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**COLLEGE OF HEALTH SCIENCE
SCHOOL OF MEDICINE, DEPARTMENT OF ANESTHESIA**

SURVIVAL STATUS AND PREDICTORS OF MORTALITY AMONG TRAUMA PATIENTS ADMITTED TO INTENSIVE CARE UNIT OF SELECTED GOVERNMENTAL HOSPITALS IN ADDIS ABABA, ETHIOPIA, 2022/23: MULTICENTRE RETROSPECTIVE COHORT STUDY.

A research thesis to be submitted to Addis Ababa University, School of Medicine, Department of Anesthesia as Part of partial fulfillment of the requirements for a Master's degree in advanced clinical Anesthesia.

29 May 1738

ADDIS ABABA, ETHIOPIA

Declaration

I, the undersigned investigator agreed to accept responsibility for the scientific, ethical, and technical conduct of the research project and provision of required progress reports as per terms and conditions of the research and publications office of the Addis Ababa University.

We declare that this thesis is our original document. We understand that plagiarism will not be tolerated and all directly quoted materials have been appropriately referenced.

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Acronyms and abbreviations

AHR	Adjusted Hazard Ratio
AKI	Acute Kidney Injury
aPTT	Activated Partial Thromboplastin Time
BSc	Bachelor of Science
DC	Data Collectors
GCS	Glasgow Coma Scale
GBD	Global Burden of Disease
HR	Hazard Ratio
HSTP	Health Sector Transformation Plan
ICU	Intensive Care Unit
KM	Kaplan–Meier
MOH	Ministry Of Health
PHDF	Doctor of Philosophy fellow
PI	Principal Investigator
RTS	Revised Trauma Score
SPH	Saint Peter's Specialized Hospital
SPHMMC	Saint Paul's Hospital Millennium Medical College
Spo2	Arterial Oxygenation Saturation
TASH	Tikur Anbesa Specialized Hospital
TBI	Traumatic Brain Injury
TPT	Total Prehospital Time
US	United States
WHO	World Health Organization

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Abstract

Introduction: Trauma has become an international concern due to millions of deaths. Mortality among trauma patients in intensive care units(ICU) remained high, especially in low and middle-income countries. Up to 50% of the trauma patients die in ICUs in Ethiopia. There is Limited information on the timing component of mortality and predictors of mortality are missed in previous studies. Hence this study was designed to investigate the survival status of trauma patients in the ICU and its predictors.

Objective: To estimate the survival status and predictors of mortality among trauma patients admitted to intensive care units of selected governmental hospitals in Addis Ababa.

Methods: A retrospective cohort study was conducted on 351 trauma patients admitted to intensive care units of purposively selected three government hospitals in Addis Ababa. Before being imported into STATA/MP version 17 for additional analysis, the data was first entered into Epidata version 3.1. To determine the predictor variables, bi-variable and multivariable Cox regression models were fitted in the analysis. A 95% confidence interval of hazard ratio (HR) was computed, and variables with a p-value of less than 0.05 in the multivariable model were considered to be significantly associated with the dependent variable.

Result: A total of 351 trauma patients were followed retrospectively, median follow-up of 8 days. Out of all 106 (30.2%), deaths were recorded with an incidence rate of 2.3 cases per 100 person-day observation. The cumulative probability of death in the intensive care unit was 0.7842 in a total of 4550.6 person day observations. Creatinine level >1.3mg/dl, Glasgow coma score(GCS) below 9, a complication in ICU, vasoactive, hypoxia upon admission, and heart rate <60 and >100 (beat per minute bpm) found to be significantly associated with mortality trauma patients in ICU.

Conclusion and recommendation: Mortality among trauma patients in the ICU was high, despite the expected national goal of 73 per 100,000 population in 2022. GCS>9, vasoactive requirement, and increased creatinine level were some of the predictors for ICU mortality. Therefore, giving special attention to the above predictor factors is crucial.

