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Morbidity, Mortality Patterns and Factors Associated With Mortality among Neonates Admitted in Wajir County Referral Hospital

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Abstract

Background: Neonatal morbidity and mortality is a global burden despite management measures that has been developed. Approximately 75% of all newborn deaths occur in the first week of life. In 2018 alone, around 2.5 million neonates died globally as a result of preventable causes such as prematurity, complications at birth, infections, and congenital abnormalities.

Objective: The objective of the study was to determine neonatal morbidity and mortality patterns, and factors associated with mortality among neonates admitted in Wajir County Referral Hospital.

Methodology: A hospital-based retrospective cross-sectional study was conducted among all neonates admitted to the New Born Unit of the WCRH from 01 January 2019 to 31 December 2020. A consecutive sampling technique based on the inclusion criteria was used. A data abstraction tool was used to extract data from the medical records of neonates admitted to the New Born Unit of the hospital.

Results: A total of 615 neonates were included in the study. There were 336 (54.6%) male and 279 (45.4%) female neonates. Almost all the deliveries 566 (92.0%) were performed at the health facility with a minority of about 49 (8%) delivered at home. The home deliveries and referrals admissions from tertiary hospitals together were 66 (10.7%). Neonatal morbidity included birth asphyxia 335 (54.5%), neonatal sepsis 144 (23.4%), 57 (9.3%) meconium aspiration syndrome and 52 (8.5%) low birth weight/preterm.

Overall mortality in 2019 at the health facility was 45 (12.97%) and in 2020, 35 (13.06%) presenting no significant difference. The deaths that occurred in the first 24 hours of life was 36 (45%). Bivariate and multivariate analysis produced a significant association between the factors associated with neonatal mortality. The multivariate analysis with day of admission (OR 2.872, 95% CI 1.293, 6.375), Sex, (OR 1.02, 95% CI 1.0.627, 1.66) and Birth weight, (OR 0.936, 95% CI 0.423, 2.068) at $p<0.05$. The logistic regression model was statistically significant, $\chi^2(7) = 20.770$, $p < 0.001$. The model explained 27% (Nagelkerke R^2) of the variance in discharge outcome and correctly classified 87% of cases. The male gender were 1.02 times more likely to die than females while the place of delivery was 0.572 times likely to result in death.

Conclusions: Birth asphyxia was found to be the leading cause of admission, followed by neonatal sepsis and meconium aspiration syndrome respectively. The leading cause of death was birth asphyxia and neonatal sepsis. The mortality rate at the facility was 13%. Neonatal fatality of the newborns admitted to NBU is high in Wajir County. Since majority of the deaths are from preventable causes, this offers chances to improve newborn survival.

Key Words: *Morbidity, Mortality, Neonates, Asphyxia*

1.1 Background to the Study

Neonatal morbidity and mortality have been decreasing gradually within the global context, although it has remained relatively high in Low and Middle Income Countries (LMICs)[1]. According to the World Health Organization (WHO), around 75% of all newborn deaths occur during the first week of life [2]. Thus the risk of death among children in the first week of life is 15 times more than before the first year of life [3]. WHO identifies that in 2018, approximately 2.5 million babies died from preventable causes such as prematurity, intrapartum related complications (asphyxia), infections and congenital abnormalities [4]. In 2019, an estimated 2.4 million children died in their first month of life globally. Approximately 7 000 newborn deaths occur daily. This is approximately 47% of total deaths of children below the age of 5 years yearly, rising from 40% in 1990 [2]. According to Hug and colleagues [5], in their assessment of the global neonatal mortality rate (NMR) between 1990 and 2017, they reported a decrease by 51% from 36.6 deaths for every 1,000 live births in 1990 to 18 per 1,000 live births in 2017. The average number of neonatal deaths also decreased from 5 million to 2.5million in 2017. All regions across the world have reported reduced NMR since 1990. It is also estimated that 27 million children will die in their first month between 2018 and 2030 [5]. The majority of neonatal deaths in the LMICs are preventable and effective interventions exist[6]. According to estimates by the United Nations Children's Fund (UNICEF)[7], sub-Saharan Africa had the highest neonatal mortality rate in 2018 at 28 deaths per 1000 live births, followed by Central and Southern Asia with 25 deaths per 1000 live births. These estimates show that a child born in sub-Saharan Africa is 10 times more likely to die in the first month than a child born in a high-income country. Thus, there is a need to integrate more essential interventions to control neonatal deaths to attain Sustainable Development Goal # 3 whose aim is to reduce NMR to less than 12 deaths per 1000 live births. According to Saleem and colleagues [8], immaturity, respiratory complications, and perinatal asphyxia were associated with increased neonatal mortality. WHO estimates that approximately 3% (3.6 million) of all infants develop severe asphyxia of whom 23% of the affected infants always end up dying [9].

In Kenya, neonatal morbidity and mortality are high despite health interventions targeting reproductive health [10]. According to KDHS (2015)[11], the infant mortality rate was 39 deaths per 1000 live births. The NMR in Kenya in 2018 was 20 deaths per 1,000 live births, with an annual reduction of 2% from 2000 to 2018. These neonatal deaths are mainly a result of preterm birth complications (28%), Intrapartum related events (asphyxia) (29%), Sepsis (16%), and congenital abnormalities (13%). Accessibility of healthcare facilities within the County has been a challenge, with the available facilities lacking resources and trained personnel to improve neonatal outcomes. This study seeks to establish the morbidity patterns and mortality among neonates admitted to Wajir County Referral Hospital (WCRH) and to determine the associated factors with neonatal mortality.

1.2 Problem Statement

Globally, approximately 25% of the 4 million annual neonatal deaths are due to neonatal asphyxia [12]. In 2019, the burden of neonatal mortality remains in Sub-Saharan Africa, with 27 deaths per 1,000 live births, followed by Central and Southern Asia, with 24 deaths per 1,000 live births [2]. Kenya's latest health statistics show that neonatal mortality amounts to 20 deaths per 1,000 live births [13]. This figure is also much higher than the projected target of meeting the Sustainable Development Goals, which by 2030 seek to have less than 12 neonatal deaths per 1,000 live births [12]. The findings of the latest study have shown that the neonatal mortality rate for Kenya in 2018 was 19.6 deaths per 1000 live births. The rate of neonatal mortality steadily fell from 35.4 deaths per 1000 live births in 1975 [14]. A report published by Africa Institute of Development Policy (AFIDEP) in 2020, shows that neonatal mortality in Wajir was indicated as 24 per 1000 live births in 2017 [15]. This figure is higher than the projected Sustainable Development Goals (SDGs) target of less than 12 neonatal deaths per 1,000 live births by 2030 per 1,000 live births [2]. Major barriers to effective neonatal health include widespread socio-economic and geographic disparities in access and use of maternal, neonatal, and child health services (MCH). To reduce these inequalities, Kenya implemented three key guidelines/strategies during the study period: abolishing user fees, Kenya's essential package for health and the community health strategy. Eliminating the use fee has been unevenly enforced since patients still have hidden costs. The Kenya Essential Package for Health allows healthcare facilities to be built and/or expanded in many areas, but the facilities are struggling to provide emergency obstetric and neonatal care (emONC), newborn care, and many essential medicines and supplies. The community health strategy has had a greater impact on the coverage vaccination, malaria prevention and the prevention of HIV/AIDS from mother to child. However, there are limitations to the community health strategy.

1.3 Purpose of the Study

The primary purpose of the study was to assess the neonatal morbidity and mortality patterns and factors associated with mortality among neonates admitted in the newborn unit of the Wajir County Referral Hospital. The secondary purposes was to determine neonatal mortality patterns and analyze factors associated with mortality among neonates admitted to the newborn unit of in Wajir County Referral Hospital between January 1st, 2019, to December 31st, 2020.

2.1 Literature Review

Globally, the neonatal mortality rate fell by 41% between 2000 and 2017; nevertheless, in 2017, 2.5 million deaths occurred in children aged under 1 month: one child in every 55 born [12]. Regionally, Sub-Saharan Africa has reported the highest neonatal mortality, with approximately 28 deaths per 1,000 live births and approximately 26 deaths per 1,000 live births in South Africa [16] . According to Hug et al. [5], children born in high-income countries are 10 times less likely to die compared to those born in the south and sub-Saharan Africa. According to Defranco et al. [17], 1.5 million neonatal deaths occur annually in developing countries, accounting for around 67% of the total neonatal global deaths. The neonatal mortality rate is high in low and middle-income countries (LMICs), which account for 99% of all neonatal deaths globally [18]. Similarly, Ekwochi et al. [19] approximate that 95% of the global neonatal deaths occur in developing countries, which have a higher number of births occurring outside a healthcare facility. About half of all deaths occur in the home. The newborn mortality rate in low-income countries ranges from 40 to 50 per 1,000 live births, especially in sub-Saharan countries and South Asia, while in many high-income countries the newborn mortality rate ranges from 2 and 4 per 1,000 live births [20].

According to Ibrahim et al. [21], Sub-Sahara Africa recorded the highest neonatal mortality, with 35 deaths per 1,000 live births. This is high above the target for Sustainable Development Goal #3.2 for decreasing neonatal deaths at least as low as estimated 12 neonatal deaths per 1,000 by 2030 [12]. To achieve this goal, necessary measures must be included that can help overcome the common problems of childbirth and labour and improve the care of small and sick newborns. Individual patient-level data would enable an analysis of service utilization and outcomes and indicate which conditions or facilities should be targeted for improvement measures, including allocation of human resources.

