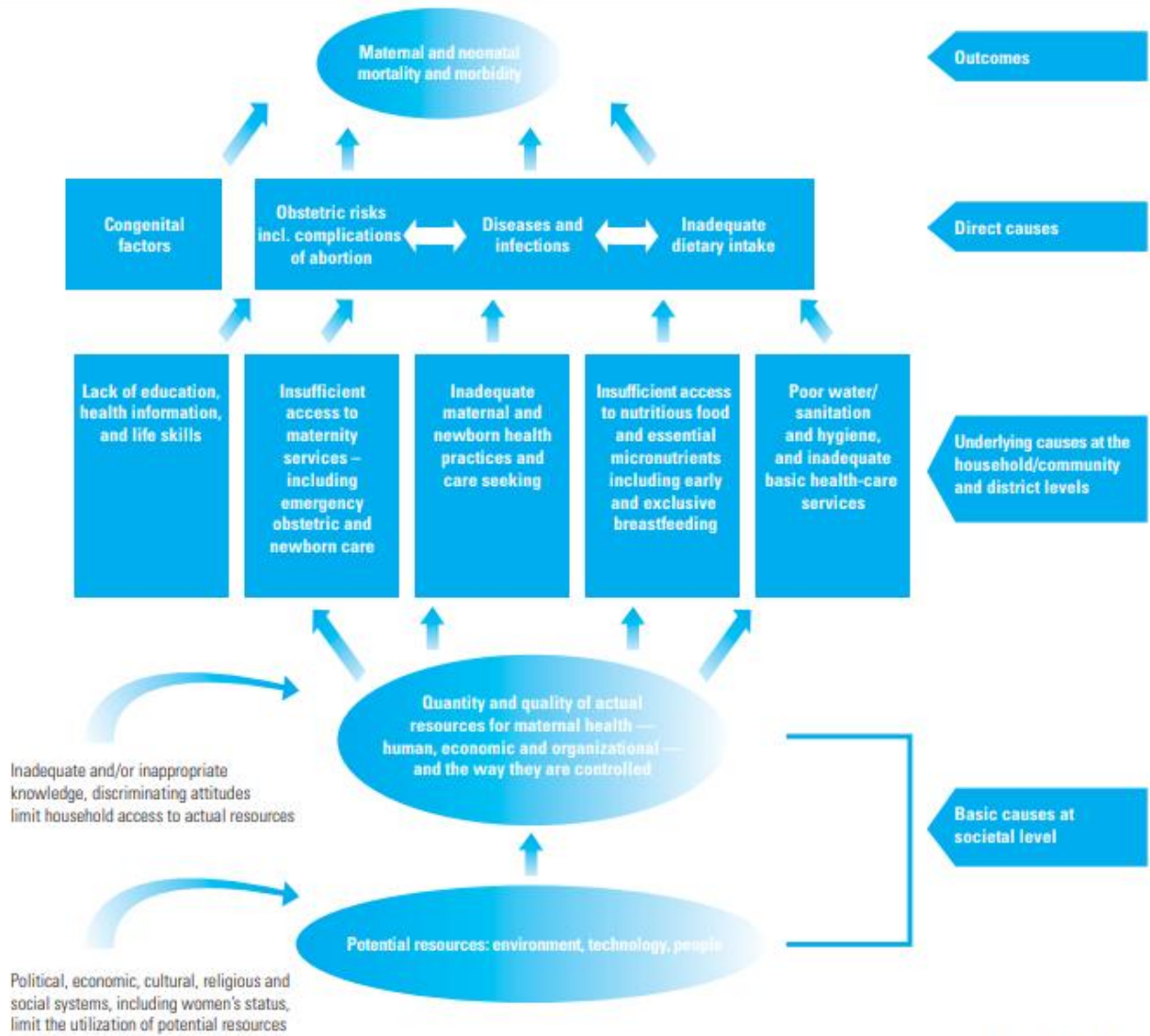


Figure 1: Conceptual Framework

Source: The state of the world's children: Maternal and Newborn Health 2009(12)

1.1.1 Situation of neonatal mortality globally and in selected countries

The World Health Organization, indicates that around 3.7 million children died within the first 28 days of life in that year. Within the neonatal period, however, there is wide variation in mortality risk. The greatest risk is during the first day after birth, when it is estimated that

between 25 and 45 per cent of neonatal deaths occur. Around three quarters of newborn deaths, or 2.8 million in 2004, occur within the first week the early neonatal period(25).

The major causes of neonatal mortality globally are severe infections (36%, including sepsis/pneumonia {26% }, tetanus {7% }, diarrhea {3% }), preterm birth (28%) and asphyxia (23%). Evidence suggests that a significant proportion of neonatal morbidity and mortality in developing countries could be prevented through inexpensive, simple practices and interventions during pregnancy, delivery and postnatal period. These include tetanus toxoid immunization to mothers, proper nutrition including iron, folate and iodine supplements, clean and skilled care at delivery, newborn resuscitation, prevention of hypothermia, early and exclusive breast feeding, clean umbilical cord care and management of pneumonia and sepsis. The distribution of causes of neonatal death has changed during the last decades, with a reduction in neonatal infections and tetanus and an increase in causes of death related to prematurity both in high-income countries and LMICs. The distribution of causes varies between countries related to the level of neonatal mortality. In very high mortality settings (NMR >45/1000) half of deaths are due to infections disease. At low NMR levels (< 15/1000), sepsis/pneumonia is usually less than one fifth. At very low NMR levels (< 5/1000), complications to severe prematurity dominate. In a global perspective the main causes of neonatal deaths are preterm birth complications (35%), neonatal infections including sepsis, meningitis, tetanus, pneumonia, diarrhea (28%) and intra-partum-related neonatal deaths (previously often labeled “asphyxia”, 23%) low birth weight, which is related to maternal nutrition and reflects intrauterine growth restriction and/or preterm birth, contributes to 60 – 80% of the neonatal deaths (25).

In India, a retrospective population-based study of determinants of neonatal mortality in rural Haryana found that the total live births during the study period were 10, 392 and neonatal deaths were 248. In addition, this study highlighted proportions related to infant and neonatal mortality, which were 45.6 and 23.8 per 1000 live births, respectively. Further, socio-economic determinants were low educational status of parents [OR 2.1, 95% CI; 1.4, 3.3] and father’s occupation [OR 1.8, 95% CI; 1.0, 3.0]. Villages with no health facility [OR 1.5, 95% CI; 1.0, 2.1] were observed to be associated neonatal deaths. Proximate determinants like early childbearing age of mother (<20 years) [OR 2.0, 95% CI; 1.2, 3.2] were least important(23).

In Nepal, Nepal Demographic and Health Survey (NDHS 2011) found that the under-five mortality rate for the five-year period preceding the survey was 54 deaths per 1000 live births(4).

In South Africa, according to Stats SA, the NMR for the country is 14/1000 live births. The major causes of neonatal deaths are related to prematurity and intra-partum hypoxia. A number of interventions have been shown to reduce neonatal deaths, and if implemented on a wider scale, they could reduce neonatal deaths significantly. They include providing basic and comprehensive emergency obstetric care, use of antenatal steroids for women in preterm labour, training in immediate care of the newborn and neonatal resuscitation, and post-resuscitation management and ongoing neonatal care (e.g. CPAP), especially to babies who are born preterm(3).

