

**INDICATIONS, CLINICAL CHARACTERISTICS, MANAGEMENT AND OUTCOME
OF PATIENTS ADMITTED TO A NEWLY DEDICATED OBSTETRICS INTENSIVE
CARE UNIT AT THE KENYATTA NATIONAL HOSPITAL: DESCRIPTIVE
RETROSPECTIVE COHORT STUDY**

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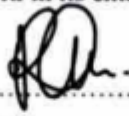
A RESEARCH DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
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(OBSTETRICS AND GYNECOLOGY) IN THE DEPARTMENT OF OBSTETRICS AND
GYNAECOLOGY
UNIVERSITY OF NAIROBI.

APRIL ,2022

DECLARATION

This dissertation is my original work in its entirety and has not been submitted for the award of a degree in any other University.

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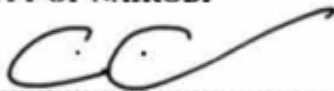
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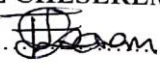
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OPERATIONAL DEFINITIONS

Intensive care unit - a organized system in a hospital for the provision of care to critically ill patients and is staffed with specially trained personnel, nurse: patient ratio of 1:1, has ventilatory machines and other equipment that allow for continuous monitoring and life support.

Dedicated intensive care unit - a specialized unit set aside to provide critical care to a specific category of patients such as neonates, obstetric patients, cardiothoracic patients.

Post-abortion admission – patient who has had termination of pregnancy at less than twenty weeks gestation and admitted to ICU because of complications arising from the procedure.

Re-admission - patient who was previously admitted to and discharged from obstetric ICU but has been readmitted again while either still pregnant or in postpartum period for the same or different indication.

TABLE OF CONTENTS

DECLARATION.....	2
LIST OF SUPERVISORS.....	2
Role of the investigator:.....	4
Role of the supervisor:.....	4
Funding Agency:	4
OPERATIONAL DEFINITIONS	4
TABLE OF CONTENTS	5
LIST OF TABLES	7
TABLE OF FIGURES.....	7
ABBREVIATION AND ACRONYMS	8
ABSTRACT.....	9
CHAPTER ONE: INTRODUCTION	10
1.1. Background to the Study	10
CHAPTER TWO: LITERATURE REVIEW.....	11
2.1. Introduction.	11
2.2. Literature review	11
2.3. Conceptual Framework	19
2.4. Problem Statement	21
2.5. Justification	21
2.6. Research Questions.....	22
2.7. Research Objectives.....	22
2.7.1. Broad Objective	22
2.7.2. Specific Objectives	22
2.7.3. Secondary objective:.....	22

2.8.	Significance and Anticipated Output.....	23
CHAPTER THREE: MATERIALS AND METHODS		23
3.1.	Study Design.....	23
3.2.	Study site	23
3.3.	Study population.....	23
3.4.	Inclusion criteria.....	23
3.5.	Exclusion criteria.....	24
3.6.	Study variables.....	24
3.7.	Sampling Techniques and Sample Size	26
3.7.1.	Sample Size Determination.....	26
3.7.2.	Sampling Techniques.....	26
3.8.	Data collection tool	27
3.9.	Data Collection Procedure.....	27
3.10.	Quality assurance and control.....	27
3.11.	Data Management.....	27
3.12.	Data Analysis.....	27
3.13.	Ethical considerations	28
CHAPTER FOUR: RESULTS		30
REFERENCES.....		42
APPENDICES		45
	Appendix I: Structured data collection tool	45

LIST OF TABLES

Table 1: Study variables	25
Table 2: Socio-demographic and clinical characteristics of patients admitted to obstetric ICU at KNH	30
Table 3: Pre-existing medical condition among patients admitted to obstetric ICU at KNH	31
Table 4: Indications for admission among patients admitted to obstetric ICU at KNH	32
Table 5: Clinical interventions among patients admitted to obstetric ICU at KNH	33
Table 6: Bivariate analysis of factors associated with maternal mortality among patients admitted to obstetric ICU at KNH	36
Table 7: Multivariate analysis of factors associated with maternal mortality among patients admitted to obstetric ICU at KNH	37

TABLE OF FIGURES

Figure 1: Conceptual framework	19
Figure 2: Study flow chart	29
Figure 3: Duration of hospital stay prior to admission to dedicated obstetric ICU at KNH	31
Figure 4: Duration of stay in obstetric ICU following admission to the obstetric ICU at KNH	34
Figure 5: Outcome of patients admitted to dedicated obstetrics ICU at KNH	34
Figure 6: Diagnoses among the mortality cases of patients admitted to dedicated obstetric ICU at KNH	35

ABBREVIATION AND ACRONYMS

APACHE II	Acute Physiology and Chronic Health Evaluation II
CVC	Central Venous Catheter
HDU	High Dependency Unit
ICU	Intensive Care Unit
KNH	Kenyatta National Hospital
LMICs	Low and Middle-Income Countries
MMR	Maternal Mortality Ratio
MSICU	Medical-Surgical Intensive Care Unit
PPH	Post-Partum Haemorrhage
SAMM	Severe Acute Maternal Morbidity
SDG	Sustainable Development Goals
UoN	University of Nairobi
WHO	World Health Organization

ABSTRACT

Background: Admission to critical care units has been shown to be a maker of severe morbidity. Critically ill obstetric patients are often admitted to non-dedicated intensive care units rather than to dedicated obstetric ICU. Studies have shown better outcome when obstetric patients are admitted to dedicated rather than integrated intensive care units. Kenyatta National Hospital (KNH) recently opened a dedicated obstetric ICU and this study sought to provide baseline data aimed at improving outcomes.

Objective: To determine the indications, clinical characteristics, management and outcomes of patients admitted to the dedicated obstetrics ICU at KNH between March 2020 to February 2021.

Methodology: Using a retrospective descriptive cohort study design, data was retrieved from 182 patients' files that met the inclusion criteria. SPSS version 26 was used to analyse data. Descriptive statistics such as means and standard deviations were used for continuous variables and frequencies and percentages for categorical variables. Mortality was calculated as a proportion of deaths among the population and presented as percentage. Chi-square test was used for categorical variables to determine factors associated with mortality. A p-value of <0.005 was taken to be statistically significant. Further multivariate logistic regression analysis was done for factors associated with mortality.

Results: A total of 182 files of the admissions were analysed in the study and the mean age was 28 years. Majority were married(n=144), unemployed(n=107), multiparous(n=134), urban-dwellers(n=112) and referrals(n=141). The most common indication for admission was hypertensive diseases of pregnancy (54%). CVC insertion (n=122,67%) and mechanical ventilation (n=107,59%) were the most common interventions. The average duration of stay was 5 days. Maternal mortality rate was at 29%. Majority ,93%, of mortalities were referrals. Factors associated with mortality: caesarean section delivery aOR4.47(1.14,17.57), mechanical ventilation aOR4.00(1.08,14.81) and central venous catheter insertion aOR8.18(1.52,44.15) which are likely procedures on critically ill patients in ICU.

Conclusion: Most of the patients admitted to the ICU would benefit from HDU care and further research on comparison of ICU outcome with disease severity score at admission is recommended.

CHAPTER ONE: INTRODUCTION

1.1. Background to the Study

According to the World Health Organization (WHO), 810 women die daily from preventable causes related to pregnancy and child-birth (1). Despite sustainable development goals, particularly SDG3 which aims to reduce maternal mortality to less than 70 per 100,000 live births, maternal mortality remains significantly high in the developing countries (2). WHO also recommends that facilities providing surgical services such as caesarean sections should also provide intensive care (3) but many hospitals in LMICs do not have such services and the problem is dire in sub-Saharan Africa where ICU bed availability is 1 per million population (4) compared to 200 per million in the United States and 58 per million in Sweden (5). LMICs contribute 94% of maternal mortality (1). Though there is a low incidence of admission of obstetric cases to ICU, the mortality rate among the admissions varies from 0% to 4.9% in high income countries, and 2% to 43.6% in LMIC (6)(7). In developed countries, the incidence of Intensive Care Unit (ICU) admission of an obstetric patient is 2–4/1000 deliveries as compared to developing countries where it is as high as 2–13.5/1000 deliveries (8). There are very few dedicated obstetrics ICU in developing countries to manage the critically ill obstetrics patients. Availability of an ICU within an obstetric setting has several advantages such as availability of both obstetric and critical care expert review concurrently and reduced need to transfer patients to integrated ICU (9). Furthermore, improvement in outcome has been reported when obstetric patients are admitted to dedicated ICU compared to admission to an integrated ICU (9). The management of critically ill obstetric patients can also be challenging due to the normal physiological changes that occur during pregnancy and the subsequent rapid resolution of the changes (10). Obstetric haemorrhage and pregnancy-related hypertensive disorders have been shown to be most common indications for admission to ICU (11). Others included acute respiratory distress syndrome, neurological disorders, cardiac complications and pulmonary embolism (12). Common interventions include mechanical ventilation, red cell transfusion and vasopressors (6)(13). The primary outcome has been noted to be in-hospital mortality (6). Knowledge on the common indications, clinical characteristics, interventions, and foetal-maternal outcomes is necessary in reducing the morbidity and mortality of critically ill obstetric patients hence this one-year retrospective study at a newly dedicated obstetric ICU at tertiary hospital in a developing country.