Keywords: Survival, Mortality, Intensive care unit, Trauma patients, cox regression

1. CHAPTER ONE: INTRODUCTION

1.1. Background Information

Trauma is traditionally defined as physical damage to a person caused by an acute transfer of energy (mechanical, thermal, electrical, chemical, or radiation energy) or by the sudden absence of heat or oxygen. This definition has been broadened to include damage that results in psychological harm, maldevelopment, or deprivation. Injuries are most commonly categorized concerning the presumed underlying intent: unintentional injuries include those caused by road traffic collisions, falls, drowning, burns, and poisonings, and injuries considered to be intentional include those caused by self-harm, interpersonal violence, and war and conflict(1).

The regions exposed to trauma are divided into four, including the head, chest, abdomen, and extremities. Injuries to more than two sites were considered multiple traumas. The head, extremities, and thorax were the most injured sites during traumas. Trauma-related injuries vary regionally. Patients were frequently admitted to the ICU due to head trauma. Airway support, mechanical ventilation, vasopressor, or inotrope supports are the most common interventions provided for trauma patients in ICU(2,3).

The majority of patients admitted to the ICU are trauma victims. They use an excessive amount of the facility's resources. Any institution's ICU population is a particularly difficult patient population for both caregivers and hospital administrators. After experiencing an extensive traumatic injury, patients who are admitted to the ICU develop many complications such as circulatory and respiratory complications, sepsis, and pressure ulcer. these complications are very closely linked to mortality(2,4–6).

Admission rates to the ICU and incidence of mortality in the ICU are different across countries and institution settings. The overall admission rate of trauma patients to the ICU is nearly comparable in Low and lower-middle-income, Upper-middle income, and High-income countries which are estimated to be around 6.3%, 8.0%, and 6.3% respectively(7), meanwhile, the mortality rate is not much comparable, which is 3.7% - 28.2% in developed countries versus 12.4% - 58% in developing countries(8). The reasons for lower mortality rates comparatively in developed countries can be due to the accessibility of better working setups in developed countries. Trauma-related mortality in developing low-income settings is

almost two times higher than in developed high-income countries. Inadequate pre-hospital trauma care protocols, a lack of staff training and retraining, inadequate health care infrastructure, a shortage of skilled staff, and the absence of proactive institutions and governments are just a few of the challenges in trauma management and combating the burden in a developing economy (7,9–11).

Trauma continues to pose problems for the medical system worldwide leading to thousands of death and injuries requiring admission to ICU. Even though the cause, kind of damage, and risk factors are different, the clinical prognosis is impacted by this heterogeneity necessitating the implementation of a comprehensive and multidisciplinary healthcare system depending on the need for various clinical, organizational, and specialization workup(2,6)

In Ethiopia, about 12.4% - 50% of ICU mortality was found to be trauma related (12–14). To strengthen this finding studies were conducted in different ICU setups of Ethiopia including Addis Ababa and other regions of Ethiopia targeting the determination of the pattern of outcome and predictor factors for mortality in ICU patients, but there was a paucity of data disclosing survival status and predictors of mortality among trauma patients in the ICU.

The sole objective of this institution-based study is an estimation of the death rate and survival status of ICU-admitted trauma patients considering the current dramatically shooting increment of accidents and violence in our country Ethiopia which directly affects the impact and demand for specialized hospital beds along with the expansion of ICUs. This study will be guided by the hypothesis that considers the characteristics of the individuals, the type and severity of the trauma, and the pre-hospital and hospital side care provisions provided are directly associated with the development of the event of death.

1.2. Statement of the problem

Death can have different origins and Causes affecting each segment of people at any age. trauma is the greatest cause of death for people under the age of 45 imposing a negative economic impact on a country due to the loss of these socio-economically active people. There are numerous Emergency Department (ED) visits, ward stays, ICU admissions, and permanent disability in each trauma, Which poses a significant concern worldwide and in Ethiopia too owing to an increase in accidents, violent crime, the development of technology with inadequate safety measures, the country's dense population, and lifestyle changes(8).

Even though tremendous efforts are being made and evidence-based advancements are being reported, traumatic injuries still play a major role and account for a substantial burden of mortality in ICUs worldwide. According to the global estimate from the world health organization(WHO), traumatic injuries account for about 9% of all deaths, and a substantial burden of such fatalities is reported from low and middle-income countries(21).