According to the study done in rural South-Western Nigeria by Lawoyin et al. they found the following results: There were 972 live births and 64 infant deaths giving an infant mortality rate of 65.8 per 1000. Neonatal deaths accounted for a half of all infant deaths (32) giving a neonatal mortality rate of 32.9 per 1,000. Twelve (37.5%) of neonatal deaths occurred on the first day of life; half of all neonatal deaths occurred within two days of birth, 21(65.6%) occurred during the first seven days of life and only 11 (34.4%) occurred over the last three weeks of the first month. The commonest known cause of death was associated with LBW which was responsible for eight (25%) of deaths, while sepsis and fever and maternal deaths and failure to thrive were responsible for four (12.5%) and three (9.4%) deaths respectively.

Asphyxia accounted for 3(9.4%) deaths; neonatal tetanus, congenital abnormality and diarrhea were responsible for one (3.1%) death each. Cause of death was unclassified in many early neonatal deaths particularly those which occurred at home. Predictors of neonatal death included LBW, RR of 4.7; delivery outside a health facility, RR of 3.6; lack of attendant at delivery, RR of 5.01; and Traditional Birth Attendant (TBA) delivering the baby, RR of 2.7. Effect of sex of the neonate, mother and father's ages were not significant at the 5% level in the model. In their conclusion they said that, the Neonatal deaths contribute significantly to the high infant mortality in this rural community. Services provided by TBAs are not optimal but appear to be better than having no one in attendance at delivery. TBAs therefore need to be trained to identify at risk neonates and refer. Obstetric and public health services have to be available and made more accessible at the grass root level(12).

In Ethiopia, according to MulukenGizaw Et al. 2008 in their study they found the Results: The trends of neonatal mortality equaled out at a higher level over the study period (P-value = 0.099). There was a high burden of early neonatal mortality (incidence rate ratio 4.8 [4.5, 5.2]) with the highest risk of death on the first day of life 18 [16.6, 19.4]. In multivariate analysis, males 1.6(1.4-1.9), neonates born from poor mothers who had no oxen 1.2(1.0-1.3) lived in thatched houses 2.9(2.4-3.5) and a distance to a health facility 1.5(1.1-2.0) conferred the highest risk of neonatal deaths. Researcher concluded that despite an urgent need in reducing neonatal mortality which contributes to more than 40% to child mortality, no significant change was observed in Butajira. Death was significantly associated with sex of the child, socio-economic variables and physical access to hospital. Prevention strategies directed at reducing neonatal death should address policy and household and level factors, which significantly influence neonatal mortality in Butajira(14)

In Zimbabwe, as mentioned by Tachiweyika Emmanuel Et al., 2009 they were interviewed 103 cases and 206 controls. Primary or no maternal education [OR=5.50 (3.14-9.33)] labor complications [OR=7.56 (4.38-13.06)], home delivery [OR=7.38 (4.03-13.68)] and preterm delivery [OR=15.06 (8.24-27.54)] increased the risk for perinatal mortality. Antenatal care booking [OR=0.19 (0.10-0.34)], having a gainfully employed husband [OR=0.36 (0.20-0.63)] and living within 5km of a health facility [OR=0.41 (0.22-0.78)] reduced the risk. Independent determinants of perinatal mortality included being apostolic [AOR=3.11 (1.05-9.18)], having a home delivery [AOR 7.17 (2.48-20.73)], experiencing labor complications [AOR=8.99(3.11-25.98)], maternal HIV infection [AOR=5.36 (2.02-14.26)], antenatal care booking [AOR=0.32 (0.18-0.87)] and birth weight below 2500g [AOR=9.46 (3.91-27.65)]. Researchers concluded that labor complications, belonging to apostolic sect, having a home delivery, maternal HIV infection, low birth weight and antenatal care booking were independently associated with perinatal mortality(3).

Health worker training in emergency management of obstetric and neonatal care was initiated Marondera District started holding perinatal mortality meetings. In 2007, Marondera District recorded 190 perinatal deaths and 3,242 live births, translating to a perinatal mortality ratio of 58.6 per 1000 live births. In 2008, the district recorded 145 perinatal deaths and 2 243 live births, translating to a perinatal mortality ratio of 64.6 per 1000 live births. These figures were above the provincial perinatal mortality ratio of 32 per 1000 in 2007 and 36 per 1000 in 2008 and the national perinatal mortality ratio which was estimated to be 27 per 1000 in

2008. These ratios might however be underestimates of the real problem given the gross underreporting of perinatal deaths and the high proportion of non-institutional deliveries in the district. They determined factors associated with perinatal mortality focusing on socio-demographic factors, intra-partum factors, obstetric factors and health service factors(21).

In Tanzania, reduction of maternal and newborn deaths is a high priority for all given the persistently high maternal and newborn morbidity and mortality rates over the past two decades in African countries; Tanzania included. It is one of the major concerns addressed by various global and national commitments, and reflected in the targets of the Millennium Development Goals, Tanzania Vision 2025, the National Strategy for Growth and Reduction of Poverty (NSGRP-MKUKUTA), and the Primary Health Services Development Program (PHSDP-MMAM), among others(18).

As described by Manji. K 2009 in the book called Situation analysis of newborn health in Tanzania produced by the Ministry of Health and Social Welfare, Tanzania has substantially reduced child mortality in the past five years, but most of the decline has come after the first month of life and neonatal mortality has not reduced. Each year, at least 51,000 Tanzanian newborns die; an additional 43,000 babies are stillborn. The three main causes of neonatal death in Tanzania are well known: 32 percent die from infections; 27 percent die from complications of preterm birth; 26 percent die from birth asphyxia. Up to two-thirds, or 34,000 newborn lives could be saved if essential care reached mothers and babies. At the current rate of progress, Millennium Development Goal 4 could be met, especially with more attention to newborn survival(18).

In the book of Situation analysis of newborn health in Tanzania on its 47th page, over 140 newborns die each day in Tanzania, most from preventable and treatable causes. Tanzania's future depends on the ability of these newborns to survive and thrive. This situation analysis sheds light on the current state of care and the opportunities to save lives. While better data, policy change and revised guidelines will make a difference, it is the people who truly save lives. Tanzania's official data published in the annual health statistical abstract capture only pre-discharge facility births; the majority of babies born at home and late neonatal deaths, especially deaths that occur from infection, are missed. Many facilities do not have up-to-date records and reviews of death that are linked to the regional and national data collection systems. This problem was clearly evident in the six districts of the six regions surveyed in this situation analysis(18).

In Brazil, according to the study done in Brazil by Nascimento Et al. That case-control study with 132 cases and 264 controls aimed to determine predictors of neonatal mortality using hierarchical modelling. Cases were defined as newborns that died within 28 days of birth, and controls as the survivors, among infants of mothers living in Fortaleza, Ceará State, Brazil. Hierarchical logistic regression identified factors associated with neonatal death: maternal race, with brown/black race showing a protective effect (OR = 0.23; 95% CI=[0.09-0.56]), time spent from home to the hospital > 30 minutes (OR = 3.12; 95% CI=[1.34-7.25]), time < 1h or > 10 hours between hospital admission and delivery (OR = 2.43; 95%CI=[1.24-4.76]), inadequate prenatal care (OR = 2.03; 95%CI=[1.03-3.99]), low birth weight (OR = 14.75; 95%CI=[5.26-41.35]), prematurity (OR =3.41; 95%CI=[1.29-8.98]), and male gender (OR = 2.09; 95%CI=[1.09-4.03]). In this case series, neonatal deaths were associated with the quality of prenatal care and direct care during labor(15)

1.1.2 Developed countries

In the USA, as stated by the U.S. Department of Health and Human Services, Health Resources and Services Administration and MCHB in their book named Child Health USA. According to preliminary data, in 2009, 17,298 infants died before reaching 28 days of age, representing a neonatal mortality rate of 4.19 deaths per 1000 live births. Although this represents a 1.9 % decrease from 4.27 per 1,000 live births in 2008, this change was not statistically significant. Neonatal mortality is generally related to short gestation and low birth weight, congenital malformations, and conditions originating in the perinatal period, such as maternal complications related to pregnancy or complications experienced by the newborn resulting from birth. Neonatal mortality rates vary by race and ethnicity. Based on preliminary data for 2009, the neonatal mortality rate among infants born to Black women (including Hispanics) was 8.20 per 1000 live births, more than twice the rate among infants born to non-Hispanic White and Hispanic women (3.43 and 3.62 per 1,000, respectively)(17).