CHAPTER TWO: LITERATURE REVIEW

2.1.Introduction.

Maternal mortality ratio remains high in LMICs with Kenya at 362 deaths per 100,000 live births (14). Admission to ICU has been shown to be an indication of severe morbidity (5). The physiological changes during pregnancy pose a challenge in the assessment and management of critically ill obstetric patients and also contribute to rapid recovery or deterioration of the patients (10). A dedicated obstetric ICU has the advantages of quick and specialised care from the obstetrician and gynaecologist as well as obstetric anaesthesiologist reviews (6). Obstetric haemorrhage and pregnancy related hypertensive disorder remain the most common indication for admission to ICU among obstetric patients (15)(8). Interventions in ICU include use of vasopressors, mechanical ventilation, blood transfusion and haemodialysis (16). Mean duration of stay varies from 2-7 days. The maternal mortality among patients admitted to ICU has been shown to be about 5% (10). Significant improvement has been shown when critically ill obstetric patients are admitted to dedicated ICU as compared to admissions to integrated HDU/ICU (9). In this study, literature review of studies conducted in high-income and LMICs countries has been done.

2.2. Literature review

In a one-year prospective observational study at multidisciplinary ICU of a tertiary hospital in East Delhi India to identify contributory factors to obstetric admissions to ICU, Srivastava et al 2019 found that 138 (0.69%) obstetric patients got admitted out of 19869 deliveries. The mean age was 24.4 years. More than half (55.8%, n=77) were illiterate and 73.9% (n=102) had received no previous antenatal care. Most (n=105, 76.1%) were admitted to hospital in the third trimester (29-42 weeks). Also, 89.9% (n=124) were postpartum. Most common indication for admission was hypertensive disorder at 50% followed by obstetric haemorrhage (21.7%). Almost all (90%) required ventilator support, 29.7% inotropic support and 75.4% blood and blood products transfusion. Referrals constituted 32% of admissions. Almost half (n=72, 52.2%) were shifted to ICU in less than 12 hours of hospital admission. There were 30 (21.8%) maternal deaths (17).

In a prospective observational study on obstetric admissions and outcomes in ICU for the period 2016 to 2018 in Malawi, Prin et al found obstetric admissions to account for about one-fifth (n=105, 23%) of the 456 admissions. Seven were excluded due to missing out-come data. Of the remaining 98, the median age was 26 years. About four-fifths (79%) had undergone surgery, almost all (n=92, 95%) required mechanical ventilation and about half (48%) required

vasopressors. Just about half (49%) had anaemia at admission. Obstetrics patients admitted to ICU from operating theatre were 44%, those from HDU were 44% also while from the wards and transfer from other hospitals accounted for 12% total. Indications for admission to ICU varied and most common was shock (40%), followed by respiratory failure at 22%, hypertensive disorder at 11%, anaesthetic complications 4%, abortion complications 1% and assault 1%. ICU mortality was 46% while in-hospital mortality was almost half (49%) (6).

In a 10-year retrospective review of obstetric admissions to ICU at the Port Harcourt hospital Nigeria in 2018, Green et al found that 302(19.5%) obstetric patients were admitted to the ICU out of 1548 total admissions. Obstetric admission to ICU accounted for 1% of the 31,200 deliveries during the study period. About half of the patients admitted (51.79%) were between 21-30 years. Majority (59%) of admissions were un-booked patients. Hypertensive disorders were the most common indication for admission at 31.6% and majority of the patients (65%) had caesarean section while 21% had abdominal hysterectomies and 15% had laparotomies with bladder and uterine repair. Un-booked patients had statistically significant higher incidence of complications such as ruptured uterus compared to booked patients. Maternal mortality was 28.99% and un-booked patients accounted for 94% the deaths (18).

In a case-control study to identify the predictors of postpartum CCU admissions from 24 weeks gestation to 6 weeks post-partum at the CCU at Kenyatta National Hospital in 2018, Kimani et al found the commonest indication for admission were severe eclampsia at 40% and obstetric haemorrhage at 20%. Statistically significant predictors of ICU admission in the postpartum period were BMI and gestational age at delivery. For BMI, the odds ratio of 1.13(CI 1.01-1.26) with a p=0.036. OR for gestational age was 0.4 (CI 0.2-0.7) with p=0.005. Meaning there was 60% reduced risk ICU admission with increasing gestational age at delivery. Age, alcohol use and ANC attendance were found not to be statistically significant (19).

In a one-year retrospective observational study to analyse the requirement of HDU/ICU among obstetric patients with regards to indication for admission, interventions required, gestational outcome and the utilization rate, Tayade et al 2018 found that the utilization rate for the obstetric HDU was 11.2 per 1000 deliveries and majority (48/57) had no prior antenatal care. About two thirds (68.42%) were admitted due to obstetric reasons and the most common indications for admission were septicaemia at 35% and PPH at 29%. Furthermore, there was marked improvement in the outcome of the patients after establishment of a functioning HDU/ICU as

evident by a reduction in maternal mortality from 5.72% to 1.85% with statistically significant difference (9).

In a five-year retrospective cohort study to review admissions, management and outcome of critically ill obstetric patients admitted to a general ICU, Dasgupta et al 2017 found that there were 205 obstetric admissions, thus a rate of 2.1 per 1000 deliveries. The most common primary diagnosis was obstetric haemorrhage (34.64%) followed by pregnancy-induced hypertension at 26.83%. The main indication for admission was severe haemorrhage leading to organ failure at 40.48%. Majority (75.61%) required mechanical ventilation and the median length of stay was five days (IQR 3-9). Mortality rate was 33.66% (20).

In a two-year retrospective descriptive study to review the clinical profile of obstetric patients admitted to ICU in a Tertiary Care Centre in Varanasi India, Panda et al 2017 found that out of a total of 4986 deliveries, 756 were HDU admission, while 92 were admitted to ICU. Majority (73.91%) were 20–35 years, 64.13% of patients constituted lower socio-economic status and almost a similar number (68.47%) resided in rural areas. Notably, about two thirds (60.86%) had inadequate antenatal care. The most common interventions include blood transfusion 64.1%, inotropic support 45.6%, central line placement 44.5% and mechanical ventilation 26.08%. Obstetric haemorrhage was the commonest indication for admission at 31.5% followed by hypertensive disorder 25%. The maternal mortality was 34.78%(n=32) among the admissions. (21).

In a one-year prospective observational study to evaluate the patterns of obstetrics admission, management and outcome at multidisciplinary ICU at KNH, Mungai et al 2016 found that a total of 50 obstetric patients were admitted to the ICU with a mean age of 27.6years (17-42). More than half (58%) were multiparous while two thirds (62%) were in the postpartum period. Almost half (40%) had attained secondary level of education and 82% were married. Notably 68% were referred from peripheral facilities and the majority (80%) had comorbidities. Most common indication was pregnancy related hypertensive disorders at 34%. Majority (80%) required mechanical ventilation and 24% inotropic support. About two thirds (66%) were admitted for 4-7 days. Mortality rate was 38% (16).

In a five-year retrospective cohort study to evaluate the admission indication, clinical characteristics and outcomes of obstetric patients admitted to the ICU of a tertiary hospital in Iran between 2009-2014, Farzi et al found that obstetric ICU admissions were 1019 equivalent to 5% of all deliveries within the study period. The mean age was 30.4 years. Notably, almost

all (90.1%) were admitted in the postpartum. Furthermore, about half (46.8%) were admitted after elective caesarean section while 33/3% after emergency caesarean section and 7.27 after vaginal birth. Most common indication for admission was pregnancy related hypertension with preeclampsia at 27.5%, PPH at 13.5%, epilepsy and cardiac diseases at 6.2% and c5.55 respectively. About two thirds (61.7%) had no prior history of any disease. The average length of ICU stay was 2.8 ± 1.64 days. Almost all (94.7%) required invasive ventilation. Mortality rate was not reported in the study (22).

In a retrospective descriptive study to determine the utilization rate of the ICU by obstetrics and gynaecology patients, indications for admission, outcome and risk factors associated with mortality at a multidisciplinary ICU in a university teaching hospital in Nigeria in 2016, Adelaiye et al found that the incidence of obstetric and gynaecological admissions to the ICU was 5.2% (37/706) of all admissions. About two-thirds (n=20, 58%) were obstetric cases, mostly due to severe preeclampsia/eclampsia (40.5%) and complications of gynaecological procedures (42%). The overall ICU mortality was 43% with obstetric cases accounting for almost two thirds (62.5%) and majorly from preeclampsia/eclampsia at 56% (23).