According to Machio [10], Kenya reported a lower decline in neonatal mortality at around 19% from 1990 to 2015. Tanzania and Uganda reported a high reduction of 51% and 53%, respectively, from 1990 to 2015. Neonatal mortality rate for Kenya was 21 deaths per 1,000 live births. The northern eastern part of Kenya has been associated with very high neonatal mortality rates estimated at 24 deaths per 1000 live births in 2019.

2.2 Factors Influencing Neonatal Morbidity

2.2.1 Birth Weight

The WHO explains low birth weight (LBW) as a newborn who weighs less than 2,500 grams. LBW newborns are further subdivided into two; extreme low birth weights (ELBW) - birth weight less than 1000 g and very low birth weight (VLBW) - birth weight 1000 g and 1499 g. Birth weight is a major determinant of infant health and survival. Epidemiological data suggest that infants born with low birth weight are at increased risk of premature death [22]. Some of the main causes of low birth weight include premature birth and small size for gestational age. Low birth weight is responsible for 60-80% of all neonatal deaths.

The global burden of LBWs is 15.5%, which means that about 20.6 million of them are produced annually, of which 96.5% are in developing countries. LBW rates vary significantly across different regions of the United Nations, with Central and South Asia having the highest incidence (27.1%) and Europe the lowest (6.4%) [23]. There is an inverse relationship between neonatal mortality and birth weight, where an increase in birth weight has been linked with a decrease in mortality for neonates [24].

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Several studies have illustrated the relationship between low birth weights, neonatal deaths, and their prevalence. For instance, a study done in Brazil found a prevalence of 8 per cent of all live births were linked to low birth weight. This group is representative of more than half of the infant deaths with a higher risk among those born with extremely low birth weight [25]. Children born weighing less than 1000 grams have a lower chance of survival. According to a study conducted in Uganda, there was an inverse relationship between mortality and birth weight and death occurred in 89% of children born weighing less than 1000 grams [26].

Low birth weight has been a major issue in low resource countries. Low-level knowledge on child care, poverty and low education status among mothers have been key factors leading to increased low birth weight in neonates [27].

Socio-economic inequalities play an essential part in the development of LBW and preterm births. Among these determinants are the mother's age, unfavourable living situations and the low education level of the mother [28]. The social status of mothers is closely related to their education. Therefore, low birth weight can be associated with low economic conditions of the mother, resulting in low birth weight during pregnancy, delay in prenatal care, and low prenatal counselling compared to the norm [28].

2.2.2 Gestational Age

Gestational age defines the newborn's development and thus prematurity is defined based on gestational age. Children born with lower gestational age are more likely to have complications due to poor developmental milestones [29]. According to WHO (2019) [12], Preterm newborns are described as children born alive before the completion of 37 weeks of pregnancy. Preterm birth, depending on gestational age, is sub-categorized as follows: (1) extremely preterm (less than 28 weeks), (2) very preterm (28 to <32 weeks), (3) moderate to late preterm (32 to <37 weeks). An estimated 15 million babies are born very early per year worldwide [30]. That's more than 1 in every 10 kids. Every year, about 1 million babies die due to premature delivery complications [30]. Worldwide, for kids under the age of five, premature birth is the most major cause of death.

In almost every country with credible data, the preterm birth rate is growing. Africa and South Asia experience over 60% of premature births [31]. Premature birth is a global concern indeed [32]. Twelve per cent of babies are delivered early in low-income countries, compared to an average of twelve per cent (12%) in high-income countries. Neonates born at a gestational age of fewer than 37 weeks are more likely to die because they are vulnerable to many risks. In a study conducted in Brazil's, the Rio Grande do Sul, the risk of death among neonates born less than 37 weeks of gestational age (GA) was 28.9 times higher than that of neonates born more than 37 weeks of gestational age (GA) [33].

2.2.3 APGAR Score

The Appearance, Pulse, Grimace, Activity, and Respiration (APGAR) score, a 10-point scoring method for assessing newborns, was identified by Virginia APGAR, an anesthetist, in 1952. 1 minute and 5 minutes after birth, the test is performed. The score helps to predict the final result after a child is resuscitated [34]. APGAR stands for "Appearance, Pulse, Grimace, Activity, and Respiration." In the test, when testing the health of the infant, five factors are considered. Each object is graded on a scale of 0 to 2, the best score being 2: appearance (skin colour), pulse (heart rate), grimace response (reflexes), movement (muscle tone), and breathing (breathing rate and effort). It is considered safe for infants who score 7 or higher on the test. A low score does not indicate that it is not safe for your child. This suggests that emergency medical treatment may be needed to support the baby's breathing, such as airway suction and oxygen. In general, a healthy baby can have a low score, especially during the first few minutes after birth [35].

A study conducted in Sweden examining the correlation between APGAR scores of 7, 8, and 9 (compared to 10) at 1, 5, and 10 minutes and neonatal mortality and morbidity found that neonatal infections, complications of asphyxia, respiratory failure, and neonatal hypoglycemia were higher at both the 5th and 10th minutes among infants with lower APGAR scores. A drop in the APGAR score from 10 at 5 minutes to 9 at 10 minutes was also correlated with higher neonatal morbidity chances (12.4%) than a constant APGAR score of 10 at 5 and 10 minutes [36].

An increased risk of neonatal death was associated with neonates with an APGAR score lower than 7 in both the 1st and 5th minutes. A comparable but different study found that neonates who experienced extreme hypoxia at the 1st and 5th minutes of life were 44 times more likely to die than those who did not experience hypoxia at birth [37]. Similar results were obtained by Ferrari et al., which revealed that 78% of neonates with low birth weights and asphyxia died in the first minute of life [38]. A low 5th minute APGAR score is considered the most reliable predictor of predicting the neurological health and death of an infant. Not only does the APGAR score reflect the vitality of the infant, but it is also directly linked to the standard of treatment during birth. It is necessary to track the adequacy of treatment during labour and after birth, provided that the lower the APGAR score in the 1st and 5th minutes of life, the lower the chances of survival [39]. The quality of prenatal care and the neonatal care network programs minimize the risk factors for hypoxia and neonatal death in this context [40]. APGAR Surgical Score is a 10-point rating method where patients that are at risk for adverse peripheral results are accurately classified by a low score.

2.2.4 Prenatal Visits

Prenatal visits form a major part of child development because of the routine reviews on the mother and fetal development by a healthcare provider. The number of prenatal visits to a health care provider plays an essential role in improving fetal health. Ibrahim and colleagues conducted a study in Indonesia and found lower odds associated with neonatal deaths and morbidity outcomes at the last trimester among women with more antenatal visits [21].

Furthermore, a study conducted in Zimbabwe found that a one-unit rise in the standard of prenatal care decreases the risk of neonatal mortality [41]. This research indicates that women who receive data on potential complications that arise during pregnancy are less likely to suffer neonatal death. It has been shown that absent or limited pregnancy monitoring is a risk factor associated with neonatal mortality [42].

A study undertaken in the United States showed that mothers who had less than seven counselling visits during pregnancy were 3.7 times more likely to experience neonatal deaths. Newborns' whose mothers had less than seven visits had a probability of death of 16.8 per 1000 compared to 4.5 per 1000 for those whose mothers had more than seven consultation visits [43]. A new collection of recommendations to improve the quality of maternal care has been released by the WHO to reduce the risk of stillbirth and pregnancy complications and provide women with a healthy experience of pregnancy. The new guidelines raise from four to eight the number of encounters a pregnant woman has with healthcare professionals during pregnancy. It suggests that pregnant women to contact healthcare professionals in her first 12 weeks of pregnancy and then visit her at 20, 26, 30, 34, 36, 38 and 40 weeks of pregnancy. By focusing on positive pregnancy experiences, these new recommendations aim to be an effective transition to a healthy pregnancy and positive labour and delivery for mother and baby, and ultimately a good maternal experience. When there are eight or more scheduled care contacts compared to 4 visits, the death rate can be reduced to 8 per 1000 births [22].

2.3 Factors Associated with Neonatal Mortality

Sub-Saharan Africa has the highest risk of neonatal morbidity and mortality globally, with approximately 71% of neonatal deaths that are preventable since they are related to facility-based care [44]. Neonatal mortality and morbidity greatly impacted the success of millennium development goal # 4 (MDG 4). In Kenya and other developing countries, neonatal mortality and morbidity was a major challenge in attaining this goal. Consequently, for the first time, we have a newborn mortality target as outlined in the United Nation SGD. The Secretary-General of the United Nations for Economic and Social Affairs underscored the importance of reducing disparities and achieving SDG target 3.2 to the most vulnerable newborns, children, and mothers by eliminating preventable mortalities of infants and kids below the age of five. Under Goal 3.2, all countries aim to reduce neonatal mortality by at least 12 deaths per 1,000 live births and under-five mortalities to at least 25 deaths per 1,000 live births by 2030 [45].

A comparative and descriptive study conducted in Nigeria to identify the causes of mortality and morbidity in neonates revealed that the most common causes of admissions among neonates include perinatal asphyxia, low birth weight, neonatal sepsis, and neonatal jaundice. However, the leading causes of death included neonatal sepsis, perinatal asphyxia, and very low birth weights. Approximately 55% of all neonatal deaths occurred 24 hours after admission [19].