II. METHODOLOGY

2.1 Study design

This was retrospective case control study. Neonates admitted in district and referral Hospitals from January the 1st to December 31st 2017 made the population of study.

2.2 Sampling Methods

3.1.1 Sample frame

The sampling frame for the primary sampling units (PSU) was the hospitals meeting the inclusion criteria. In total, 42 district hospitals and 3 referral hospitals were retained in the sampling frame. Muhima hospital was included among referral hospitals because it is a Centre of Excellence of Maternity and Neonatology having a high volume of neonates. Registers from hospitals were used to obtain the final sampling frame. In these hospitals, it was expected to have 13,057 admitted neonates and 1565 deaths during the period of the study according to HMIS data.

3.1.2 Sample size

A representative sample of neonates was selected, assuming a need to detect an odds ratio of 1.4 or greater, 80% power ($Z_{\beta}=0.84$), 0.05 significance level ($Z_{\alpha}=1.96$), equal number of cases and controls ($r=1$) and proportion exposed in the control group equal to 20%. The sample size required was computed using the following formula:

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

Where:

n = Sample size in the case group

r = ratio of controls to cases

Z_{β} : Represents the desired power

$Z_{\alpha/2}$: Represents the desired level of statistical significance

$(p_1 - p_2)$: Effect Size (the difference in proportions)

(\bar{p}) : A measure of variability (similar to standard deviation)

To get proportion of cases exposed:

$$P_{caseexp} = \frac{OR p_{controlexp}}{p_{controlexp}(OR-1)+1} \quad P_{caseexp} = \frac{1.4(0.20)}{(0.20)(1.4-1)+1} = 0.259$$

Average proportion exposed = $(0.259+0.20)/2=0.229$

$$n = 2 \frac{(0.229)(1 - 0.229)(0.84 + 1.96)^2}{(0.259 - 0.20)^2} = 792$$

Therefore, n=1584 (792 cases, 792 controls)

3.1.3 Sampling strategy

The sampling design was a two stage stratified cluster sampling where at the first stage a half of district hospitals (21) was selected using simple random sampling. All three referral hospitals and Muhima hospital were included. In total 25 hospitals fulfilling the inclusion, criteria were considered. A second sampling stage was selected proportionally to size neonates (cases and controls) using a systematic sampling method. This allowed having 1584 cases to be reviewed among others 792 survived and 792 died. The inclusion and exclusion criteria were age of neonates at admission.

2.3 Data Collection

Data was sourced from neonatal and maternal medical files including referral notes. Registers were used to know the total number of neonates admitted during the study period. A standardized data collection tool (annex I) containing different study variables was pretested and adjusted accordingly. The Data collection was done in wide team together with staff members of Center for Sustainable Access to Health in Africa that was interested largely on Rwanda's achievements in maternal and child health (MCCH) including family planning. Herewith, the researcher, having participated in data collection process, picked only a small proportion of neonates related data from the general data base for analysis.

2.4 Study variables

Dependent variable consisted of neonatal deaths. Different independent variables were collected. These have been decided based on literature and these were susceptible to influence the neonatal outcome.

Independent variables were grouped into, general information on mother and new-born including anthropometric measures, delivery factors, admission factors both for mother and new-born, neonatal factors and factors related to management of the mother during or before

delivery and the one for the new-born during the stay in neonatal unit. Detailed independent variables for this study are in the data collection tool (annex 1).

2.5 Data Analysis

Data were analysed using SPSS version 21. For the descriptive analysis, frequencies and percentages of neonatal characteristics with their confidence intervals were calculated. Babies discharged (survivors) and those died during their stay were compared. All p values were two tailed and p values below significance level of 5% ($p < 0.05$) were considered as statistically significant. Risk factors associated with neonatal death in bivariate analysis were further analysed using multivariable logistic regression analysis by estimating the adjusted odds ratios (OR) and their 95% confidence intervals (CI).

2.6 Ethical Consideration

The following ethical considerations were taken into consideration:

- An approval by NHRC was requested and obtained
- Patients files were reviewed following the approval of district hospital authorities
- Results will be shared with the hospitals for the improvement of management of neonates in coming days

III. RESULTS

3.1 . General description of the sample

a) Description of the sample

A total of 11,464 admissions were found over 13,057 expected leading to the percentage of 87.8%. With regard to the number of deaths, 1, 418 were found compared to 1565 expected (90.6%) (Table 1).

Table 1: Cases found compared to cases expected

Hospitals	Total admission expected (Source: HMIS)	Total admissions found	Total hospital deaths expected (Source: HMIS)	Total hospital deaths found
Kiziguro DH	323	331	76	55
Bushenge PH	231	195	30	18
Nemba DH	688	554	64	74
Munini DH	236	281	15	15
Butaro DH	479	475	43	44
Gisenyi DH	1,167	1,132	143	154
Gakoma DH	118	146	20	33
Gihundwe DH	337	343	31	27
Murunda DH	394	390	55	60
Kabgayi DH	813	806	57	61
Ruhango PH	444	320	40	43
Kibungo PH	758	710	100	80
Mugonero DH	187	171	26	13
Shyira DH	124	126	25	30
Rwamagana PH	1260	1235	98	85
Kaduha DH	87	88	17	15
Ruli DH	447	415	37	36
Nyanza DH	558	560	83	85
Kabaya DH	445	447	75	74
Kibagabaga DH	721	670	92	106
Kibilizi DH	355	362	53	48
CHUK	565	549	51	50
CHUB	716	713	131	128
Rwanda Military Hospital	299	144	70	5
Muhima DH	1,305	1,107	133	140
Total	13,057	11,464	1,565	1,418

3.2 History of the mother of the new-born

The table below (Table 2) presents obstetrical history and general information on delivery of the mothers. Mortality among admitted newborn was 16.2% among mothers who received less than 2 ANC visits while it was 9.1% among the group of newborn born to mother who performed 3 ANC Visits or more. The difference is statistically significant (p-value=0.000). The multiple pregnancies was also shown to be associated with neonatal deaths as mortality among newborns from single pregnancy was 11.2% while it was 17.5% among the group from multiple pregnant mothers. The difference being statistically significant (p-value=0.005)

Table 2: General obstetrical characteristics on the mother and pregnancy (bivariate analysis)