Despite they only make up a small portion of all hospital patients, the number of critically sick trauma patients admitted to intensive care units has rapidly increased in recent years. Their care consumes a large amount of hospital resources(15). In high-income countries, mortality from the ICU among trauma patients has remained consistent and lower than 28.2%. whereas up to 58% of trauma patients die in the ICUs of low-income countries, such as Ethiopia(8,12). The consequences of higher ICU mortality will extend its burden beyond patients and families, as providing care for critically ill patients has a more significant economic impact on individuals, and a country's financial status, with the approximate deployment of 1% of a countries growth domestic product(GDP), for financing and facilitation of the critical care delivery unit(16).

Trauma patient management in the ICU is manpower and cost-intensive with unfavorable outcomes and admissions to the ICU secondary to trauma associated with an increased incidence of mortality despite tremendous and magnificent healthcare practices being made in the modern world. The severity of the injury at the time of admission, exposure to trauma as a pedestrian, traumatic brain injury (TBI), septic shock and acute kidney injury, duration of a mechanical ventilator, blood transfusion, low GSC score at admission, and the presence of multiple organ failure are all strongly linked to this increased mortality(3,6,17).

Boosting the existing knowledge and clinical practice towards care deliveries and management protocols are possible solutions that are being tried to improve ICU care quality to increase trauma patients' survival rates. Efforts made in the health sectors over the last decades had improvements in trauma care in the field of pre-hospital care, emergency department (ED) care, operation techniques, and ICU leading to a constant reduction in mortality rates in high and middle high-income countries(18–20).

However, As reported by the Ministry of Health(MOH) trauma regardless of its economic and health burden on society has never been given the accordant type of emphasis in our country Ethiopia. There is also a clear clinical gap in the critical care delivery system in the country(21). In addition to this, it has been reported from the Addis Ababa mortality surveillance system using verbal autopsy that trauma-related death accounted for 7% of all fatalities(22).

Moreover in developing countries like Ethiopia, treatment outcomes generated by local clinical trials are rarely available and unlikely to be used, so healthcare professionals in resource-limited settings must rely on trial literature generated from developed countries. However, intervention modalities adopted from resource-rich settings may not always be relevant for an improved patient outcome(24).

It is undeniable that the prediction of mortality outcomes in trauma patients in the ICU is an important and key role of scholars for initializing and directing improved patient care for tracking quality improvements(23). The findings of this thesis will also assist in setting standards and identifying patients who may benefit from corrective quality improvement actions. Therefore the purpose of the study is to assess the incidence and identify the potential predictors of mortality of these trauma patients admitted to the ICU of selected governmental hospitals in Addis Ababa.

1.3. Justification of the study

It has been clearly defined that trauma causes significant mortality worldwide. From these most patients are dying after ICU admission which is speculative of the record of accomplishment and defined profile mortality due to trauma remains an ongoing assignment of most researchers. In this regard, the Ethiopian health sector transformation plan(HSTP-II)gives attention to trauma planning to reduce mortality related to it. The plan was to reduce from 79 to 67 per 100,000 by 2024/25(24). The status of patients in the periods between the occurrence of trauma, hospital admission, and the ICU stay and other several significant factors remained to be questioned till now and are highly associated with the mortality of trauma patients in ICU.

Early identification of factors associated with the death of ICU trauma patients, which takes into consideration severity score and appropriate trauma care provisions at all stages of care, may have a positive impact on patient prognosis and outcome in general. Therefore, analyzing the determinants of death in traumatized ICU patients becomes crucial when these determinants are organized hierarchically at different levels of determination. It is strongly believed that this analysis strategy can contribute a lot to the knowledge of factors that are associated with death and, above all, to monitor and direct patient care with the adoption of a teamwork approach and qualified interdisciplinary and inter-professional care provisions in the study setting and the country at large.

This study will aid healthcare professionals, governments, and non-governmental organizations in their attempts to reduce trauma patients' avoidable deaths. healthcare professionals should prioritize interventions, Assist MOH in monitoring and evaluating the HSTP II trauma in ICUs across the country and the study area by providing factual information. Managers assign resources and oversee health service programmes. Additionally, it will be a helpful resource for other scholars and a plan for further research.