A case-control study of risk factors associated with early neonatal deaths in a tertiary hospital in Kenya showed that maternal age, gestational age of admission, birth attendant qualification, intensity and number of antenatal care visits were some of the risk factors for neonatal morbidity [46]. Similarly, a cohort study of predictors of post-neonatal mortality in western Kenya found that infant mortality is high and is associated with out-of-hospital births, maternal HIV infection, and infant HIV infection. The post-neonatal mortality rate was 58 (95% CI: 48.69) per 1000 person-years of follow-up [47]. To achieve a steady decline in infant mortality, efforts to reduce mother-to-child transmission and other HIV prevention measures need to be improved. Some of the leading causes of neonatal mortality include intrapartum complications (perinatal asphyxia), sepsis in neonates and pneumonia in neonates.

2.3.1 Intrapartum Complications

Intrapartum complications commonly known as perinatal asphyxia, which is a failure at the time of birth to start and maintain breathing, is the fifth leading cause of under-five mortality after pneumonia, diarrhea, neonatal infection and complication of preterm births [48]. Globally, asphyxia is estimated to cause 19% out of the total of 4 million neonatal deaths that occur annually [49].

The WHO estimated in 2018 that about 4-9 million newborns each year develop asphyxia at birth. Studies have also shown that 15% to 20% of the many children affected die in the neonatal phase and up to 25% of survivors experience permanent neurological disability such as epilepsy, cerebral paralysis, mental retardation and neuro-developmental delay [12]. Wayessa et. al.;[50], found a prevalence rate of birth asphyxia in Ethiopia to be 32.9% and 12.5% in the first and fifth minutes, respectively, of APGAR scoring. Maalim observed a perinatal asphyxia rate of 31.1% at the fifth minute among term infants admitted in Kenyatta National Hospital [51], and these findings demonstrate close semblances to the ones previously replicated in Ethiopia by Wayessa and colleagues. In Nigeria, a prospective study by Ugwu, Abedi, & Ugwu established a prevalence rate of asphyxia among neonates to be approximately 2% (28 per 1000 birth), which was attributed to a lack of health education among health care workers stemming from the influence of unsubstantiated religious beliefs among residents [52].

2.3.2 Sepsis in Neonates

Early development of sepsis remains the most common cause of neonatal illness and mortality. The identification of newborns at risk of early sepsis is often based on a constellation of perinatal risk factors that are neither sensitive nor specific. In addition, diagnostic tests for neonatal sepsis have low positive prognosis accuracy. As a result, even though the bacterial culture is negative, physicians often treat healthy infants for a long time. Broad-spectrum antimicrobial agents, including ampicillin and aminoglycosides, are the best treatment for infants with suspected premature sepsis [53].

According to WHO, sepsis is considered a major healthcare priority in neonates for the coming decade [54]. Neonatal and infant mortality from extreme sepsis is nearly 11% in high-income nations, despite enhanced health care. The Global Disease Burden Study widely characterizes the burden of serious infectious diseases on infant mortality in low-income countries. In 2013, infectious diseases such as lower respiratory tract infections (708,600 deaths), diarrhoea (474,900 deaths) and malaria (570,000 deaths). killed 2.3 million children under the age of 5. Causes of death are typically classified in these reports by the form of infection rather than the involvement of sepsis. The general pathophysiological final pathway to death from organ failure and most infectious diseases is sepsis [55].

A study investigating neonatal sepsis in Tanzania found culturally proven sepsis in 24% of newborns. Staphylococcus aureus, Klebsiella, and Escherichia coli were primarily isolated bacterial pathogens. In 32.7% of newborns <7 days, Klebsiella was the predominant blood culture, while Staphylococcus aureus (54.5%) was the most prevalent in newborns> 7 days. Staphylococcus aureus showed different pus inflammation in both neonates 0-6 days (42.2%) and 7-28 days (52.3%). The results also showed that in newborns with fever, hypothermia, cutaneous pupillary secretion, umbilical cord pus and abdominal wall hypertension, sepsis was higher. In children with sepsis, the neonatal mortality rate was 13.9% and greater (24%) compared to those without sepsis (10%) [56].

2.3.4 Pneumonia in Neonates

Neonatal pneumonia is significant in low resource settings. Sub-Saharan Africa has been largely affected by high neonatal pneumonia rates, leading to increased neonatal mortality [30]. Most countries in Sub-Saharan Africa, including Kenya, have been making significant efforts to improve infant and maternal health. However, these countries are far from achieving the WHO SDGs for decreasing infant morbidity and death [57]. Group B streptococci (and other streptococci) and gram-negative species, most notably Escherichia coli and Klebsiella spp., are common bacterial pathogens. Popular respiratory pathogens, namely the respiratory infection virus, human rhinovirus, and influenza, are the dominant viruses. The viral disease is sometimes nosocomial, and infected newborns are infected in a neonatal intensive care unit or another neonatal environment by infected parents and nurses. Newborn pneumonia often presents with shortness of breath in the newborn. In premature infants, it cannot be distinguished from respiratory distress syndrome often associated with surfactant defects [58].

Infants who die within 28 days of birth suffer from diseases and conditions related to a lack of quality treatment at birth, according to the WHO. The leading causes of neonatal death include complications of preterm birth, pneumonia, malaria neonatal sepsis, and diarrhea [2]. Most of these newborns occur in developing countries with low access to quality healthcare and deliver at home without quality and skilled care.

3.1 Research Methodology

3.1.1 Study Design

This was a hospital based retrospective study. The study focussed on routine hospital and clinical data to help in answering the research objectives. The exposure and outcome variables were evaluated at one point in time from the patient files. This study was conducted in Wajir County Referral Hospital Neonatal and Paediatric wards. The WCRH is the referral facility for Habaswein District Hospital, Wajir TB Manyatta Sub-District Hospital, Griftu District Hospital, Tarbaj Health Centre, Buna Sub-District Hospital, Eldas Health Centre among other health facilities in the county. WCRH offers both outpatient and inpatient services, which include preventive, curative, and rehabilitative services. The facility has six inpatient wards and a total bed capacity of 83 with an average annual inpatient turnover of 8,341[15]. The average annual outpatient workload inclusive of both adults and children was 6,700. The newborn unit has a bed capacity of 28 and an average bed occupancy of 71%. The unit was manned by 15 nurse-midwives, two (2) medical officers. The facility had no pediatrician during the study period. The study population comprised of on neonates aged 0-28 days admitted to NBU at Wajir County Referral Hospital from January 1st, 2019, to December 31st, 2020. The study included the medical records of the neonates admitted to the NBU and excluded the neonates with incomplete records as per the data extraction tool. In this case, any records with missing gestation age, birth weight, diagnosis, and treatment record were treated as incomplete record and therefore excluded from the study. The study utilized a consecutive sampling method based on the inclusion criteria to ensure that all neonates are considered. All the neonates who meet the inclusion criteria were included in the study. Consecutive sampling was used to assess all patient files and ensure that only those who meet the inclusion criteria are included in the study.

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3.1.2 Data Collection

A data abstraction tool was developed based on the research objective identified and was used to find relevant information from the patient files. The data abstraction tool was specific and only included information that was relevant to the study. The variables of interest included: neonate characteristics such as sex, age, gestation age, APGAR score, birth weight, diagnosis on admission and treatment. The data collected included date of admission, gestation age, birth weight, APGAR score, admission diagnosis, treatment, discharge date and discharge outcome. Starting with 2019, the Inpatient (IP) numbers was retrieved from the admission file based on each month. Once the IP numbers of the recruited patients are identified based on the inclusion criteria, the researcher retrieved these files from the records department for data abstraction. This was done for each year 2019 and 2020 on monthly basis. The researcher, through the help of the research assistants, assessed all the patient files and selected those that meet the inclusion criteria. The researcher was assisted by the hospital medical records clerks who are experienced in retrieving data to ensure efficiency with a high level of accuracy. Data quality control measures included selecting randomly about 5% of the data and re-entered by another person and compared for consistency and quality of data. Providing patient registry clerks and research assistants with accuracy between two records that might or could not be the same individual, algorithms was used to solve and avoid duplicates of records.

3.1.3 Data Analysis

Data cleaning was done using the exclusion criteria whereby missing data on gestation age, birth weight, diagnosis, and treatment were treated as incomplete record and therefore excluded from the data analysis. The data analysis included descriptive statistics, which describes and visualize the data obtained from the patient files. Descriptive statistics included measures of central tendency such as means, median and percentages. Descriptive analysis was done using means, frequencies, percentages, cross tabulations and represented in graphs and charts. The Pearson's chi-square tests with corresponding 95% confidence intervals (CI) with an upper and lower bound was computed to find the association between variables. A bivariate and multivariate logistic regression analysis was used to explain the relationship between co-morbidities and outcomes. The neonatal mortality was calculated by dividing the number of deaths over 12 months by the number of neonates admitted within the same period for both 2019 and 2020 and expressed as a percentage. Kaplan-Meir survival analysis was used to explain the pattern of survival from admission in 0 to 28 days.

The chi-square test can be used to prove the validity of an association, but it does not give any measure to assess the strength of each valid association. After filtering out the invalid associations using chi-square test, we used the Odds Ratio (OR) to measure the strength of each association and to rank them based on their strength. The OR is a measure of association between a condition and an outcome. The OR shows that an outcome will occur in a particular condition, as compared to the odds of the outcome occurring in other conditions.

A multivariate logistic regression was carried out to further assess the association between sex, gestational age, gestation (single/multiple), birth weight, APGAR score, place of delivery, and day of admission and the dependent variable discharge outcome of alive or dead. We used the Cox & Snell R Square and Nagelkerke R Square values to explain the variation in the dependent variable.

4.1 Key Result and Findings

The key results and findings of the study are summarized under the following headings.

