COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF ANAESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE

PREDICTORS OF MORTALITY AMONG PATIENTS ADMITTED TO SURGICAL AND MEDICAL INTENSIVE CARE UNITS AT TIKUR ANEBESSA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA

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A THESIS TO BE SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF MEDICINE, DEPARTMENT OF ANESTHESIOLOGY , CRITICAL CARE AND PAIN MEDICINE FOR PARTIAL FULFILMENT OF THE REQUIREMENT OF ASPECIALITY CERTIFICATE IN ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE.

April, 2025

ADDIS ABABA, ETHIOPIA

ADDIS ABABA UNIVERSITY

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Predictors of Mortality Among Patients Admitted to Surgical and Medical Intensive Care Units at TikurAnebessa Specialized Hospital, Addis Ababa, Ethiopia 2024 Retrospective study

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A thesis to be Submitted to Addis Ababa University, College of Health Sciences, School of Medicine, Department of Anesthesiology,Critical Care and Pain Medicine in Partial Fulfilment of the Requirement for certificate in Anesthesiology , Critical Care and Pain Medicine.

April, 2025

Addis Ababa, Ethiopia

Acknowledgement

First of all, I would like to express my gratitude to the Tikur Anbesa Specialized Hospital, Department of Anaesthesiology, Critical Care and pain medicine for offering me the chance to conduct this research. My sincere thanks go my Advisors Dr. Nura kedir and Dr.Yonatna Abebe for their help, guidance, recommendations, and assistance in the preparation of this thesis. I want to express my gratitude to my friends for their unwavering support

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Abbreviations and Acronyms

ACCPM……Anesthesiology,criticalcare,and pain medicine
AOR ……Adjusted odd ratio
AUROC……Area Under the Receiver Operating Characteristic Curve
COR ……Croud odd ratio
ICU……Intensive care unit
MPM……Mortality Predictor Model
MV……Mechanical Ventilator
ROC……..Receiver Operating Characteristic Curve
RR……Relative Risk
TASH……...Tikur Anbessa Specialized Hospital
SPSS……Statistical Package for Social Sciences

Abstract

Background: Intensive care units (ICUs) play a vital role in managing critically ill patients, yet mortality rates within these settings remain a pressing concern worldwide. Various factors,including demographic characteristics, underlying health conditions, and interventions received, influence patient outcomes in ICUs. In Ethiopia, particularly in high-demand facilities like Tikur Anbessa Specialized Hospital, data on ICU mortality and its predictors are scarce. Understanding the predictors of mortality in surgical and medical ICUs is essential for enhancing patient care and resource allocation.

Objective: To determine the incidence predictors of mortality among patients admitted to the surgical and medical intensive care units at Tikur Anbessa Specialized Hospital.

Methods:A retrospective study was conducted at Tikur Anbessa Specialized Hospital, among adult patients admitted to the surgical and medical ICUs from January to march 2025. A total of 244 patients admitted to ICU were enrolled using stratified sampling. Data were collected retrospectively from patient medical chart using a structured data collection tool. The tool captured demographic variables,comorbid conditions, interventions received, and mortality probability model III (MPMIII) scores. Statistical analysis was performed using SPSS version 26, both descriptive statistics and multivariable logestic regression analysis was performed. Receiver Operating Characteristic curve (ROC) were used to evaluate the performance of MPMIII score.

Result: A total of 244 ICU patients were included, with over all observed mortality was 24.6%.The expected mortality based on MPMIII was 18.2% and the standard mortality rate was 1.35.The standardized mortality ratio (SMR) was 1.35,indicating higher than expected mortality. Multivariate logistic regression identified age>60yr(AOR=6.1, 95%CI=1.98, 37.57), admitted to the medical ICU (AOR=3.1, 95%CI=1.33, 3.98), having comorbidity (AOR=3.7, 95%CI=1.90, 15.64) and the need for MV 3-7days (AOR=5.7, 95%CI=1.41, 23.43) and >7days (AOR=4.2, 95%CI=1.85, 30.95) as independent predictors of ICU mortality curve for MPMIII model showed excellent performance (AUC=0.966)

Conclusion: Age, comorbidity, mechanical ventilation and admission to medical ICU were significant predictors of ICU mortality.

Keywords: -ICU mortality, predictors of mortality, intensiv care units, Tikur Anbessa specialized Hospital, surgical ICU, medical ICU, Ethiopia, critical care, patient outcomes.

1. Introduction

1.1 Background

Intensive Care Units (ICUs) play a critical role in the management of patients with lifethreatening conditions, providing advanced medical care and continuous monitoring that are essential for improving survival rates[1, 2]. Mortality in ICUs remains a significant concern worldwide, with rates varying significantly based on factors such as patient demographics, clinical conditions, and institutional practices[3-9]. A retrospective understanding of the incidence of mortality and its predictors is critical for improving patient outcomes and optimizing resource allocation, particularly in resource-limited settings like Ethiopia.

In Ethiopia, the healthcare system faces unique challenges, including limited resources, a high burden of infectious diseases, and a growing prevalence of non-communicable diseases[10-14]. Tikur Anbessa Specialized Hospital,one of Ethiopia's largest referral institutions, plays a crucial role in providing critical care to a diverse patient population; however, there is a notable paucity of contemporary data on mortality rates and predictors among critically ill patients in its Intensive Care Units (ICUs). The only available data, derived from a retrospective study conducted a decade ago focused on the surgical ICU, indicated a mortality rate of 31.5%[32]. To enhance understanding of these factors and improve ICU outcomes, it is imperative to conduct retrospactive research thereby informing health policies and practices in Ethiopia.

Globally, numerous studies have identified key predictors of ICU mortality, such as age, gender, comorbidities, severity of illness, and the nature of medical interventions received. Tools like the Sequential Organ Failure Assessment (SOFA) score, admission diagnosis, and complications during ICU stay have been shown to significantly influence outcomes [4, 15, 16]. However, these studies primarily focus on high-income countries, and there is a notable lack of localized research in Ethiopia.

This study aims to fill the gap by determining the incidence and predictors of mortality among patients admitted to the surgical and medical ICUs at Tikur Anbessa Specialized Hospital.