Characteristics	Outcome of the newborn (% and Confidential Interval)			
	Controls	95% CI	(Cases)%	95% CI
Parity				
1-2 (n=849)	88.4	[86.8,89.8]	11.6	[10.2,13.2]
3+ (n=442)	87.5	[85.1,89.5]	12.5	[10.5,14.9]
Pearson: Uncorrected chi2(2) =	0.239	P-value	0.786	
Gravidity				
1-2 (n=775)	88.5	[86.8,89.9]	11.5	[10.1,13.2]
3+ (n=557)	86.9	[84.7,88.8]	13.1	[11.2,15.3]
Pearson: Uncorrected chi2(2) =	1.2413	P-value	0.275	
Number of Antenatal care visits				
0-2 (n=380)	83.8	[80.7,86.5]	16.2	[13.5,19.3]
3+ (n=509)	90.9	[89.3,92.3]	9.1	[7.7,10.7]
Pearson: Uncorrected chi2(2) =	10.5341	P-value	0.000	
History of illness during pregnancy				
Yes (n=189)	87.1	[83.2,90.2]	12.9	[9.8,16.8]
No (n=772)	88.3	[86.7,89.8]	11.7	[10.2,13.3]
Pearson: Uncorrected chi2(2) =	0.2019	P-value	0.807	
Type of pregnancy				
Single (n=1,298)	88.8	[87.6,89.9]	11.2	[10.1,12.4]
Multiple (n=131)	82.5	[76.4,87.2]	17.5	[12.8,23.6]
Pearson: Uncorrected chi2(2) =	5.8981	P-value	0.005	
Delivery at health facility				
Yes (n=1,348)	88	[86.8,89.2]	12	[10.8,13.2]
No (n=82)	86.9	[80.7,91.3]	13.1	[8.7,19.3]
Pearson: Uncorrected chi2(2) =	0.2053	P-value	0.811	
Total (n=1,526)	88	[86.9,89.1]	12	[10.9,13.1]

3.3 Characteristics of the labour

Table 3 below presents details on labour by outcome of the newborn admitted. The only factor associated with neonatal deaths is the abnormal FHR (out of 120-160 per min range) during

the labour; the mortality among admitted newborn with history of abnormal FHR during labour is 15.1% while it is 10.3% in the group of newborn admitted without any history of abnormal FHR during the labour; P=0.003. Other variables were not shown to be statistically significant associated with neonatal deaths. These include mode of delivery, use of oxytocin used during labor, existence of meconium and prolonged labour.

Table 3: Characteristics of the labour

Variables	Outcome of the newborn			
	Controls		Cases	
	%	95% CI	%	95% CI
Prolonged labor (> 8 Hours)				
Yes (n=82)	88.1	[82.2,92.2]	11.9	[7.8,17.8]
No (n=732)	88.3	[86.6,89.8]	11.7	[10.2,13.4]
Pearson: Uncorrected chi2(2)	0.11	P-value	0.896	
Expulsive phase more than 1 hour				
Yes (n=65)	85.1	[77.3,90.6]	14.9	[9.4,22.7]
No (n=831)	88.6	[87.1,90.0]	11.4	[10.0,12.9]
Pearson: Uncorrected chi2(2)	0.9458	P-value	0.393	
Oxytocin used during labor				
Yes (n=88)	87.9	[82.2,92.0]	12.1	[8.0,17.8]
No (n=816)	87.8	[86.1,89.3]	12.2	[10.7,13.9]
Pearson: Uncorrected chi2(2)	0.1593	P-value	0.849	
Fetal Heart Rate abnormal (out of 120-160 per min range)				
Yes (n=208)	84.9	[80.8,88.3]	15.1	[11.7,19.2]
No (n=548)	89.7	[87.9,91.2]	10.3	[8.8,12.1]
Pearson: Uncorrected chi2(2)	3.5181	P-value	0.033	
Presence of meconium				
Yes (n=282)	89.6	[87.0,91.7]	10.4	[8.3,13.0]
No (n=595)	87.9	[86.0,89.6]	12.1	[10.4,14.0]
Pearson: Uncorrected chi2(2)	0.9672	P-value	0.363	
Mode of delivery				
Vaginal delivery (n=979)	87.7	[86.2,89.1]	12.3	[10.9,13.8]
Cesarean section (n=438)	88.9	[86.7,90.7]	11.1	[9.3,13.3]
Instrumental (n=17)	84.5	[66.9,93.7]	15.5	[6.3,33.1]
Pearson: Uncorrected chi2(3)	0.5289	P-value	0.771	

3.4 Danger signs on pregnant women

As per the Table 44: Newborn to mothers with fever during the labor (p-value=0.001), pre-eclampsia/eclampsia (p-value=0.018) and risk of premature delivery (MAP) (p-value=0.001) are associated to newborn deaths.

Table 4 : Danger signs on pregnant women

Danger signs	Outcome of the newborn			
	Survived	Confidential Interval	Died	Confidential Interval
	%	95% CI	%	95% CI
Risk of premature delivery				
Absent (n=263)	88.1	[85.2,90.5]	11.9	[9.5,14.8]
Present (n=262)	80	[75.4,84.0]	20	[16.0,24.6]
Pearson: Uncorrected chi2(1)	6.3577	P-value	0.001	
Foetal distress				
Absent (n=400)	84.1	[81.0,86.7]	15.9	[13.3,19.0]
Present (n=125)	87	[82.1,90.6]	13	[9.4,17.9]
Pearson: Uncorrected chi2(1)	0.6821	P-value	0.282	
Hemorrhage on pregnancy				
Absent (n=494)	85.4	[82.9,87.6]	14.6	[12.4,17.1]
Present (n=31)	72	[50.4,86.7]	28	[13.3,49.6]
Pearson: Uncorrected chi2(1)	2.9713	P-value	0.08	
Pre-eclampsia/eclampsia				
Absent (n=497)	84.3	[81.7,86.7]	15.7	[13.3,18.3]
Present (n=28)	93.4	[86.4,96.9]	6.6	[3.1,13.6]
Pearson: Uncorrected chi2(1)	1.8461	P-value	0.018	
Cord prolapse				
Absent (n=518)	84.8	[82.2,87.0]	15.2	[13.0,17.8]
Present (n=7)	91	[68.4,97.9]	9	[2.1,31.6]
Pearson: Uncorrected chi2(1)	0.231	P-value	0.445	
Fever				
Absent (n=512)	84.3	[81.7,86.6]	15.7	[13.4,18.3]
Present (n=13)	97.5	[90.6,99.3]	2.5	[0.7,9.4]
Pearson: Uncorrected chi2(1)	2.9568	P-value	0.001	

3.5 Gestational age by outcome of the newborn

As per theTable 55: Mortality increases with the low gestational age. Among newborn with extreme prematurity, more than one half died, among those with severe prematurity, one third died while 12.8% among newborn admitted with moderated prematurity died. Meanwhile, the mortality among those born at term was 8.6%. This means that Newborn with extreme prematurity and those with severe prematurity are more than 6 and 3.5 times higher exposed

to deaths compared to newborn born at term. The low age of the newborn is a factor highly associated to newborn death; (p=0.000).