(a) Descriptive Statistics

There were 630 admitted in the NBU of WCRH during the entire study period out of whom 615 (97.6%) were eligible for this study. Out of the 615 neonates whose records were included in this study, 336 (54.6%) were male and the remaining 279 (45.4%) were female. Majority 602 (97.9%) were singletons and 13 (2.1%) were twins. Majority were delivered in health facility-inborns (566/615, 92%) while 49 (8%) were delivered outborns. Overall, 66 (10.7%) of the total admissions to the NBU were either home deliveries or referrals from other hospitals, the rest were born in the WCRH. The summary of this findings is as depicted in Table 1.

Table 1: Summary descriptive statistics

No	Variable	Description	Frequency N=615	Percent (%)
1	Place of Delivery	Hospital	566	92.0
		Home	49	8.0
2	Referral to WCRH	Yes	66	10.7
		No	549	89.3
3	Sex	Male	336	54.6
		Female	279	45.4
4	Single/Multiple Gestation	Single	602	97.9
		Multiple (Twins)	13	2.1
5	Place of birth	Inborn	566	92.0
		Outborns	49	8.0
6	APGAR Score at 5 min	Normal (7-10)	190	30.9
		Moderately Abnormal (4-6)	323	52.5
		Abnormal (0-3)	53	8.6
		No Information	49	8.0

(a) APGAR Scores

Using the task force on neonatal encephalopathy categories of APGAR score at 5 minutes, out of the 615 neonates admitted to the NBU, 49 had missing APGAR record. Of the remaining 566, 190 (33.6%) had an APGAR score of 7-10, 323 (57.1%) had a score of 4-6 and the remaining 53 (9.4%) a score of 0-3 at the 5 min. Figure 1 provides the summary of the APGAR score for all the neonates admitted to the NBU.

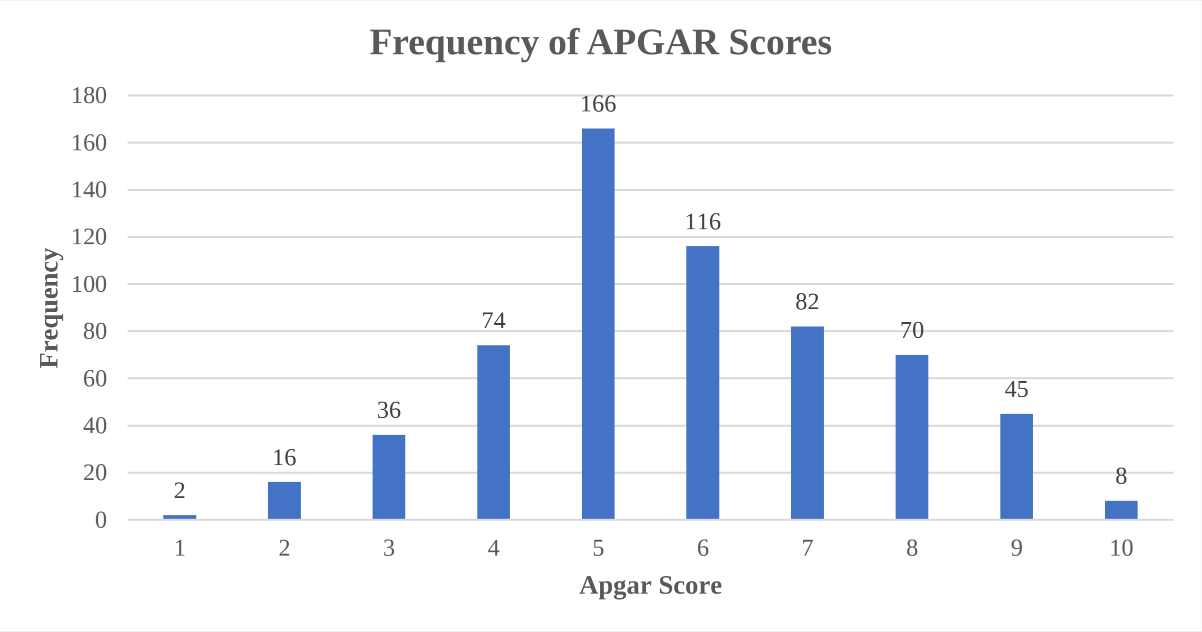

Figure 1: APGAR Score

(a) Gestational Age and Birth Weight

Table 2: Summary of gestational age and birth weight

No.	Variable	Description	Sex: Female n=279	Sex: Male n=336	Total	Percent (%)
1	Birth Weight n=615	Extremely Low Birth Weight (<1kg)	1	2	3	0.5
		Very Low Birth Weight (1kg to less than 1.5kg)	7	17	24	3.9
		Low Birth Weight (1.5kg to less than 2.5kg)	52	67	119	19.3
		Normal Birth Weight (2.5kg to less than 4.5kg)	210	242	452	73.5
		High Birth Weight (>4.5kg)	9	8	17	2.8
		Total	**279**	**336**	**615**	**100.0**
2	Gestation Age n=615	Extremely Pre-term (<28 weeks)	1	2	3	0.5
		Very Pre-term (28 to 32 weeks)	9	18	27	4.4
		Moderate to late pre-term (33 to 37 weeks)	62	87	149	24.2
		Full-term (38 to 41 weeks)	205	224	429	69.8
		Post term (>42 weeks)	2	5	7	1.1
		Total	**279**	**336**	**615**	**100.0**

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Nearly a quarter of the neonates were of extremely to low birth weight while the normal birth weights constituted about three quarters. Majority 452 (73.5) of the neonates were of normal birth weight of ≥ 2.5kg and ≤4.0kg. The breakdown of the birth weight by gender of the neonates shows about 242 (39.3%) male and 210 (34.1%) female had birth weight ≥ 2.5kg and ≤4.0kg. Table 2 provides the summary of these findings.

Based on these sub-categories, the gestational age of the neonate that range less than 28 weeks were about 3 (0.5%), very pre-term 27 (4.4%) and moderate to late pre-term 149 (24.2%). The mean gestational age was 37 weeks and 2 days (SD 2.0) and the mean birth weight was 2.888 Kg (SD 0.7569). Table 3 shows the cross-tabulation of birth weight and gestation age. The LBW category had 14 (2.3%), very preterm, 87 (14.1%) preterm and 18 (2.9%) full term.

Table 3: Gestational age and birth weight cross-tabulation

Birth Weight	Gestation Age					Total	%
	Extremely Pre-term	Very Pre-term	Moderate to late pre-term	Full-term	Post term		
Extremely Low Birth Weight	1	2	0	0	0	3	0.5
Very Low Birth Weight	2	9	13	0	0	24	3.9
Low Birth Weight	0	14	87	18	0	119	19.3
Normal Birth Weight	0	2	49	400	1	452	73.5
High Birth Weight	0	0	0	11	6	17	2.8
Total	3	27	149	429	7	615	100

We further introduce the risk classification of size for gestational age. This is a measure of fetal growth, where small-for-gestational-age is considered an indicator of fetal growth restriction and a marker for increased fetal and infant mortality and morbidity risk, and large-for-gestational-age is considered an indicator of accelerated fetal growth and a marker for increased risk of birth complications and infant morbidity (Health Canada, 2000, 2003).

The classification of size for gestational age is defined as follows from Kramer et al. (2001):

(i) Small for Gestational Age (SGA): Infants that are at or below the 10th percentile in birth weight, from an infant population of the same sex and gestational age.

(ii) Large for Gestational Age (LGA): Infants that are at or above the 90th percentile in birth weight, from an infant population of the same sex and gestational age.

(iii) Appropriate-for-Gestational-Age (AGA): A birth is appropriate for gestational age if the birth weight is between the 10th and 90th percentiles for the infant's gestational age and sex.

From the proceeding table, the neonates are subsequently classified as follows: small for pre-term, small for term, and small for post-term are rolled up into "small-for-gestational age (SGA)" whereas large for pre-term, term and post-term are rolled up into "large-for-gestational age (LGA).

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Risk Classification	Frequency	%
Small for gestational age (SGA)	146	23.7
Appropriate for gestational age (AGA)	452	73.5
Large for gestational age (LGA)	17	2.8
Total	615	100

We were also interested in testing whether there is a different distribution of gestational age and birth weight between male and female neonates. We employed the chi square test of independence since the data satisfied the assumption of being in frequencies or counts of cases rather than percentages or some other transformation of the data.

The hypotheses tested are as follows:

Ho: The gestational age distribution of male and female neonates is independent

Ha: The gestational age distribution of male and female neonates is independent

We obtained a chi square statistic of 4.41012 against a critical value of 9.488 at the 95% level of significance. We therefore failed to reject the null hypothesis and concluded that the distribution of the gestational age of male and female neonates is independent.

For the case of birth weight, the hypotheses tested were as follows:

Ho: The birth weight distribution of male and female neonates is independent

Ha: The birth weight distribution of male and female neonates is independent

We obtained a chi square statistic of 3.4618 against a critical value of 9.488 at the 95% level of significance. We therefore failed to reject the null hypothesis and concluded that the distribution of the birth weight of male and female neonates is independent

(b) Admission Diagnosis, Treatment, and Discharge Outcome

(i) Diagnosis

Out of the 615 neonates included in the study, 335 (54.5%) had birth asphyxia, 144 (23.4%), neonatal sepsis and 57 (9.3%) meconium aspiration. These three-diagnosis accounted for 87.2% of all admissions in the NBU with intrapartum related complications accounting for 63.8% of all the admissions. Of the 55 with admission diagnosis of RDS, their gestation weights ranged from ELBW 3 (5.5%), VLBW 10 (18.2%) and 42 (76. 4%) LBW. Table 4 gives a summary of the admission diagnosis of the neonates.