1.2 Statement of the Problem

Mortality rates in Intensive Care Units (ICUs) are a critical measure of healthcare quality, reflecting both the severity of patient conditions and the effectiveness of real-time clinical interventions and management strategies. Although ICUs are designed to provide intensive medical care for critically ill patients, high mortality rates continue to pose significant challenges worldwide. In Ethiopia, particularly at Tikur Anbessa Specialized Hospital in Addis Ababa, the burden of ICU mortality remains poorly characterized, despite the increasing complexity of cases.

Existing literature identifies various demographic, clinical, and treatment-related factors that predict mortality among ICU patients. However, there is a lack of comprehensive data specific to Ethiopia, where socioeconomic challenges, healthcare system limitations, and a high burden of infectious and non-communicable diseases may influence patient outcomes differently than in high-income countries. The absence of real-time data collection and analysis of ICU outcomes further compounds this knowledge gap, limiting the ability to identify specific predictors relevant to this unique context.

Furthermore, the lack of localized studies leaves healthcare providers and policymakers without essential data to guide clinical practices and operational strategies within the ICU. Without understanding the incidence and predictors of mortality in this setting, it is difficult to implement targeted, evidence-based interventions to reduce preventable deaths.

This study aims to systematically investigate the incidence and predictors of mortality among patients admitted to the surgical and medical ICUs at Tikur Anbessa Specialized Hospital through a retrospective study design. This research will provide a clearer understanding of the factors contributing to mortality, enabling the development of improved patient care protocols and culturally relevant healthcare policies.

1.3 Significance of the Study

By identifying specific predictors of mortality in the ICU setting through a retrospective study, healthcare providers at Black Lion Hospital can formulate targeted interventions for high-risk patients based on real-time data. The results will contribute valuable insights to the existing body of knowledge regarding ICU care in Ethiopia. By documenting unique risk factors and mortality patterns, the study will inform the development of clinical guidelines and protocols that are not only specific to the local context but also adaptable to patient needs as they evolve in the ICU.

This study addresses a significant research gap in the Ethiopian healthcare landscape by providing empirical data on ICU mortality and its predictors. This research will contribute to the global scientific discourse and encourage further exploration of critical care in low- and middle-income countries, which are often underrepresented in global health literature.The study addresses a significant research gap in the Ethiopian healthcare landscape. The insights gained from this study will serve as an educational resource for healthcare providers, equipping them with real-time knowledge about the specific challenges and risk factors in the ICU environment.

2. Literature Review

2.1 Preview

The intensive care unit (ICU) serves as a critical component of healthcare systems worldwide, providing specialized treatment for patients suffering from life-threatening conditions. Understanding the incidence and predictors of mortality in ICUs is crucial for improving patient outcomes and optimizing healthcare resources. This literature review synthesizes existing research on ICU mortality, particularly focusing on the factors that influence mortality rates in surgical and medical units.

2.2 Incidence of Mortality in ICUs

Intensive care units (ICUs) are critical components of healthcare systems, providing lifesaving interventions for critically ill patients. However, mortality rates within ICUs vary significantly across different regions, with developing nations experiencing disproportionately higher rates.

Multicentre European cohort study on Hospital mortality of adults admitted to Intensive Care Units in hospitals with and without Intermediate Care Units:showed over all 19% ICU mortality [17].

The African continent has been identified as having particularly high ICU mortality rates, ranging from 32.9% to 54%[19]. Within this context, Ethiopia exhibits one of the highest ICU mortality rates in Africa, fluctuating between 30% and 50.4%[12, 14, 20]. A retrospective study conducted at Tikur Anbessa Specialized Hospital has revealed a mortality rate of 31.5% among critically ill patients in the surgical ICU [32]. These figures highlight the urgent need for comprehensive research to understand the underlying factors contributing to these elevated mortality rates and to develop effective interventions to improve patient outcomes.

2.3 Predictors of Mortality

Numerous studies have identified various predictors that contribute to ICU mortality, which can be broadly categorized into demographic, clinical, and treatment-related factors.

Study done on Predictors of ICU Mortality among Mechanically Ventilated Patients in Addis Ababa found that ICU mortality was 60.7%. Four additional patients died in the hospital. Seventy

patients (43.8%) developed complications. From these, sepsis (30%) was the most common cause of death followed by re-intubation (16.9%)and hospital-acquired pressure injury (11.3%).As the number of organ systems affected increased, the probability of death also increased.The mean (SD) admission Mortality Prediction Model (MPM) II score was

36.9 (25.5). The largest category (48.1%) comprised priority one admissions. Eighty-five percent of the participants (n = 136/160) had at least one comorbidity, notably, immunosuppression (56.3%) and hypertension (20%). Respiratory failure (45%) was the most common reason for intubation and mechanical ventilation [31].

The study done on Patterns of Admission and Mortality of Patients Admitted to Surgical Intensive Care of TikurAnbesssa Specialized Teaching Hospital found the mortality was 31.5% .The average SICU stay in the study was 5.76 days. Of 30.9% cases which were trauma related RTA accounted for 15.2% of the patient followed by assault 6.2% and fall down 4.5%. From these trauma patients 40% of RTA patient had concomitant pneumonia and 48% of RTA patients died (13 out of 27). Mechanical ventilator was used by 28.1 % of the patients' during their SICU stay [32].

Study done in india on admission scoring System as a Predictor ofMortality in SICU Patients found that Mean age of the study participants was 50.5 years, leading cause of admission was perforation peritonitis followed then by acute pancreatitis. Cut off MPMIII probability of death score was >11.3. The area under curve (AUROC) was 0.771 and 95% confidence interval of 0.677 to 0.849.Sensitivity of 95.16%, specificity of 76.32%, PPV and NPV being 75.70% and 70% respectively with significance p value <0.0001.On application of linear analysis and calculation of SMR, MPMIII had SMR of 1.93.The MPM III curve shows a larger underestimation below predicted probability of about 0.4 and an less underestimation above this value. even though MPM III is good , easy ,simple admission scoring system predicting mortality in a surgical ICU model, it has tendency to slightly underestimate mortality for border linepatients [33].

Astudy done in Boston on Mortality Probability Admission Model (MPM0 -III) found that the hospital mortality rate in the current data set was 13.8% vs. 20.8% in the MPM0 -II cohort.All MPM0 -II variables remained associated with mortality. The area under the receiver operating characteristic curve was 0.823 [34].