Table 5: Gestational age by outcome of the newborn

Characteristics (Gestational age)	Outcome of the newborn			
	Controls (%)	95% CI	Cases (%)	95% (CI)
Extreme prematurity (n=74)	44.8	[24.0,67.7]	55.2	[32.3,76.0]
Severe prematurity (n=168)	69.6	[60.8,77.2]	30.4	[22.8,39.2]
Moderate prematurity (n=63)	87.2	[79.9,92.0]	12.8	[8.0,20.1]
Term birth (n=703)	91.4	[90.0,92.6]	8.6	[7.4,10.0]
Pearson: Uncorrected chi2(5)	89.3077	P-value	0.000	

3.6 General characteristics of the newborn

As per the table 6 below, although the percentage of deaths among male newborns is higher compared to females, the difference was not statically significant and the sex of the newborn was not shown to be a risk factor. However, both low and critically low APGAR Scores are factors of neonatal deaths (p-value=0.000).

Table 6: General characteristics of the newborn at birth

Characteristics of the newborn	Outcome of the newborn			
	Survived (%)	95% CI	Died (%)	95% CI
Sex of newborn				
Male (n=844)	87.2	[85.5,88.7]	12.8	[11.3,14.5]
Female (n=674)	89	[87.3,90.5]	11	[9.5,12.7]
Pearson: Uncorrected chi2(2)	1.1857	P-value	0.249	
APGAR at the 1st minute				
Critically low (n=108)	61	[46.3,74.0]	39	[26.0,53.7]
Fairly low (n=450)	84.6	[81.7,87.0]	15.4	[13.0,18.3]
Normal Score (n=660)	92.1	[90.7,93.2]	7.9	[6.8,9.3]
Pearson: Uncorrected chi2(3)	56.1339	P-value	0.000	
APGAR at the 5th minute				
Critically low (n=58)	62.2	[42.6,78.5]	37.8	[21.5,57.4]
Fairly low (n=272)	72.1	[65.5,77.8]	27.9	[22.2,34.5]
Normal Score (n=801)	92.7	[91.6,93.7]	7.3	[6.3,8.4]
Pearson: Uncorrected chi2(3)	85.3012	P-value	0.000	
APGAR at the 10th minute				
Critically low (n=32)	68.3	[46.2,84.4]	31.7	[15.6,53.8]
Fairly low (n=156)	62.3	[51.0,72.3]	37.7	[27.7,49.0]
Normal Score (n=703)	92.1	[90.8,93.2]	7.9	[6.8,9.2]
Pearson: Uncorrected chi2(3)	72.7204	P-value	0	

3.7 APGAR Score at birth (Logistic Regression)

The table 7 below confirmed that critical APGAR and low APGAR are both associated to newborn deaths (P=0.000). At the first minute, admitted newborn with critical APGAR and low APGAR were 7 and more than 2 times likely to die compared to newborn admitted with normal APGAR Scores.

Table 7 . APGAR score

APGAR Scores	Newborn outcomes				
	N	%	OR	95% CI	P-value
APGAR at the 1st minute					
Normal Score (n=660)	243	7.9	1		
Critically low (n=108)	92	39	7.39	[3.97-13.77]	0.000
Fairly low (n=450)	263	15.4	2.12	[1.63-2.76]	0.000
APGAR at the 5th minute					
Normal Score (n=801)	284	7.3	1		
Critically low (n=58)	50	37.8	7.68	[3.41-17.30]	0.000
Fairly low (n=272)	205	27.9	4.91	[3.48-6.91]	0.000
APGAR at the 10th					
Normal Score (n=703)	262	7.9	1		
Critically low (n=32)	26	31.7	5.38	[2.12-13.70]	0.000
Fairly low (n=156)	129	37.7	7.03	[4.31-11.46]	0.000

3.8 Causes of admission by outcome

The table 8 below shows case fatality rate among retained causes of admissions. Top five ranking factors of admissions with high fatality rate include congenital abnormalities (41.9%), respiratory distress syndrome (26.9 %); prematurity (20.9%), hypothermia (20.2%), low birth weight (17.1%) and Birth Asphyxia /HIE (16.5%). Meanwhile both hypothermia, congenital abnormalities, risk of infection, neonatal infection, low birth weight, birth Asphyxia /HIE, respiratory distress syndrome (MMH) and prematurity are statistically significant associated to newborn deaths.

Table 8: Factors leading to admission and retained causes by outcome/died (Case fatality rate by cause)

	N	%	OR	95% CI	P-value
Birth Asphyxia /HIE					
Not mentioned (n=979)	425	9.8	1		
Mentioned (n=547=35%)	327	16.5	1.81	[1.44-2.28]	0.000
Respiratory distress syndrome (MMH)					
Not mentioned (n=1,205)	527	9.8	1		
Mentioned (n=321=26%)	225	26.9	3.38	[2.54-4.51]	0.000
Prematurity					
Not mentioned (n=968)	391	8.6	1		
Mentioned (n=558=36%)	361	20.9	2.79	[2.21-3.52]	0.000
Low birth weight					
Not mentioned (n=1,223)	571	10.9	1		
Mentioned (n=303=19.8%)	181	17.1	1.69	[1.29-2.23]	0.000
Neonatal Infection					
Not mentioned (n=1,128)	590	13	1		
Mentioned (n=398=26%)	162	9.1	0.67	[0.52-0.85]	0.001
Risk of infection					
Not mentioned (n=1,193)	622	13.7	1		
Mentioned (n=333=21%)	130	7.4	0.5	[0.39-0.65]	0.000
Congenital abnormalities					
Not mentioned (n=1,442)	680	11.2	1		
Mentioned (n=84=5.5%)	72	41.9	5.74	[2.97-11.10]	0.000
Hypothermia					
Not mentioned (n=1,422)	686	11.5	1		
Mentioned (n=104=6%)	66	20.2	1.95	[1.25-3.05]	0.003

3.9 Type of pregnancy and number of ANC and danger signs at admission and place of birth

The table 9 below shows that newborn to mothers who did two ANC visits or less are more exposed to deaths (OR=1.93, [1.45-2.57]). Newborn to multiple pregnancy are more exposed to death compared to those born from single pregnancy (OR=1.69, [1.14-2.49]). With regards to the existence of the danger signs, newborns admitted with danger signs are more exposed to deaths (OR=2.24, [1.64-3.04]) and newborn admitted from outside the hospital are more exposed to deaths compared to those born within the hospital of admission (OR= 1.91, [1.40-2.61]).

Table 9: Type of pregnancy and number of ANC and danger signs at admission and place of birth

Characteristics	N	%	OR	95% CI	P
Number of Antenatal care done					
3+ (n=509)	212	9.1	1		
0-2 (n=380)	217	16.2	1.93	[1.45-2.57]	0.000
Type of pregnancy					
Single (n=1,298)	615	11.2	1		
Multiple (n=131)	80	17.5	1.69	[1.14-2.49]	0.008
Existence of Danger Signs					
No (n=315)	113	7.4	1		
Yes (n=525)	297	15.1	2.24	[1.64-3.04]	0.000
Delivered outside hospital (n=493)	262	13.2	1.91	[1.40-2.61]	0.000

3.10 Danger signs at admission of the mother and place of delivery by outcome

From the danger signs presented in the table below, risk of premature delivery is shown to be a risk factor of neonatal deaths (OR=1.84, [1.27-2.67]) with statistically significant difference. However, haemorrhage on pregnancy is shown to be a risk factor of neonatal deaths (OR= 2.28 [0.89-5.87]) but this is not statistically significant. Other danger signs are not shown to be a risk factor of neonatal deaths.