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Table 4: Admission diagnosis of the neonates

No.	Diagnosis	Frequency	Percent (%)
1	Birth Asphyxia	335	54.5
2	Neonatal Sepsis	144	23.4
3	Meconium Aspiration Syndrome	57	9.3
4	Preterm/RDS/LBW	42	6.8
5	Preterm/RDS/VLBW	10	1.6
6	Congenital Malformation	5	0.8
7	Neonatal Jaundice	5	0.8
8	Preterm/LBW	3	0.5
9	Preterm/RDS/ELBW	3	0.5
10	Hydrocephalus	2	0.3
11	Hypoglycemia	2	0.3
12	Pneumonia	2	0.3
13	Congenital Heart Disease	1	0.2
14	Down Syndrome	1	0.2
15	Macrosomia	1	0.2
16	Rhesus Incompatibility/LBW	1	0.2
17	Tetanus	1	0.2
	Total	615	100.0

(ii) Treatment

All the admitted neonates were put on Tetracycline Eye Ointment (TEO) and Vitamin K. The treatment options included Crystalline Penicillin, Gentamicin, Ceftazidime, oxygen therapy, and Intravenous fluids (IVF). Table 4 gives a summary of the treatment options administered to the neonates admitted to the NBU. Overall, the Crystalline Penicillin, Gentamicin and IVF combination treatment option constituted 489 (79.5%). Crystalline Penicillin and Ceftazidime Monotherapies constituting 35 (5.7%) and 82 (13.3%) respectively. Other treatment options included medical oxygen therapy 35 (5.7%) while 524 (85.2%) had intravenous fluid prescribed on admission. Table 5 provides the summary of the findings.

Table 5: Administered Treatment Options

No	Treatment option	Frequency	Percent (%)
1	Crystalline Penicillin, Gentamicin, IVF	489	79.5
2	Ceftazidime Monotherapy	82	13.3
3	Crystalline Penicillin, IVF, O2	35	5.7
4	Floxapen	7	1.1
5	Phenobarbital	1	0.2
6	Surgery	1	0.2
	Total	615	100.0

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(iii) Discharge Outcome

There were 45 neonates who died among the 615 who were admitted to the Newborn Unit of the hospital giving an in-hospital fatality rate of 13%, 95% CI [13.9, 15.8]. There was no significant difference in mortality in 2019 (12.97%) and 2020 (13.06%) as depicted in figure 2. The overall mortality in respect of the hospital-based mortality for the two-year period is 130 deaths per 1000 live births.

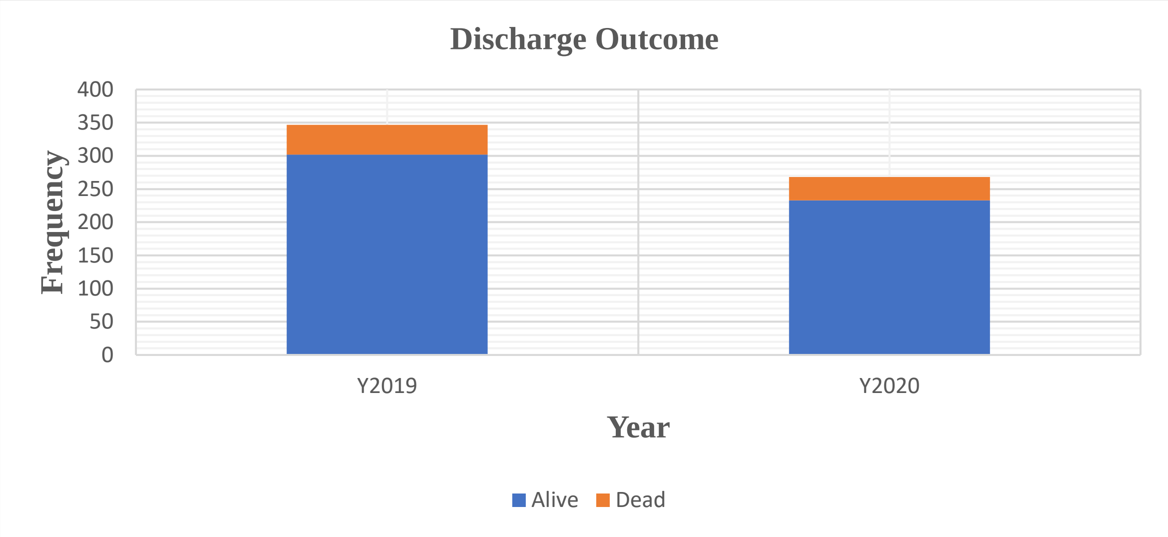

Figure 2: 2019 and 2020 Discharge outcome

(c) Patterns of Neonatal Mortality and Associated Factors

Within the first 24 hours of admission, out of the 228 neonates who were born alive in, 192 (84.2%) survived while 36 (15.8%) died. Similarly, out of the 259 neonates who survived up to 24 hours, 223 (86.1%) survived while 36 (13.9) died. Beyond the 72 hours of life, the survival rate increased to 93.8% while the death rate decreased to 6.2%. The pattern of neonatal discharge outcome is as shown in figure 3.

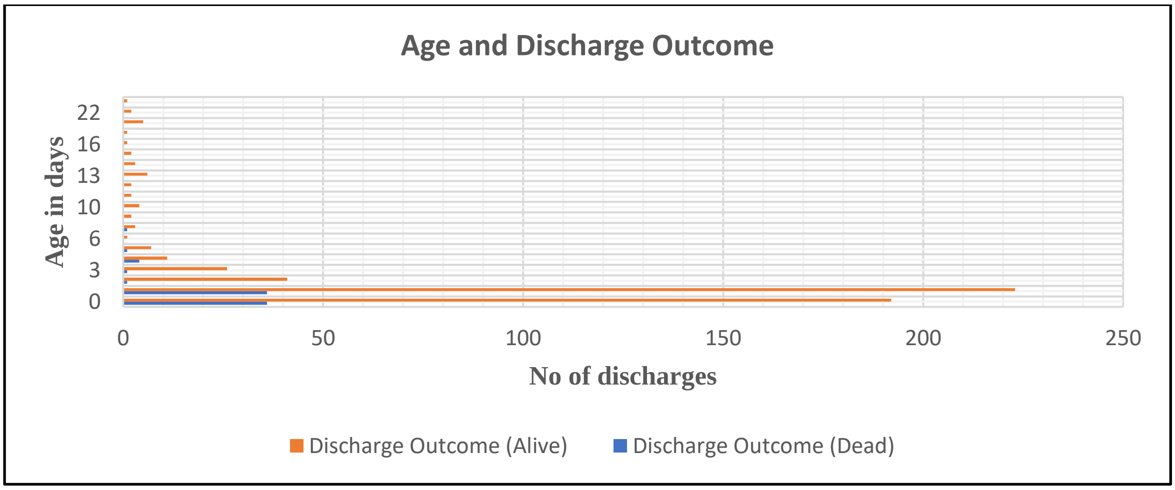

Figure 3: Pattern of neonatal discharge outcome by age

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The Kaplan-Meier (K-M) survival time analysis was used to depict the pattern of death in 28 days. Survival analysis is used to analyse data in which the time until the event is of interest, in this case discharge alive or dead. The survival time was calculated in days between the date of admission to NBU and the date of discharge outcome. The K-M as depicted in figure 4 shows the survival increases as the time from birth increases. Of the 80 neonates who died 45% died on the day of first admission, 46.3% died within first two days and 1.3% died within the three days of admission and 7.5% of the deaths occurred in the first one week of admission.