2. LITERATURE REVIEW

To determine the profile of survival status and mortality rate due to trauma we have to explore several factors that remain associated with death. A sociodemographic factor of the patient, the factors after the initial trauma care, either by accident or violence, in the period between the occurrence of trauma and hospital admission, and the ICU stay, are some of identified associated factors. Early identification of factors associated with death from ICU trauma, which considers severity and trauma care at all stages of care, may have a positive impact on patient prognosis(2,15).

2.1. The magnitude of trauma patients in ICU among trauma patients

A multi-centered prevalence study done by the American Association for Surgery of Trauma reported that among total ICU patients, 46.69% of them were found to be trauma patients(25). An ecological time-series study done in Brazil found that the magnitude of trauma patients had covered almost half of(44.3%) ICU Patients(26). Another prospective and retrospective study done in Tanzania and Ethiopia reported that the magnitude of trauma patients in ICU was 37.1%, and 35.5% respectively(13,27).

2.2. The incidence of mortality in trauma patients admitted to the ICU

A worldwide large-scale study analyzed all-cause mortality for 188 countries from 1950 to 2013; it presented only results from 1990–2013, which had been coincided with the period of the overall Global Burden of Disease (GBD) 2013 assessment, According to a report, for the majority of countries, the general trend of declining age-sex-specific mortality and progressive shift towards an increased share of the remaining deaths brought on by non-communicable diseases and injuries(28).

Retrospective and prospective Studies conducted in the United States (US) and Europe revealed that trauma patients admitted to the ICU had a mortality rate of 20.7% and 15.5 % - 28.2% respectively(2,6,29,30).

In contrast to mentioned studies, African and Asian retrospective and prospective studies conducted independently in Yemen, Tanzania, and Ethiopia had documented that the mortality rate of trauma patients admitted to the ICU was 28.1%, 32.7%, and 12.4 %- 50.% respectively(12,13,27,29).

2.3. Factors Affecting Admission and Mortality in trauma patients admitted to the ICU

Sociodemographic factors

In Global Based, European, Asian, and African settings similar retrospective research, which had been conducted in the association of sex with trauma patients' ICU mortality, revealed that the male gender had got a higher incidence of mortality in the ICU than the female gender. The reason for this can be considered that the admission time, the male gender is higher in number than females which once again can be justified that men take a more outdoor active role in daily life than women and they spend more time in risky environments such as battlefield at large(15,16,27,32).

On the other hand, in an attempt of describing the association between age and ICU, mortality well-defined studies conducted in Brazil, Turkey, and Yemen revealed that old age was found to be an independent risk factor; it means that as one gets older and older the risk of dying in the ICU dramatically increases. Despite these findings, the mean age of patients who had been discharged and died in the ICU was found to be similar (2,3,5,29).

Total pre-hospital Time (from trauma scene to hospital admission)

For trauma victims, travel time to the medical facility is a key consideration. One hour is determined to be a determining factor for patients' greater survival based on The Golden Hour concept. Longer total pre-hospital time (TPT) is independently associated with increasing all-cause in-hospital mortality(33,34).

A study done in France shows that TPT is shorter than 60 minutes, the results of this retrospective cohort study from two French trauma registries demonstrate a linear association between TPT and in-hospital all-cause mortality. The odds of death increased by 8% for each 10-minute increase in prehospital time(34). In contrast, a similar study in Saudi Arabia shows that the mean time from the incident to arrival at the hospital was 41.3 ± 79.8 minutes(35).

A prospective study review in South Africa showed that the average transfer time to the hospital among road crash victims was 9.2 hours (range 1 - 17 hours) which shows an immature trauma system(36).

The majority of Ethiopia's trauma patients are found in Gondar and Addis Abeba, where prospective hospital-based follow-up and cross-sectional studies among trauma patients were conducted. The results of the first study conducted in Gondar show that the total pre-hospital time interval was 6.02 hours, and the hospital arrival time for injuries sustained in the town was 144 minutes while it was 537 minutes for injuries sustained in the rural areas. In the second study, the time of arrival within an hour from the scene to the initial medical facility was 56.1%, and in 1-3 hours was 35.5%. Variations in TPT between different countries may be caused by travel distances to the closest trauma centers from incident scenes, traffic congestion or other road conditions, or weather conditions(33,37,38).