In a retrospective descriptive study to evaluate obstetric admissions to ICU of a tertiary hospital in India over a three-year period, Rathod et al 2016 found that of the 61,615 deliveries, 765 obstetric patients were admitted to the ICU which is 1.24% of total deliveries. Almost all (90 %) were referral from other hospitals. More than half (56.20 %) were 20–25 years, about one third (38.4%) were in their first pregnancy and 36.4% were between 37-40 weeks gestation. Notably postpartum admissions accounted for four-fifths (80.9%) of the ICU admissions. The most common indications for admission were obstetric haemorrhage (44.05%), hypertensive disorder (28.8%) and severe anaemia (14.4%). Maternal mortality was 15.5% and majorly from haemorrhagic shock (26.9%) and multiple organ dysfunction syndrome (26.1%). Notably just below half (40.4 %) did not require ICU admission but HDU which was not available in this hospital (24).

In a prospective descriptive study conducted to determine the clinical characteristics and outcomes of obstetric patients admitted in ICU and HDU of a tertiary hospital in Jharkhand India between October 2014 to October 2016, Kamal et al found that ICU admissions were 50. About two thirds (60%) were primigravids. Majority (84%) had inadequate or no antenatal care. Obstetric haemorrhage was the most common indication (36%) for admission. Most common

interventions were mechanical ventilation 40%, blood and blood products transfusion 70% and inotropic support (n=20,40%). Maternal mortality rate was 20% (25).

In a one-year retrospective descriptive study to review the indications for admission, demographics, clinical characteristics and outcomes of obstetric patients admitted to ICU of a medical college hospital in Southern India, Ashraf et al 2014 found that 55 patients were admitted translating to 0.38% of deliveries. The mean age was 27 years and 76% were in the antepartum period and 82% had obstetric indications for admission. Most common indication was obstetric haemorrhage at 51% and 855 required mechanical ventilation. Mortality rate was 13% (26).

In a retrospective descriptive study on evaluation of obstetric admissions to ICU at a tertiary hospital in coastal India between 2005 to 2011, Ramachandra et al 2013, found that obstetric admissions to the ICU constituted 0.39% of deliveries and majority were in the postpartum period (70.8%). Most common indication for admission were obstetric haemorrhage 27.7% and pregnancy induced hypertension and its complications at 26.2%. Notably about two thirds (63%) required artificial ventilation and a third (32.3%) were appropriate for HDU care. The mortality was 33.8% (11).

In a prospective observational study on the clinical profile of obstetric patients admitted to the medical-surgical ICU of an inner-city hospital in New York between 2009-2012, Orsini et al found that hypertensive disorder as the most common comorbidity at admission (21%). About half (47%) were admitted due to hemodynamic instability and shock. The median age was 29 years (18-41 years) and the mean gestation was 23.5 weeks (6-39 weeks). The mean duration of stay was 3.5 days. Slightly below half (42%) required mechanical ventilation and about a fifth (21%) were managed with vasopressors. Out of the 19 admissions, there was one mortality (5.2%) (27).

In a 1 year prospective analysis of critically ill obstetric patients admitted to a newly developed dedicated obstetric ICU in a tertiary hospital in India to determine causes of admission, interventions, course and foetal-maternal outcome in 2010, Gupta et al found that out of 16,756 deliveries, there were 24 ICU admissions which translates to an ICU utilization ratio of 0.14% with mean age of 25 years and mean gestational age was 36 weeks. Postpartum admissions were significantly high (83%, n=20) with almost all (92%, n=22) presenting with obstetric complications and 8% with medical complications. Most common indications for admission were obstetric haemorrhage with subsequent haemodynamic instability at 83%. Notably almost

all (92%) of the patients required inotropic support while more than two thirds (71%) required ventilatory support. The observed mortality was about half (42%, n=10) (13).

In a retrospective descriptive study to identify the indications and outcomes of obstetric patients admitted to an integrated ICU in Jordan: a 7year review, Lataifeh et al 2010 found that 43 women were admitted to the ICU during the study period representing 0.37% of all deliveries. Of note is that almost all (95.3%) were in the postpartum period and the commonest indication for admission was pre-eclampsia (39.6%, n=17) and obstetric haemorrhage (37.2%). Others included respiratory distress syndrome at 6.9%, pulmonary embolism 2.3% and neurological disorders 4.6%. mechanical ventilation was required by 18.6% while the most common intervention was red cell transfusion at 48.8%. mortality rate was 6.9% (12).

In another retrospective descriptive study on the course and outcome of obstetric patients admitted to an integrated ICU at the Aga Khan university hospital, Kenya between 2003 and 2010, F. Githae et al 2010 found that obstetric admissions constituted 1.25% of the total admissions. The most common indications were haemorrhage (44%), sepsis (26%), and HELLP syndrome (12%). About a third (33%) were mechanically ventilated, 30% had vasopressor support, 24% were transfused blood and blood products, 8% required dialysis and only 5% had surgical interventions. The mean duration of stay was seven days. Case fatality was 75% from HELLP syndrome, 30% from sepsis and 26.7% from haemorrhage (28).

In a retrospective cohort study on obstetric admissions to ICU at the King Abdulaziz Medical City in Saudi Arabia over 10year period, Aldawood et al 2010 found that 75 obstetric patients were admitted to the ICU and 78.6% were in the antepartum period. Main indication for admission was pregnancy -induced hypertension (28%, n=21) and non-obstetric was sepsis at 16%. The predicted maternal mortality as per the APACHE II score was 21.97% but actual mortality rate was 8% which was commendable (29).

In a retrospective descriptive study to determine the indications for admission of obstetric patients to ICU, the presence of comorbid, outcome and survival rate and factors that contributed to maternal mortality between 2006-2010, Bajwa et al found that 61 cases were admitted to ICU out of 6895 deliveries. About half (45%) were multigravida and the median age was 29 years. More than half (55%) were un-booked cases. Main indications for admissions were haemorrhage (28%, n=46), pregnancy induced hypertension at 18%, cardiac diseases 8%, acute respiratory insufficiency 7%. Mortality rate was 29.50% (8).

A retrospective case control study conducted to review obstetric admissions to ICU at Royal Free Hospital in London and determine the risk factors for admission in 2005, Selo-Ojeme et al found that 33 obstetric patients were admitted to ICU translating to 0.11% of 31,097 deliveries during the study period. The ICU utilization rate by obstetric patients was 0.81%. Most of the patients were in the postpartum period (80%) and the common indications for admission were hypertensive disorders of pregnancy at 39.4% followed by obstetric haemorrhage at 36.4%. No statistically significant difference was found between the cases and controls with regards to age, parity, smoking and employment status. In comparison to controls, women of black race were more likely to be admitted ($p < 0.05$) and delivered via emergency caesarean section ($p < 0.001$). Risk factors for admission included black race OR 2.8, emergency caesarean section OR 14.9 and primary PPH (OR 5.4). Access to antenatal services was not factored in the study (30).

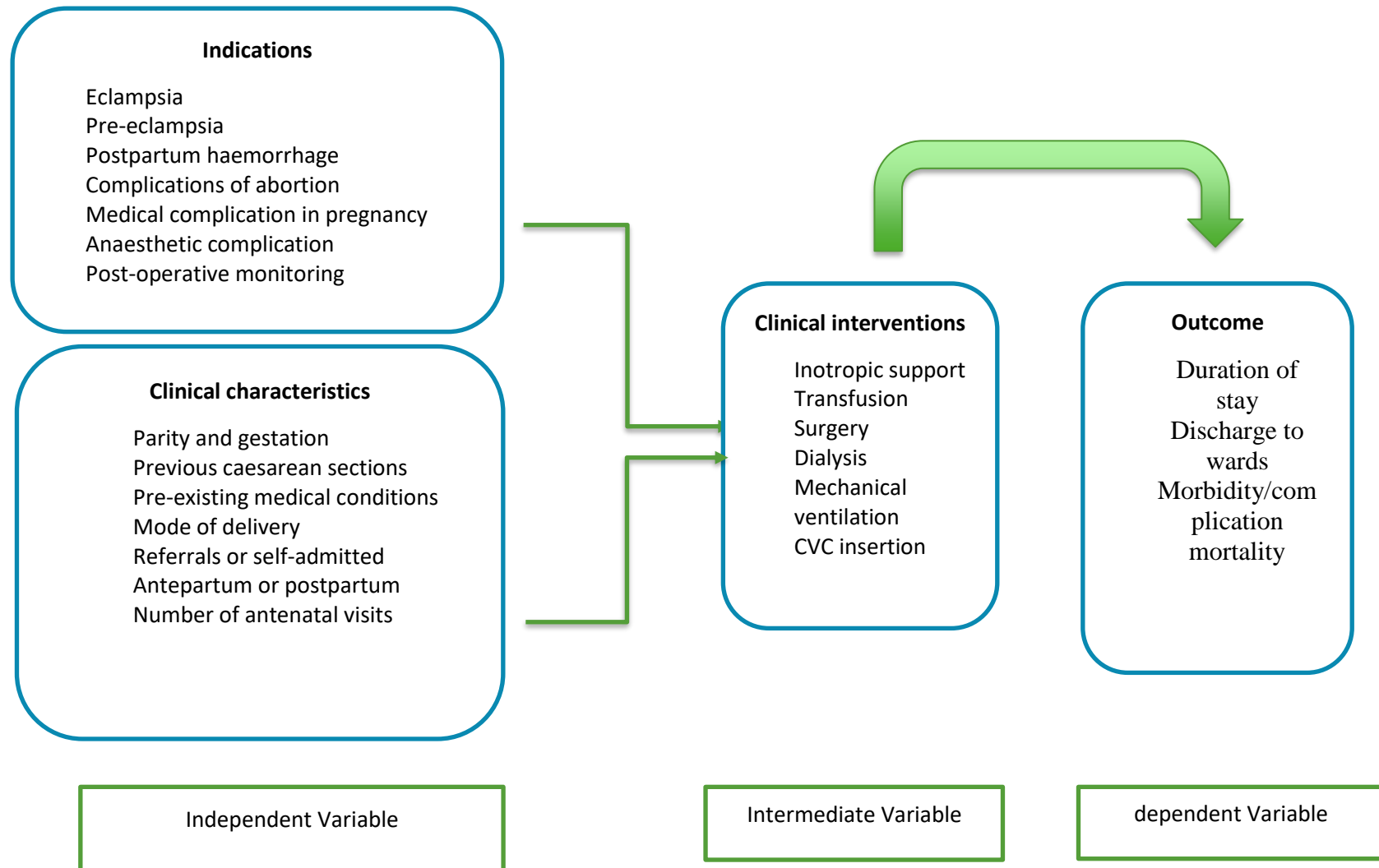
A descriptive retrospective study at a university college hospital in Ibadan Nigeria to determine the utilization of ICU by obstetric patients, the spectrum of diseases, interventions and outcomes of the admissions between 1998-2002, Osinaike et al, found that 70 obstetric patients were admitted to the ICU accounting for 1.4% of all the deliveries during the study period. About a fifth (21.4%) had received antenatal care while two thirds (66%) were primiparous and 61% uneducated. Notably, all patients were admitted postpartum. Most common indication was pregnancy-induced hypertension (60%), respiratory insufficiency 55% and cardiovascular instability 31%. The mortality rate was 52%. Factors associated with poor outcomes include mechanical ventilation ($p = 0.003$) and inotropic support ($p = 0.031$) (31).

