MAKERERE UNIVERSITY

CLINICAL PROFILE AND IN-HOSPITAL OUTCOMES OF NEONATES MANAGED WITH MECHANICAL VENTILATION AT THE NICU OF KAWEMPE NATIONAL REFERRAL HOSPITAL; A RETROSPECTIVE STUDY.

PRINCIPAL INVESTIGATOR

TWESIIME ENOCK (MBChB)

REG.NO: 2023/HD07/2884U

SUPERVISORS

Dr. PILOYA THEREZA (MBChB, MMed, FESPE)

Dr. NSUBUGA RONALD (MBChB, MMed)

Dr. MUBIRU IDRIS (MBChB, MMed)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF PAEDIATRICS AND CHILD HEALTH IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF MEDICINE IN PAEDIATRICS AND CHILD HEALTH OF MAKERERE UNIVERSITY

JUNE, 2026

DECLARATION

I, Dr Twesiime Enock, affirm that this dissertation presented in this document is entirely my original work and has not been previously submitted, either partially or its entirety, to any university or institution for any academic recognition or award.

Signature………………… Date…26th June 26.

TWESIIME ENOCK

2023/HD07/2884U

APPROVAL

This dissertation titled 'Clinical profile and In-hospital outcomes of neonates managed with mechanical ventilation at the NICU of Kawempe National referral Hospital' is my original Master's dissertation, and has never been partially or fully submitted to any University or Institution for any award.

This dissertation has been submitted with the approval of my supervisors:

Name: **Dr. PILOYA THEREZA (MBChB, MMed, FESPE)**

Signature .... Date: 24th JUN 2026

Name: **Dr. NSUBUGA RONALD (MBChB, MMed)**

Signature............................ Date: 26/06/2026

Name: **Dr. MUBIRU IDRIS (MBChB, MMed)**

Signature Date: 24th June 2026

DEDICATION

This work is dedicated to the countless neonates, especially preterm babies, who required mechanical ventilation at the Neonatal Intensive Care Unit of Kawempe National Referral Hospital, and to their families whose courage, endurance, and hope in the face of critical illness continue to inspire the pursuit of improved neonatal care and better in hospital outcomes. Their experiences highlight the urgent need for stronger evidence, timely interventions, and more responsive neonatal critical care services.

It is also dedicated to my family for their unwavering love, encouragement, sacrifice, and support throughout this academic journey. Their constant belief in me provided the strength and motivation needed to complete this work.

ACKNOWLEDGEMENT

I sincerely thank my supervisors, Dr.Piloya Thereza, Dr. Nsubuga Ronald, Dr Kikaire and Dr. Mubiru Idris, for their invaluable guidance, constructive criticism, patience, and unwavering support throughout the development of this study. Their scholarly mentorship, thoughtful insights, and consistent encouragement greatly shaped this work and strengthened my understanding of neonatal research and scientific writing.

I am also deeply grateful to my family for their love, prayers, encouragement, and sacrifice during the entire period of my study. Their emotional and moral support gave me the strength to persevere through the demanding moments of this academic journey.

Special appreciation goes to my classmates and colleagues for their companionship, encouragement, and the enriching academic discussions we shared along the way. I also acknowledge the management and staff of Kawempe National Referral Hospital, especially those in the Neonatal Intensive Care Unit, for their contribution. Finally, I extend my gratitude to the research team for their invaluable commitment and support during the process of this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

OPERATIONAL DEFINITIONS

1.	Clinical profile	This refers to the newborn infant's health status, including gestational age, birth weight, mode of delivery, and specific diagnoses such as respiratory distress syndrome, sepsis, and perinatal asphyxia.
2.	Extreme low birth weight	This refers to a birth weight of less than 1000 grams.
3.	In-hospital primary outcome	This refers to survival at discharge or death during the course of admission.
4.	In-hospital secondary outcomes	These refer to complications occurring during admission or prolonged hospital stay.
5.	Mechanical ventilation	This refers to the use of artificial means to support oxygenation and ventilation.
6.	Neonatal Intensive Care Unit (NICU)	This refers to a unit within the special care unit that provides level III care, including ventilator support, to critically ill neonates.
7.	Preterm	This refers to a live baby born before 37 completed weeks of gestation.
8.	Special Care Unit (SCU)	This refers to an inpatient unit that cares for sick neonates admitted within 72 hours of life.
9.	Survival	This refers to being alive at the time of discharge from the hospital.
10.	Ventilator-associated pneumonia	Pneumonia that develops 48 hours or more after endotracheal intubation and initiation of mechanical ventilation, which was not present or incubating at the time of intubation.
11.	Very low birth weight	This refers to a birth weight of less than 1500 grams.
12.	Prolonged hospitalization	This referred to hospital stay of 14 days or more

ABBREVIATIONS

HIE	Hypoxic Ischemic Encephalopathy
IRB	Institutional Review Board
MAS	Meconium Aspiration Syndrome
MV	Mechanical Ventilation
NICU	Neonatal Intensive Care Unit
PI	Principal Investigator
PPHN	Persistent Pulmonary Hypertension
RDS	Respiratory Distress Syndrome
SCU	Special Care Unit
VAP	Ventilator-associated pneumonia

ABSTRACT

Background: Neonatal mechanical ventilation and its judicious use play a significant role in preventing neonatal mortality, which is an important contributor to infant and under-5 mortality. However, mechanical ventilation is not without adverse effects. There is scarcity of data on the In-patient outcomes of neonates managed with mechanical ventilation in Uganda, despite the increasing use of this mode of management in the country. This study aimed to determine the clinical profile and In-hospital outcomes of neonates being managed with mechanical ventilation at Kawempe National Referral Hospital.

Methods: This was a retrospective hospital-based cohort study conducted in the Neonatal Intensive Care Unit of Kawempe National Referral Hospital. Patient files for neonates who were mechanically ventilated between 1st August 2023 and 31st July 2025 were reviewed. Data collected included neonatal characteristics, maternal characteristics, primary morbid conditions, clinical and laboratory findings, mechanical ventilation and care related factors, and in hospital outcomes. The primary outcome was survival to discharge. Data were analyzed using STATA version 19.0. Modified Poisson regression was used to estimate crude and adjusted risk ratios for predictors of survival.

Results: A total of 384 neonates managed with mechanical ventilation were included in the study. Most neonates were male, 228 (59.4%), low birth weight; 260 (67.7%), and preterm; 265 (69.0%). Respiratory distress syndrome; 293 (76.3%) was the commonest indication for mechanical ventilation followed by perinatal asphyxia, 164 (42.7%) & neonatal sepsis, 139 (36.2%). Overall, 80 (20.8%) neonates survived to discharge. In the multivariable analysis, neonates without apnea of prematurity (aRR = 2.84, 95% CI: 1.304-6.185; $p = 0.009$), neonates without haemorrhagic disease of the newborn (aRR = 2.93, 95% CI: 1.080-7.938; $p = 0.035$), those who did not require resuscitation prior to mechanical ventilation (aRR = 4.05, 95% CI: 2.298-7.148; $p < 0.001$), and neonates who did not receive anticonvulsants (aRR = 1.64, 95% CI: 1.018-2.629; $p = 0.042$) were more likely to survive.

Conclusion: Neonates requiring mechanical ventilation at Kawempe National Referral Hospital represented a critically ill population with poor in-hospital outcomes. Only 1 in 5 neonates survived after MV. Respiratory distress syndrome is the commonest cause of Mechanical ventilation. Survival was mainly influenced by markers of respiratory immaturity, bleeding

complications, compromise before ventilation, and neurological instability, highlighting the need to prevent premature births and improve early management of those born preterm. There’s urgent need to improve comprehensive neonatal critical care.

CHAPTER 1: INTRODUCTION

1.1 Background

The global neonatal mortality rate was 17 deaths per 1,000 live births in 2023. This represents a significant decrease from 37 deaths per 1,000 live births in 1990, a decline of 53 % (1). Sub-Saharan Africa continues to bear the heaviest burden of neonatal deaths at 27 deaths per 1000 live births. In Sub-Saharan Africa, the risk of death in the first month of life is 11 times higher than that in the lowest-mortality region, Australia and New Zealand (2). In Uganda, the Neonatal mortality rate declined from 33 deaths per 1000 live births in 2001 to 27 deaths per 1000 live births in 2006, but minimal change between 2006 and 2016 to 22 per 1000 live births (3).

The common contributors to neonatal mortality include complications of prematurity, neonatal sepsis, and birth asphyxia. The priority strategies to reduce the neonatal mortality include scaling up antenatal care, postnatal care, skilled health personnel, and emergency & newborn care. Increasing financial and allocating resources towards two very high- impact but high-cost interventions, that is, care for small and sick newborns and emergency obstetric care, are critical to reducing maternal deaths, stillbirths, and newborn deaths (4).

Mechanical ventilation plays a major role in reducing mortality in critically ill babies. The introduction of mechanical ventilation and its judicious use in neonatal intensive care units has revolutionalised the outcome and survival of sick newborn babies (5).

The goal of mechanical ventilation is to maintain adequate pulmonary gas exchange with minimum lung injury and oxygen toxicity and to reduce patient work of breathing. In that regard, neonatal mechanical ventilation has become critical in enhancing neonatal survival. It is also an important component of neonatal intensive care (5, 6).

Although frequently lifesaving, invasive mechanical ventilation has many adverse effects on the vital organ systems that is the cardiovascular system, brain, and lungs. Whereas preterm babies are more vulnerable, term newborn babies are not immune to these adverse effects (7). It is therefore necessary to have a good understanding of pulmonary physiology to choose the best ventilator modes and adequate ventilator settings for each patient to minimize lung injury (8).

The profile and In-hospital outcomes of neonates on mechanical ventilation have been studied in the developed world and some developing countries. The short-term outcome of babies from these studies is dependent on multiple factors, which include primary disease condition, gestational age, birth weight, and associated co-morbid illnesses, among others (9, 10).

This study intends to describe the clinical profile, determine In-hospital outcomes, and predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital.

1.2 Problem statement

The neonatal mortality rate remains high in Uganda at 22 per 1000 live births in 2022, despite the multiple interventions that have been put in place such as training of health workers, including neonatal specialists, provision of more equipped newborn treatment spaces, SCU's, and NICU's. Mechanical ventilation (MV) has been introduced in some of the newborn specialized units to improve newborn outcomes. However, successful MV requires adequate staff, diagnostic and monitoring investigations, together with emergency medicines, which are not readily available at all times in our setting.