Astudy done in south Korea on Mortality prediction of patients in intensive care units using machine learning algorithms based on electronic health records found that the predictive performance of conventional scoring models and machine learning algorithms was assessed by the area underthe receiver operating characteristic curve (AUROC). The conventional scoring models had various predictive powers(AUROC 0.803 [0.795–0.810] for hospital G) showing the highest AUROC among them. The bestperforming machine learning models achieved an AUROC of 0.977 (0.973–0.980) [35].

Astudy done in spain during the COVID -19 pandemic assessed risk factors for ICU mortality among critically ill patients found that Age was independently associated with mortality,with each additional year increasing the risk of death by 1% (95%CI: 1-10%,p=0.014).Similarly,for every 5 point increase in the APACHE II score ,the odds of death increased by approximately 51%.Clinical complications such as acute kidney injury ,cardiac arrest and septic shock were strongly associoated with increased mortality.[4]

A study done in in Amhara Regional State, Northwest Ethiopia,on the magnitude of mortality and its predictors among adult patients admitted to ICUs with a focus on treatment-related factors. found several critical treatment variables that significantly affect mortality rates, including the timeliness and appropriateness of medical interventions such as mechanical ventilation, fluid management, and the administration of antibiotics. The findings reveal that early and effective treatment correlates with improved patient survival, whereas delays in intervention and inadequate treatment protocols are associated with higher mortality.[20]

A study carried out at Northwest Bank Hospital explored mortality determinants among 227 adult patients admitted to the intensive care unit. The patients had an average age of 55.5 years , and the observed ICU mortality rate was 31.7%. found Individuals admitted from inpatient wards had more than double the odds of dying (aOR = 2.1; 95% CI: 1.1–3.9; $p < 0.05$), elevated creatinine levels (≥2 mg/dl) also had significantly higher mortality (aOR = 2.7; 95% CI: 1.3–5.8; $p < 0.01$). Additional high-risk groups included patients with hematologic cancers (aOR = 3.4; 95% CI: 1.6–6.7; $p = 0.001$) and those who were immunocompromised (aOR = 2.5; 95% CI: 1.3–4.7; $p < 0.01$).Furthermore, increased SOFA and APACHE scores were important predictors of poor prognosis. [21]

2.4 Gaps in Literature

Despite the existing body of knowledge on ICU mortality, significant gaps remain, particularly regarding the Ethiopian context. Most literature focuses on high-income countries, limiting the generalizability of findings to LMICs. There is a pronounced need for studies that explore the unique demographic, clinical, and treatment-related factors influencing ICU outcomes in Ethiopia. This study aims to address these gaps by collecting real-time data on the incidence and predictors of mortality among patients in the surgical and medical ICUs at TikurAnbessa Specialized Hospital.

2.5 Rationale for the Current Study

Given the critical importance of understanding the dynamics within ICU settings, this research seeks to elucidate the incidence and predictors of mortality among ICU patients at Tikur Anbessa Specialized Hospital through a retrospactive approach. The findings will enhance understanding of patient dynamics in critical care, informing clinical practices, resource allocation, and policy decisions.

Conceptual framework

Figure 1.Conceptual framework for predictors of ICU mortality was adopted by the author from the literature.

3. Objectives

3.1 General Objective

- To determine the incidence and predictors of mortality among patients admitted to the surgical and medical intensive care units at Tikur Anbessa Specialized Hospitalfrom September 1,2023 and August 31,2024

3.2 Specific Objectives

I. To determine the overall incidence of mortality among patients admitted to the surgical and medical intensive care units at Tikur Anbessa Specialized Hospital from September 1,2023 and August 31,2024

II. To identify the predictive value of MortalityProbability Model III (MPMIII) among patients admitted to the surgical and medical intensive care units at Tikur Anbessa Specialized Hospital from September 1,2023 and August 31,2024

III. To determine predictors of mortality among patients admitted to the surgical and medical intensive care units at Tikur Anbessa Specialized Hospital.fromSeptember 1,2023 and August 31,2024

4. Methods

4.1 Study Design

This was a retrospective observational study design conducted at the surgical and medical intensive care units (ICUs) of Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia patients admitted from September 1,2023 to August 31,2024.. This design enabled the longitudinal tracking of patients from admission to discharge or death, facilitating a deeper understanding of how various factors contribute to mortality.

4.2 Study Setting and Period

The proposed study was conducted at Tikur Anbessa Specialized Hospital, the largest teaching hospital in Ethiopia, which features both surgical and medical ICUs. Equipped with a total of 24 beds with MV. 1:1 nurse-to-patient ratio, physician –to-patient ratio varies each month depending on the attached residents . As a referral center for critical health conditions, the hospital serves a diverse population, making it an ideal setting for this research.

The study was conducted from January 1 to March 31, 2025

4.3 Population

4.3.1 Source Population

The source population consisted of patients admitted to the surgical and medical ICUs of Tikur Anbessa Specialized Hospital between September 1,2023 and August 31,2024. .

4.3.2 Study Population

The study population consisted of sample of patients who fulfilled the inclusion criteria from source population selected by stratified sampling technique.

4.4 Inclusion and Exclusion Criteria

4.4.1 Inclusion Criteria

- Patients aged 18 years and above who admitted to the surgical or medical ICU during the study period.

4.4.2 Exclusion Criteria

- Patients with incomplete medical records or missing vital data.

- Patients discharged or transferred before 24 hours was excluded to ensure that sufficient time has passed to observe the factors influencing mortality.

4.5 Sample Size Determination and Technique

4.5.1 Sample size determination

The sample size was determined using single population proportion formula with the following assumption

Given that the mortality rate in the surgical ICU was 31.5%, as reported in retrospective study conducted in 2014 at Tikur Anbessa Specialized Hospital [32],

$$Sample\ size\ n = \frac{\left[\left(z_{\alpha/2}\right)^2 \times p(1-p)\right]}{d^2}$$

Z= Standard normal distribution value at 95% CI= (1.96)2

p= ICU mortality rate (0.315) at tikuranbessa specialized hospital [32].

d= margin of error (0.05)

n= sample size

Therefore, n= [(1.96) $\times^2$) (0.315)×(1-0.315)]/(0.05)^2= 331

Since population size is <10,000 it was adjusted using the formula

$$\mathbf{n} = \frac{\mathbf{nO}}{\mathbf{1} + \frac{\boldsymbol{nO}}{\boldsymbol{N}}}$$

N =222

Adding another10% for non-respondents, making total sample size N 244 westratifed our population into surgical and medical ICUs, which had annual admissions of 445 and 235, respectively

Formula for proportional allocation sample size for each stratum:

n_h= N_h/N x n

Surgical ICU Sample Size: Approximately 159

Medical ICU Sample Size: Approximately 85

4.5.2 Sampling technique

Stratified sampling technique was used to select study participants we stratifed our population into surgical and medical ICUs, which had annual admissions of 487 and 257, respectively this stratification was allowed us to obtain a representative sample that accurately reflects the characteristics and outcomes of patients in both ICUs.