Condition at admission factors

Prospective studies well-articulated that the presence of pre-existing comorbidities such as coronary artery disease, hypertension, low level of consciousness or Glasgow Coma Scale(GCS), end-stage renal disease end-stage renal disease, and higher trauma severity scores are highly associated with mortality in trauma ICU. In other studies, the type of trauma, such as multiple trauma, head trauma, or thoracic trauma, was found to be an independent risk factor for trauma ICU mortality and was associated with higher odds of trauma patient mortality outcome in the ICU. Distorted laboratory reports, such as a higher level of lymphocytes and lower level of red blood cells and platelets, longer activated partial thromboplastin time (aPTT), and lower level of platelet to lymphocyte ratio (PLR), were also found to be risk factors(31,39).

In studies conducted in Spain and Yemen, the concomitance of multiple organ injuries such as severe head/neck injuries, acute renal injuries, septic shock, and hemorrhagic shock was also strongly related to trauma ICU mortality(6,29).

Reason for admission factors

A worldwide approach study done under GBD reported that mortality rates in the trauma ICU dependent on traffic-related injuries had been found to increase in low- and middle-income countries. The literature also showed that pedestrians were more likely to encounter traffic-related injuries, followed by car users and motorcycle riders, while deaths due to traffic-related injuries are getting reduced in high-income countries(28).

On the other hand Reasons for ICU admission of trauma patients greatly vary from set up to set up for example; According to a study by a Turkish scholar, falls (32.7%), extra-vehicular traffic accidents (24.8%), and in-vehicle traffic accidents (33.7%) were the most prevalent reasons for trauma ICU admission. Head trauma was the most common reason for admission for the majority of patients(3).

Post admission factors

According to a New York retrospective study, patients in the intensive care unit who experienced one or more complications had a significantly higher mortality rate (16.9% as opposed to 10.7% for those who did not). Pneumonia (10.9%), urinary tract infection (4.7%), and ARDS (4.4%) were the most common hospital complications among ICU patients. Concerning hospital problems among patients admitted to the ICU, mechanical ventilation had the highest odds ratio. The majority of these complications are related to comorbidities, ICU interventions, and length of stay in the ICU(5).

Similar retrospective Studies conducted in Brazil, Taiwan, and Turkey which had been independently studied well revealed that the duration of mechanical ventilator support was highly associated with trauma ICU mortality. Mechanical ventilation support and its increased duration are risk factors for mortality in trauma patients and it was reported that the mortality rate was about 50% in patients receiving mechanical ventilatory support. The possible scientific justification for this can best be explained by that an increased duration of mechanical ventilation leads to the Utility of vasoactive drugs, the Coincidence of circulatory complications, and, posing of hemodynamic instability, prolonged hospital stay, and other mechanical ventilatory support associated problems which increase mortality in ICU trauma patients(2,40,41).

There are no set definitions, but the prolonged length of stay (LOS) generally refers to patients with a LOS of more than 7 to 14 days, which is highly associated with mortality and utilization disproportionate amount of hospital resources(15).