In summary, most of the studies in LMICs were conducted in integrated critical care units. Locally, Retrospective study by Githae et al on course and outcomes of obstetric patients admitted to ICU at Aga Khan university hospital (23) was equally conducted in an integrated unit at a private hospital. This study had the advantage of being carried out at KNH, a public regional referral hospital which boasts of having a high number of referrals of critically ill obstetric patients from across the socio-economic strata. To the best of our knowledge at the time of this study, this new obstetric ICU at KNH was the only one in the East African region. Other countries with dedicated obstetric units in Sub-Saharan Africa include South Africa and Nigeria. Therefore, this study provided important preliminary data for future consideration and planning of other dedicated obstetric units for better maternal outcomes.

2.3. Conceptual Framework

The conceptual framework (Figure 1) demonstrates the relationship between the independent and dependent variables in this study.

Figure 1: Diagrammatic representation of the conceptual framework



1. Independent Variables: Indications and Clinical Characteristics

The framework commences with independent variables - indications and clinical characteristics. Indications such as eclampsia, pre-eclampsia, and postpartum hemorrhage direct the course, while clinical characteristics like gestation, previous caesarean sections, and medical conditions provide vital context.

2. Intermediate Variable: Clinical Interventions

Transcending the initial variables is the intermediary variable - clinical interventions. This stage witnesses the careful application of strategies like inotropic support, surgery, and transfusions, molded by the indications and clinical characteristics, collectively shaping the path of care.

3. Dependent Variable: Outcomes

The journey culminates in the dependent variable - outcomes. Duration of stay, discharge destinations, and measures of morbidity, complications, and even mortality stand as markers of success, bearing the imprint of the interventions carried out in response to the indications and clinical characteristics.

2.4.Problem Statement

Obstetric ICU is a recently established infrastructure in the obstetric unit of KNH. It is the first dedicated obstetric ICU in the country thus no research studies had been done to investigate the indications for admission to dedicated obstetric ICU, clinical characteristics, management, and associated outcomes. Baseline information on these issues will guide future planning, resource allocation, monitoring and evaluation which lead to better quality of care of patients thus a reduction in morbidity and mortality.

2.5.Justification

Before the development of a dedicated obstetric ICU unit at KNH, all critically ill obstetric patients were admitted to an integrated ICU which had the challenges of unavoidable delays in reviews by obstetricians, the nursing team had no midwives to handle the obstetric needs of these critically ill patients and inadequate bed-space due to demand by other specialties such as neurosurgery. The integrated unit is also far from the maternity wing thus causing delays in transfer of patients to the unit. A dedicated obstetric ICU was set up in February 2020 to curb these limitations. Other advantages of a dedicated obstetric unit included prompt identification and assessment of patients who are at risk of severe acute maternal morbidity (SAMM). It also allows for systemic maternal evaluation and management of underlying condition by an obstetrician during the daily ward rounds and continuous foetal monitoring. Some dedicated units have amenities to allow rooming-in of healthy new-borns with the mothers. Location of the unit within the maternity wing allows for quick and easy movement of patients from the labour ward or maternity theatre to the ICU.

Following the opening of this five-bed space obstetric ICU at KNH, no study had been done to evaluate its performance. There are very few dedicated units in LMICs and most of the research on critical care of obstetric patients have been conducted in integrated ICUs and thus may not be replicable in such dedicated units. This study sought to establish the indications for admission, clinical characteristics and management of patients admitted to the obstetric ICU which will allow better preparedness, optimal allocation and use of available resources thus improving patient care resulting in overall reduction in morbidity and mortality. The study also aimed at providing baseline data that would guide future planning, monitoring and evaluation of quality of care offered at the newly dedicated obstetric ICU.

2.6. Research Questions

What were the indications, clinical characteristics, management, and outcome of patients admitted to obstetric ICU at KNH between 1st March 2020 to 28th February 2021?

2.7. Research Objectives

2.7.1. Broad Objective

To evaluate the indications, clinical characteristics, management and outcome of patients admitted to a dedicated obstetrics ICU at KNH between 1st March 2020 and 28th February 2021.

2.7.2. Specific Objectives

Among patients admitted to KNH's dedicated obstetric ICU between 1st March 2020 and 28th February 2021:

- i) To determine the indications for admission and clinical characteristics of patients
- ii) To describe the types of clinical interventions and management
- iii) To evaluate the incidence of adverse maternal outcomes

2.7.3. Secondary objective:

- i) To evaluate the factors associated with maternal mortality.

2.8. Significance and Anticipated Output

The findings of this study will help to inform on care and management of patients in the Obstetric ICU setting as elaborated in section 2.5 (Justification).

CHAPTER THREE: MATERIALS AND METHODS

3.1. Study Design

This was a descriptive retrospective cohort study.

3.2. Study site

Kenyatta National Hospital is a teaching and tertiary care hospital located in the city of Nairobi in Kenya. The hospital serves residents of Nairobi and is a referral hospital with a catchment area that includes and is not limited to other parts of the country and the East and central Africa region. It is a teaching hospital for undergraduate and postgraduate medical students under the University of Nairobi and colleges offering medical diploma courses such as in nursing. The hospital has a multidisciplinary ICU of 24 beds with facilities to manage critically ill medical, surgical, and obstetric patients. However, in 2020 February KNH launched a dedicated Obstetric ICU to manage critically ill obstetric patients. The ICU is equipped with 5 beds, ventilators for both invasive and non-invasive ventilation, airway access equipment, suction apparatus, vascular access equipment, defibrillator, chest drainage equipment, specialised beds, infusion pumps among other items. The unit has a high admission rate, 20 per month on average.

Patients in the unit are attended to by critical care trained medical officers and reviewed by residents and consultants from obstetrics and gynaecology departments. Nurse: Patient ratio is often 1:1.

3.3. Study population

Patients admitted to obstetrics ICU at KNH between 1st March 2020 and 28th February 2021.

3.4. Inclusion criteria

All pregnant patients, postpartum (less than 42 days) and post-abortion referred for ICU care or whose follow up was at KNH and got admitted to the obstetric ICU between 1st March 2020 and 28th February 2021.

3.5.Exclusion criteria

- i. Patients whose files do not contain adequate information to allow data collection and analysis (missing data) on key variables such as age, parity, indication for admission, duration of stay in the unit or outcome.
- ii. Patients who are resuscitated and died before formal admission to the ICU.
- iii. Patients brought in dead into the ICU.
- iv. Patients without confirmed pregnancy or beyond the defined postpartum period of 42 days.
- v. Non-obstetric patients admitted due to inadequate bedspace at the integrated ICU at the hospital.

3.6.Study variables

The dependent variables in this study included duration of stay, discharge to the wards, morbidity and mortality in the ICU within the study period.

The independent variables included Indications for admission to the ICU, clinical characteristics of the patients, interventions and management procedures administered as outlined in Table 1.