Although there is an increasing number of hospitals and medical centers, both government and private, which provide neonatal intensive care in Uganda, there is a paucity of data on the profile and In-hospital outcomes of neonates managed with mechanical ventilation, and there are currently no published studies that have been done in the country.

This study may improve survival among sick neonates managed with MV through identifying the bad prognostic factors and their prompt management, as well as determining the predictors of survival. It may further help prognosticate babies that will benefit from MV in our resource-limited setting with few mechanical ventilators.

1.3 Justification

This study aimed to determine the clinical profile and In-hospital outcomes of babies managed with mechanical ventilation, together with the associated factors. Profiling of neonates on MV aims to identify the common indications for MV, possible correlation of underlying diseases with survival, and complications occurring during MV. Findings from the study would show which babies are likely to have better outcomes and also guide management decisions, especially in our resource-limited setting and prognostication of the admitted newborns.

Findings from this study will not only inform the hospital management on the gaps that need to be addressed to improve mechanical ventilation at a national referral hospital in Uganda, but also inform the Ministry of Health and policy-makers on newborn health needs, management gaps, and guide policy and resource allocation.

1.4 Study hypothesis

Neonates requiring mechanical ventilation in the Kawempe NICU have distinct clinical profiles, and their In-hospital outcomes are influenced by factors such as gestational age and birth weight.

1.5 Research questions

1. What is the clinical profile of neonates managed with mechanical ventilation at Kawempe National Referral Hospital?
2. What are the in-hospital outcomes of neonates managed with mechanical ventilation at Kawempe National Referral Hospital?
3. What are the predictors of survival among neonates managed with mechanical ventilation at Kawempe National Referral Hospital?

1.6 Study objectives

1.6.1 General objectives

To describe the clinical profile, determine In-hospital outcomes, and predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital.

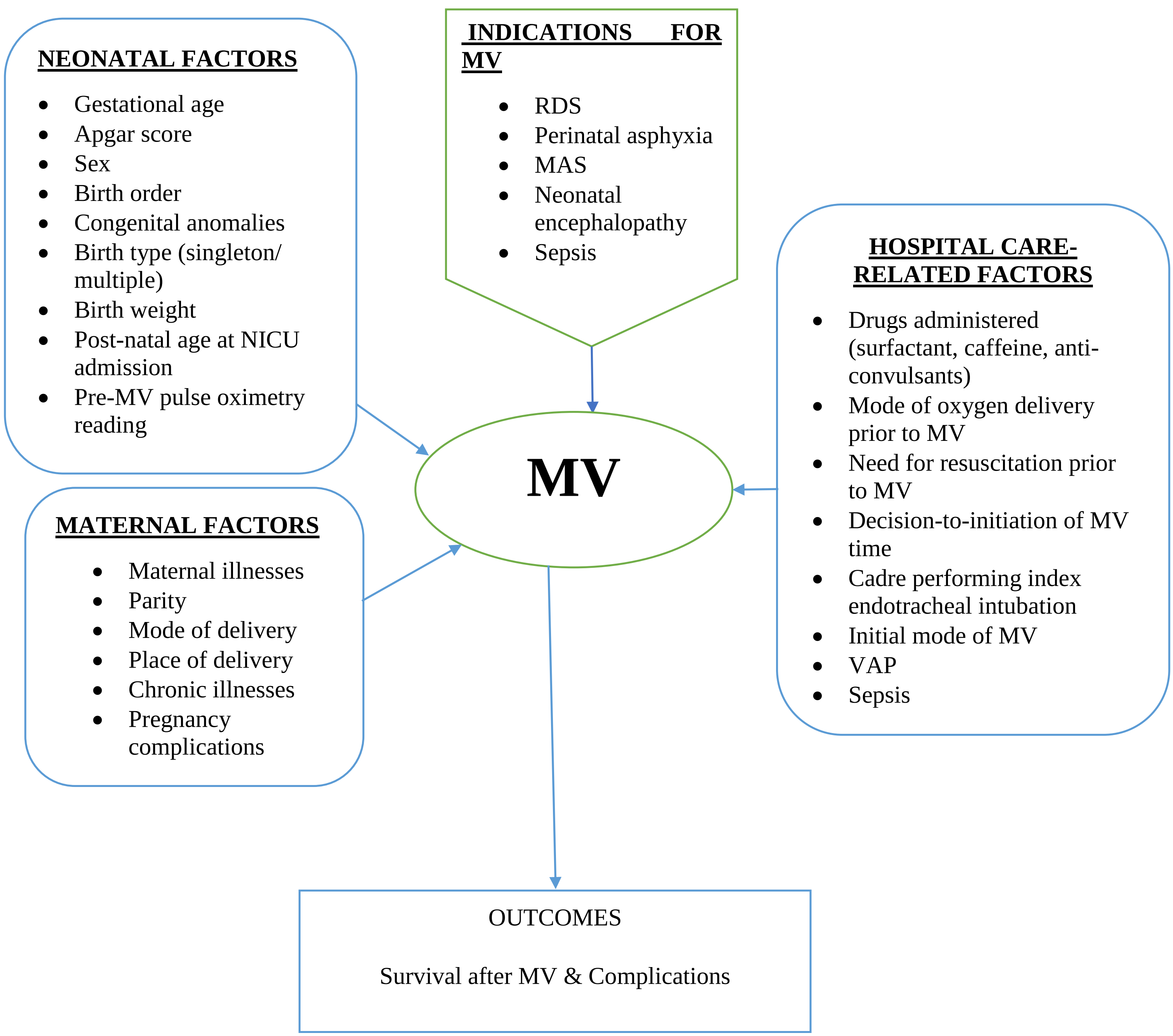
1.6.2 Specific objectives

1. To describe the clinical profile of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital
2. To determine the In-hospital outcomes of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital.
3. To determine the predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital.

1.7 Conceptual framework

The conceptual framework is summarized in Figure 1 below;

Figure 1: Conceptual framework



1.8 Description of the conceptual framework

The conceptual framework highlights the neonatal indications and In-hospital outcomes of the babies managed on mechanical ventilation at Kawempe National Referral Hospital, which includes survival, complications, and mortality. It also highlights the factors that predict survival among these babies, which are categorized into: the neonatal, maternal and hospital care-related factors.

1.9 Study Scope

The study assessed the common indications for mechanical ventilation, and the factors that determine survival among these babies including neonatal and maternal factors.

.

CHAPTER 2: LITERATURE REVIEW

2.1 Definitions

Mechanical ventilation refers to various artificial means to support oxygenation and ventilation (11). It may also be defined as the movement of gas into and out of the lungs by an external source directly connected to the patient by way of a tracheostomy or an endotracheal tube (12).

Clinical profile refers to a newborn infant's health status, including gestation age, birth weight, mode of delivery, and specific diagnoses such as RDS, Sepsis, and Birth asphyxia (12).

2.2 Clinical profile

In a prospective observational analytical study by Othman, Oshaib and Abd El Moneim (13) in Egypt, of the 110 babies mechanically ventilated, 58.2% were male, while 41.8% were female. 38.18% were 28 to 34 weeks of gestation, 16.3% were delivered between 34 and 37 weeks of gestation, and 45.4% were delivered between 37 and 42 weeks of gestation; 3.6% were <1000g, 30% weighed between 1000 &1500g, 24.5% weighed between 1500 g & 2500g, and 41.8% weighed greater than 2500g (13).

In a prospective study by Thakkar, Pansuriya (14) in India, of the 190 babies mechanically ventilated, 65.3% were male, while 34.7% were female. 16.8% were less than 32 weeks of gestation, 31.5% were delivered between 32 and 36 weeks of gestation, and 51.5% were delivered after 37weeks of gestation; 7.9% were <1000g, 13.7% weighed between 1000 &1500g, 43.7% weighed between 1500 g & 2500g, and 34.7% weighed greater than 2500g (14)

In a retrospective chart review from January 2012 to July 2013 by Jahan, Haque (10) in Dhaka, Bangladesh, at Al-Din Medical College Hospital, 66% were male while 34% were female. 13% were less than 30 weeks of gestation, 8% were delivered between 30 and 33 weeks of gestation and 9% were delivered between 34 & 37weeks of gestation and 28% were greater than 37weeks of gestation. 5% were <1000g, 13% weighed between 1000 &1500g, 19% weighed between 1500 g & 2500g and 21% weighed greater than 2500g (10).

In a study by Iqbal, Younus (15) from October 2011 to November 2013, Sher-l-Kashmir institute of medical sciences, India. 52% were male while 48% were female. Mean weight 2320+-846.2g and mean gestation age 35.2+-4.9 weeks (15).

2.3 Indications for mechanical ventilation

Different disease conditions necessitate mechanical ventilation among neonates. In a retrospective chart review in Dhaka, Bangladesh, the commonest indication for mechanical ventilation among the 58 ventilated neonates was respiratory distress syndrome (RDS) (32.75%) followed by perinatal asphyxia (18.96%), pneumonia (13.79%), neonatal sepsis (13.79%), meconium aspiration syndrome (MAS) (10.16%) and pneumothorax (10.16%) (10).

In a Nepal study among 119 ventilated babies, the most common indication for mechanical ventilation was sepsis, followed by birth asphyxia, respiratory distress syndrome/hyaline membrane disease and meconium aspiration syndrome (11).

In a cross-sectional study of prospective data in a tertiary center in India, July 2021 to June 2013, a total of 72 neonates were studied. Majority of the preterm babies were ventilated for RDS (89.5%). And majority of full term were ventilated for MAS (100%) followed by Hypoxic ischemic encephalopathy (HIE) (88.89%) (12).

An Indian based study among 300 ventilated neonates, respiratory distress syndrome (31.1%), sepsis (22.7%) and birth asphyxia (18%) were the most common indications for mechanical ventilation (15).

In a prospective observational analytical study on the outcomes of mechanical ventilation at the NICU at EL-Zaharaa University Hospital, Egypt, respiratory distress syndrome was the most common indication for mechanical ventilation, at 30% among the studied neonates (13).

A study in India, in October 2013 and November 2015 at AJ Institute of Medical Sciences Mangalore, indications included respiratory distress syndrome (26.7%), sepsis (26.7%), and birth asphyxia (12% were the most common indications for mechanical ventilation among the 280 ventilated neonates (5)

2.4 In-hospital Outcomes of babies on mechanical ventilation

Several studies have been done worldwide to determine the outcome of babies on mechanical ventilation. In a retrospective chart review from January 2012 to July 2013 in Dhaka, Bangladesh, at Al-Din Medical College Hospital, 67.24% of the 58 ventilated neonates survived. The common complications of mechanical ventilation among these babies were pneumonia (12.06%), pneumothorax (10.34%), sepsis (8.6%), and pulmonary hemorrhage (3.4%) (10).