2.4. Conceptual framework

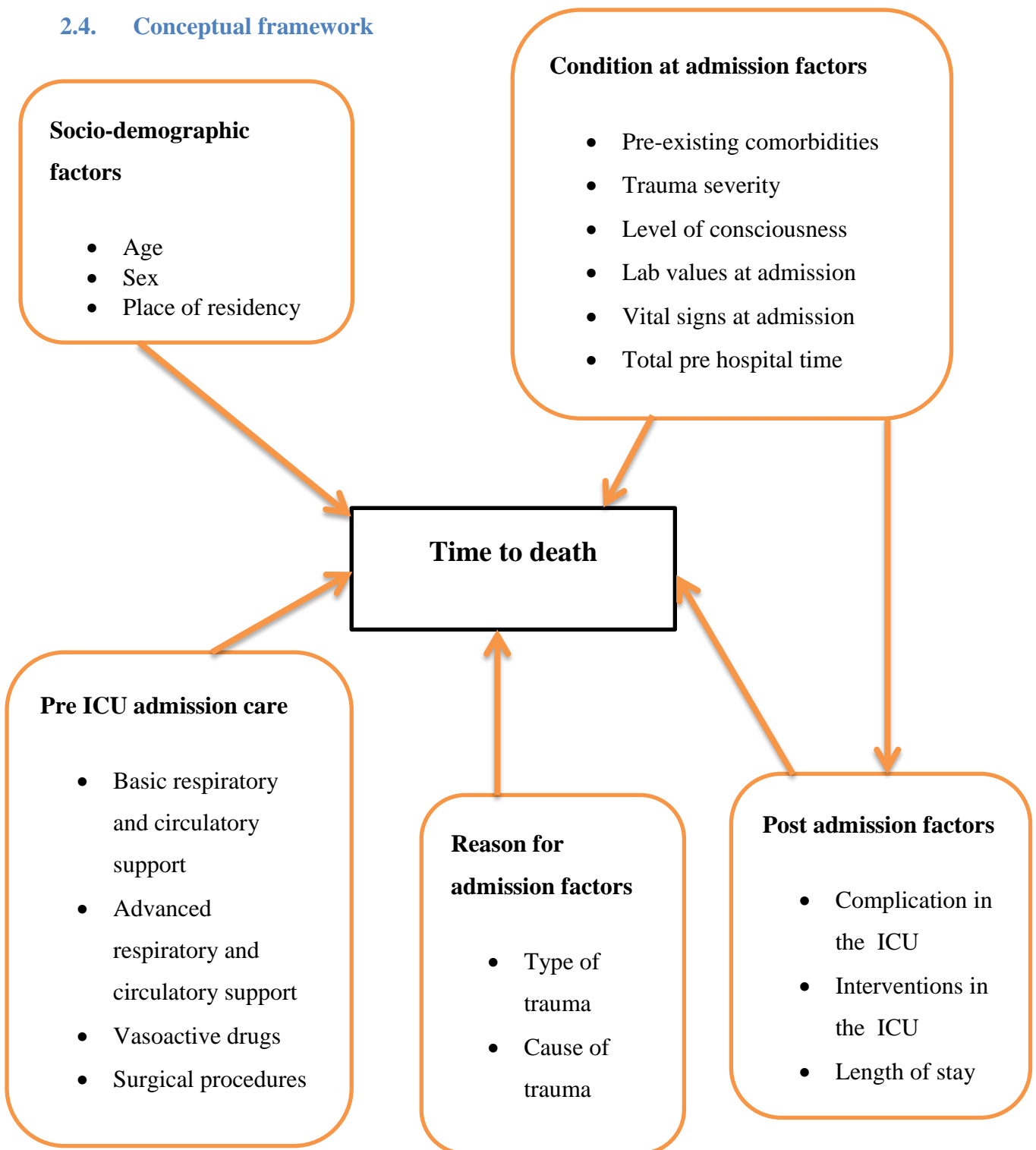


figure 1. Conceptual framework mortality from trauma patients admitted to ICU –formulated from a review of the literature.

3. OBJECTIVES

3.1. General objective

- ✚ To estimate the survival status and predictors of mortality among trauma patients admitted to intensive care units of selected governmental hospitals in Addis Ababa from December 2017 to December 2022 G.C.

3.2. Specific objective

- ✚ To determine the survival status of trauma patients admitted to the intensive care unit of Selected Governmental Hospitals in Addis Ababa from December 2017 to December 2022G.C.
- ✚ To identify predictors of mortality among trauma patients admitted to intensive care units of selected governmental hospitals in Addis Ababa from December 2017 to December 2022 G.C.

4. METHODS

4.1. Study design

An institution-based multi-centered retrospective cohort study was conducted from December 2017 to December 2022 G.C.

4.2. Study area and study setting

Addis Ababa is the capital and largest city of Ethiopia (figure 2). According to World Population Review 2022, the population size of Addis Ababa town is estimated to be 5,227,794. There are 12 public and 46 private hospitals in Addis Ababa, but only three public and four private hospitals have trauma care units (42). Previously, only Tikur Anbessa Specialized Hospital (TASH) provided specialized care to all types of trauma patients, but now AaBET(St. Paul) and ALERT hospitals have trauma centers to handle all patients(21). Therefore the study was conducted in purposively selected three governmental hospitals based on a higher number of trauma patients admitted to the ICU per year in Addis Ababa. TASH, AaBET hospital, and ALERT hospital.