Table 10: Danger signs at admission of the mother and place of delivery by outcome

Type of danger signs	N	%	OR	95%	p
Risk of premature delivery					
No risk of premature delivery (MAP) (n=263)	130	11.9	1		
Risk of premature delivery (MAP) (n=262)	167	20	1.84	[1.27-2.67]	0.001
Hemorrhage on pregnancy					
No hemorrhage on pregnancy (n=494)	273	14.6	1		
Hemorrhage on pregnancy (n=31)	24	28	2.28	[0.89-	0.0
Pre-eclampsia/eclampsia					
No pre-eclampsia/eclampsia (n=497)	285	15.7	1		
Pre-eclampsia/eclampsia (n=28)	12	6.6	0.38	[0.17-	0.0
Total (n=1,526)	752	12			
Fever					
No fever (n=512)	294	5.7	1		
Fever (n=13)	3	2.5	0.14	[0.04-	0.0

3.11 Characteristics of the newborn

The table below shows that critical APGAR and low APGAR are both associated to newborn deaths ($P=0.000$). At the first minute, admitted newborn with critical APGAR and low APGAR are 7 and more than 2 times exposed to deaths compared to newborn admitted with normal APGAR Scores.

Table 11: Characteristics of the newborn

	N	%	OR	95% CI	p
Gestational age, grouped					
Term birth (n=703)	279	8.6			
Extreme prematurity (n=74)	67	55.2	13.08	[5.01-34.19]	0
Severe prematurity (n=168)	128	30.4	4.64	[3.05-7.06]	0
Moderate prematurity (n=63)	33	12.8	1.57	[0.90-2.74]	0.115
Late-preterm infants (n=121)	44	7.9	0.91	[0.60-1.39]	0.661
Were corticosteroids administered to mother when indicated?					
No (n=119)	98	34	5.54	[3.28-9.36]	0.000
Were FHR abnormal (out of 120-160/min)?					
No (n=548)	52	10.3	1		
Yes (n=208)	19	15.1	1.54	[1.09-	0.014
APGAR Scores at first minute					
Normal Score (n=660)	243	7.9	1		
Critically low (n=108)	92	39	7.39	[3.97-13.77]	0.000
Fairly low (n=450)	263	15.4	2.12	[1.63-2.76]	0.000
APGAR at the 5th minute					
Normal Score (n=801)	284	7.3			
Critically low (n=58)	50	37.8	7.68	[3.41-17.30]	0.000
Fairly low (n=272)	205	27.9	4.91	[3.48-6.91]	0.000

3.12 Management

Table 12 below highlight that newborns with severe hypothermia were 3.61 times more likely than newborn with normal temperature. However, newborns who did not receive Vitamin K after birth were 1.58 times more likely than newborns who received Vitamin K after birth.

Table 12 : Management

	N	%	OR	95% CI	P-value
Temperature of the newborn					
Normal temperature (n=339)	118	6.7	1		
Severe hypothermia (n=379)	260	20.6	3.61	[2.59-5.04]	0.000
Moderate Hypothermia (n=550)	264	11.4	1.79	[1.33-2.41]	0.000
Fever (n=96)	24	4.9	0.72	[0.41-1.26]	0.249
Not documented (n=162)	86	15.1	2.48	[1.64-3.73]	0.000
Was vitamin K administered after birth?					
Yes (n=1,026)	488	10.8	1		
No (n=376)	208	16.1	1.58	[1.23-2.04]	0.000
Not documented (n=124)	56	11.3	1.05	[0.70-1.56]	0.827
If newborn less than 34 weeks, was put on CPAP?					
No CPAP indication (n=824)	323	8.5	1		
Yes (n=113)	89	31.3	4.9	[2.99-8.04]	0.000
No (n=328)	223	24	3.4	[2.55-4.54]	0.000

IV. DISCUSSION

4.1 Study findings versus findings of other recent studies

This study found many risk factors that have a statistically significant association with neonatal death. The risk factors were as follows: Prematurity, critically and fairly low APGAR Scores, respiratory distress syndrome (MMH), Low birth weight, severe and moderate hypothermia, birth Asphyxia, danger sign for the newborn on admission, the fact that the newborn was resuscitated, the fact that the newborn was admitted from outside the hospital and being born from the multiple pregnancies

Our study findings are similar to many studies done across the world found risks factors for newborn deaths, while others are different to our findings. For example, similarly to our study findings; results from the study entitled maternal and newborn risk factors associated with neonatal mortality conducted in Gitwe District Hospital in Ruhango District, Rwanda by Théoneste the following risk factors were identified as being associated with a higher risk of neonatal death in the final model: place of delivery (aOR = 8.24, 95% CI: 2.0 – 35), prolonged labor duration (aOR = 17.4, 95% CI: 2 – 144.2), and eclampsia (aOR = 23, 95% CI: 2.4 – 25.2). As one of our results, the same study identified clinical characteristics of neonate at birth that showed statistical significant association with neonatal mortality, those include LBW (cOR = 0.21, 95% CI: 0.1 – 0.4), very lower Apgar score (cOR = 12.5, 95% CI: 4.2 – 37.7), preterm birth (cOR = 4.8, 95% CI: 2.5 – 9.2), first birth rank (cOR = 2.1, 95% CI: 1.1 – 3.9), neonate presented feet at birth (cOR = 2.1, 95% CI: 1.1 – 3.9) and birth spacing (with previous birth) less than 24 months (cOR = 0.12, 95% CI: 0.05 – 0.3), and birth asphyxia (cOR = 3.6, 95% CI: 2.0 – 7.0)(9).

Furthermore, another study entitled the neonatal mortality and its determinants in rural communities of Eastern Uganda done in Uganda by Ronald M. Kananura *et al* showed that factors associated with increased neonatal deaths were parity of 5+ (adj. RR =2.53, 95 % CI =1.14–5.65) relative to parity of 4 and below, newborn low birth weight (adj. RR = 3.10, 95 % CI = 1.47–6.56) and presence of newborn danger signs (adj. RR = 2.42, 95 % CI = 1.04–5.62)(9). Factors associated with lower risk of neonatal death were, home visits by community health workers (CHW) (RR =0.13, 95 % CI = 0.02–0.91), and attendance of at least 4 antenatal visits (RR = 0.65, 95 % CI = 0.43–0.98).

In Tunisia, in the study entitled “Determinants” conducted by Emira Ben Hamida Nouaili et al., factors associated to neonatal mortality were identified as follows prematurity (aOR=6.03- 95%CI: [2-18.13] p=0.001), neonatal respiratory distress (aOR=16.12 - 95%CI: [5.67-45.78] p<10⁻³), perinatal asphyxia (aOR=11.49- 95%CI: [3.68-35.92] p<10⁻³), nosocomial infection aOR=8.71- 95%CI: [1.77-42.70] p=0.008, and small for gestational age aOR=7.11- 95%CI: [2.23-22.69] p=0.001(24).

In Namibia, Nelago Indongo in his study entitled “risk factors and causes of neonatal deaths in Namibia” showed that low birth weight, prematurity, Respiratory distress syndrome, birth asphyxia, sepsis and congenital malformations as most prevalent causes of neonatal deaths(25).

In Indonesia, a study called Risk factors associated with neonatal deaths: a matched case–control study in Indonesia” carried out by Asnawi Abdullah et al in 2016 identified six factors which were found to be significantly associated with a higher risk of neonatal death. The factors identified were as follows: neonatal complications during birth; mother noting a health problem during the first 28 days; maternal lack of knowledge of danger signs for neonates; low Apgar score; delivery at home; and history of complications during pregnancy. Three risk factors (neonatal complication at delivery; neonatal health problem noted by mother; and low Apgar score) were significantly associated with early neonatal death at age 0–7 days. For normal birth weight neonates, three factors (complications during delivery; lack of early initiation of breastfeeding; and lack of maternal knowledge of neonatal danger signs) were found to be associated with a higher risk of neonatal death. Globally, as per studies above, many risk factors for newborn deaths are similar to those identified by our study with few differences.