In a hospital-based retrospective study from February 2015 to January 2017, conducted at Chitwan Medical, College Nepal, among 119 mechanically ventilated babies; the overall survival was 37.8% and the two most common complications encountered during ventilation were shock and disseminated intravascular coagulopathy (DIC) (12).

A study of ventilator associated pneumonia in a neonatal intensive care unit at CSM Medical University, Lucknow (India) found that 30.6% of the 98 babies studied developed ventilator associated pneumonia (VAP). The VAP rates were 37.2 per 1000 days of mechanical ventilation (11).

In a study from October 2011 to November 2013, Sher-l-Kashmir institute of medical sciences, India, a total of 300 neonates were ventilated. Of these, 130 (43%) died. Mortality in ventilated patients with sepsis, pneumonia, RDS or birth asphyxia was 64.7%, 60%, 44.6% and 33.3% respectively (15).

In a prospective observational analytical study in the NICU at EL- Zaharaa University Hospital, Egypt, from March 2019 to March 2020, the overall survival was 59.1% among the 110 ventilated neonates. Ventilator-associated pneumonia and device- associated infections were the most common complications related to mechanical ventilation (19.1% and 11.8%, respectively). Septic shock and multi-organ failure were the most common complications related to the underlying disease (24%) (13).

In a study by Nidhi Srinivas et al in India, between October 2013 and November 2015 at the AJ Institute of Medical Sciences Mangalore, a total of 280 ventilated neonates were studied, 57% (160 babies) died (5).

2.5 Determinants of survival of babies on mechanical ventilation

Several factors have been found to determine the survival of babies on mechanical ventilation. In a study in Dhaka, Bangladesh, survival rate was higher (76%) among babies with birth weight of 2500gms, 69% among those less than 30 weeks gestation, and 60% among those less than 1000gms. Prolonged ventilator support was required for respiratory distress syndrome without surfactant (254 hours) (10).

In a study in Nepal, increasing birth weight, higher gestational age and Downes score at intubation of 6 or less was associated with a better outcome. Shock, multi organ dysfunctions, and ventilator associated pneumonia were the statistically proven individual predictors of outcome (16).

In a cross-sectional study in India, hypotension on ventilator, and requirement of more than three inotropes was associated with a high mortality. Mechanical and pulmonary complications of mechanical ventilation were not significant for outcome of mechanical ventilation, but were associated with increased duration of NICU stay (12).

In a study on ventilator associated pneumonia, duration of mechanical ventilation and very low birth weight were significantly associated with VAP (11).

An Indian based study on 300 ventilated neonates, gestation <34 weeks, initial PH< 7.1, pulmonary hemorrhage, or shock were independently significant predictors of mortality (15).

In a prospective observational analytical study on the outcomes of mechanical ventilation at the NICU at EL-Zaharaa University Hospital, Egypt, there was a significant negative association between gestational age, birth weight and mortality among the 110 mechanically ventilated babies (13).

A study in India, on indications and outcome of mechanical ventilation between October 2013 and November 2015 at AJ institute of medical sciences Mangalore, weight less than 2000 grams, gestational age less than 32 weeks, presence of sepsis, apnea, shock, hypoglycemia, neutropenia and thrombocytopenia were significantly associated with mortality, among the 280 mechanically ventilated babies (5).

CHAPTER 3: METHODS

3.1 Study design

This was a retrospective cohort study carried out at the NICU of Kawempe National Referral Hospital on neonates admitted between 1st Aug 2023 and 31st July 2025.

3.2 Study setting

The study was carried out at the NICU of Kawempe National Referral Hospital. Kawempe NRH is one of the five national referral hospitals in the country. It's one of the busiest public hospitals in Uganda, offering maternal and child health services, and on average, 40-60 babies are delivered daily. The hospital offers free services to residents around Kampala and the entire country at large on a referral basis. It mainly caters for the low-income earners.

The Department of Pediatrics comprises a neonatal Intensive care unit (NICU), a Pediatric emergency care unit, also called the Acute Care Unit, and general pediatric outpatient and inpatient units.

The NICU offers neonatal care up to level 3 with six functional mechanical ventilators. The unit's staff includes Neonatologists, pediatricians, Neonatology fellows, Residents, and a team of nurses. The unit, on average, has 60 to 80 babies per day being managed for different conditions. The preterm babies account for close to 60% of the total admissions and stay longer in the unit. Ten percent of the total admissions require respiratory support, and half of these babies may need mechanical ventilation. Admitted babies are delivered from Kawempe NRH labour suite and also referred from peripheral units within the Kampala Metropolitan area. NICU bed capacity is 80 beds with 6 mechanical ventilators and electric CPAPs. The average number of ventilated babies is 15 per month, thus an annual total of 180 babies. Services offered include respiratory and cardiovascular support and supportive management. Babies are discharged when clinically stable and when treatment is completed. They are then followed up in the outpatient clinic for further assessment.

3.3 Study population

3.3.1 Target population

All neonates who were managed with mechanical ventilation at the NICU of KNRH.

3.3.2 Accessible population

All neonates who were mechanically ventilated between 1st Aug 2023 and 31st July 2025.

3.3.3 Eligible population

All neonates who were mechanically ventilated and met the inclusion criteria.

3.3.4 Study unit

A neonate admitted and mechanically ventilated during the study period and met the inclusion criteria.

3.3.5 Selection criteria Inclusion criteria

All neonates who were mechanically ventilated during the selected study period between 1st August 2023 and 31st July 2025 and had complete medical records with the baby's file, including laboratory results (CBC, ELECTROLYTES, RFTs, and LFTs) that were retrieved from the E-AFYA electronic system.

Exclusion criteria

Neonates who were mechanically ventilated during the selected study period with incomplete medical records (Baby's file without laboratory results (CBC, ELECTROLYTES, RFTs, LFTs) that were retrieved from the E-AFYA electronic system.

3.4 Sample size estimation

Objective 1: To describe the clinical profile of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital. The sample size was determined using the formula for estimating proportions in a population, considering a confidence level of 95% and a margin of error of 5%. Because of the absence of contextual data of the clinical profile, we estimated the incidence at 50%. The formula used for sample size calculation is:

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

Where,

N = required sample size

Z = Z-value corresponding to the desired level of confidence (1.96 at 95% confidence level)

p = estimated proportion was 50%

d = desired margin of error or precision (0.05)

$$N = \frac{(1.96)^2 \times 0.50 \times (1-0.50)}{(0.05)^2}$$

N= 384

Objective 2: To determine the in-hospital outcomes of neonates managed with mechanical ventilation at NICU, Kawempe National Referral Hospital.

Using the Kish-Leslie formula, the survival rate in a study done in Egypt (Mechanical ventilation outcomes at the NICU at EL- Zahraa University Hospital in March 2019 to March 2020) is 59.1%

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

Where,

- N is the sample size required
- Zα is the standard normal value corresponding to a set level of confidence
- P is the estimated proportion /prevalence in previous studies
- d is the level of precision / tolerable sampling error (usually 5% except when p is less than 10%; use 3% or less).

P=0.591, d= 0.05, Z= 1.96

N=371 neonates

Objective 3

To determine the predictors of survival among neonates managed with mechanical ventilation at the NICU, Kawempe National Referral Hospital.

Sample size calculated using the Fleiss formula;

$$N_{Fleiss} = \frac{[z_{\alpha/2}\sqrt{(r+1)p(1-p)} + z_{\beta}\sqrt{rp_0(1-p_0)+p_1(1-p_1)}]^2}{r(p_0-p_1)^2}$$

Using results from a study that was conducted in India, where; 21.6% babies were VLBW, with a survival rate of 29.3%, while the survival rate was 53% in babies who weren't VLBW.

α = 0.05, the probability of type I error (significance level) is the probability of rejecting the true null hypothesis

β= 0.2, the probability of type II error (1 - power of the test) is the probability of failing to reject the false null hypothesis.

P 0 = weight> 1500g, 53 % survival (0.53), p1= Very low birth weight<1500g had 29.3% survival (0.293), r = 1, the ratio of unexposed to exposed

P = (P0+rP1)/(r+1)

From Table A.2 in Fleiss;

•If 1-αis 0.95, then Zα/2is 1.960

•If 1-βis 0.80, then Z1-β is -0.842

N Fleiss-cc = 94 required sample size for the population 1 group using Fleiss formula with continuity correction.

Required Sample size = N1 + N2= 94+85= 179 neonates

Since the sample size calculated in objective 1 is larger, 384 participants were recruited in the study.

3.5 Sampling procedure

A consecutive sampling method was used. All files that met the inclusion criteria were included consecutively until the desired sample size was achieved.

3.6 Study procedure

The study consisted of the principal investigator, research assistants, and a statistician. Files were retrieved from the NICU records office. All files for babies who were ventilated from 1st August 2023 to 31st July 2025 were reviewed and screened for inclusion. Those that met the inclusion criteria were then reviewed further to collect the different study variables.

Data collected included the patient's natal and demographic characteristics, the underlying baby's condition, maternal factors, and interventions such as duration of hospital stay, surfactant administration, and duration of mechanical ventilation. Any accessible information on missing hospital services, such as laboratory tests at the time of mechanical ventilation, was also recorded.

The natal and demographic characteristics of the baby included age at admission, sex, gestational age at birth, Apgar score, birth weight, mode of delivery, indication for the mode of delivery in case of cesarean delivery, and place of birth. Maternal factors included maternal chronic conditions such as diabetes, hypertension, and premature rupture of membranes for more than 18 hours. Hospital factors included time to mechanical ventilation in hours since birth, who prescribed mechanical ventilation, duration on mechanical ventilation, and other interventions given while on mechanical ventilation, such as transfusions.

Information on outcome was recorded as alive at discharge or dead. The main underlying baby's condition at the time of intubation was considered as the indication for mechanical ventilation.

3.7 Study variables

3.7.1 Outcome variables (dependent variables)

The primary outcome of this study was survival status at discharge. The secondary outcomes were complications occurring during admission and prolonged hospitalization.

3.7.2 Independent variables

The independent variables were the factors assessed for their association with the outcomes of babies on mechanical ventilation. These included the baby's demographic and natal characteristics, such as level of maturity, Apgar score, birth weight, and sex. They also included intervention-related characteristics, such as duration of mechanical ventilation, surfactant administration, and duration of hospital stay. In addition, underlying neonatal illnesses, which constituted the indications for mechanical ventilation, were included as independent variables.