Table 1: Study variables

Objective	Outcome Variables	Source of data
Describe the clinical characteristics and indication for admission of patients	Age, parity, gestation, employment, level of education, residential area. Eclampsia, Pre-eclampsia, Postpartum haemorrhage, Complications of abortion, medical complication in pregnancy, Anaesthetic complication Post-operative monitoring	Admission register, patients' files
The clinical management	Inotropic support, Transfusion, Surgery, Dialysis, Mechanical ventilation, magnesium sulphate infusion	Patient files
To evaluated maternal outcomes	Duration of hospital stay, Discharge to the wards, transfer out, mortality	Patient files

Secondary objective	variables	outcome	Source of data
To evaluate the factors associated with maternal mortality	Eclampsia, Pre-eclampsia, Postpartum haemorrhage, Complications of abortion, medical complication in pregnancy, Anaesthetic complication	mortality	Patients' file

3.7. Sampling Techniques and Sample Size

3.7.1. Sample Size Determination

The study incorporated a complete enumeration method where the whole population that meets the inclusion criteria will be included in the study. All patients admitted in the ICU during the study period whose records are available were recruited into the study. Complete enumeration method was used and provided the researcher with a true measure of the population and no sampling error will be introduced. However, the researcher will also use Taro Yamane's sample size formulae to calculate the minimum number required for the thresh-hold of this study (32).

$$n = \frac{N}{1+N(e)^2}$$

Where:

n is the sample size.

N is the population size (Obstetric admissions to ICU in 1st March 2020 and 28th February 2021 was 250)

e is the acceptable margin of error (5%)

substituting in the formulae

$$n = \frac{250}{1+250(0.05)^2}$$

$$n = \frac{250}{1.625}$$

$$n = 153$$

Thus, the minimum sample size that was sought was 153 patients admitted to obstetrics ICU at KNH between 1st March 2020 and 28th February 2021.

3.7.2. Sampling Techniques

Consecutive sampling techniques was utilized to sample patients into the study. All patients who were admitted to the Obstetric ICU during the study period and meet the inclusion criteria were recruited consecutively for the entire study duration period.

3.8.Data collection tool

A structured data abstraction tool (Appendix 1) detailing all the variables of interest was used to collate data from patients' files and records. The structure of the abstraction tool included patients' demographics, indications for ICU admission, clinical characteristics, interventions administered and outcomes of interest.

3.9.Data Collection Procedure

The data collection process began after approval by KNH-UoN Ethics Committee and permission from Kenyatta National Hospital to access patient files between 1st March 2020 and 28th February 2021. The PI then proceeded to the KNH health information department to retrieve the files based on the IP number. The PI then reviewed the files and selected consecutively all files that met the inclusion criteria within the study period. Extraction of vital information using the developed data abstraction tool was done. The PI returned the patients' files for re-filing.

3.10. Quality assurance and control

The research assistants were postgraduate students who underwent certified ethical training and training on the study protocol and how to collate data from the files.

Collected data was counterchecked by the principal investigator for accuracies and consistencies to ensure they met the standards required of this research.

3.11. Data Management

All data collected was kept confidential, password protected and only accessible to principal investigator and data manager.

3.12. Data Analysis

SPSS version 26 was used for data analysis. Descriptive statistics such as means, median, modes and proportions shall be used to describe characteristics of the study participants and clinical outcomes. Incidence rates of mortality shall be calculated as a proportion of deaths from all patients admitted to the ICU over the 1year study period. Pearson's Chi square shall be used for categorical variables to assess the risk factors for mortality while Student's t test for continuous variables. P values of 0.05 shall be considered statistically significant. Logistic regression analysis shall be used to model risk factors for mortality. Results of the regression analysis shall be presented in adjusted Odds ratios and 95% Confidence Intervals

3.13. Ethical considerations

This research underwent ethical review and approval at the KNH-UON ERC.

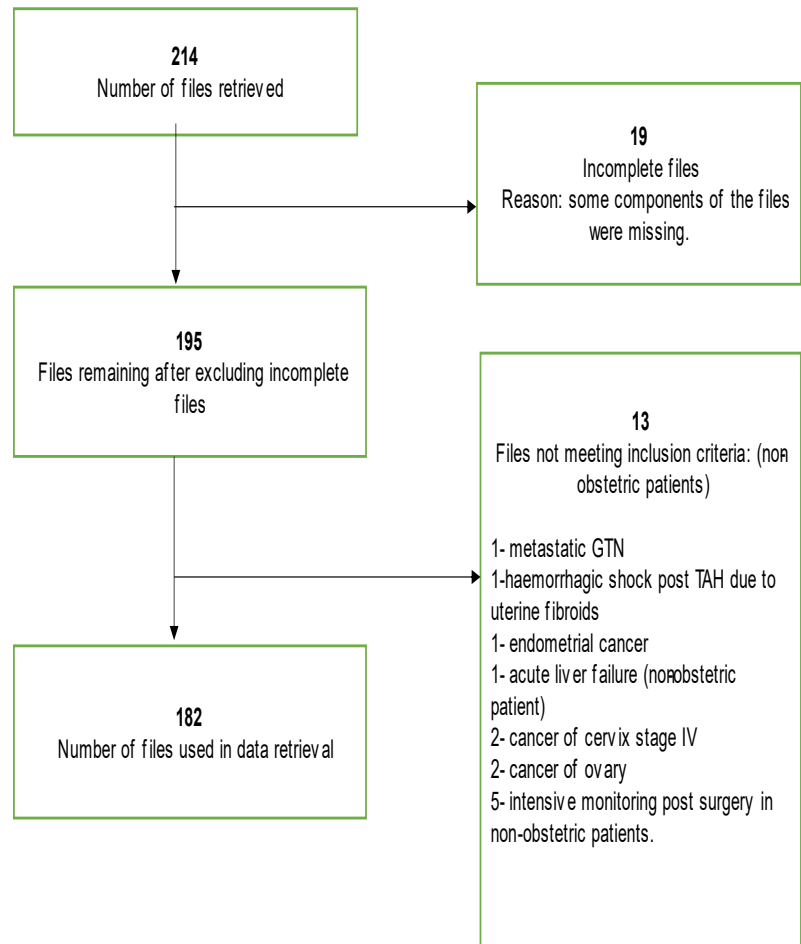
Principles of confidentiality and privacy of information were maintained throughout the research process. Patients' data was kept confidential at all data abstraction, processing, and analysis stages. Data will be anonymized and key patient identifiers like names, residence and age among others will be de-identified.

Anonymity and Confidentiality: The researcher also maintained anonymity and confidentiality by using non-identifiers such as codes that could not link a participant with the information provided during the study. Recorded data is under custody of the principal investigator until validation within one year after which the data will be destroyed.

To observe and sustain moral values concerned with the degree to which research procedures adhere to professional, legal and sociological obligations to the study, the researcher followed the ethical guideline provided by the University and Kenya National Hospital /University of Nairobi Ethics and Review Committee.

STUDY FLOW CHART:

Fig 2: Studyflow chart



CHAPTER FOUR: RESULTS

During the study period, a total of 214 patients were admitted to the unit. Nineteen files were excluded because certain components of the files were missing. Further thirteen files were excluded as the patients were non-obstetrics and had been admitted to the unit due to lack of space in the integrated ICU in the hospital. A total of 182 files met the inclusion criteria and were analysed in this study.

Socio-demographic and clinical characteristics.

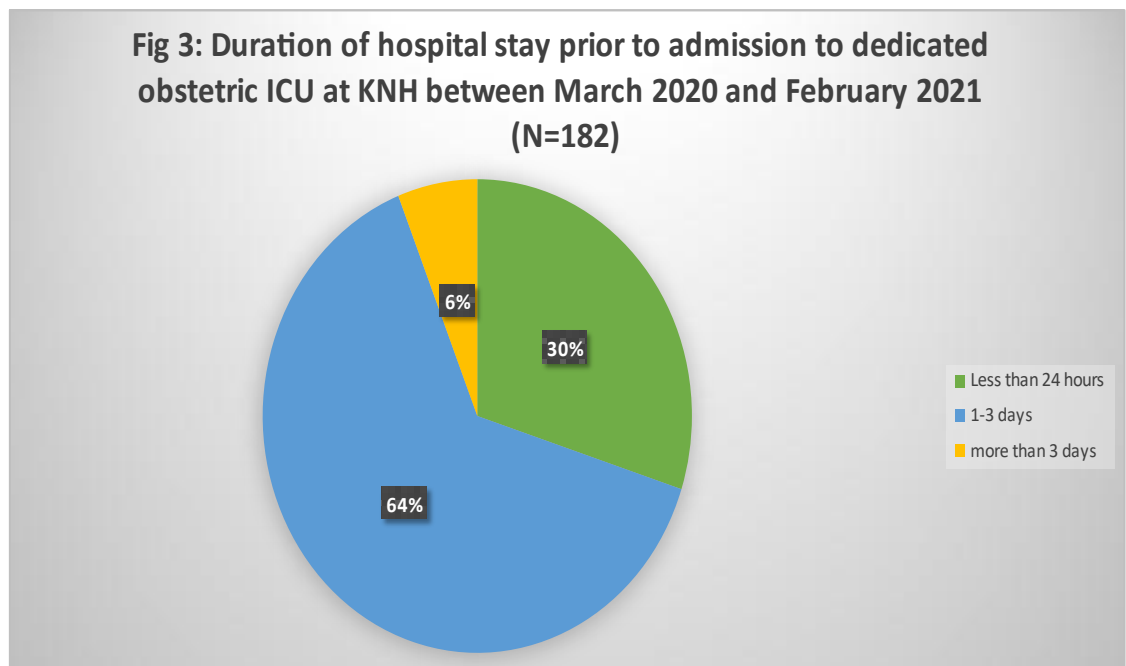
The mean age among the admissions was 28 years with 77% being between 20-35 years of age. More than half, 59% (n=107) were unemployed and 62% (n=112) were urban dwellers. Only 8% (n=15) did not have any formal education and 79% (n=144) were married. Referrals from other hospitals accounted for 77% (n=141) of the admissions and 74% (n=134) were multiparous. Caesarean section births accounted for 66% (n=120) and 99 patients (54%) were antepartum (Table 2). Pre-existing medical conditions were in 25% (n=45) of the admissions of which hypertension and HIV were the commonest at 6% (n=11) each (Table 3). Almost two-thirds, (64%, n=116) had stayed in the hospital for 1-3 days prior to admission to the ICU (Fig 3).