4.2 Discussion of our main risk factors of the newborn deaths

4.2.1 Prematurity

In this study, 36% of the total admitted newborn was born prematurely. This is the sign that neonatology units of hospitals have to have enough capacities to save lives of premature babies.

Globally, mortality rate among premature babies was 20.9% versus 8.6% among term babies ((OR= 2.79) [2.21-3.52]). However, risk of death increases with decreasing gestational age as

mortality was 55.2% among new born with extreme prematurity (less than 28 weeks) while it was 30.4% and 12.8% among newborn with severe and moderate prematurity respectively.

The findings of this study vis a vis prematurity are in line with others conducted recently; in the study called Maternal and Newborn Risk Factors associated With Neonatal Mortality in Gitwe District Hospital in Ruhango District, preterm babies were found to have higher risk of dying compared to full term ones (OR=3.1 (1.3 – 7.8)(5).

In another study entitled “Risk factors and causes of neonatal deaths in Namibia” reviewing a total of 498 neonatal deaths occurred in health facilities during the period under study January 1, 2010–June 30, 2012 , prematurity was shown to be the most common cause of neonatal death (n=270 or 54)(5).

Worldwide, preterm birth (less than 37 completed weeks of gestation) contributes to 28% of neonatal deaths globally. There are many reasons for premature delivery, but in many cases, the causes are unknown. Reasons for premature delivery include high maternal blood pressure, acute infections, multiple births, hard physical work and stress.

As reported by Darmstadt et al, cost-effective and inexpensive interventions such as antibiotics for preterm premature rupture of membranes, antenatal corticosteroids, clean delivery practices, resuscitation of the newborn, prevention of hypothermia and strengthening the use of KMC can reduce neonatal deaths by 41 - 72%(24).The use of antenatal steroids can reduce the incidence of hyaline membrane disease, intra-ventricular haemorrhages and necrotizing enterocolitis, and ultimately significantly reduce neonatal deaths. Finally, prevention and active management of hypothermia, starting in the delivery room, also reduces mortality of premature infants significantly.

4.2.2 Low birth weight

Our study results revealed that low birth weight (less than 2.5Kg), which is mostly an indicator for prematurity or intrauterine foetal growth restriction, was associated with higher risk for neonatal death. Low birth weight (LBW) pre disposes newborns to increased risk of infections, low blood sugar and low body temperatures, which increase the risk of death compared to normal newborns. Similarly to the study done in the USA highlights that neonatal mortality is generally related to short gestation and low birth weight, congenital malformations, and conditions originating in the perinatal period, such as maternal complica-

tions related to pregnancy or complications experienced by the newborn resulting from birth(24).A need to strengthen the use of kangaroo mother care (KMC) practices across hospitals as a low cost intervention for taking care of LBW babies is therefore apparent. Furthermore, there is a need to prevent and control hypothermia and infection among this group with view to reduce mortality rate.

4.2.3 Hypothermia

Our study revealed that hypothermia upon admission to neonatology was an important factor associated to the newborn death. Whereas findings from the study carried out by Laptook et al. studying 5,227 very low birth weight preterm infants found that in-hospital mortality among newborn was inversely proportional to temperature at admission. It is therefore essential to plan feasible strategies for thermal protection of the newborn and to reduce the incidence of hypothermia on admission to the neonatology unit, protecting the patient from complex web of factors related to poor quality of perinatal care, the outcome of which is death.

4.2.4 Antenatal care

Attendance of ANC at least three times was found to be independently associated with a lower risk of newborn death. This is because additional antenatal visits may serve to reinforce maternal education and compliance and provide an opportunity for screening and treatment danger signs and infections respectively. Furthermore, health providers can teach mothers to recognize danger signs during pregnancy, labor, and delivery and encourage them to plan clean and safe deliveries. This is in keeping with existing evidence which indicates that attending ANC at least four times may lead to timely diagnosis and treatment of maternal infections and other health problems during pregnancy which can lead to significant improvement in foetal and neonatal outcomes.

4.2.5 Low APGAR score/Birth asphyxia

The Apgar score is an important factor that has been shown to be associated with a higher risk of neonatal death. This score is not only useful for evaluating the clinical status of the neonate in the first minutes after birth but also for determining their need for resuscitation and evaluating effectiveness. This study found that neonates who were born with very low Apgar scores had a risk of neonatal death 7 times higher compared with those with a normal

Apgar score and those with fairly low APGAR score had a risk of neonatal death more than 2 times compared to those with normal APGAR score. Although most babies breathe spontaneously at birth, up to 10% of newborns require some assistance to initiate breathing. Less than one percent of babies need extensive resuscitation. Suctioning and provision of oxygen is often successful as an intervention. Preventing deaths from birth asphyxia requires special resuscitation skills in only a small proportion of neonates. However, when resuscitation is needed, it must be administered in a timely manner.

Without immediate intervention, babies who survive oxygen deprivation to the brain may suffer severe and lifelong developmental disabilities.

4.2.6 Newborn admitted from outside of the hospital

The fact that the newborn was admitted from outside the hospital was associated with neonatal death. Our study findings are related to the study conducted in India entitled Neonatal morbidity and mortality of sick newborns admitted in a teaching hospital of Uttarakhand results showed that the chief causes of mortality were prematurity (25.6%), sepsis (21.6%), perinatal asphyxia (19.5%), and RDS (17.3%) with a statistically higher rate in the outborn in comparison with inborn. Total 20.5% neonates died due to poor outcome of outborn neonates.

This may be due to many factors including the fact that the newborn was presenting serious issues, lack of prevention of hypothermia in the way before reaching the hospital among others. Special measures to be implemented during the transfer of the newborn have to be put in place to prevent some issues among others hypothermia and low blood sugar.

4.2.7 Multiple pregnancies

Multiple pregnancies were shown to be associated with neonatal death. This is mainly linked to the complications rising during the delivery due to lack of skills. World Health Organization report highlight that multiple pregnancy carries a higher risk of prematurity, intrauterine growth restriction, and prenatal death, as well as elevated risks to the mother including preeclampsia, diabetes, and hemorrhage during delivery(25). Delivery should be performed by high skilled staff for multiple pregnancies and a reference should be done on

time where there are no staffs with capacity to perform delivery for multiple pregnant women.

V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In the design of this study, we were particularly interested in identifying risk factors that were amenable to intervention by health services and that addressed neonatal death in newborn. The study confirmed a high proportion of deaths in premature newborns (20.9%), those with hypothermia (20.2%), low birth weight infants (17.1% as well as those having birth asphyxia (16.5%). Neonatal death was associated with problems at delivery and a low Apgar score. This reinforces the importance of delivery attended by staffs that have the skills and equipment needed to manage newborn with birth asphyxia. This particularly applies to mothers at risk of having low birth weight infants, including mothers of young age, suffering from other complications including poor nutrition, and with premature onset of labour. A range of factors associated with higher risk of neonatal death have been identified, several of these risk factors could be addressed by health care providers interventions, including promotion of the use of ANC services to reach four ANC standard visits as recommended together with more focus on neonatal care during antenatal care, better communication to mothers of danger signs of pregnant mothers and newborns and better access to appropriate care for newborns when parents detect problems.