4.6.1 Dependent Variable

ICU mortality

4.6.2 Independent Variables

Socio-demographic factors:age, gender

Clinical factors :Comorbidities, Type of ICU admission, Reason for ICU admission.Readmission status ,Length of ICU saty

Interventional factors: Mechanical ventilation,Vasopressor use, Dialaysis ,Blood transfusion Invasive procedures

4.7 Operational Definitions

ICU Mortality: Death occurring during the ICU stay or within 24 hours of ICU admission.

MPM III Predicted Mortality: Probability of death on ICU admission calculated using the Mortality probability modelIII based on standard variables

SMR: The ratio of observed deaths in the ICU to the expectednumber of deaths predicted by MPMIII model

Comorbidities: The presence of one or more additional diseases or disorders occurring simultaneously with the primary disease.

Length of ICU stay : Total number of days a patient remained in the ICU from admission to discharge or death

Mechanical Ventlation : Requirement for invasive mechanical ventilation during ICU stay

4.8 Data Collection Instruments and Procedure

4.8.1 Data Collection Instruments

A structured data collection questionnaire was developed to extract relevant information from medical records and charts.It was piloted prior to the study to ensure clarity and comprehensiveness.

4.8.2 Data Collection Procedure

Data was collected by trained research ACCPM residents who reviewed medical charts of eligible patients. Each patient's demographic, clinical, and treatment data was recorded from the time of admission until discharge or death.

4.9 Data Quality Assurance

To ensure data quality, regular trainings was conducted for data collectors. Random audits of collected data was carried out throughout the study duration. In addition, data entry was double-checked for accuracy and completeness.

4.10 Data Analysis

All responses to the questionnaires were coded ,entered and analyzed using SPSS version 26.Binary logistic regression was employed for each independent variable,those having a P value <0.25 entered into a multivariate logistic regression to account for confounding factors when identifying mortality predictors. P value <0.05 at 95% confidence interval was considered as statistically significant value.

4.11 Ethical Considerations

The research was conducted after obtained ethical clearance and approved from department of Anesthesiology ,crtical care and pain medicine.An official support letter was written to out patient department and ICU director.Confidentiality was maintained at all levels of the study.

4.12 Result Dissemination Plan

Findings of the study will disseminated through presentations at local and international conferences and published in peer-reviewed journals. Additionally, results was shared with hospital stakeholders to inform clinical practices and policy decisions.

5.Result

5.1 Sociodemographic characteristics of the study participants

From the total of 244 participants Majority of the study participants were in the age group of 18-30 years(87,35.7%). with the mean age of 41.45. There was an equal proportion of female and male 123 (50.4%)and 121(49.65%) participants respectively. 159 participants (65.2%) were admitted in surgical ICU. The chi-square test revealed that as age increase the death rate increase and it was also statistically significant. the type ICU admission also another statistically significant factor for death as shown in the table below.

Table 1.The sociodemographic characteristics of the study participants among Patients Admitted to Surgical and Medical Intensive Care Units at TikurAnebessa Specialized Hospital, Addis Ababa, Ethiopia September 2023.to August 2024

Variable	Total (%)	Survived(discharged)(n=184)	Death(n=60)	p-value
Age in years				
18-30	87(35.7)	78(42.4)	9(15)	0.000
31-45	67(27.5)	54(29.3)	13(21.7)	
46-60	53(21.7)	36(19.6)	17(28.3)	
>60	37(15.2)	16(8.7)	21(35)	
Sex				
Male	121(49.6)	86(46.7)	35(58.3)	0.119
female	123(50.4)	98(53.3)	25(41.7)	
Types of ICU admission				
Medical ICU	85(34.8)	57(31)	28(46.7)	0.027
Surgical ICU	159(65.2)	127(69)	32(53.3)	

5.2 Reasons for ICU admission

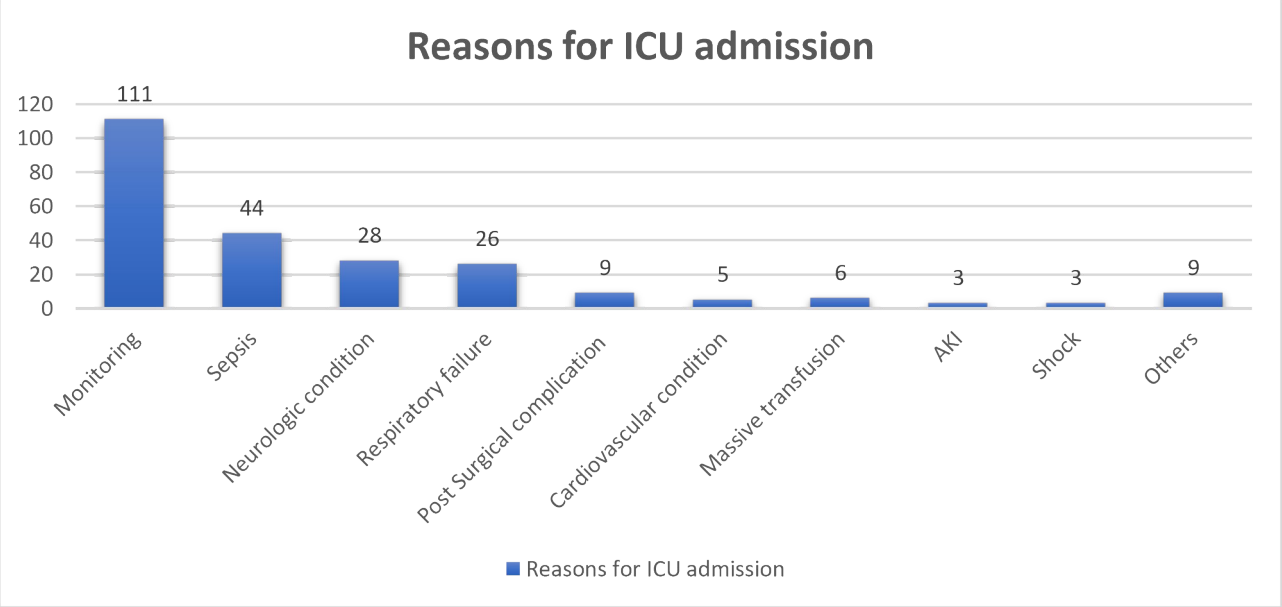

Figure 2. Reason for ICU admission.