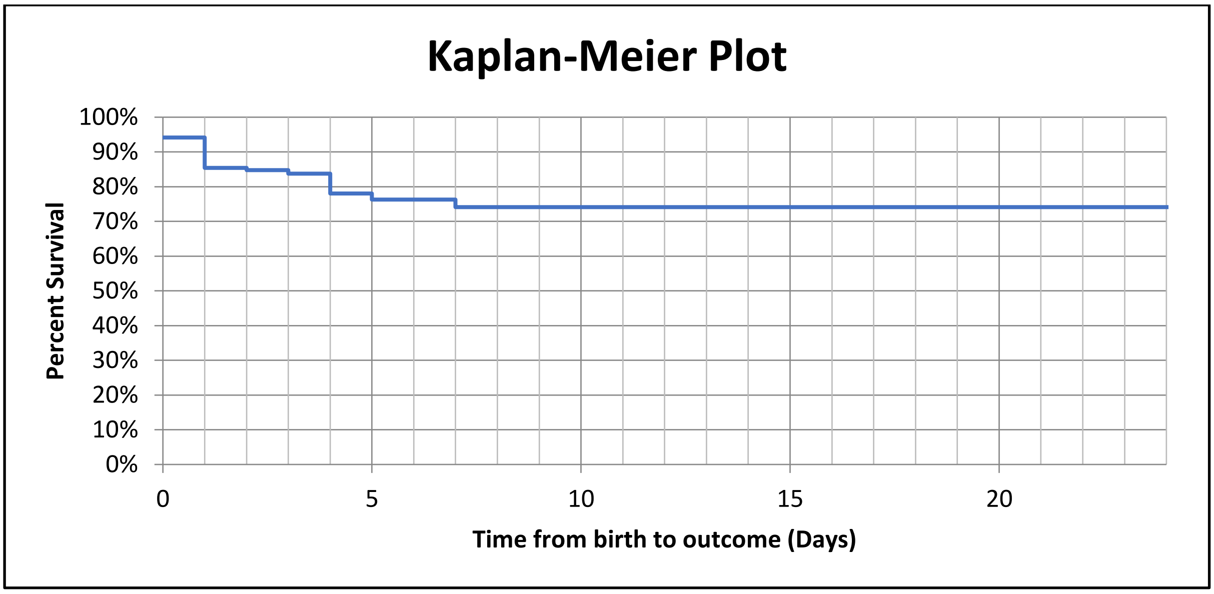

Figure 4: Kaplan-Meier Survival analysis curve

(d) Factors Associated with Neonatal Mortality

(i) Bivariate Analysis

Bivariate and multivariate logistic regression analysis was performed to evaluate the relationship between factors associated with neonatal mortality. Variables that were significant at P value of < 0.05 level in the bivariate analysis were included and retained in the multivariate model. The independent variables are sex, gestational age, gestation (single/multiple), birth weight, sex, APGAR Score, place of delivery, age from admission to discharge and the dependent variable is the discharge outcome. The results show the correlation between them is significant at the 0.01 and 0.05 levels for the two tailed Pearson correlation. The findings from bivariate analysis showed that sex, gestational age, single/multiple gestation, birth weight, place of delivery and APGAR score at five- at birth are significantly associated with time to death of preterm neonates. Based on the results (table 6), the discharge outcome has a statistically significant relationship with sex, gestational age, gestation (single/multiple), birth weight, sex, APGAR Score, place of delivery, age from admission to discharge delivery at $p<0.05$.

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Table 6: Bivariate association between neonatal characteristics and discharge outcome

No.	Variable	Description	Discharge outcome		Chi Square	P-Value
			Died	**Alive**		
1	Day of admission	Day 1of life	72	415	6.524	0.011
		Older than one day	8	120		
2	APGAR Score at 5 minutes	0 to 6	66	359	7.728	0
		7 to 10	14	176		
3	Gestation	Single	76	526	2.545	0.044
		Multiple	4	9		
4	Place of birth	Inborn	71	495	1.351	0.0245
		Outborns	9	40		
5	Birthweight	<2.5kg	22	124	0.718	0.0397
		≥2.5kg	58	411		
6	Gestation	Preterm	27	152	0.197	0
		Term	53	383		
7	Sex	Male	42	294	0.169	0.0481
		Female	38	241		

(ii) Multivariable Analysis

The overall model is statistically significant, $\chi^2(7) = 20.770$, $p = 0.004$ which is $p < 0.05$. The explained variation in the dependent variable based on this model ranges from 27% to 51%. The model correctly classified 87% of the discharge outcome. Table 7 gives a summary of the ranked associations using the OR. Based on the results (table 5), demonstrate that mortality has a statistically significant relationship in the multivariate analysis with day of admission (OR 2.872, 95% CI 1.293, 6.375), Sex, (OR 1.02, 95% CI 1.0.627, 1.66) and Birth weight, (OR 0.936, 95% CI 0.423, 2.068) at $p<0.05$.

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Table 7: Multivariable analysis of factors associated with neonatal mortality

No.	Variable	Description	Discharge Outcome		Odds Ratio	P MH Value	Adjusted OR	P MH Value
			Died (N)	Alive (N)				
1	Day of admission	Day 1of life	72	415	2.6 (1.2, 5.6)	0.01	2.4 (1.2,4.8)	0.02
		> One day	8	120				
2	Sex	Male	42	294	0.9 (0.6, 1.5)	0.7	0.9 (0.6,1.4)	0.8
		Female	38	241				
3	Birthweight	<2.5kg	22	124	1.2 (0.7, 2.1)	0.4	1.2 (0.8,1.9)	0.5
		≥2.5kg	58	411				
4	Gestation age	Preterm	27	152	1.2 (0.8, 2.1)	0.3	1.2 (0.8,1.9)	0.4
		Term	53	383				
6	Place of birth	Inborn	71	495	1.6 (0.7, 3.4)	0.2	0.6 (0.4,1.3)	0.3
		Outborns	9	40				
5	APGAR Score at 5 minutes	0 to 6	66	359	2.3 (1.2, 4.2)	0.05	2.1 (1.2,3.6)	0.08
		7 to 10	14	176				
6	Gestation	Single	76	526	3.08 (0.9, 10.2)	0.05	0.4 (0.17, 0.95)	0.13
		Multiple	4	9				

The odds ratio is a measure of association between exposure and an outcome. An odd ratio >1 indicates an increased occurrence of an event while an OR <1 indicates decreased occurrence of an event. The results show that only day of admission and APGAR score are independent predictors of death in these neonates. Babies with APGAR > 6 have reduced risk of death. There is nearly 3-fold significantly higher risk of death on day 1 compared to other days while babies with APGAR > 6 have 50% reduced risk of death. Sex is independent predictors of death with the greater occurrence of the male neonates dying than the female neonates.

5.1 Discussion

From the data collected at WCRH, it was noted that of the variables considered, the key predictors of the mortality of neonates are the day of admission and the APGAR score. In terms of admission, neonates admitted on the first day of life are 2.6 times less likely to die than those admitted in subsequent days. This may be understood by the immediate medical care afforded within the first hours of life along with appropriate medical attention which increase the chances of survival. It is also understood that mortality within the first few hours of birth occurs from causes that are preventable.

The other indicator, the APGAR score, as a value that quantifies the effects of obstetric anaesthesia, the 10-point APGAR score, regardless of underlying cause, has been routinely used worldwide for more than 60 years, since 1953, to assess the condition and prognosis of every new-born child quickly and summarily. The 5 minutes after birth APGAR score is the most used index in assessing the early neonatal condition. From the data, there is a strong association between the 5-minute APGAR score. Neonates with an APGAR score of between 0 and 6 (generally considered low) are 2.3 times more likely to die than those with a score of between 7 and 10.

The use of APGAR score as a predictor of neonatal outcome is highly disputed in the medical field. However, it still appears a strong predictor of discharge outcome for neonates and hence useful in evaluating the risk of clinical neonatal deaths. The advantage of the APGAR score over these advanced indicators is that it is immediately available on site, and the results based on the score can also be used for timely intervention treatment. Therefore, the APGAR score has been used clinically to guide neonatal resuscitation. Given that the APGAR score does have some subjectivity, it should be assessed by both the obstetrician and the neonatologist to improve the accuracy. In this study, the leading probable causes of admission among neonates admitted to the NBU at the referral hospital as Low-Birth Weight (LBW) and pre-term related complications such as birth asphyxia, neonatal sepsis, and meconium aspiration syndrome.

These findings are similar to the study by Olack et al., [59] which showed in addition, respiratory distress syndrome and hypothermia. Several other studies have also reported neonatal jaundice, pneumonia, dysmorphism and preponderance of preterm as the leading cause of admission [60,61].

The mortality among the LBW and pre-term neonates occur within the first 72 hours of life due to preventable causes [59]. This situation can be reversed with heightened implementation of execution of existing facility-based intrapartum and immediate postpartum care interventions, targeting asphyxia, sepsis, respiratory distress syndrome and hypothermia. Neonatal deaths and stillbirths have been described as the "unfinished agenda" of the Millennium Development Goals (MGDs). In an effort to end neonatal deaths, the World Health Organization put in place a new action plan that presents a vision for ending preventable newborn deaths and stillbirths by the year 2035", [62]. According to Gathara et. al.,[63] the careful introduction of better technologies may help in the management of the neonatal conditions.

The sample was derived from a single site, and may reflect mortality and morbidity patterns unique to a single institution thus making it difficult to generalize the findings for the entire county. Hospital mortality can be biased because discharge standards may vary, especially if discharge occurs followed by an immediate post-discharge death. However, this data is useful for decision-making, especially for patient groups and service planning.

The majority of the admissions were predominantly male neonates suggesting that the male gender is more prone to illness during the neonatal period [64,65]. The findings indicate that the highest admissions were during the first 24 to 72 hours of birth. These finding is similar to other studies by Desalew et al., and Orsido et al., [66,67]. This is the period when the neonates are most vulnerable. The leading cause of admission and neonatal mortality point to birth asphyxia, neonatal sepsis and meconium aspiration among the neonates admitted to the WCRH. As a result, knowing the pattern of admission, outcome and cause of death would be essential in bringing change and reduction of burden of infant mortality. These findings are in line with the studies conducted by Liang et al., and Weddih et al., [1,68].

Overall mortality observed in 2019 and 2020 was 12.97% and 13.06% respectively. Mortality was observed higher among preterm neonates diagnosed with birth asphyxia, neonatal sepsis, and meconium aspiration and more so during the first 48 – 72 hours of life in our study.

A large-scale multisite study by Irimu et al., [69] indicated that high proportion of neonatal deaths in hospitals died of preventable causes despite the availability of high impact low-cost interventions in Kenya. A study on the Assessment of quality of NBU's services also point to a comprehensive and targeted quality improvement to provide complete care for all pre-term neonates and optimization of obstetrical care practices [70]. The study's main strength is the large sample size for the single site study and the two-year period it covered. However, this study also has important limitations arising from data extracted from health records which led to missing data or incomplete information.

6.1 Conclusion

Neonatal fatality of the newborns admitted to NBU is high in Wajir County. In our study, birth asphyxia was found to be the leading cause of admission at WCRH's Newborn Unit, followed by neonatal sepsis and meconium aspiration syndrome respectively. Regarding the final admission outcome, nearly 87% of the neonates were discharged home with satisfactory condition. The leading cause of death was birth asphyxia and neonatal sepsis. Over half of the deaths were due to birth asphyxia which can be partially preventable by good antenatal follow up and possible early intervention if the labor is closely monitored.