3.8 Data collection

Data were collected using standardized, pretested, and pre-coded data collection tools. These tools were used to obtain relevant information from the neonatal files.

3.9 Data management and analysis

3.9.1 Data management

Data were collected by the principal investigators and research assistants using a standardized data collection tool that had both closed- and open-ended questions. All data collection tools were cross-checked for completeness, and data entry was done by the principal investigators with support from hired data entry clerks. Data were entered using EpiData version 4.7. A computer data entry file resembling the layout of the data collection tools was created to minimize errors. Data audits using frequency distributions and cross-tabulations were performed to detect missing, out-of-range, and illogical values.

For data cleaning, range and consistency checks were run for each variable to identify errors and inconsistencies. In cases where it was not possible to correct errors in the data, a missing code was assigned.

For storage and retrieval, all data were securely stored after entry to maintain confidentiality at the end of data collection.

3.9.2 Data analysis

Data were entered into the computer using EpiData version 4.7 and were subsequently exported to STATA version 19.0 for analysis.

For Objective 1, which was to describe the clinical profile of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital, baseline characteristics were summarized descriptively using proportions, means, medians, and standard deviations. Continuous variables were analyzed using means, medians, and standard deviations, while categorical variables were analyzed using frequencies and percentages. The findings were summarized in tables.

For Objective 2, which was to determine the in-hospital outcomes of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital. Each of the study outcomes was calculated as a proportion and presented with frequencies and percentages in a table.

For Objective 3, which was to determine the predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital, bivariable and multivariable modified Poisson regression was used to determine the predictors of survival. Variables with a p-value of less than 0.2 at bivariable analysis and the factors with biological plausibility were considered for multivariable analysis. Confounding and interaction was also assessed at multivariable analysis. All variables with a p-value of less than 0.05 were considered statistically significant.

Graphical presentation of findings was done using bar graphs where appropriate.

3.10 Quality control

The data collection tool was pre-tested with two research assistants before the start of data collection to assess the suitability of the questions. The research assistants were trained before the start of data collection. In addition, the data collection tools were cross-checked by the principal investigator for completeness and were kept safely throughout the study.

3.11 Ethical consideration

Ethical approval was obtained from the Institutional Review Board of Makerere University School of Medicine (SOMREC). Administrative clearance was also sought from Kawempe National Referral Hospital to allow data collection. Confidentiality was maintained by storing all data securely, with access limited to only the research team. There was no disclosure of the obtained information to anyone outside the study team.

3.11 Dissemination

The results of this study have been prepared in a report and submitted as a dissertation for the award of Master of Medicine in Pediatrics. Copies of the report to be availed to the Department of Pediatrics and Child Health, School of Medicine in the College of Health Sciences, the Albert Cook Library, the Makerere University Directorate of Graduate Studies, Kawempe National Referral Hospital, and the Ministry of Health of Uganda. The results from the study to be presented at conferences, and a manuscript to be written and submitted to a peer-reviewed journal for publication.

CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter presents findings on the clinical profile, In-hospital outcomes, and predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital. A total of 434 patient files were retrieved and screened for eligibility, 50 were excluded and 384 were assessed for the study outcome. (Figure 2)

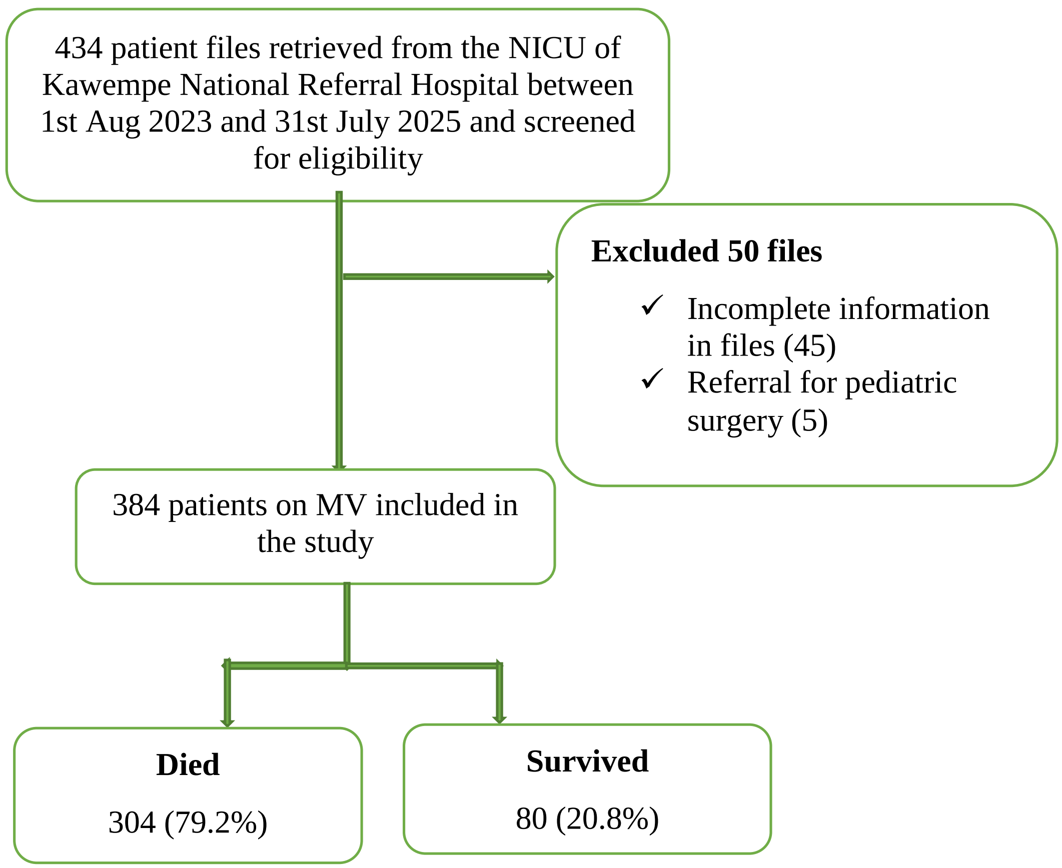


Figure 2: Study flow chart of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Patients' file missing CBC, electrolytes, RFTs and LFTs was considered incomplete.

4.1 Baseline characteristics of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Neonatal-related characteristics

Among the 384 neonates managed with mechanical ventilation, 228 (59.4%) were male. The majority, 307 (80.2%), were admitted within 24 hours of life. In relation to gestational age, half

194(50.2%) were born between 28 to 36 weeks. Most neonates, 260 (67.7%), had low birth weight (1.5 - 2.5 kilograms). Among neonates with documented Apgar scores at 5 minutes, most, 290 of 384, 75.5%, had an Apgar score of 7 or more. Singleton births constituted 342 (89.1%) of all births; 236 (61.6%) of the neonates were delivered by spontaneous vaginal delivery, while 147 (38.4%), were delivered by caesarean section. Most neonates were delivered either in a health facility, 191 (49.7%), or referred from a lower health facility, 176 (45.8%). (Table 1).

Table 1: Neonatal-related characteristics of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Variable	Frequency	Percentage
Sex of the baby		
Female	156	40.6
Male	228	59.4
Age at admission (n=384)		
<24 hours	308	80.2
24 to 71 hours	60	15.6
72 hours or more	16	4.2
Gestational age in weeks		
<28 weeks	71	18.5
28 to 36 weeks	194	50.2
37 weeks or more	119	31.3
Birth weight		
Low birth weight (<2.5kg)	260	67.7
Normal birth weight (2.5-4.0kg)	120	31.2
Macrosomia (>4.0kg)	4	1.0
Low birth weight (n=260)		
LBW (1.5-2.5kg)	100	38.5
Very LBW (1.0-1.5kg)	126	48.5
Extreme LBW (<1.0kg)	34	13.1
Apgar score at 5 minutes (n=384)		
<7	94	24.5
7 or more	290	75.5
Birth type		
Multiple	42	10.9
Singleton	342	89.1
Mode of delivery		
Caesarean section	148	38.4
Spontaneous vaginal delivery	236	61.6
Place of delivery		
Home	17	4.4
Kawempe National referral	191	49.7
Referral from lower facility	176	45.8

Maternal-related characteristics

Among mothers with age documented, 32 (8.8%) were adolescent mothers. In terms of parity, 158 (41.1%), were born to mothers with parity of 3 or more. Rupture of membranes greater than 18 hours occurred in 27 (7.0%), while antenatal attendance was reported among 376 (97.9%), mothers. Pregnancy complications were documented for 281 mothers; preterm labour was the commonest complication, 100 (35.6%), followed by hypertensive disorders, 41 (14.6%). (Table 2).

Table 2: Maternal related characteristics of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Variable	Frequency	Percentage
Mother's age in years		
<20 years	32	8.8
20-34 years	289	79.8
≥35 years	41	11.3
Mother's parity category		
Para 1	145	37.8
Para 2	81	21.1
Para 3 or more	158	41.1
Rupture of membranes greater than 18 hours		
No	357	93.0
Yes	27	7.0
Antenatal attendance		
No	8	2.1
Yes	376	97.9
HIV serostatus		
Negative	368	95.8
Positive	16	4.2
Highly active antiretroviral therapy		
No	369	6.2
Yes	15	93.8
Pregnancy complications (n=281)		
Antepartum haemorrhage	24	8.5
Foetal distress	30	10.7
Hypertensive disorders	41	14.6
Multiple complications	37	13.2
Preterm premature rupture of membranes	16	5.7
Preterm labour	100	35.6
Previous scar	8	2.8
Prolonged or delayed labour	25	8.9

Indications for Mechanical Ventilation among neonates managed with mechanical ventilation at Kawempe National Referral Hospital

The main indication for mechanical ventilation was respiratory distress syndrome, reported among 293 (76.3%) neonates. This was followed by perinatal asphyxia (HIE) 164 (42.7%), Neonatal sepsis 139 (36.2%), and apnea of prematurity 131 (34.1%). Less common indications included persistent pulmonary hypertension, haemorrhagic disease of the newborn, meconium aspiration syndrome, and aspiration pneumonitis. Some neonates had more than one indication e.g. Prematurity with RDS and apnea of prematurity. (Table 3)