Table 2: Socio-demographic and clinical characteristics of patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021 (N=182)

		Frequency(N=182)	Percentage (%)
Age (Mean ± SD)		28 ± 6.59	
Age groups	<20	13	7%
	20-35	140	77%
	>35	29	16%
Employment status	Formal	2	1%
	Self-employed	73	40%
	Unemployed	107	59%
Residential area	Urban	112	62%
	Rural	70	38%
Level of education	None	15	8%
	Primary	68	38%
	Secondary	79	43%
	Tertiary	20	11%
Marital status	Single	37	20%
	Married	144	79%
	Divorced	1	1%
Place of ANC services	ANC at KNH (study institution)	8	4%
	ANC at other facilities or no documented ANC contact	174	96%
Mode of delivery	Vaginal birth	51	28%
	Caesarean section	120	66%
	Miscarriage	9	5%
	Not delivered	2	1%
Primiparous		48	26%
Multiparous		134	74%
History of previous caesarean section		82	45%
Hospital-referrals		141	77%
Non-referral or admission from KNH Wards		41	23%
Antepartum		99	54%
Postpartum		83	46%
Pre-existing medical condition		45	25%

Table 3: Pre-existing medical conditions among patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021

	Frequency (N=182)	Percentage
HIV/AIDS	11	6%
Hypertension	11	6%
Diabetes	9	5%
Cardiac disease	8	4%
CVA	1	1%
DVT	2	1%
Epilepsy	2	1%
Thyroid disease	1	1%
Osteogenesis imperfecta	1	1%
Sickle cell disease	1	1%



Indications for admission.

The most common indication for admission was hypertensive disorders of pregnancy (eclampsia, pre-eclampsia, HELLP) at 54% (n=98). Other indications included admission for

critical or intensive monitoring of patients after surgery (45%, n=81), shock (42%, n=77) with haemorrhagic shock being the most common at 26% followed by septic shock 13%. Postpartum haemorrhage accounted for 28%(n=51). Rare indications for admission included acute respiratory distress due to COVID-19 pneumonia, status epilepticus, hepatic encephalopathy and metabolic derangements following hyperemesis gravidarum, all at 1%. (Table 4).

Table 4: Indication for admissions among patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021 (N=182)

	Frequency(N=182)	Percentage (%)
Shock	77	42%
Type of shock:		
Haemorrhagic	48	26%
Septic	24	13%
Cardiogenic	3	2%
Neurogenic	2	1%
Critical /intensive monitoring after surgery	81	45%
Eclampsia	61	34%
Post-partum haemorrhage	51	28%
Post cardiac resuscitation	38	21%
Severe anaemia due to PPH	37	20%
Preeclampsia with severe features/ HELLP	37	20%
Acute respiratory failure	37	20%
Pulmonary embolism	18	10%
Anaesthetic complication: poor reversal	19	10%
Intracranial haemorrhage	12	7%
Meningo-encephalitis	9	5%
Septic abortion	7	4%
DKA	8	4%
Assault	3	2%
Intoxication	4	2%
DIC	4	2%
Acute decompensated heart failure in pregnancy	3	2%
COVID 19 acute respiratory distress syndrome	2	1%
Status epilepticus	2	1%
Metabolic derangement due to hyperemesis gravidarum	1	1%
Hepatic encephalopathy	1	1%

Eclampsia, pre-eclampsia with severe features/HELLP(54%), PPH (28%)

Clinical interventions.

Central venous catheterization (67%, n=122), mechanical ventilation (59%, n=107) and inotropic support (58%, n=106) were the most common interventions. Other interventions included administration of anticonvulsants (47%, n=85), blood transfusion (40%, n=72) and haemodialysis (27%, n=50). Emergency caesarean section (26%, n=48) and hysterectomy (4%, n=7) were the common surgeries performed on the patients during the stay in ICU. (Table 5)

Table 5: Clinical interventions and management of patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021 (N=182)

	Frequency(N=182)	Percentage (%)
Central venous catheter insertion	122	67%
Mechanical ventilation	107	59%
Inotropic support	106	58%
Anticonvulsants	85	47%
Blood transfusion	72	40%
Surgery	68	37%
Type of Surgery		
Emergency C/S	48	26%
Hysterectomy	7	4%
Exploratory laparotomy	6	3%
Others	7	4%
Dialysis	50	27%

Others: D & C, EVD shunts insertion, MVA and Examination under anaesthesia for cervical tear.

Outcome of the patients admitted.

Majority of the patients (58%, n=105) were admitted for 1-3 days. About one-fifth (23%, n=42) stayed for 4-7 days in the unit and 7 % (n=13) were admitted for less than 24hours. Few (n=5) patients had a prolonged stay in ICU for 78days,67days, 41days, 27 days and 21 days. (Fig. 4)

Most of the admissions were discharged to the ward (70%, n=127) and 1 patient was re-admitted to ICU due to pulmonary embolism. The mortality rate was 29% of the total

admissions. (Fig 5) Hypertensive diseases of pregnancy were the most common diagnosis among the mortalities at 54% (29/54) followed by Acute kidney injury (20%, 11/54). Fig 6