Finally, measures to prevent birth asphyxia, hypothermia and reinforcing capacity to manage premature babies, those with hypothermia and those having respiratory distress syndrome may reduce significantly deaths among newborn population.

Delivery for women with multiple pregnancies should be attended with staff having enough skills and measures to prevent hypothermia during the transfer of newborn with low birth weight and prematurity should be put in place.

5.2 Recommendations

Based on the findings, the following recommendations were formulated to face some risk factors associated with the newborn:

We have realized that the one-size-fits-all approach would not work since health facilities within the same category have different volume of patients and treat predominantly different conditions. It has therefore become clear that the staffing levels and the skills mix should be tailored to the specifics of each health facility.

The increasing number of patients at different health facilities, calls for a need to address the following main concerns:

- ❖ Increase the number of staff vis-a-vis the actual workload at health facilities especially in high volume hospitals.
- ❖ Revise some professional requirements to meet up-to-date norms and standards
- ❖ Solve the critical shortage of ambulances especially in remote area
- ❖ Scale up the establishment of Health posts to improve geographic accessibility to health services

5.2.1 Recommendations for training and practice regarding Health Care Practitioners related factors

- ❖ Training of Health Care Practitioners on the importance of record keeping.
- ❖ Dissemination of audits findings and implantation of related recommendations to improved newborns health outcomes should be assured.
- ❖ HCPs must have knowledge, skills and greater understanding of the importance of interventions in reduction of neonatal deaths, such as implementing the EMOC guidelines, as well as maintaining sterile procedures during birth and postnatal care.
- ❖ There is a need for education and training of Health Care Practitioners on labor monitoring in order to minimize the chances of prolonged labor and foetal distress.
- ❖ There is also a need to look at aspects of care that were not recorded such as duration of resuscitation and nature of drugs given which should be addressed during in-service education sessions.
- ❖ Emphasis should be made on the importance of auditing records of inpatients on a continuous basis.
- ❖ Implementation of national maternal and neonatal guidelines.

Recommendations for the community regarding patient related factors

- ❖ Pregnant women and the community at large need to be educated about danger signs in pregnancy.

- ❖ The community needs to be educated on the significance of early attendance of the antenatal clinic and its benefits.

5.2.2 Areas for further research recommended

- ❖ Further research regarding the knowledge, skills and behaviors of Health Care Practitioners needs to be conducted.
- ❖ Development of appropriate intervention strategies to reduce neonatal mortality and morbidity at the district and referral hospitals.
- ❖ Research to identify factors contributing to the rate of infection among the neonates.
- ❖ Determination of the availability of human and material resources within maternal and neonatal services.
- ❖ Identification of the factors contributing to the high rate of preterm delivery.
- ❖ Evaluation of the utilization of maternity services by the community at large.

5.3 Study Limitations

Main limitations of this study were linked to its design of being retrospective as some information was not found in the medical files on one hand. On the other hand, some medical files and mainly maternal were missed. A prospective study may allow having additional contributing factors to neonatal deaths.

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ANNEXES

ANNEXE 1: Data collection tool for the study entitled” factors contributing to neonatal mortality in hospitals of Rwanda”

Code of Data collector	
A. Administrative and description of health facility	
1.Province :	
2.District:	
3.Name of Hospital :	
4.Type of hospital:	District Hospital...Referral..... MuhimaHospital.....
B. Information on the outcome of the newborn	
1.Outcome of the new born	Survivor.... Died..... Transferred.....
If died, what about the time of the death	Working days.....Week end.....
Time of death	During the day..... During the night.....
c. General Information on mother and pregnancy	
1.Age of the mother in years:	
2. Parity 3. Number of pregnancy	Yes..... No.....
4. History of children who died previously in the first year 5. Height of the mother (in cm)	Not documented.....
6. Weight in (in kg) 7. Number of Antenatal care done	
8. History of hospitalization during pregnancy	Yes..... No.....
9. Type of pregnancy	Single.....Multiple...
D. Information related to admission of mother for delivery	

1. Was the mother admitted referred by another health facility?	Yes..... No..... Not Applicable.....
2. Was the mother admitted in labor?	Yes..... No.....
3. If yes, was she in active phase of labor?	Yes..... No.....
4. Were there any danger sign for the foetus on admission?	Yes..... No.....
5. If yes, which danger signs was present?	
01. Risk of preterm delivery	Yes..... No.....
02. Foetal distress	Yes..... No.....
03. Hemorrhage on pregnancy	Yes..... No.....
04. Pre-eclampsia	Yes..... No.....
05. Cord prolapse	Yes..... No.....
06. Other problem on admission	Yes..... No.....
07. If other problem, specify	Yes..... No.....
6. Was the pregnancy at term?	Yes..... No.....
7. If no, Indicate the gestational age in weeks	
8. If less than 34 weeks, were corticoids administered to mother during labor?	Yes..... No.....
E. Information related to labor and delivery	
1. Early rupture of membranes?	Yes..... No.....
2. If early rupture of the membranes more than 18 hrs, were antibiotic prescribed to the mother?	
3. Was active phase of labor prolonged ?(> 8 Hours)	Yes..... No.....
4. Was expulsive phase more than 1 hour?	Yes..... No.....
5. Was ocytocine used during labor to accelerate labor?	Yes..... No.....
6. Was there bad FHR during labor?	Yes..... No.....
7. Was there any meconium during labor	
8. Mode of delivery	Spontaneous Vaginal delivery.....
	Cesarean section.....
	Assisted delivery.....
9. Was the delivery occurred in health facilities?	Yes..... No.....
10. If no, was it occurred at home?	Yes..... No.....
F. General information related to newborn	
1. APGAR at the 1 st minute	
2. APGAR at the 5 th minute	
3. APGAR at the 10 th minute	
4. Was the newborn resuscitated?	Yes..... No.....

5. If yes, indicate the duration of resuscitation in minutes	
6. Age of the newborn on admission	
7. Length of stay (in days) If less than 24 hours, write length of stay in hours	
8. Age of the newborn at the end of hospitalization	
9. Sex of newborn	Male.....
	Female.....
10. Weight of the newborn in grams	
11. Height in cms	
12. Head circumference in cm	
G. Information related to the management of the newborn	
1. Was Temperature checked on admission?	Yes..... No.....
2. If checked, indicate the values on admission	
3. Was Vitamine K administered at birth?	Yes..... No.....
4. Was glycemiacheked at admission?	Yes..... No.....
5. If the weight was <1500 Gr , was aminophilline administered immediately after admission?	Yes..... No.....
6. If the weight was <1500 Gr , was aminophilline administered but not immediately after admission?	Yes..... No.....
7. Was the newborn examined by a medical doctor on admission?	
8. Indicates how many times was the newborn seen by a medical doctor from admission to the end of hospitalization	
6. Causes of admission	
01. Asphyxia at birth	
02. Prematurity	
03. Risk or neonatal Infection	
04. Congenital abnomalties	
05. Other causes of hospitalization	
06. If other cause, specify	
19.If died, retained cause of death in register	
01.Asphyxia at bith or its complications	
02.Neonatal infections or septicemia	
03.Complications of prematurity	
04.Congenital abnolmalties	
05. Other cause no mentionned	
06. If other, specify	
Names of data collector	signature

Date of data collection:...../...../.....