Table 3: Indications of Mechanical Ventilation among neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Variable	Frequency	Percentage
Perinatal asphyxia (HIE)		
No	220	57.3
Yes	164	42.7
Apnea of prematurity		
No	253	65.9
Yes	131	34.1
Neonatal Sepsis		
No	245	63.8
Yes	139	36.2
Respiratory distress syndrome		
No	91	23.7
Yes	293	76.3
Meconium aspiration syndrome		
No	345	89.8
Yes	39	10.2
Aspiration pneumonitis		
No	378	98.4
Yes	6	1.6
Hemorrhagic disease of the newborn		
No	331	86.2
Yes	53	13.8
Persistent pulmonary hypertension		
No	328	85.4
Yes	56	14.6

Mechanical ventilation and care-related characteristics of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Regarding mechanical ventilation and care-related characteristics, most neonates, 224 (58.3%), were initiated on mechanical ventilation at 24 to 72 hours, while 114 (29.7%) were initiated after 72 hours. More than half, 215 (56.0%), required resuscitation before mechanical ventilation. Pressure-assisted control ventilation was the commonest initial mode of mechanical ventilation, used in 366 (95.6%), neonates. Surfactant was administered to 176 (45.8%), and blood transfusion was given to 154 (40.1%). (Table 4)

Table 4: Mechanical ventilation and care-related characteristics of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Variable	Frequency	Percentage
Age at initiation of mechanical ventilation		
<24 hours	46	12.0
24 to 72 hours	224	58.3
>72 hours	114	29.7
Total days on antibiotics (n=384)		
1 to 3 days	104	27.6
4 to 7 days	125	33.2
8 to 14 days	101	26.8
>14 days	47	12.5
Duration on mechanical ventilation (n=384)		
<24 hours	39	10.3
24 to 72 hours	128	33.8
>72 hours	212	55.9
Need for resuscitation before mechanical ventilation		
No	169	44.0
Yes	215	56.0
Surfactant		
No	208	54.2
Yes	176	45.8
Caffeine		
No	0	0
Yes(All Preterm babies)	260	100
Blood transfusion		
No	230	59.9
Yes	154	40.1
Anticonvulsants		
No	289	75.3
Yes	95	24.7
Mode of oxygen delivery prior to mechanical ventilation		
Bubble CPAP	285	74.2
Electric CPAP	97	25.3
Free flow oxygen	2	0.5

4.2 Clinical characteristics of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

Among the clinical signs assessed in the 384 neonates, jaundice was the most common, reported in 130 neonates (33.9%), followed by signs of septic shock reported in 42 neonates (10.9%). Pyrexia, signs of hypovolemic shock, and having two or more conditions were less common. Details are presented in Figure 3

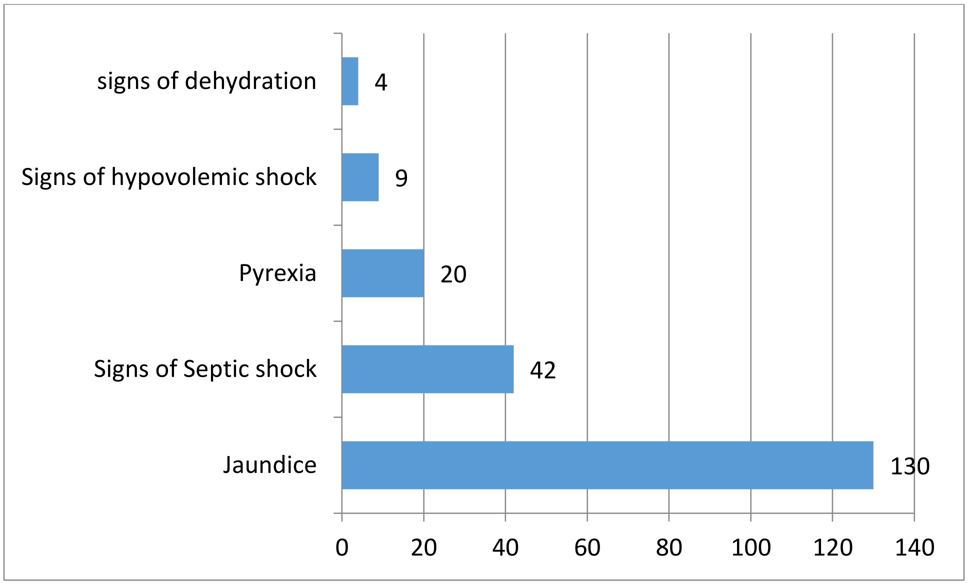


Figure 3: Clinical characteristics of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

Laboratory characteristics of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

Among the laboratory characteristics assessed in the 384 neonates, raised C-reactive protein was the most common laboratory finding, reported in 139 neonates (36.2%). This was followed by hyperbilirubinemia in 131 neonates (34.1%), thrombocytopenia in 123 neonates (32.0%), and elevated liver transaminases in 121 neonates (31.5%). Other abnormalities included hyperkalemia, elevated urea and creatinine, severe anaemia, and hyponatremia. Details are presented in Figure 4.

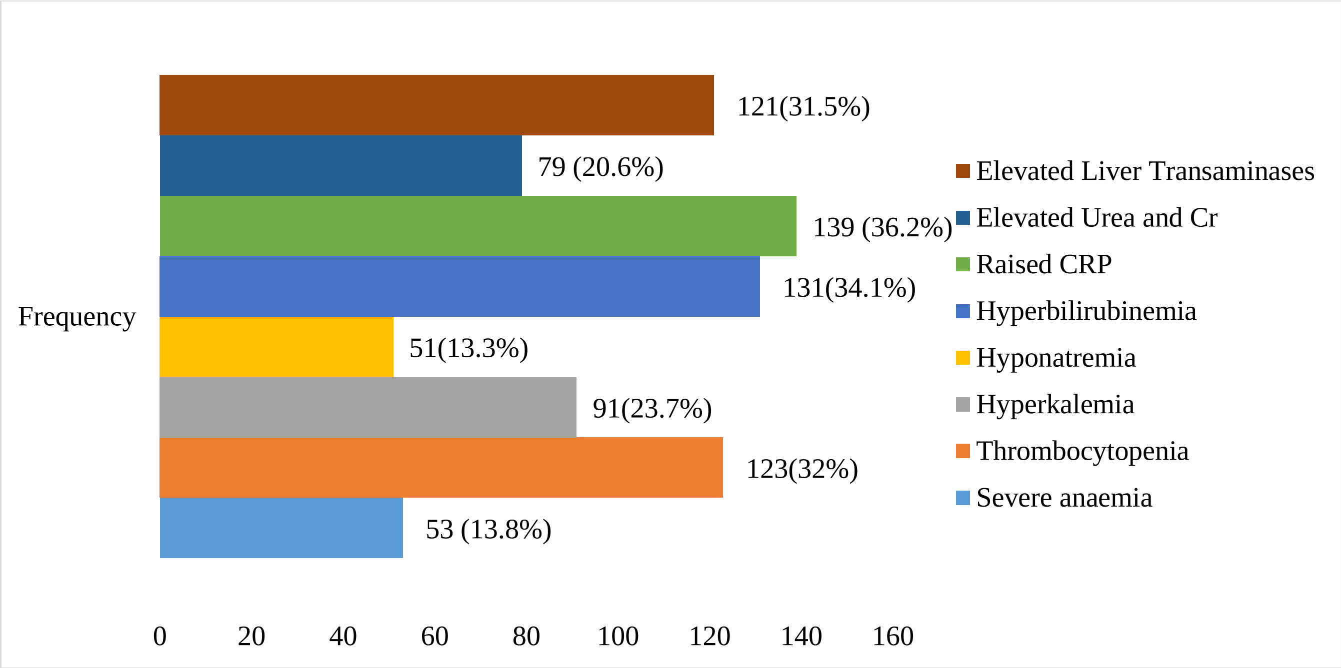


Figure 4: Laboratory characteristics of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

4.3 In-hospital outcomes of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Among the 384 neonates managed with mechanical ventilation, 304 (79.2%) died during hospitalization, while 80 (20.8%) were discharged alive. The mean duration of stay was 8.39 days, standard deviation 7.38, and the mean age at discharge was 14.97 days, standard deviation 9.26. Most neonates, 118 (30.7%), stayed for 4 to 7 days. (Table 5)

Table 5: In-hospital outcomes of neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Variable	Frequency	Percentage
Duration of stay in days Mean (SD)	8.37(±7.37)	
Age at discharge in days Mean (SD)	14.97(±9.26)	
Outcome of care		
Died	304	79.2
Survived	80	20.8
Length of stay category		
3 days or less	98	25.5
4 to 7 days	118	30.7
8 to 14 days	103	26.8
>14 days	65	16.9
Complications of mechanical ventilation		
Bronchopulmonary dysplasia	3	0.8
Endotracheal tube blockage	79	20.6
Pneumothorax	2	0.5
Pulmonary haemorrhage	19	4.9
Ventilator-associated pneumonia	7	1.8
Condition at discharge (n=80)		
No complications	80	100

4.4 Bivariable analysis of predictors of survival among neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Indications of Mechanical Ventilation among neonates managed with mechanical ventilation at Kawempe National Referral Hospital

Neonates without apnea of prematurity were 4.66 times more likely to survive compared with those with apnea of prematurity (cRR = 4.66, $p < 0.001$). Neonates without meconium aspiration syndrome were 58% more likely to survive compared with those with meconium aspiration syndrome (cRR = 0.42, $p < 0.001$). Neonates without haemorrhagic disease of the newborn were 4.11 times more likely to survive compared with those with haemorrhagic disease of the newborn (cRR = 4.11, $p = 0.013$). Neonates without persistent pulmonary hypertension were 52% more likely to survive compared with those with persistent pulmonary hypertension (cRR = 0.48, $p < 0.001$). (Table 6).