5.3 The clinical condition related characteristics of the study participants

Forty-nine percent of the participants had comorbid diseases, which accounted for 85% of the deaths. Among those with comorbid diseases, hypertension accounted for 47.1%, followed by diabetes mellitus (16.8%), chronic obstructive pulmonary disease (14.3%), and chronic liver disease (9.2%). The majority of them stayed in the ICU for 2-7 days, which accounted for 45.6% of the deaths. Thirty-five percent of the cases required mechanical ventilation, and 95% of the deaths were among those who used mechanical ventilation, as shown in the table below. All the clinical conditions were statistically significant for ICU mortality at a p-value < 0.05.

Table 2.The clinical condition related characteristics of the study participants

Variable	Total (%)	Survived(discharged)(n=184)	Death (n=60)	p-value
Comorbidity				
Yes	119(48.8)	68(37)	51(85)	0.000
No	125(51.2)	116(63)	9(15)	
Types of comorbid disease(n=119)				
hypertension	56(47.1)	29	27	0.000

DM	20(16.8)	6	14	
COPD	17(14.3)	15	2	
CLD	11(9.2)	5	6	
Malignancy	14(11.8)	4	10	
CKD	11(9.2)	3	8	
Cardiac disease	11(9.2)	10	1	
Immunocompromised	9(7.6)	1	8	
Cardiovascular disease	6(5)	4	2	
hyperthyroidism	1(0.8)	1	0	
IHD	1(0.8)	1	0	
Epileptics	1(0.8)	1	0	
Suprasellar mass	1(0.8)	1	0	
Length of stay in ICU in days				0.000
1-2	59(24.2)	58(31.5)	1(1.7)	
2-7	146(59.8)	116(63)	30(50)	
>7	39(16)	10(5.4)	29(48.3)	
Mechanical ventilation used				0.000
Yes	86(35.2)	29(15.8)	57(95)	
No	158(64.8)	155(84.2)	3(5)	
Duration mechanical ventilation				0.000
1-2	34(39.5)	21(72.4)	13(22.8)	
3-7	31(36)	5(17.2)	26(45.6)	
>21	21(24.4)	3(10.3)	18(31.6)	
Vasopressor used				
Yes	72(29.5)		55(91.7)	0.000
no	172(70.5)		5(8.3)	
Duration of vasopressor(n=72)		17(9.2) 167(90.8) 17(100) 0		
≤4	52(72.2)		35(63.6)	0.003
>4	20(27.8)		20(36.4)	

5.4 Management related characteristics of the study participants

Dialysis was performed for 8 cases, and of those, 7 died. Additionally, 13.9% of the patients received blood transfusions, and transfusion cases accounted for 23.3% of the total deaths.

Almost five percent of the cases were readmitted, and all of them were deceased. Invasive procedures were performed for 9.4% of the cases, and among those who underwent invasive procedures, 83.3% died, accounting for 31.7% of the total deaths.

Table 3.Management related characteristics of the study participants

Variable	Total (%)	Survived(discharged)(n=184)	Death(n=60)	p-value
Dialysis				
Yes	8(3.3)	1(0.5)	7(11.7)	0.000
no	236(96.7)	183(99.5)	53(88.3)	
Blood transfusion				
Yes	34(13.9)	20(10.9)	14(23.3)	0.015
no	210(86.1)	164(89.1)	46(76.7)	
Unit of transfusion				
≤2	24(68.6)	15(71.4)	9(64.3)	0.656
>2	11(31.4)	6(28.6)	5(35.5)	
Readmission status				
Yes	12(4.9)	0	12(20)	0.000
no	232(95.1)	184(100)	48(80)	
Invasive Procedures central line chest tube tracheostomy				
Yes	23(9.4)	4(2.2)	19(31.7)	0.001
no	221(90.6)	180(97.8)	41(68.3)	

5.5 Patient outcome related characteristics of the study participants

The ICU mortality of the patients was 24.6% but its predicted mortality using MPMIII were 18.2%

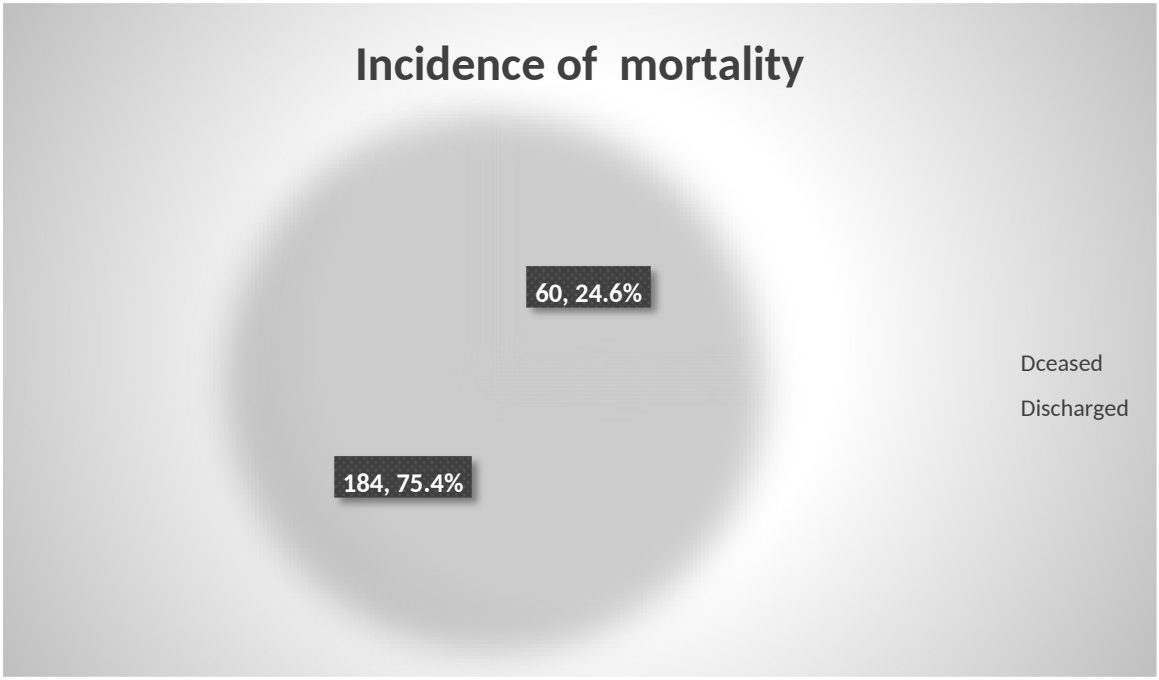

Figure 3.percentage of mortality in ICU among Patients Admitted to Surgical and Medical Intensive Care Units At TASH