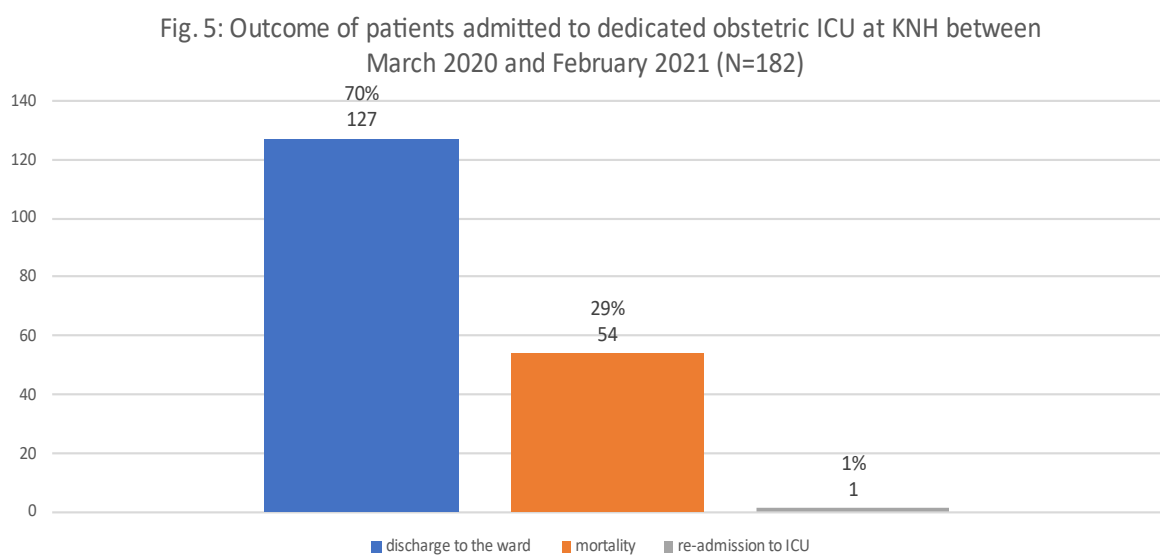
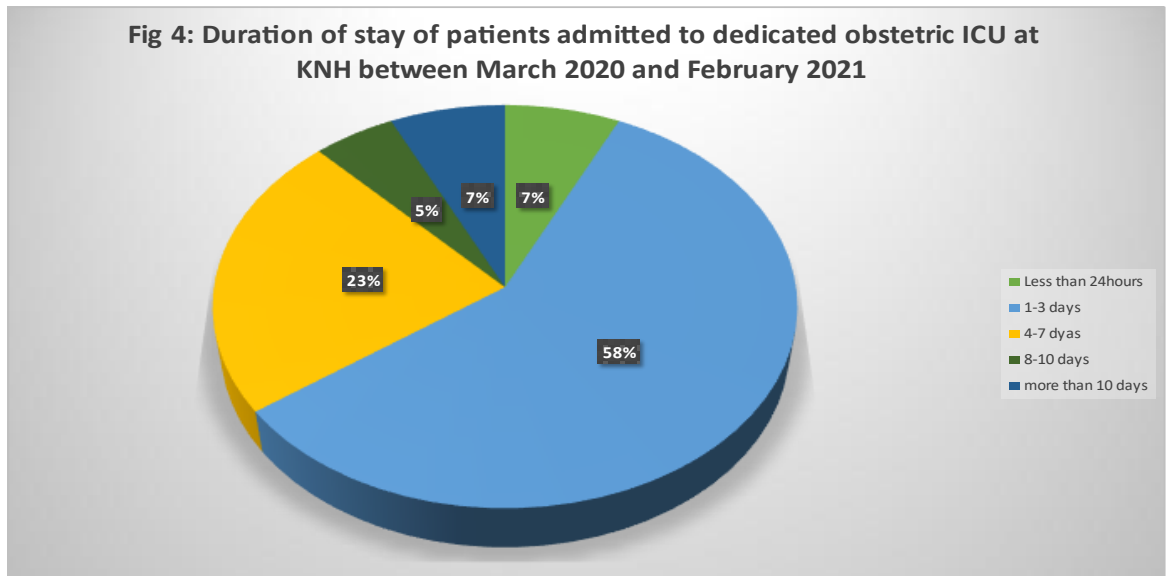
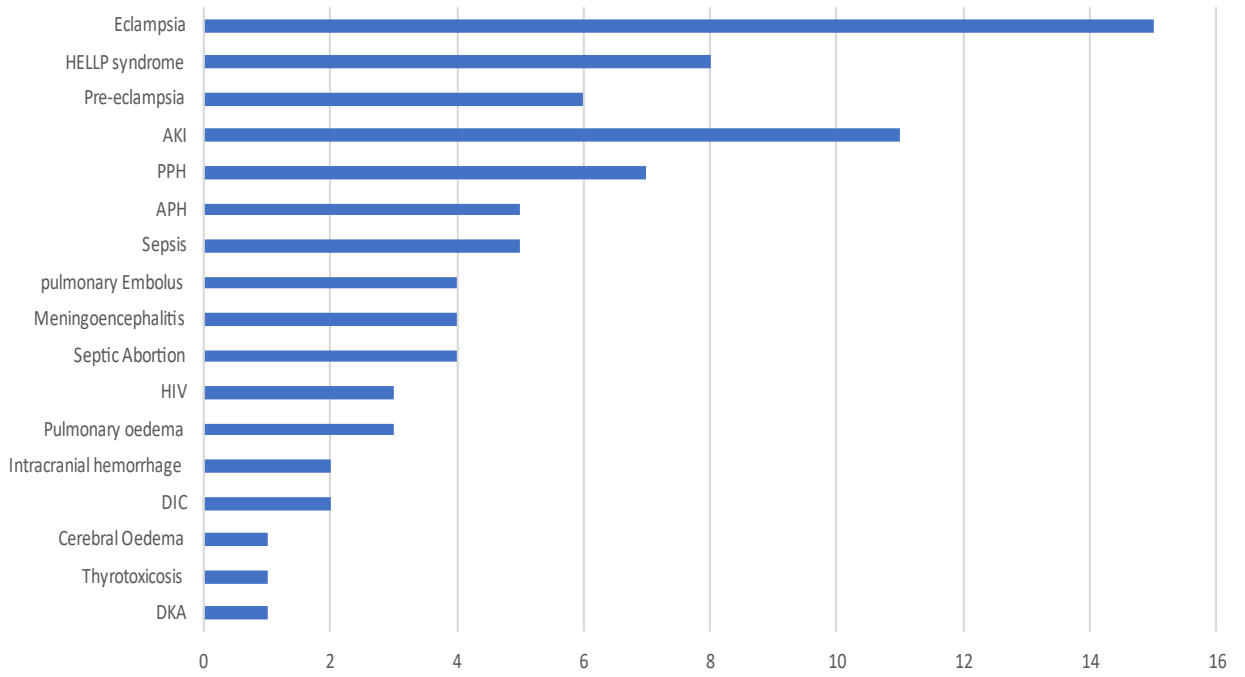


Fig 6: Diagnoses among the mortality cases of patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021



Factors associated with mortality.

A bivariate analysis (Table 6) of all factors was done and further multivariate analysis was done on the factors that were found to be statistically significant. Caesarean section AOR 4.47(1.14,17.57), mechanical ventilation AOR 4.00(1.08,14.81) and central venous catheterization AOR 8.18(1.52,44.15) were significantly associated with mortality. (Table 7)

Table 6 : Bivariate analysis of factors associated with mortality among patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021

		Mortality		OR(CI)	P-value
		Yes	No		
		N= 54	N= 128		
Hospital -referrals	Yes	50(93%)	91(71%)	5.08(1.71,15.08)	0.003
	No	4(7%)	37(29%)	Ref	
Mode of delivery	Vaginal birth	14(26%)	37(29%)	Ref	0.025
	Caesarean section	33(61%)	87(68%)	0.11(0.02,0.58)	0.01
	Miscarriage	7(13%)	2(2%)	0.11(0.02,0.55)	0.007
	Not delivered	0(0%)	2(2%)	-	-
Surgery	Yes	13(24%)	55(43%)	0.42(0.21,0.86)	0.018
	No	41(76%)	73(57%)	Ref	
Mechanical ventilation	Yes	49(91%)	58(45%)	11.83(4.42,31.63)	<0.001
	No	5(9%)	70(55%)	Ref	
Inotropic support	Yes	41(76%)	65(51%)	3.06(1.50,6.24)	0.002
	No	13(24%)	63(49%)	Ref	
Central venous catheter insertion	Yes	49(91%)	73(57%)	7.38(2.76,19.76)	<0.001
	No	5(9%)	55(43%)	Ref	
Post cardiac resuscitation	Yes	17(32%)	21(16%)	2.34(1.12,4.91)	0.024
	No	37(68%)	107(84%)		
Meningitis	Yes	7(13%)	2(2%)	9.38(1.88,46.79)	0.006
	No	47(87%)	126(98%)		
Critical/intensive monitoring after surgery	Yes	12(22%)	69(54%)	0.24(0.12,0.51)	<0.001
	No	42(78%)	59(46%)	Ref	
duration of stay in ICU	<24 hrs	12(22%)	1(1%)	Ref	0.001
	1-3 days	23(43%)	82(64%)	0.02(0.00,0.19)	<0.001
	4-7 days	10(19%)	32(25%)	0.03(0.00,0.23)	0.001
	8-10 days	6(11%)	3(2%)	0.17(0.01,1.96)	0.154
	> 10 days	3(6%)	10(8%)	0.03(0.00,0.28)	0.003

Table 7: Multivariate regression analysis of factors associated with mortality among patients admitted to dedicated obstetric ICU at KNH between March 2020 and February 2021

		Multivariable Regression	
		AOR(CI)	P-value
Hospital -referrals	Yes	4.39(1.00,19.17)	0.05
	No	Ref	
Mode of delivery	Vaginal birth	Ref	(0.016)
	Caesarean section	4.47(1.14,17.57)	0.032
	Miscarriage	17.92(1.73,185.46)	0.016
Surgery	Yes	0.71(0.25,2.05)	0.524
	No	Ref	
Mechanical ventilation	Yes	4.00(1.08,14.81)	0.038
	No	Ref	
Inotropic support	Yes	1.60(0.56,4.57)	0.379
	No	Ref	
Central venous catheter insertion	Yes	8.18(1.52,44.15)	0.015
	No	Ref	
Post cardiac resuscitation	Yes	1.01(0.31,3.37)	0.983
	No	Ref	
Meningitis	Yes	5.38(0.60,47.88)	0.132
	No	Ref	
Critical/intensive monitoring after surgery	Yes	0.19(0.05,0.67)	0.01
	No	Ref	
duration of stay in ICU	<24 hrs	Ref	(0.009)
	1-3 days	0.02(0.00,0.22)	0.002
	4-7 days	0.01(0.00,0.17)	0.001
	8-10 days	0.13(0.01,2.91)	0.196
	>10 days	0.02(0.00,0.33)	0.007

Multivariate regression analysis of factors that were statistically significant following the bivariate analysis .