Table 6: Indications for Mechanical Ventilation associated with survival among neonates managed with mechanical ventilation

Variable	Died n (%)	Survived n (%)	cRR (95% CI)	P value
Perinatal asphyxia				
No	170 (77.3)	50 (22.7)	1.24(0.828 - 1.864)	0.294
Yes	134 (81.7)	30 (18.3)	1	
Apnea of prematurity				
No	181 (71.5)	72 (28.5)	4.66(2.314 - 9.386)	**<0.001**
Yes	123 (93.9)	8 (6.1)	1	
Respiratory distress syndrome				
No	67 (73.6)	24 (26.4)	1.38(0.909 - 2.094)	0.130
Yes	237 (80.9)	56 (19.1)	1	
Meconium aspiration syndrome				
No	282 (81.7)	63 (18.3)	0.42(0.275 - 0.639)	**<0.001**
Yes	22 (56.4)	17 (43.6)	1	
Aspiration pneumonitis				
No	300 (79.4)	78 (20.6)	0.62(0.196 - 1.956)	0.414
Yes	4 (66.7)	2 (33.3)	1	
Hyperbilirubinemia				
No	208 (79.1)	55 (20.9)	1.01(0.664 - 1.543)	0.955
Yes	96 (79.3)	25 (20.7)	1	
Haemorrhagic disease of the newborn				
No	254 (76.7)	77 (23.3)	4.11(1.344 - 12.569)	**0.013**
Yes	50 (94.3)	3 (5.7)	1	
Persistent pulmonary hypertension				
No	269 (82.0)	59 (18.0)	0.48(0.318 - 0.723)	**<0.001**
Yes	35 (62.5)	21 (37.5)	1	

4.5 Multivariate Analysis of predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital.

The following covariates (p<0.2) were put in the Multivariable model:

Neonatal related: Gestation age 28-36 weeks & > 37 weeks, LBW 1-1.5kg, Apgar score <7 at 5 minutes and multiple pregnancy.

Indications of MV: Apnea of prematurity, MAS, HDN, PPHN.

Clinical & lab related predictors: Signs of Septic shock, Thrombocytopenia.

MV & Care-related predictors: Age of initiation of MV 24-72 hours, Need for resuscitation prior to MV, Surfactant, inotrope.

In the multivariate analysis, apnea of prematurity, haemorrhagic disease of the newborn, need for resuscitation prior to mechanical ventilation, and anticonvulsant use remained significantly associated with survival. Neonates without apnea of prematurity were 2.84 times more likely to survive compared with those with apnea of prematurity, (aRR = 2.84, 95% CI: 1.304, 6.185; $p = 0.009$). Similarly, neonates without haemorrhagic disease of the newborn were 2.93 times more likely to survive compared with those with the condition, (aRR = 2.93, 95% CI: 1.080, 7.938; $p = 0.035$). Neonates who did not require resuscitation prior to mechanical ventilation were 4.05 times more likely to survive compared with those who required resuscitation, (aRR = 4.05, 95% CI: 2.298, 7.148; $p < 0.001$). Likewise, neonates who did not receive anticonvulsants were 1.64 times more likely to survive compared with those who received anticonvulsants, (aRR = 1.64, 95% CI: 1.018, 2.629; $p = 0.042$. (Table 7)

Table 7. Predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital.

Variable	cRR(95%CI)	aRR(95%CI)	P-value
Gestational age in weeks			
<28 weeks	1		
28-36 weeks	2.5(1.109 - 5.641)	0.73(0.3 - 1.783)	0.491
≥37 weeks	3.28(1.446 - 7.449)	1.09(0.702 - 1.689)	0.703
Apnea of prematurity			
No	4.66(2.314 - 9.386)	2.84(1.304 - 6.185)	**0.009**
Yes	1		
Hemorrhagic disease of the newborn			
No	4.11(1.344 - 12.569)	2.93(1.08 - 7.938)	**0.035**
Yes	1	1	
Persistent pulmonary hypertension			
Yes	1	1	
No	0.48(0.318 - 0.723)	0.97(0.646 - 1.449)	0.874
Hyponatremia			
No	2.3(0.975 - 5.413)	2.09(0.988 - 4.431)	0.054
Yes	1	1	
Neonatal sepsis with raised C reactive protein			
Yes	1	1	
No	0.77(0.519 - 1.136)	1.13(0.765 - 1.683)	0.529
Age at initiation of MV			
<24 hours	1	1	
24-72 hours	2.38(1.01 - 5.617)	1.37(0.57 - 3.281)	0.484
>72 hours	1.37(0.537 - 3.504)	1.18(0.447 - 3.131)	0.736
Need for resuscitation prior to MV			
Yes	1	1	
No	6(3.491 - 10.303)	4.05(2.298 - 7.148)	**<0.001**
Surfactant			
Yes	1	1	
No	1.76(1.151 - 2.683)	1.23(0.803 - 1.891)	0.34
Blood transfusion			
Yes	1	1	
No	1.47(0.961 - 2.258)	1.03(0.663 - 1.601)	0.895
Anticonvulsants			
Yes	1	1	
No	1.55(0.913 - 2.63)	1.64(1.018 - 2.629)	**0.042**

CHAPTER FIVE: DISCUSSION

5.0 Introduction

The study aimed to describe the clinical profile, determine In-hospital outcomes, and predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital. The study found that neonates managed with mechanical ventilation had low in-hospital survival; only 1 in 5 survived with a short mean hospital stay of mean 8.37 days. Majority of those ventilated were preterm with apnea, RDS, sepsis and a minority were term babies with asphyxia. Survival was independently predicted by apnea of prematurity, haemorrhagic disease of the newborn, resuscitation before mechanical ventilation, and anticonvulsant use.

5.1 Clinical profile of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

This study found that most neonates managed with MV were preterm (67.7%) who presented with several complications of prematurity such as RDS, Apnea of prematurity, hemorrhagic disease of the newborn that were indications for MV.

There was a high burden of birth asphyxia (42.7%) especially among the term babies who presented with multi-organ involvement as evidenced by laboratory findings of elevated urea and creatinine, electrolyte abnormalities and elevated liver transaminases and neurological compromise presenting with seizures that necessitated anti-convulsant drug use.

This study also found a high burden of neonatal sepsis (36.2%) as evidenced by laboratory findings of raised C-reactive protein & thrombocytopenia with multi system involvement.This is similar to a study that reported RDS (31.1%), Sepsis (22.7%), & Birth asphyxia (18%) Iqbal, Younus (17). Additionally, Othman, Oshaib and Abd El Moneim (13) reported RDS (30%), sepsis (16.4%), Apnea(10%), Asphyxia(7.2%).

These findings are also generally consistent with previous studies showing that neonates requiring mechanical ventilation often have severe underlying illness, including sepsis, respiratory distress, birth asphyxia, prematurity-related complications, and laboratory evidence of organ dysfunction (18). They are also consistent with studies reporting jaundice, raised inflammatory markers, and thrombocytopenia as common findings among sick neonates, especially those with sepsis or birth asphyxia (19, 20).

These findings imply that neonates receiving mechanical ventilation require comprehensive monitoring beyond respiratory support alone. Routine assessment of bilirubin levels, full blood count, CRP, renal function, liver function, and electrolytes is important for early detection of complications and timely management. The findings also highlight the need to strengthen sepsis screening, jaundice management, fluid and electrolyte monitoring, and early recognition of shock among mechanically ventilated neonates.

5.2 In hospital outcomes of neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

This study found that in-hospital survival among neonates managed with mechanical ventilation was low, with only 20.8% surviving to discharge. The low survival may be explained by the critical condition of many neonates at initiation of ventilation, including prematurity, respiratory distress syndrome, neonatal sepsis, perinatal asphyxia, shock, and laboratory evidence of multisystem involvement. Mechanical ventilation is a lifesaving intervention, but survival depends not only on the availability of ventilation, but also on the neonate's condition before ventilation, timeliness of referral, quality of resuscitation, infection control, monitoring capacity, and availability of comprehensive neonatal intensive care.

Survival in the current study was lower than that reported in several other studies. In Nepal, a study reported a survival proportion of 33.0% among mechanically ventilated neonates at a tertiary-level hospital study (22). In Central Gujarat, India, Thakkar, Pansuriya (14) reported survival of 48.0%, while Iqbal, Younus (17) reported survival of approximately 57.0%. The higher survival in these studies may be due to differences in case mix, earlier initiation of ventilation, better nurse-to-patient ratios, availability of monitoring equipment, timely surfactant administration, blood gas analysis, infection prevention measures, and more established neonatal ventilation protocols.

The low survival in this study therefore, suggests the need to strengthen the full continuum of neonatal critical care, not mechanical ventilation alone. The findings imply that mechanically ventilated neonates should be treated as a very high-risk group requiring early identification, timely referral, skilled resuscitation, rapid initiation of appropriate respiratory support, close monitoring for shock and organ dysfunction, and aggressive management of sepsis, jaundice, prematurity-related complications, and birth asphyxia

This study found that the mean duration of hospital stay among neonates managed with mechanical ventilation was about eight days, with a very wide standard deviation of 7.4 days with some neonates staying for a few days and others staying for more days, with most neonates staying between four and seven days. This relatively short hospital stay should be interpreted in relation to the low survival observed in the study, because shorter admission among critically ill neonates may reflect early death rather than early recovery.

The mean duration of hospital stay in this study was shorter than findings reported in other settings. In Pakistan, Fatima, Shafique (23) reported a mean hospital stay of 13.4 days among neonates managed with conventional mechanical ventilation, which was longer than the duration observed in the current study (23). Similarly, Das et al. reported a mean total hospitalization duration of 13.1 days among mechanically ventilated neonates in Bangladesh (24). Additionally, Iqbal, Younus (17) reported a mean hospitalization duration of 10.3 days.

This study also found that most common recorded complication was endotracheal tube blockage. Other complications, including pulmonary haemorrhage, ventilator-associated pneumonia, bronchopulmonary dysplasia, and pneumothorax, were less common. In neonates, this may occur due to small endotracheal tube size, thick secretions, inadequate humidification, blood-stained secretions, poor suctioning practices, or prolonged intubation (25). This finding therefore suggests the need to strengthen routine airway care, humidification, suctioning protocols, and close monitoring of ventilator pressures and oxygen saturation. Complications such as tube blockage, pneumothorax, and pulmonary haemorrhage have also been reported among ventilated neonates and have been associated with poorer survival in tertiary neonatal care settings (25).

Ventilator-associated pneumonia was uncommon in this study compared with some previous reports. For example, Torres-Castro, Valle-Leal (26) reported pneumonia as one of the frequent pulmonary complications among ventilated neonates , while El-Rebigi, Fekry (29) found ventilator-associated pneumonia to be the most common mechanical ventilation-associated complication in a pediatric emergency intensive care setting. The lower occurrence in the current study may reflect shorter duration of ventilation or hospital stay, early mortality before development or diagnosis of VAP, differences in diagnostic criteria, or under-documentation. Since VAP usually requires time to develop, cohorts with prolonged ventilation often report higher VAP burden.

Bronchopulmonary dysplasia was rarely documented. This may be because BPD is usually associated with prolonged oxygen exposure and longer duration of mechanical ventilation, especially among very preterm neonates (30).