5.6 The immediate cause of death

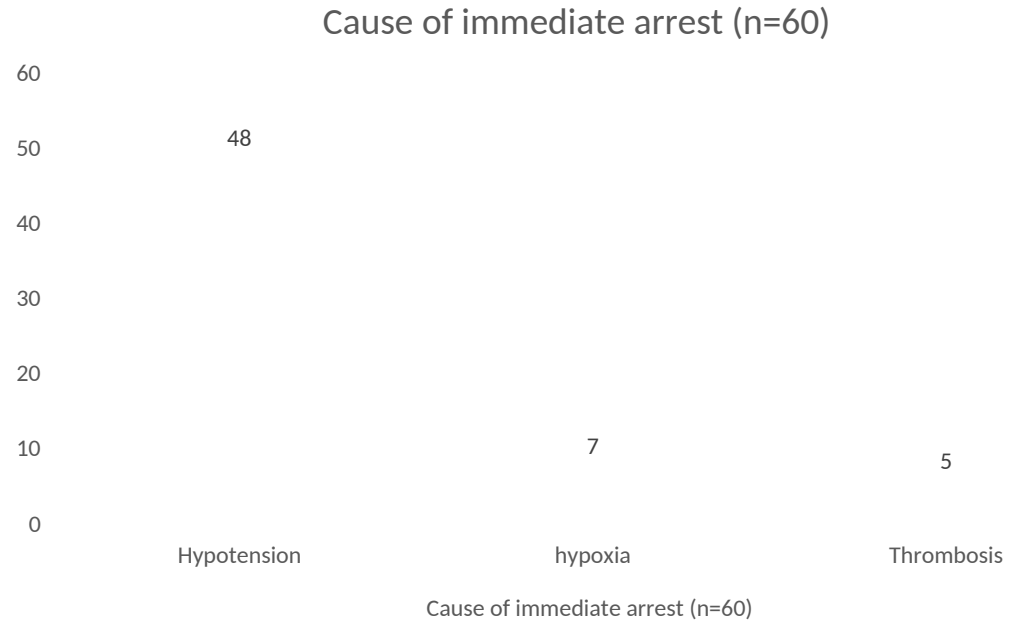

*Figure 2.*The immediate cause of ICU mortality

One-fourth of patients (24.6%) died in the ICU, and the mean predicted mortality rate based on the modified MPM-III score was 18.2%. The modified MPM-III score has a 'excellent' discriminatory function (AUROC =0.966, 95% CI: 0.946-0.986) (Figure 3). 0.966 AUC means the model has good discriminatory ability, meaning it is quite effective at

distinguishing between the positive and negative classes. It indicates that the model correctly ranks a random positive instance higher than a random negative instance about 96.6% of the time. It suggests that the model has high accuracy and is fairly reliable in making predictions.

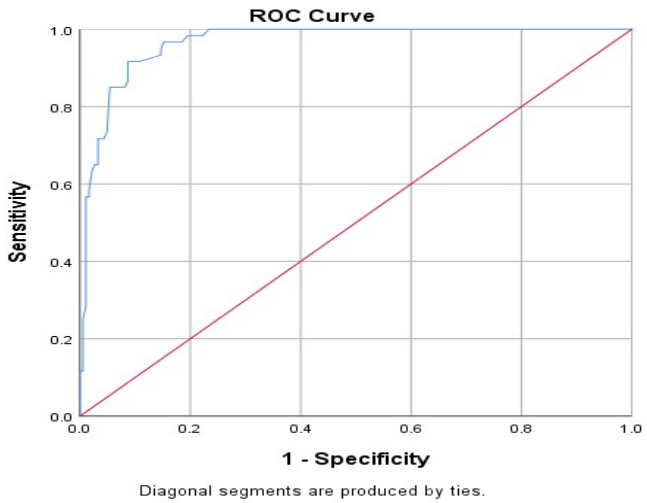

Figure 4.Receiver operating characteristics curve for the prediction of mortality (AUC 0.966 (95% CI: 0.946-0.986)

Area Under the Curve				
Test Result Variable(s): MPM III score result				
Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.966	.010	.000	.946	.986
The test result variable(s): MPM III score result has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.				
a. Under the nonparametric assumption				
b. Null hypothesis: true area = 0.5				

Across all the listed variables the observed and expected survival and mortality were comparable. There was a discrepancy between observed and expected mortality. In some variable observed mortality was higher than expected mortality and Vis versa to other variables as shown in the table. The finding of the study also showed that the overall SMR were 1.23 and the specific types of SMR was as shown the table 5. below

Table 4.Performance of MPMIII across Subgroups

Variable	Frequency	Mean MPM III predicted death	Survived		Death		SMR
			Observed	expected	observed	Expected	
Age in years							
18-30	87	0.095	78	65.6	9	21.4	0.42
31-45	67	0.13	54	50.5	13	16.5	0.79
46-60	53	0.22	36	40	17	13	1.31
>60	37	0.43	16	27.9	21	9.1	2.31
Sex							
Male	121	0.19	86	91.2	35	29.8	1.17
Female	123	0.17	98	92.8	25	30.2	0.83
Types of ICU admission							
Medical ICU	85	0.26	57	64.1	28	20.9	1.34
Surgical ICU	159	0.14	127	119.9	32	39.1	0.82
Comorbidity							
Yes	119	0.31	68	89.7	51	29.3	1.74
No	125	0.06	116	94.3	9	30.7	0.29
Length of stay in ICU in days							
1-2	59	0.04	58	44.5	1	14.5	0.069
2-7	146	0.16	116	110.1	30	35.9	0.84
>7	39	0.47	10	29.4	29	9.6	3.02
Mechanical ventilation used							
Yes	86	0.39	29	64.9	57	21.1	2.70
No	158	0.06	155	119.1	3	38.9	0.08
Duration mechanical ventilation							
≤2	34	0.24	21	11.5	13	22.5	0.58
3-7	31	0.41	5	10.5	26	20.5	1.27
>7	21	0.63	3	7.1	18	13.9	1.29
Vasopressor used							
Yes	72	0.45	17	54.3	55	17.7	3.11
No	172	0.07	167	129.7	5	42.3	0.12
Dialysis							
Yes	8	0.54	1	6	7	2	3.5
No	236	0.17					
Blood transfusion							
Yes	34	0.25	20	25.6	14	8.4	1.67
No	210	0.17	164	158.4	46	51.6	0.89