Tikur Anbessa Specialized Hospital was established in 1972. It is the largest teaching and specialized hospital in Ethiopia, with over 800 beds, and serves as the teaching center for undergraduate and postgraduate medical students, and medical-related fields, it offers diagnosis and treatment for approximately more than 700,000 patients per year. It has 4 Pediatric ICU tables, 6 surgical ICUs to which trauma patients are also admitted, beds, 28 fully functional Neonatal ICU beds, and 13 adult ICU beds as multipurpose for both medical and surgical cases and the operation room working with nine tables and 8 postoperative anesthesia care unit beds. The hospital provides specialties of internal medicine, general surgery, orthopedics, obstetrics, gynecology, pediatrics, psychiatry, dermatology, pathology, radiology, ophthalmology, and dental health services.

AaBET Hospital is an affiliate of Saint Paul's Hospital Millennium Medical College(SPHMMC), which was established in 2015 to improve emergency and trauma care in Addis Ababa, Ethiopia. The hospital has a well-organized emergency department with more than 50 beds 13 ICU beds, including three semi-ICU beds, 200 beds in inpatient departments of orthopedics, neurosurgery, general surgery, and burn unit, and 4 operation theaters. In AaBET hospital, more than 30,000 patients are seen per year; out of these, more

than 70% are trauma cases. Emergency medical and critical care, orthopedics, neurosurgery, general surgery, and burn care are available.

ALERT Hospital is a medical facility on the edge of Addis Ababa. Currently, it has a 240-bed in-patient department, and 10 ICU beds, it has also specialty teaching departments including dermatology, ophthalmology, and surgery departments, an orthopedic workshop, and a rehabilitation program. 6 Surgical ICU beds at Tikur Anbessa Hospital, 13 ICU beds at AaBET Hospital, and 10 ICU beds at ALERT Hospital. On average 20 trauma patients in AaBET hospital, 10 trauma patients in ALERT, and 5 trauma patients in Tikur Anbessa are admitted per month.