5.3 Predictors of survival among neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital

The multivariable analysis identified apnea of prematurity as an independent predictor of survival among neonates managed with mechanical ventilation. Neonates without apnea of prematurity were 2.84 times more likely to survive than those with apnea of prematurity. This suggests that apnea of prematurity was not merely a coexisting diagnosis, but an important marker of poor physiological resilience in ventilated neonates. Clinically, this is plausible because recurrent apnea in premature neonates is often associated with immature respiratory drive, repeated hypoxic episodes, bradycardia, and worsening cardiorespiratory instability. In the context of mechanical ventilation, the presence of apnea of prematurity may therefore reflect a subgroup with severe immaturity and greater difficulty maintaining respiratory stability even with advanced support. This interpretation is consistent with neonatal literature showing that apnea is common among preterm and critically ill neonates, and is often associated with adverse outcomes, particularly in settings where close monitoring and rapid escalation of care may be constrained (21, 31). Neonates with apnea of prematurity who require ventilation should be regarded as a particularly high-risk group, warranting closer monitoring, timely use of methylxanthine (caffeine) therapy where appropriate, and early efforts to prevent repeated hypoxic insults (32).

Haemorrhagic disease of the newborn also remained an independent predictor of survival. Neonates without haemorrhagic disease of the newborn were 2.93 times more likely to survive than those with the condition. This finding indicates that bleeding disorders were strongly associated with poor prognosis among ventilated neonates. The association is biologically coherent because haemorrhagic disease in the neonatal period may lead to hypovolemia, impaired tissue perfusion, worsening shock, intracranial complications, and progression to multiorgan dysfunction. In critically ill neonates, such bleeding episodes can rapidly compound pre-existing respiratory and circulatory instability. Previous evidence has similarly shown that bleeding complications and haemostatic disturbances are associated with increased mortality and morbidity, particularly among preterm and critically ill newborns (33, 34). Early prevention and prompt correction of bleeding disorders, including effective vitamin K prophylaxis, rapid recognition of coagulopathy, and timely transfusion support, are likely to be important components of improving survival among neonates requiring mechanical ventilation.

Need for resuscitation prior to mechanical ventilation was another strong predictor of survival. Neonates who did not require resuscitation before mechanical ventilation were 4.05 times more likely to survive than those who required resuscitation. This shows that the condition of the neonate before initiation of ventilatory support had a major influence on subsequent survival. The need for resuscitation often reflects severe intrapartum compromise, immediate postnatal collapse, profound early respiratory failure, or poor transition at birth. Such neonates are likely to begin their clinical course with significant hypoxia, acidosis, and circulatory instability, all of which may persist even after ventilation has been commenced. This finding aligns with evidence from low resource settings showing that poor neonatal outcomes are more common among newborns that require intensive resuscitation, while timely and effective resuscitation is associated with better early survival (35-37). Survival among ventilated neonates cannot be improved through ventilator support alone. It also depends heavily on the quality of intrapartum care, immediate newborn resuscitation, rapid stabilization after birth, and early recognition of neonates who are likely to deteriorate.

Anticonvulsant use independently predicted survival, with neonates who did not receive anticonvulsants being 1.64 times more likely to survive than those who received them. This finding most likely reflects the severity of the underlying illness rather than a harmful effect of the drugs themselves. In neonatal intensive care, anticonvulsants are usually administered to neonates with seizures arising from serious conditions such as hypoxic ischemic encephalopathy, intracranial haemorrhage, severe sepsis, or metabolic derangements. Their use therefore tends to mark severe neurological dysfunction and a high-risk clinical course. This interpretation is supported by current guidance and systematic review evidence showing that anticonvulsant therapy is essential for seizure control, but that outcomes are driven primarily by the underlying cause of seizures rather than by anticonvulsant exposure itself (38-40). In this study, anticonvulsant use should therefore be understood as a proxy indicator of serious neurological compromise. Ventilated neonates who require anticonvulsants should be prioritized for intensified neurological assessment, metabolic evaluation, and close monitoring because they represent a subgroup at particularly high risk of poor survival.

5.4 Study strengths and limitations

A major strength of this study was that it was the first to assess the in-hospital outcomes of babies managed with mechanical ventilation at a public health facility in Uganda.

However, being a retrospective study, it relied on review of patient files, and missing or incompletely documented data may have affected the completeness of some variables.

Other limitations included:

- Single-Centre study limits generalizability.
- We excluded 50 of 434 files due to incomplete data and this could have introduced selection bias since neonates dying very early may lack complete labs.
- Health system factors at the period we selected were not picked e.g. stockout of major medications and supplies, staffing level during the chosen period.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

In Objective 1, this study found that neonates managed with mechanical ventilation at the NICU of Kawempe National Referral Hospital were mainly preterm with respiratory distress syndrome, apnea of prematurity, neonatal sepsis and a minority were term with perinatal asphyxia.

In Objective 2, the in-hospital outcomes were poor, with low survival to discharge. Most neonates had a relatively short hospital stay, and the main documented complication of mechanical ventilation was endotracheal tube blockage, followed by pulmonary haemorrhage and ventilator-associated pneumonia.

In Objective 3, survival was independently predicted by apnea of prematurity, haemorrhagic disease of the newborn, resuscitation before mechanical ventilation, and anticonvulsant use. Neonates without these conditions or treatment indicators were more likely to survive, suggesting that survival was mainly influenced by respiratory immaturity, bleeding complications, compromise before ventilation, and neurological instability.

6.2 Recommendations

1. Prevention and management of Prematurity-related complications through initiating CPAP in the delivery room and administering surfactant timely using less invasive surfactant administration method (LISA).

2. Prevention of birth asphyxia through improved intrapartum monitoring, timely resuscitation in delivery room and also mentor lower health facilities to reduce load of referrals.

3. Refresher trainings on neonatal resuscitation to the labour suite and theatre teams.

4. Develop protocols of care while on MV to improve outcomes (e.g. VAP bundle and regular bedside checks for ETT patency and circuit leaks).

5. Future studies should focus on the feasible interventions on improving MV outcomes among neonates.

REFERENCES

1. . U. Neonatal mortality –UNICEF Data.; 2025.

2. UNICEF. United Nations Inter-agency Group for Child Mortality Estimation(UN-IGME)/UNICEF.(2024). Child Mortality Report 2024. . 2024.

3. Uganda Bureau of Statistics. Uganda Demographic and Health Survey, 2022. 2023.

4. Asiimwe JB, Nyegenye W, Muyingo E. Trends and determinants of neonatal mortality in Uganda: further analysis of the demographic and health surveys. 2019.

5. Srinivas N, Oommen R, Shriyan A. Neonatal mechanical ventilation: Indications and Outcome. IJSR. 2016;5(6):236-8.

6. Singh M, Deorari A, Paul V, Mittal M, Shanker S, Munshi U, Jain Y. Three-year experience with neonatal ventilation from a tertiary care hospital in Delhi. Indian pediatrics. 1993;30(6):783-9.

7. Donn SM, Sinha SK. Invasive and noninvasive neonatal mechanical ventilation. Respiratory care. 2003;48(4):426-41.

8. Keszler M. Mechanical ventilation strategies. Semin Fetal Neonatal Med. 2017;22(4):267-74.

9. Chakkarapani AA, Adappa R, Ali SKM, Gupta S, Soni NB, Chicoine L, Hummler HD. "Current concepts of mechanical ventilation in neonates"–Part 1: Basics. International Journal of Pediatrics and Adolescent Medicine. 2020;7(1):15-20.

10. Jahan N, Haque ZS, Mannan MA, Nasrin M, Afroz F, Parvez A, et al. Indication and short term outcome of Mechanical Ventilation in Neonates in a tertiary care hospital. Bangladesh Journal of Medical Science. 2017;16(1):24-8.

11. Regmi S, Pathak S, Awasti PR, Bhattarai S, Poudel R. Outcome of neonates requiring mechanical ventilation in a tertiary hospital. Journal of Chitwan Medical College. 2018;8(3):24-30.

12. Sharma R, Baheti S. Outcome of neonatal ventilation: a prospective and cross-sectional study in tertiary care centre. Int J Contemp Pediatr. 2017;4(5):1820-6.

13. Othman A, Oshaib Z, Abd El Moneim M. Mechanical Ventilation Outcomes at the NICU at EL-Zahraa University Hospital. Open J Pediatr. 2020;10(4):732-43.

14. Thakkar PA, Pansuriya HG, Bharani S, Taneja KK. Clinical Profile, Outcome and Risk Factors for Mortality of Neonates Requiring Mechanical Ventilation at Tertiary Care Centre of Central Gujarat, India. Journal of Nepal Paediatric Society. 2021;41(1):29-34.

15. Iqbal Q, Younus MM, Ahmed A, Ahmad I, Iqbal J, Charoo BA, Ali SW. Neonatal mechanical ventilation: Indications and outcome. Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine. 2015;19(9):523.

16. Ali M, Maruf A, Rashid M. Pattern and outcome of admissions in a neonatal high dependency unit of a medical college hospital in Khulna, Bangladesh. Mediscope. 2018;5(2):1-7.

17. Iqbal Q, Younus MM, Ahmed A, Ahmad I, Iqbal J, Charoo BA, Ali SW. Neonatal mechanical ventilation: Indications and outcome. Indian J Crit Care Med. 2015;19(9):523-7.

18. Gupta N, Subedi K, Paudel P, Vaidya S, Karmacharya S, Mishra M, et al. Clinical Profile and Outcome of Mechanically Ventilated Neonates: Evidence from a Prospective Study. Journal of Perinatal Society of Nepal. 2024;2:9-15.

19. Al Ghadeer HA, Alabdallah RH, AlKhalaf GI, Aldandan FK, Almohammed HA, Al Busaeed MM, et al. Characteristics and Associated Risk Factors of Neonatal Sepsis: A Retrospective Study From Saudi Arabia. Cureus. 2024;16(12):e76517.

20. Ayalew T, Molla A, Kefale B, Alene TD, Abebe GK, Ngusie HS, Zemariam AB. Factors associated with neonatal jaundice among neonates admitted at referral hospitals in northeast Ethiopia: a facility-based unmatched case-control study. BMC Pregnancy Childbirth. 2024;24(1):150.

21. Tekulu TG, Lemma HH, Hadgu A, Gebrekidan G, Seyoum D, Hailu H, et al. Clinical profile and predictors of mortality of mechanically ventilated neonates in a tertiary hospital in Ethiopia. Discover Medicine. 2025;2(1):258.