Readmission							
Yes	12	0.59	0	9	12	3	4.1
No	232	0.16	184	175	48	57	0.84
Invasive Procedures central line chest tube tracheostomy							
Yes	23	0.55	4	17.3	19	5.7	3.33
No	221	0.14	180	166.7	41	54.3	0.76

5.6 The determinant factors of ICU mortality

Age, sex, types of admission, duration of mechanical ventilation, comorbidity and blood transfusion had association with ICU mortality by bivariate logistic regression. The multivariate logistic regression found that, study participants whose age of > 60 years had 6.1 times increased its ICU mortality compared to those of age 18-30 (AOR=6.1, 95%CI=1.98, 37.57) and the study participants who were admitted to the medical ICU had 3.1 times increased in ICU mortality compared to those admitted in the surgical ICU (AOR=3.1, 95%CI=1.33, 3.98). The study participants having comorbid disease had 3.7 times increased ICU mortality compared to those did not have comorbid disease (AOR=3.7, 95%CI=1.90, 15.64). The study participants whose duration of MV stay 3-7 days had 5.7 times (AOR=5.7, 95%CI=1.41, 23.43) and those stayed >7 days had 4.2 times (AOR=4.2, 95%CI=1.85, 30.95) respectively increased ICU mortality compared to those stayed in MV ≤2 days.

Table 5.The association between bivariate and multivariate independent variable and ICU mortality among Patients Admitted to Surgical and Medical Intensive Care Units At TASH, 2024/5.

Variable	Mortality		Pvalue	COR with 95%CI	Pvalue	AOR with 95%CI
	Yes (%)	No (%)				
Age in years						
18-30	9(15)	78(42.4)	1		1	
31-45	13(21.7)	54(29.3)	0.116	2.1(0.83,5.22)	0.200	2.9(0.56, 15.89)
46-60	17(28.3)	36(19.6)	0.002	4.1(1.67, 10.06)	0.230	2.9(0.51, 16.57)
>60	21(35)	16(8.7)	0.000	11.4(4.41, 29.36)	0.042	**6.1(1.98, 37.57)**
Sex						
Male	35(58.3)	86(46.7)	0.0120	1.6(0.89, 2.88)	0.555	1.4(0.44, 4.66)
Female	25(41.7)	98(53.3)	1		1	
Types of ICU admission						
Medical ICU	28(46.7)	57(31)	0.028	1.9(1.07, 3.54)	0.036	**3.1(1.33, 3.98)**
Surgical ICU	32(53.3)	127(69)	1		1	
comorbidity						
Yes	51(85)	68(37)		9.7(4.48, 20.86)	0.049	**3.7(1.90, 15.64)**

No	9(15)	116(63)			1	
Duration mechanical ventilation						
≤2	13(22.8)	21(72.4)	0.000 1 1 0.000 0.002		1	
3-7	26(45.6)	5(17.2)		8.4(2.58, 27.36)	0.015	**5.7(1.41, 23.43)**
>7	18(31.6)	3(10.3)		9.7(2.38, 39.48)	0.048	**4.2(1.85, 30.96)**
Blood transfusion						
Yes	14(23.3)	20(10.9)	0.018	2.5(1.17, 5.32)	0.051	11.5(0.99, 133.67)
No	46(76.7)	164(89.1)	1		1	

6. Discussion

The finding of this study indicated that the rate of mortality among surgical and medical patients in ICU was 24.6% and its modified MPM-III score was 18.2% and the overall SMR was 1.23. This finding was higher than the study's done in developed countries, multicentre retrospective study in European 19% [17], multicentre retrospective study in USA 13.8% [34].

The finding was lower than the study done in other developing countries, across-sectional study done in iran 34.9% [24]. Retrospective study done in kenya 53.6% [19].

It was also lower than the study done at different hospitals of Ethiopia Retrospective Study done at St.paulos hospital 40% [11], multi-centerchort study done in southern Ethiopia 46.8% [10],retrospective cross-sectional study done at Gondar university hospital 38.7% [14] ,retrospective cross-sectional study at Tibebe Ghion hospital 29.6% [20] and retrospective observational study done at Tikur Anbessa hospital previously (31.5%)[32]. This difference was may be due to higher ICU survival rates in developed countries often stem from better healthcare infrastructure, including advanced medical equipment, higher nurse-to-patient ratios, more specialized staff, and access to newer medications and treatments.WhileTikur Anbessa is one of the largest referral hospitals in Ethiopia and has access to good resources for the region, it may still face challenges such as limited ICU capacity, underfunding, or resource shortages (e.g., ventilators, medical staff, medications). In some developing countries, ICU staff may have less training or fewer resources to improve

their skills, leading to higher mortality rates in those settings. However, this may not be the case universally across all developing countries, and some may have better-trained professionals and healthcare systems.

In this study the mean prediction of mortality using MPMIII were 18.2%. This finding was correlated with the retrospective study done in United state of america 20.8% [34].And also the AUC of predictive mortality using MPMIII were an excellent level, which is 0.966. this finding more fitted than the other study done on prediction of MPMIII (AUC=0.77) [33] and the study done in Boston (AUC=0.82) [34]. The excellent performance of MPM III in this study might be due to accurate and timely data collection, a more homogenous or moderately severe patient group, good calibration with local outcomes.

On the other hand, the determinant factors of ICU mortality found that study participants whose age of > 60 years had 6.1 times increased ICU mortality (AOR=6.1, 95%CI=1.98, 37.57). This finding was supported by the study listed in the reference [4, 7, 16, 21]. This was may be due to aging is associated with a reduced capacity to mount an effective physiological response to acute stress, diminished immune function, and a higher burden of chronic comorbidities. Additionally, elderly patients are more prone to complications such as delirium, infections, and treatment-related side effects.