7.1 Recommendations

The higher incidence of birth asphyxia and the mortality associated with it warrants strategies to be implemented to prevent birth asphyxia. Neonatal sepsis can be prevented by enforcing strict hand hygiene and aseptic protocols. Pre-term births and low birth weight were the significant contributors to mortality. This calls for strategies to strengthen antenatal programs to prevent prematurity and low birth weight neonates at all levels of government. The following are specific recommendations.

1. A review and evaluation of the obstetrical care is required to identify the cause of birth asphyxia.
2. Health professionals should consider induction in mother with Premature Rupture of Membranes (PROM) to reduce neonatal sepsis.
3. Meconium aspiration syndrome is a leading cause of severe illness and death in the newborn. It typically occurs when the fetus is stressed during labor, especially when the infant is past its due date. The incidences of MAS can be attributed to the quality of care of the newborn. To reduce the cases of MAS, the fetal distress signs need to be monitored and action taken as appropriate.
4. To improve neonatal outcome, it is critical to initiate proactive surveillance programs to ensure all deliveries are at a health facility. This will guarantee quick response and skilled care during the first 24 hours of the neonates' life.

Policy makers need to design and streamline neonatal health programs to improve antenatal care services, neonatal care, and timely referral to tertiary care hospitals. In addition, develop national guidelines for the appropriate planning, management, and timely intervention.

In summary, neonates were found to die within the first 24 hours of age. Implementation of better referral system and timely interventions cloud greatly reduce the neonatal mortality and morbidities.

References

1. Weddih A, Ahmed MLCB, Sidatt M, Abdelghader N, Abdelghader F, Ahmed A, et al. Prevalence and factors associated with neonatal mortality among neonates hospitalized at the National Hospital Nouakchott, Mauritania. Pan Afr Med J. 2019 Nov 18;34:152.

2. World Health Organization. Global status report on alcohol and health 2018 [Internet]. Geneva: Creative Commons; 2018 [cited 2021 Sep 27]. 472 p. Available from: https://www.who.int/publications/i/item/9789241565639

3. Oza S, Lawn JE, Hogan DR, Mathers C, Cousens SN. Neonatal cause-of-death estimates for the early and late neonatal periods for 194 countries: 2000–2013. Bull World Health Organ. 2015 Jan 1;93(1):19–28.

4. GBD 2017 Inflammatory Bowel Disease Collaborators. The global, regional, and national burden of inflammatory bowel disease in 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet Gastroenterol Hepatol. 2020 Jan;5(1):17–30.

5. Hug L, Alexander M, You D, Alkema L, UN Inter-agency Group for Child Mortality Estimation. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. Lancet Glob Health. 2019 Jun;7(6):e710–20.

6. Gülmezoglu AM, Lawrie TA, Hezelgrave N, Oladapo OT, Souza JP, Gielen M, et al. Interventions to Reduce Maternal and Newborn Morbidity and Mortality. In: Black RE, Laxminarayan R, Temmerman M, Walker N, editors. Reproductive, Maternal, Newborn, and Child Health: Disease Control Priorities, Third Edition (Volume 2) [Internet]. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2016 [cited 2021 Sep 27]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK361904/

7. United Nations Children's Fund. UNICEF: Child Mortality 2019 [Internet]. New York: UNICEF; 2019 [cited 2021 Oct 26]. Available from: https://www.unicef.org/reports/levels-and-trends-child-mortality-report-2019

8. Saleem S, McClure EM, Goudar SS, Patel A, Esamai F, Garces A, et al. A prospective study of maternal, fetal and neonatal deaths in low- and middle-income countries. Bull World Health Organ. 2014 Aug 1;92(8):605–12.

9. Abdurashid N, Muhye A, Abdulie S. Prevalence of Birth Asphyxia and Associated Factors among Neonates Delivered in Dilchora Referral Hospital, in Dire Dawa, Eastern Ethiopia. Clinics in Mother and Child Health. 2017 Jan 1;14.

10. Machio PM. Determinants of Neonatal and Under-five Mortality in Kenya: Do Antenatal and Skilled Delivery Care Services Matter? Journal of African Development, African Finance and Economic Association. 2018;20(1):59–67.

11. DHS. Kenya Demographic and Health Survey 2014: Key Indicators [Internet]. Rockville, MD, USA; 2015. Available from: http://dhsprogram.com/pubs/pdf/FR308/FR308.pdf

12. World Health Organization. World health statistics 2019: monitoring health for the SDGs, sustainable development goals [Internet]. Geneva; 2019 [cited 2021 Sep 27] p. 120. Available from: https://www.who.int/publications-detail-redirect/world-health-statistics-2019-monitoring-health-for-the-sdgs-sustainable-development-goals

13. Murphy GAV, Nyakangi VN, Gathara D, Ogero M, English M. A hidden burden of neonatal illness? A cross-sectional study of all admissions aged less than one month across twelve Kenyan County hospitals. Wellcome Open Res. 2018 Jan 30;2:119.

14. Masaba B Barasa. Socioeconomic inequality in neonatal mortality in a county referral hospital in Kenya. Internal Journal of Social Science and Technology. 2019;4:27–34.

15. AFIDEP. Reproductive, Maternal, Neonatal and Child Health: Wajir County [Internet]. Africa Institute of Development Policy. 2020 [cited 2020 Aug 18]. Available from: https://www.afidep.org/publication/reproductive-maternal-neonatal-and-child-health-wajir-county/

16. Ranjeva SL, Warf BC, Schiff SJ. Economic burden of neonatal sepsis in sub-Saharan Africa. BMJ Global Health. 2018 Jan 1;3(1):e000347.

17. De Franco E, Flanagan SE, Houghton JA, Allen HL, Mackay DJ, Temple IK, et al. The effect of early, comprehensive genomic testing on clinical care in neonatal diabetes: an international cohort study. Lancet. 2015 Sep 5;386(9997):957–63.

18. Belizán JM, McClure EM, Goudar SS, Pasha O, Esamai F, Patel A, et al. Neonatal death in low- to middle-income countries: a global network study. Am J Perinatol. 2012 Sep;29(8):649–56.

19. Ekwochi U, Ndu IK, Nwokoye IC, Ezenwosu OU, Amadi OF, Osuorah DIC. Pattern of morbidity and mortality of newborns admitted into the sick and special care baby unit of Enugu State University Teaching Hospital, Enugu state. Nigerian Journal of Clinical Practice. 2014 May 1;17(3):346.

20. Lawn JE, Cousens S, Zupan J, Lancet Neonatal Survival Steering Team. 4 million neonatal deaths: when? Where? Why? Lancet. 2005 Mar 5;365(9462):891–900.

21. Ibrahim J, Yorifuji T, Tsuda T, Kashima S, Doi H. Frequency of antenatal care visits and neonatal mortality in Indonesia. J Trop Pediatr. 2012 Jun;58(3):184–8.

22. World Health Organization. World health statistics 2016: monitoring health for the SDGs, sustainable development goals [Internet]. Geneva: World Health Organization; 2016 [cited 2021 Sep 27]. 121 p. Available from: https://apps.who.int/iris/handle/10665/206498

23. World Health Organization. Guidelines on optimal feeding of low birth-weight infants in low- and middle-income countries [Internet]. Geneva: World Health Organization; 2011 [cited 2021 Sep 27]. ii, 51 p. Available from: https://apps.who.int/iris/handle/10665/85670

24. McCall EM, Alderdice F, Halliday HL, Vohra S, Johnston L. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database Syst Rev. 2018 Feb 12;2:CD004210.

25. Rodrigues NCP, Monteiro DLM, Almeida AS de, Barros MB de L, Pereira Neto A, O'Dwyer G, et al. Temporal and spatial evolution of maternal and neonatal mortality rates in Brazil, 1997-2012. J Pediatr (Rio J). 2016 Dec;92:567–73.

26. Hussein J, Hirose A, Owolabi O, Imamura M, Kanguru L, Okonofua F. Maternal death and obstetric care audits in Nigeria: a systematic review of barriers and enabling factors in the provision of emergency care. Reproductive Health. 2016 Apr 22;13(1):47.

27. Akombi BJ, Agho KE, Hall JJ, Wali N, Renzaho AMN, Merom D. Stunting, Wasting and Underweight in Sub-Saharan Africa: A Systematic Review. Int J Environ Res Public Health. 2017 Aug;14(8):863.

28. Love C, David RJ, Rankin KM, Collins JW. Exploring weathering: effects of lifelong economic environment and maternal age on low birth weight, small for gestational age, and preterm birth in African-American and white women. Am J Epidemiol. 2010 Jul 15;172(2):127–34.

29. Boyle EM, Poulsen G, Field DJ, Kurinczuk JJ, Wolke D, Alfirevic Z, et al. Effects of gestational age at birth on health outcomes at 3 and 5 years of age: population based cohort study. BMJ. 2012 Mar 1;344:e896.

30. Liu L, Oza S, Hogan D, Chu Y, Perin J, Zhu J, et al. Global, regional, and national causes of under-5 mortality in 2000-15: an updated systematic analysis with implications for the Sustainable Development Goals. Lancet. 2016 Dec 17;388(10063):3027–35.

31. Chawanpaiboon S, Vogel JP, Moller AB, Lumbiganon P, Petzold M, Hogan D, et al. Global, regional, and national estimates of levels of preterm birth in 2014: a systematic review and modelling analysis. Lancet Glob Health. 2019 Jan;7(1):e37–46.