22. Shrestha P, Basnet S, Shrestha L. Clinical profile and outcome of mechanically ventilated neonates in a tertiary level hospital. Journal of Nepal Paediatric Society. 2015;35(3):218-23.

23. Fatima B, Shafique MF, Murad M, Irfan I, Mehmood A, Hussain S, Habib MF. Indications and Short-Term Outcomes of Conventional Mechanical Ventilation in a Neonatal Intensive Care Unit of a Tertiary Care Hospital in a Developing Country. Journal of Health and Rehabilitation Research. 2024;4(2):629-35.

24. Das BK, Begum NNF, Yasmeen S, Raha BK. Immediate Outcome of Mechanically Ventilated Neonate: One Year Experience in Neonatal Intensive Care Unit of Combined Military Hospital Dhaka. IAHS Medical Journal. 2021;4(1):27-32.

25. Shashi Vinod GV, Akash Verma. Study of indicators of outcomes and complications in neonates on mechanical ventilation in a tertiary care hospital

The Journal of Contemporary Clinical Practice. 2025.

26. Torres-Castro C, Valle-Leal J, Martínez-Limón AJ, Lastra-Jiménez Z, Delgado-Bojórquez LC. Pulmonary complications associated with mechanical ventilation in neonates. Boletín Médico Del Hospital Infantil de México (English Edition). 2016;73(5):318-24.

27. Araújo GTd, Guimarães EL. Ventilatory complications in neonates in the Neonatal Intensive Care Unit: an integrative review. 2022.

28. Bacha T, Tsegaye N, Tuli W. Utilization of mechanical ventilators in low resource Faculty: a cross sectional study. 2020.

29. El-Rebigi AM, Fekry AN, Elfaramawy MA, Zakaria RM. Mechanical ventilation-associated complications and comorbidities in children admitted at pediatric intensive care unit: A cross-sectional retrospective study. Turkish Journal of Emergency Medicine. 2025;25(3):230-8.

30. Escobar V, Soares DS, Kreling J, Ferrari LSL, Felcar JM, Camillo CAM, Probst VS. Influence of time under mechanical ventilation on bronchopulmonary dysplasia severity in extremely preterm infants: a pilot study. BMC Pediatr. 2020;20(1):241.

31. Eichenwald EC. Apnea of Prematurity. Pediatrics. 2016;137(1).

32. Tumuhamye J, Sommerfelt H, Bwanga F, Ndeezi G, Mukunya D, Napyo A, et al. Neonatal sepsis at Mulago national referral hospital in Uganda: Etiology, antimicrobial resistance, associated factors and case fatality risk. PLoS One. 2020;15(8):e0237085.

33. Kariuki E, Sutton C, Leone TA. Neonatal resuscitation: current evidence and guidelines. BJA Educ. 2021;21(12):479-85.

34. Lee HC, Strand ML, Finan E, Illuzzi J, Kamath-Rayne BD, Kapadia V, et al. Part 5: Neonatal Resuscitation: 2025 American Heart Association and American Academy of Pediatrics Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2025;152(16_suppl_2):S385-s423.

35. Helldén D, Myrnerts Höök S, Pejovic NJ, McLellan D, Lubulwa C, Tylleskär T, Alfven T. Neonatal resuscitation practices in Uganda: a video observational study. BMJ Paediatr Open. 2021;5(1):e001092.

36. Kamath-Rayne BD, Thukral A, Visick MK, Schoen E, Amick E, Deorari A, et al. Helping Babies Breathe, Second Edition: A Model for Strengthening Educational Programs to Increase Global Newborn Survival. Glob Health Sci Pract. 2018;6(3):538-51.

37. Msemo G, Massawe A, Mmbando D, Rusibamayila N, Manji K, Kidanto HL, et al. Newborn mortality and fresh stillbirth rates in Tanzania after helping babies breathe training. Pediatrics. 2013;131(2):e353-60.

38. Booth D, Evans DJ. Anticonvulsants for neonates with seizures. Cochrane Database of Systematic Reviews. 2004(3).

39. He Y, Tang J, Zhang M, Xiong T, Ojha S, Choonara I, Mu D. Efficacy of antiepileptic drugs in neonatal seizures: a systematic review protocol. BMJ Paediatr Open. 2020;4(1):e000683.

40. Pressler RM, Abend NS, Auvin S, Boylan G, Brigo F, Cilio MR, et al. Treatment of seizures in the neonate: Guidelines and consensus-based recommendations-Special report from the ILAE Task Force on Neonatal Seizures. Epilepsia. 2023;64(10):2550-70.

APPENDIX I: DATA ABSTRACTION TOOL

A	**PATIENT'S DEMOGRAPHICS**			
1	STUDY NUMBER			
2	IP NUMBER			
3	INITIALS			
4	AGE AT ADMISSION	DD/MM/YYYY		
5	SEX OF BABY			
6	NEXT OF KIN/relationship			
7	ADDRESS OF NEXT OF KIN			
8	AGE AT RECRUITMENT	DD/MM/YYYY		
B	**PATIENT'S NATAL DETAILS**			
1	DATE OF BIRTH	DD/MM/YYYY		
2	TIME OF BIRTH	HHMM (24 HC)		
3	PLACE OF BIRTH			
4	MODE OF DELIVERY			
5	INDICATIONS FOR CESEREAN DELIVERY			
6	DATE OF ADMISSION			
7	TIME OF ADMISSION			
8	GESTATIONAL AGE AT BIRTH			
9	BALLARD SCORE			
11	APGAR SCORES AT 1 MIN AND 5 MIN			
12	BIRTH WEIGHT			
13	BIRTH WEIGHT CATEGORY (grams)			
14	BIRTH TYPE (SINGLETON OR MULTIPLE)			
C	**MATERNAL DETAILS**			
1	MOTHER'S AGE IN YEARS			
2	MOTHER'S PARITY			
3	RUPTURE OF MEMBRANES > 18 hours		Y	N
4	MOTHER'S MEDICAL CONDITION	HTN, DM, HEP B		
5	ANTENATAL ATTENDANCE		Y	N

6	HIV SEROSTATUS		+	-
7	HAART		Y	N
8	PLACE OF DELIVERY			
9	PREGNANCY COMPLICATIONS			
D	PRIMARY MORBID CONDITIONS			
1	PERINATAL ASPHYXIA			
2	APNEA OF PREMATURITY			
3	NEONATAL SEPSIS			
4	RESPIRATORY DISTRESS SYNDROME (HMD)			
5	MECONIUM ASPIRATION SYNDROME			
6	HYPERBILIRUBINEMIA			
7	HAEMORRHAGIC DISEASE OF THE NEW BORN			
8.	PERSISTENT PULMONARY HYPERTENSION			
E	CLINICAL AND LAB CHARACTERISTICS	At any point during care		
1	Signs of dehydration		Y	N
2	Pyrexia (T=37.5)		Y	N
3	Hypoxia (SPO2 <90%)		Y	N
4	Signs of hypovolemic shock		Y	N
5	Jaundice			
6	Thompson score			
7	Severe Anemia (HB <10g/dl)		Y	N
8	Acidosis (HCO3-) < 15mmol/l		Y	N

9	Hyperkalemia (K > 5.5mmol/l)		Y	N
10	Hyponatremia (Na < 135mmol/l)		Y	N
11	Hypocalcemia		Y	N
12	Total hyperbilirubinemia		Y	N
13	Proven Sepsis (Positive Blood Culture)		Y	N
14	Raised CRP		Y	N
15	Abnormal renal functional tests			
16	Abnormal Liver functional tests			
F	CARE –RELATED FACTORS			
1	DURATION OF MECHANICAL VENTILATION	DD:HH:MM		
2	AGE AT INITIATION OF MECHANICAL VENTILATION	DD:HH:MM		
3	MODE OF OXYGEN DELIVERY PRIOR TO MV			
4	NEED FOR RESUSCITATION PRIOR TO MV			
5	CADRE PERFORMING INDEX ENDOTRACHEAL INTUBATION			
6	DECISION-TO-INITIATION OF MV TIME			
7	INITIAL MODE OF MECHANICAL VENTILATION			
8	INDICATION FOR MECHANICAL VENTILATION	Refer to section D		
9	SURFACTANT		Y	N
10	DOSES OF SURFACTANT			
11	AGE AT SURFACTANT ADMINISTRATION			

12	FIRST LINE ANTIBIOTICS		Y	N
13	DURATION AND DOSES			
14	SECOND LINE ANTIBIOTICS		Y	N
15	DURATION AND DOSES			
16	THIRD LINE ANTIBIOTICS		Y	N
17	DURATION AND DOSES			
17	DEXTROSE 10%		Y	N
18	METHOD OF ADMINISTRATION	BOLUS/ INFUSION		
19	DURATION			
20	BLOOD TRANSFUSION		Y	N
21	ANTICONVULSANTS		Y	N
22	DURATION			
23	OXYGEN THERAPY		Y	N
24	DURATION AND METHOD	<48hr >48hr		
		FFO2, b CPAP, e CPAP		
25	INOTROPE			
26	COMPLICATIONS OF MV			
H	OUTCOMES OF CARE			
1	Death			
2	Duration of stay	DD:HH:MM		
3	Discharged			
4	Condition at discharge	(Good/with complications		

5	Age at discharge	Dd:hh:mm		
6	Ran away			

APPENDIX II: WORKPLAN

ACTIVITIES	Timeframe 2025					2026		
	JAN- MAY	JUN	JULY-SEPT	OCT	DEC	JAN	MAY	JUNE
Concept development and proposal writing								
Proposal presentation to the department								
Corrections and application to IRB for ethical clearance								
Approvals complete								
Data collection								
Data cleaning and analysis								
Presentation of study findings								
Writing dissertation								

APPENDIX III: BUDGET

Items	Item quantity	Unit cost (UGX)	Total cost (UGX)
Printing proposal to the department	10 copies	100 per page	50000
Printing proposal to IRB	2 copies	100 per page	20000
Institutional Research Board fee		100000	100000
Training of research assistants	2	50000	100000
Printing data collection tool	371 copies x 4 pages	100 per page	148,400
Pens	1 box	12000	12000
Box file	3	15000	45000
Note book	10	1500	15000
Hospital Clearance Fee			150000
Research assistants	2	200000 each	400000
Statistician	1	1,500,000	1,500,000
Printing final book for the department	10 copies	100 per page	40,000
Dissemination of final book	10 copies	100 per page	80,000
TOTAL			**UGX 2,660,000**