The study participants who were admitted in medical ICU had 3.1 times increased ICU mortality (AOR=3.1, 95%CI=1.33, 3.98). This was may be due to the higher mortality observed among Medical ICU (MICU) patients may be attributed to several interrelated factors. MICU admissions typically involve patients with severe systemic illnesses and multiple comorbidities, which complicate treatment and reduce survival chances. Unlike surgical patients, medical cases often lack immediate corrective interventions, making management more complex.

The study participants having comorbid disease had 3.7 times increased ICU mortality compared to those of with out comorbid disease (AOR=3.7, 95%CI=1.90, 15.64). This finding was congruent with the study listed in the reference [5, 7, 21-23].This was may be due to patients with severe systemic illnesses and multiple comorbidities, which complicate treatment and reduce survival chances.

The study participants whose duration of stayed in MV 3-7days had 5.7 times (AOR=5.7, 95%CI=1.41, 23.43) and MV stayed duration >7days had 4.2 times (AOR=4.2, 95%CI=1.85, 30.95) increased ICU mortality compared to those stayed MV ≤2 days.This was may be due

to prolonged mechanical ventilation is strongly associated with increased ICU mortality due to a combination of direct complications and the severity of the underlying illness. Extended ventilation increases the risk of ventilator-associated pneumonia, ICU-acquired weakness, nosocomial infections, and sedation-related delirium. It also often indicates a more severe disease process, such as ARDS or sepsis, which inherently carry a high risk of death.

7.Strength and limitation

Strength

- To the best of my knowledge there was only one research done at TASH on this topic; so this study will provide further information and encourage others for further study.

- The study clearly addressed its main objectives.

Limitation

- Retrospective nature of the study

    - the data might not be sufficient

- The study was conducted at a single center

- Small sample size

- Limitted variables

8. Conclusion

A total of 244 ICU patients were included, with over all observed mortality was 24.6%. The expected mortality based on MPMIII was 18.2% and the standard mortality rate was 1.23. The SMR was 1.35, indicating higher than expected mortality. Multivariate logistic regression identified age>60years (AOR=6.1), admitted to the medical ICU (AOR=3.1), having comorbidity (AOR=3.7) and the need for MV 3-7days (AOR=5.7) and >7days (AOR=4.2) as independent predictors of ICU mortality curve for MPMIII model showed excellent performance (AUC=0.966)

9. Recommendation

Based on the findings of this study, the recommendation will be

I. Given that the MPMIII model demonstrated excellent predictive accuracy (AUC = 0.966), it should be more routinely used for early risk stratification to guide clinical decision-making and resource allocation.

II. The higher odds of mortality in medical ICU patients suggest potential differences in care processes, case severity, or resource availability. A review of staffing, protocols, and outcomes in the medical ICU is warranted.

III. As comorbidities significantly increased mortality risk, improving chronic disease management prior to ICU admission

IV. Develop and implement evidence-based protocols for elderly care, mechanical ventilation management, and comorbidity-specific interventions to reduce modifiable mortality risks.

V. Regular analysis of ICU SMR over time can help identify trends, evaluate the impact of quality improvement interventions, and benchmark against other institutions.

VI. Staff training in critical care, especially in high-mortality subgroups, and improving access to equipment and medications could contribute to lowering the SMR.

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11 Annexes

11.1 Questionnaire

Addia Abeba University College of health sciences department of anesthesiology,critical care and pain medicine

The questionnaire was preparerd to assess the predictors of ICU mortality among patients admitted to TASH medical and surgical ICUS

Section 1: Patient Demographic Information

1. Patient ID: _____

2. Age: _____ (in years)

3. Gender:

- Male

- Female

Section 2: Clinical Information

4. ICU Type:

- Medical ICU

- Surgical ICU

5. Admission Diagnosis

6. Reason for ICU Admission (Check all that apply):

- Trauma

- Post-surgical complications

- Cardiovascular disease

- Respiratory failure

- Sepsis/Infection

- Neurological condition

- Renal failure

- Others (Specify): _____

7. Comorbidities (Check all that apply):

- Hypertension

- Diabetes Mellitus

- Chronic Kidney Disease

- Chronic Obstructive Pulmonary Disease (COPD)

- Heart Failure

- Cancer

- Liver Disease

- Immunocompromised Status

- Others (Specify): _____

8. Length of Stay in ICU (days): _____

9. Mechanical Ventilation:

- Yes

- No 10 If yes for how long

11. Vasopressor Use:

- Yes

- No

12 If yes for how long

13. Renal Replacement Therapy (Dialysis):

- Yes

- No

14 If yes for how long

15. Blood Transfusion:

- Yes

- No

16.If yes number of units

17 Readmission status

-Yes

- No

18. Invassive procedures (central line,chesttube,thrachostomy)

-Yes

-No

19 Mortality probability score (MPMII)

-Coma or stupor with GCS of 3 or 4

- Heart rate >150

-Systolic blood pressure <90

-Chronic renal insufficiency

-Cirrhosis

-Metastatic cancer

-Acute renal failure

-Cardiac arrhythmia

-Cerebrovascular accident

-Gastrointestinal bleeding

-Intracranial mass effect

-Cardiopulmonary resuscitation before admission -Mechanical ventilation employed with in the first hour of admission

-Medical or unscheduled surgical admission

Section 3: Outcome Information

20. ICU Outcome:

- Discharged

- Deceased

21.If deceased Cause of Immediate arrest

-Hypotenstion

-Hypoxia

- Hyper/hypokalemia

- Hypothermia

-Thrombosis

-Tenstionpneumothorax

-Cardiac tamponade

- Others (Specify): _____

9.2 Declaration of the prinicipal investigator

The undersigned agrees to accept responsibility for the scientific ethical and technical conduct of the research project and for the provision of required progress reports as per terms and conditions of the Department and College, in effect at the time of grant is forwarded as the result of this application.

Name of the student: _____

Date. _____

Signature _____

APPROVAL OF THE FIRST ADVISOR

Name of the first advisor: _____

Date. _____

Signature _____

APPROVAL OF THE SECOND ADVISOR

Name of the second advisor: _____

Date. _____

Signature _____