32. Blencowe H, Cousens S, Oestergaard MZ, Chou D, Moller AB, Narwal R, et al. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. Lancet. 2012 Jun 9;379(9832):2162–72.

33. Glass HC, Costarino AT, Stayer SA, Brett CM, Cladis F, Davis PJ. Outcomes for extremely premature infants. Anesth Analg. 2015 Jun;120(6):1337–51.

34. Nair A, Bharuka A, Rayani BK. The Reliability of Surgical Apgar Score in Predicting Immediate and Late Postoperative Morbidity and Mortality: A Narrative Review. Rambam Maimonides Med J. 2018 Jan 29;9(1):e0004.

35. Pejovic NJ. No cry at birth : Neonatal resuscitation in low-resource settings: role of the laryngeal mask airway [Internet]. The University of Bergen; 2020 [cited 2021 Sep 27]. Available from: https://bora.uib.no/bora-xmlui/handle/1956/21575

36. Razaz N, Cnattingius S, Joseph KS. Association between Apgar scores of 7 to 9 and neonatal mortality and morbidity: population based cohort study of term infants in Sweden. BMJ. 2019 May 7;365:l1656.

37. Oliveira TG de, Freire PV, Moreira FT, Moraes J da SB de, Arrelaro RC, Rossi S, et al. Apgar score and neonatal mortality in a hospital located in the southern area of São Paulo city, Brazil. Einstein (São Paulo). 2012 Mar;10:22–8.

38. Ferrari RAP, Bertolozzi MR, Dalmas JC, Girotto E. Determining factors for neonatal mortality in a city in the Southern Region of Brazil. Rev esc enferm USP. 2013 Jun;47:531–8.

39. Razaz N, Cnattingius S, Persson M, Tedroff K, Lisonkova S, Joseph KS. One-minute and five-minute Apgar scores and child developmental health at 5 years of age: a population-based cohort study in British Columbia, Canada. BMJ Open. 2019 May 1;9(5):e027655.

40. Zanardi DM, Parpinelli MA, Haddad SM, Costa ML, Sousa MH, Leite DFB, et al. Adverse perinatal outcomes are associated with severe maternal morbidity and mortality: evidence from a national multicentre cross-sectional study. Arch Gynecol Obstet. 2019 Mar;299(3):645–54.

41. Makate M, Makate C. The impact of prenatal care quality on neonatal, infant and child mortality in Zimbabwe: evidence from the demographic and health surveys. Health Policy Plan. 2017 Apr 1;32(3):395–404.

42. Kananura RM, Tetui M, Mutebi A, Bua JN, Waiswa P, Kiwanuka SN, et al. The neonatal mortality and its determinants in rural communities of Eastern Uganda. Reproductive Health. 2016 Feb 16;13(1):13.

43. Groskaufmanis L, Brunner Huber LR, Vick T. Group Prenatal Visits: Maternal and Neonatal Health Outcomes. J Midwifery Womens Health. 2018 Aug 8;

44. Stoll BJ, Hansen NI, Bell EF, Walsh MC, Carlo WA, Shankaran S, et al. Trends in Care Practices, Morbidity, and Mortality of Extremely Preterm Neonates, 1993-2012. JAMA. 2015 Sep 8;314(10):1039–51.

45. You D, Hug L, Ejdemyr S, Idele P, Hogan D, Mathers C, et al. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. Lancet. 2015 Dec 5;386(10010):2275–86.

46. Yego F, D'Este C, Byles J, Williams JS, Nyongesa P. Risk factors for maternal mortality in a Tertiary Hospital in Kenya: a case control study. BMC Pregnancy Childbirth. 2014 Dec;14(1):1–9.

47. Kaguthi G, Nduba V, Borgdorff MW, Verver S. Predictors of post neonatal mortality in Western Kenya: a cohort study. Pan Afr Med J. 2018;31:114.

48. Zeretzke-Bien CM, Swan TB, Allen BR, editors. Quick Hits for Pediatric Emergency Medicine [Internet]. Springer International Publishing; 2018 [cited 2021 Sep 27]. Available from: https://www.springer.com/gp/book/9783319938295

49. Bansal SC, Nimbalkar AS, Patel DV, Sethi AR, Phatak AG, Nimbalkar SM. Current Neonatal Resuscitation Practices among Paediatricians in Gujarat, India. Int J Pediatr. 2014;2014:676374.

50. Wayessa ZJ, Belachew T, Joseph J. Birth asphyxia and associated factors among newborns delivered in Jimma zone public hospitals, Southwest Ethiopia: A cross-sectional study. Journal of Midwifery & Reproductive Health. 2018;6(2):1289–95.

51. Abdisalan MM. Short term outcomes of term neonates admitted with perinatal asphyxia in Kenyatta National Hospital newborn unit [Internet] [Thesis]. University of Nairobi, Kenya; 2011 [cited 2021 Sep 27]. Available from: http://erepository.uonbi.ac.ke/handle/11295/4536

52. Ugwu GIM, Abedi HO, Ugwu EN. Incidence of birth asphyxia as seen in central hospital and GN children's clinic both in Warri Niger Delta of Nigeria: an eight year retrospective review. Glob J Health Sci. 2012 Aug 9;4(5):140–6.

53. Polin RA, Denson S, Brady MT, Committee on Fetus and Newborn, Committee on Infectious Diseases. Strategies for prevention of health care-associated infections in the NICU. Pediatrics. 2012 Apr;129(4):e1085-1093.

54. Fleischmann-Struzek C, Goldfarb D, Schlattmann P, Schlapbach L, Reinhart K, Kissoon N. The global burden of paediatric and neonatal sepsis: a systematic review. The Lancet Respiratory medicine. 2018;6(3):223–30.

55. Prusakowski MK, Chen AP. Pediatric Sepsis. Emerg Med Clin North Am. 2017 Feb;35(1):123–38.

56. Mhada TV, Fredrick F, Matee MI, Massawe A. Neonatal sepsis at Muhimbili National Hospital, Dar es Salaam, Tanzania; aetiology, antimicrobial sensitivity pattern and clinical outcome. BMC Public Health. 2012 Oct 24;12(1):904.

57. Fuchs A, Bielicki J, Mathur S, Sharland M, Van Den Anker JN. Reviewing the WHO guidelines for antibiotic use for sepsis in neonates and children. Paediatr Int Child Health. 2018 Nov;38(sup1):S3–15.

58. Green RJ, Kolberg JM. Neonatal pneumonia in sub-Saharan Africa. Pneumonia. 2016 Apr 12;8(1):3.

59. Olack B, Santos N, Inziani M, Moshi V, Oyoo P, Nalwa G, et al. Causes of preterm and low birth weight neonatal mortality in a rural community in Kenya: evidence from verbal and social autopsy. BMC Pregnancy and Childbirth. 2021;21(1):1–9.

60. Tanveer S, Basheer F, Motlaq FMA, Khushdil A, Nawaz R, Khan FA. Pattern of admission and outcome of neonates admitted to tertiary care neonatal ICU. Fatima Jinnah Medical University. 2019;(January 2019):116–20.

61. Ismail SA, McCullough A, Guo S, Sharkey A, Harma S, Rutter P. Gender-related differences in care-seeking behaviour for newborns: A systematic review of the evidence in South Asia. BMJ Global Health. 2019;4(3):1–8.

62. World Health Organization (WHO). Every newborn: an action plan to end preventable deaths. World Health Organization; 2014. 55 p.

63. Gathara D, Serem G, Murphy GAV, Obengo A, Tallam E, Jackson D, et al. Missed nursing care in newborn units: a cross-sectional direct observational study. BMJ Quality and Safety. 2020;29(1):19–30.

64. Namrata KC, Shrestha B, Bhattarai A, Paudel S, Subedi N. Pattern of morbidity and mortality among neonates admitted to neonatal intensive care unit in tertiary care centre, western Nepal. Journal of Gandaki Medical College-Nepal. 2021 Jul 3;14(1):24–8.

65. Ahmed SAM, Ali MAO, Mahgoub EAA, Nimir M, Malik EM. The pattern of admission and outcome of neonates managed in the neonatal intensive care unit in a Sudanese hospital. International Journal of Contemporary Pediatrics. 2021;8(4):616.

66. Desalew A, Sintayehu Y, Teferi N, Amare F, Geda B, Worku T, et al. Cause and predictors of neonatal mortality among neonates admitted to neonatal intensive care units of public hospitals in eastern Ethiopia: A facility-based prospective follow-up study. BMC Pediatrics. 2020;20(1):1–11.

67. Orsido TT, Asseffa NA, Berheto TM. Predictors of Neonatal mortality in Neonatal intensive care unit at referral Hospital in Southern Ethiopia: A retrospective cohort study. BMC Pregnancy and Childbirth. 2019;19(1):1–9.

68. (Danny) Liang L, Kotadia N, English L, Kissoon N, Mark Ansermino J, Kabakyenga J, et al. Predictors of mortality in neonates and infants hospitalized with sepsis or serious infections in developing countries: A systematic review. Frontiers in Pediatrics. 2018;6(October):1–12.

69. Irimu G, Aluvaala J, Malla L, Omoke S, Ogero M, Mbevi G, et al. Neonatal mortality in Kenyan hospitals: A multisite, retrospective, cohort study. BMJ Case Reports. 2021;6(5):1–10.

70. Cao Y, Jiang S, Sun J, Hei M, Wang L, Zhang H, et al. Assessment of Neonatal Intensive Care Unit Practices, Morbidity, and Mortality among Very Preterm Infants in China. JAMA Network Open. 2021;4(8):1–13.