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECCOMENDATIONS

Complications of pregnancy are associated with increased morbidity and mortality. In LMICs, the incidence of intensive care admission of an obstetric patient is 2-13.5/1000 deliveries as compared to 2-4/1000 deliveries in high income countries. Similar studies have been conducted with or without admission criteria such as SOFA or APACHE II and this particular dedicated obstetric ICU did not use strict ICU admission criteria but rather admits all critically ill obstetric patients. The hospital also has no dedicated HDU hence some patients were admitted to the ICU that may have benefited from HDU services and this was similar to findings by Panda et al 2017(1), Rathod et al 2016(2) and Ramachandra et al 2013(3).

The mean age of patients admitted to the obstetric ICU was 28 years. This is similar to study by Rasooli et al 2015 Iran(4), Ashraf et al 2014 India (5), Bajwa et al 2012(6) and Prin et al 2018(7). Of the admissions, more than half were unemployed and this can be attributed to the preference of the facility by people of low socioeconomic background due to its subsidized charges by the government hence more affordable. Majority had attained primary education and above and this finding was different from studies conducted by Gupta et al India 2011(8) which found that the uneducated accounted for 54% and 61% in a study by Osinaike et al Nigeria 2006(9). This can be attributed to improved accessibility to primary and secondary education having been greatly subsidized by the government in the past years. More than half were urban dwellers and this was similar to Jain et al India 2021(10). Both studies were conducted in hospitals located in urban areas hence better accessibility for the residents around as compared to those in rural areas. Almost all had not been attending clinic at the facility and was similar to findings by Green et al Nigeria 2018(11). This could be due to attempts by the ministry of health to decentralize antenatal services hence most women have access to antenatal care without travelling to a referral hospital like KNH and also considering other factors that influence health seeking behaviour such as socio-cultural beliefs and cost of services.

More than two-thirds of the patients were referral from other facilities and this was not any different from a similar study by Mungai et al 2014(12) with regards to referral state of the obstetric admissions. This hospital serves as a central and national referring institution to all hospitals in the country.

This study also demonstrated that majority of the obstetric admissions were multiparous, 74%, and this was in tandem with a study by Lataifeh et al 2010(13) in Jordan. More than half were in the antepartum period while 46% were postpartum and this was similar to Aldawood et al 2010(14) but different from previous studies by Rathod et al India (2) and Mungai et al 2014(12). This could be due to low-threshold for admission for stabilization in our dedicated ICU prior to other interventions such as caesarean section.

The mean duration of hospital stay at the facility prior to admission to the ICU was 1+/- 1.56 days. This is because majority of the patients were referrals from other hospital with significant morbidity and almost all stayed for less than 3days prior to ICU admission. Patients who had stayed for less than 24hrs were analyzed as 1 day hence the SD of 1.56. This considerably short duration of stay prior to admission is one of the advantages of a dedicated obstetric ICU as the critically ill obstetric patients do not have to solely rely on availability of ICU space in the integrated ICU in the hospital to access critical care services.

Hypertensive disorders of pregnancy (preeclampsia/HELLP/eclampsia) were the most common indication to admission to the ICU at 54%. This was similar to findings by Lataifeh et al(13),Srivastava et al(15) Green et al(11),Farzi et al(16), Adelaiye et al(17), Selo-Ojeme et al(18) and Kimani et al(19) but different from a local study by Githae et al 2011(20), Dasgupta et al(21), Kamal et al(22) and Ashraf et al 2014 India(5) who all found PPH to be the most common indication for admission. Our findings could be different due to extensive research, interventions and training on the management of PPH over the years worldwide and also the increase in non-communicable diseases such as hypertension globally. The other most common indications for admission were for post-operative monitoring after surgery, shock and PPH. Of note is that most patients had more than one indication for admission and all were captured separately and expressed as a percentage of the total admissions to accurately capture the indications.

The most common intervention among the admissions was central venous catheterization, mechanical ventilation and inotropic support. Several other studies have shown mechanical ventilation to be the most common type of intervention among obstetric patients admitted to ICU (15)(7)(12)(23). Panda et al 2017 India(1) found that more than half, 64%, required blood transfusion and 45% had central venous catheter inserted. The high percentage in CVC in our study is attributed to the anticipated multiple intravenous infusions on critically ill patients hence most were inserted at admission.

The average duration of stay in the ICU was 5 days. This was similar to findings by Githae et al 2010 (20) found mean duration of stay at 7days and Orsini et al 2012 New York,3.5 days(23).

The average mortality rate for obstetric admissions to ICU range between the mortality rate among the admissions varies from 0% to 4.9% in high income countries, and 2% to 43.6% in LMIC (7)(24)(25). This study found a mortality rate of 29% and similar to other studies in LMIC such as by Green et al Nigeria 2018(11) and Panda et al 2017 India (1). Higher mortality rates were reported by Prin et al Malawi 2018(7). Possible reasons for this high mortality rate in our study could be lack of proper antenatal care especially to high-risk pregnancies, late referrals, long travel distance to the tertiary facility, limited obstetricians and critical care specialists at the referring facilities and inadequate emergency obstetric care at the referring facilities close to the patients. Of note is a similar study by Mungai et al 2014 Kenya(12) at the same facility in an integrated ICU found a higher mortality rate of 38%. We cannot conclusively attribute the decline in mortality to any factor and other studies can be done to compare the periods before and after establishment of the dedicated unit. However, a reduction in mortality rate has been shown to be one of the advantages of a dedicated ICU(26).

The factors that were associated with maternal mortality were delivery by caesarean section, mechanical ventilation and central venous catheterization. This was contrary to studies by Saintrain et al Brazil 2016(27) who found acute kidney injury, hypotension and respiratory failure as the associated factors while Rudakemwa et al Rwanda 2021(28)found the MEOW and q-SOFA score as the associated factors. The probable reasons for findings in present study would be that theoretically patients requiring mechanical ventilation have high severity score and hence poor prognosis and that caesarean section is also a major surgery that is associated with higher morbidity and mortality.

The strengths of this study include in-depth data retrieval, large sample size, wide catchment area of the national referral hospital and the multivariate analysis of the factors associated with mortality.

The main limitations of this study are its retrospective nature hence data on disease severity score as predictor of mortality at admission was unavailable thus not adjusted for in analysis of factors associated with mortality.

In conclusion, almost all mortalities were referrals from other institutions hence we recommend auditing of the referring institutions to identify gaps and improve capacity training in handling obstetric emergencies even as they consider referring for further management. Also, most of the patients who were admitted to this unit would have benefited from intermediate level of care such as HDU hence availing more ICU space for other critically ill obstetric patients. We thus recommend establishment of a functional HDU for this purpose. Further research on comparing ICU outcomes and the disease severity score at admission would shed more light into factors associated with mortality.

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APPENDICES

Appendix I: Structured data collection tool

1. Socio-demographic and clinical characteristics
 - a) Age _____ years
 - b) Employment status: formal/self-employed/unemployed
 - c) Residential area: urban/rural
 - d) Level of education: primary/secondary/tertiary
 - e) ANC visits: <8, 8 or more
 - f) Delivery: booked/un-booked
2. Indications for ICU admission
 - a. Shock Yes / No
 - b. Type of shock
 - i. Haemorrhagic ii. Septic iii. Cardiogenic iv. Neurogenic
 - c. Post-partum haemorrhage Yes / No
 - d. Eclampsia Yes / No
 - e. Preeclampsia Yes / No
 - f. Cardiac arrest Yes / No
 - g. Respiratory failure Yes / No
 - h. Medical complication in pregnancy: Yes / No
 - i. Malaria Yes / No
 - j. thyroid disease Yes / No
 - k. meningitis Yes / No
 - l. pulmonary embolism Yes / No
 - m. severe anaemia Yes / No
 - n. Complications of abortion Yes / No
 - o. Assault Yes / No
 - p. Intoxication Yes / No
 - q. Anaesthetic complication Yes / No
 - r. Post- operative monitoring Yes / No
 - s. Peritonitis Yes / No
 - t. Others (specify) _____, _____

3. CLINICAL CHARACTERISTICS

- a. Primigravida Yes / No
- b. Multiparous Yes / No
- c. History of caesarean section Yes / No
- d. hospital -referrals Yes / No
- e. Self or non-referral Yes / No
- f. Antepartum Yes / No
- g. Postpartum Yes / No
- h. Pre-existing medical condition Yes / No
- i. Post-operative Yes / No
- j. Mode of delivery vaginal birth / caesarean section
- k. Number of days in hospital prior to ICU admission

4. INTERVENTIONS Number of patients (% of total cohort)

- a. Surgery Yes / No
- b. Type of surgery _____
- c. Magnesium sulphate infusion Yes / No
- d. Mechanical ventilation Yes / No
- e. Blood transfusion Yes / No
- f. Inotropic support Yes / No
- g. dialysis Yes / No
- h. antibiotics Yes / No
- i. anticonvulsants
- j. central venous catheter insertion

5. OUTCOMES

- a. Date of ICU admission dd/mm/year
- b. Date of ICU discharge dd/mm/year
- c. Duration of stay in ICU _____ days
- d. Outcome of ICU admission
 - i. Discharged to the wards
 - ii. Transfer-out
 - iii. Mortality
 - iv. Re-admission