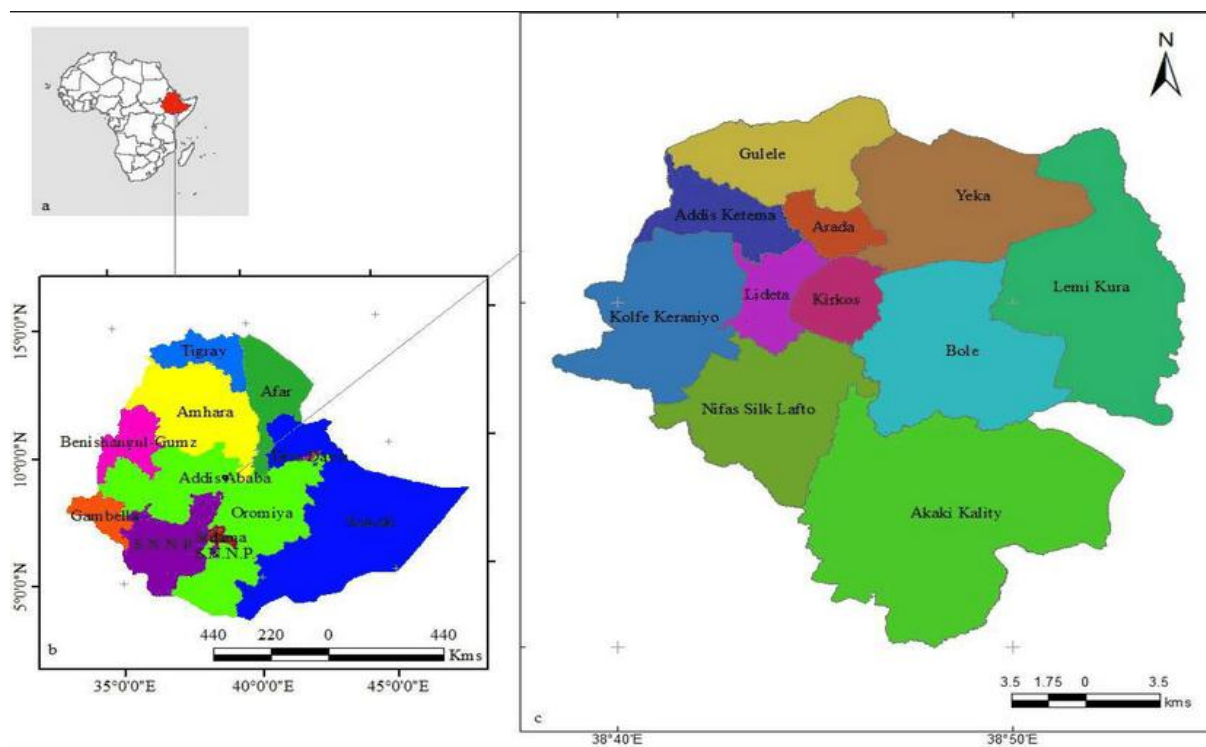


figure 2. Map of Addis Ababa, Ethiopia, Source: Ethio GIS (2022)

4.3. Population and study periods

4.3.1. Source population

All trauma patients who are admitted to the intensive care unit of selected governmental Hospitals in Addis Ababa.

4.3.2. Study population

All adult trauma patients admitted to the intensive care unit of the selected governmental Hospitals in Addis Ababa from December 2017 to December 2022 G.C.

4.3.3. Study period

The study period covers from December 2017 to December 2022 G.C

4.3.4. Data collection period

The actual data collection period was from February 1-March 30, 2023G.C

4.4. Sample size and sampling techniques

4.4.1. Sample size determination

Since we do not find similar studies in a similar setting as much as our search to calculate sample size by using the sample size formula for survival to fulfill variables needed for survival sample size calculation like hazard ratio(HR). So the sample size for this study is calculated by epi info using single population assumptions for the first objective by considering

p= proportion of mortality rate among trauma patients in ICU

$\frac{z\alpha}{2}$ z score of 95%CI

d= margin of error(5%)

$$n = \frac{\left(\frac{z\alpha}{2}\right)^2 (1-p)}{d^2}$$

And double population proportion assumptions for the second objective.

$$n1 = \frac{\{z\alpha/2\sqrt{1+\frac{1}{r}p(1-p)}+z\beta\sqrt{p1(1-p1)+p2(1-p2)}\}^2}{(p1-p2)^2}$$

The size is calculated by considering $Z_{1-\beta}$ the desired power (80%), $Z_{1-\frac{\alpha}{2}}$ critical value (95%), percent of the event unexposed, percent of the event exposed, the ratio of subjects(unexposed pre-exposed), and margin of error(5%). The Percentage of events and frequency of outcomes were taken from different studies, which have similarities in scope with this research objective (table 1).

Table 1. Sample size determination

For the first objective(ICU mortality)

Population size	Frequency of outcome	Margin of error	Sample size	Total sample size after adding a 15% contingency	Reference
2100	50%	5	325	374	(12)
2100	12.4%	5	155	179	(13)

For the second objective (factors predict mortality in ICU)

Variables	The ratio of unexposed to exposed	% of outcomes in unexposed	% of outcomes in exposed	Sample size	Total sample size after adding a 15% contingency	Reference
Vasoactive Drug use	1	30.5%	69.5%	52	60	(2)
Mechanical ventilator	1	9.3	90.7	12	14	(2)
Renal dysfunction	1	41.5	58.5	272	313	(2)
Hepatic dysfunction	1	40.7	59.3	228	263	(2)
Neurologic dysfunction	1	25.4	74.8	34	40	(2)

Therefore, based on the above calculations, the highest number of subjects (n) will be selected and the final sample size is going to be 374 (From the primary objective).

4.4.2. Sampling procedures

The five years total ICU admission in each Z, Y, and X hospitals were 300, 1200, and 600 respectively. The total ICU admission in the three study centers was ($N = 2100$) patients. The study populations are taken from each ICU with proportional allocation formula by dividing the admission in each ICU by the total admission of the three ICUs multiplied by the sample size which is $K = n_i \cdot n_f / N$, ($n_f = 374$). $Z = n_1 / N \cdot n$, $Y = n_2 / N \cdot n$, and $X = n_3 / N \cdot n$ where n_1 , n_2 , and n_3 were the total admission in Z, Y, and X hospitals respectively as shown in the strobe flow diagram Figure 1. Computer generated simple random sampling technique was employed to choose the needed number of participants from all trauma patients admitted in the given recruitment period.

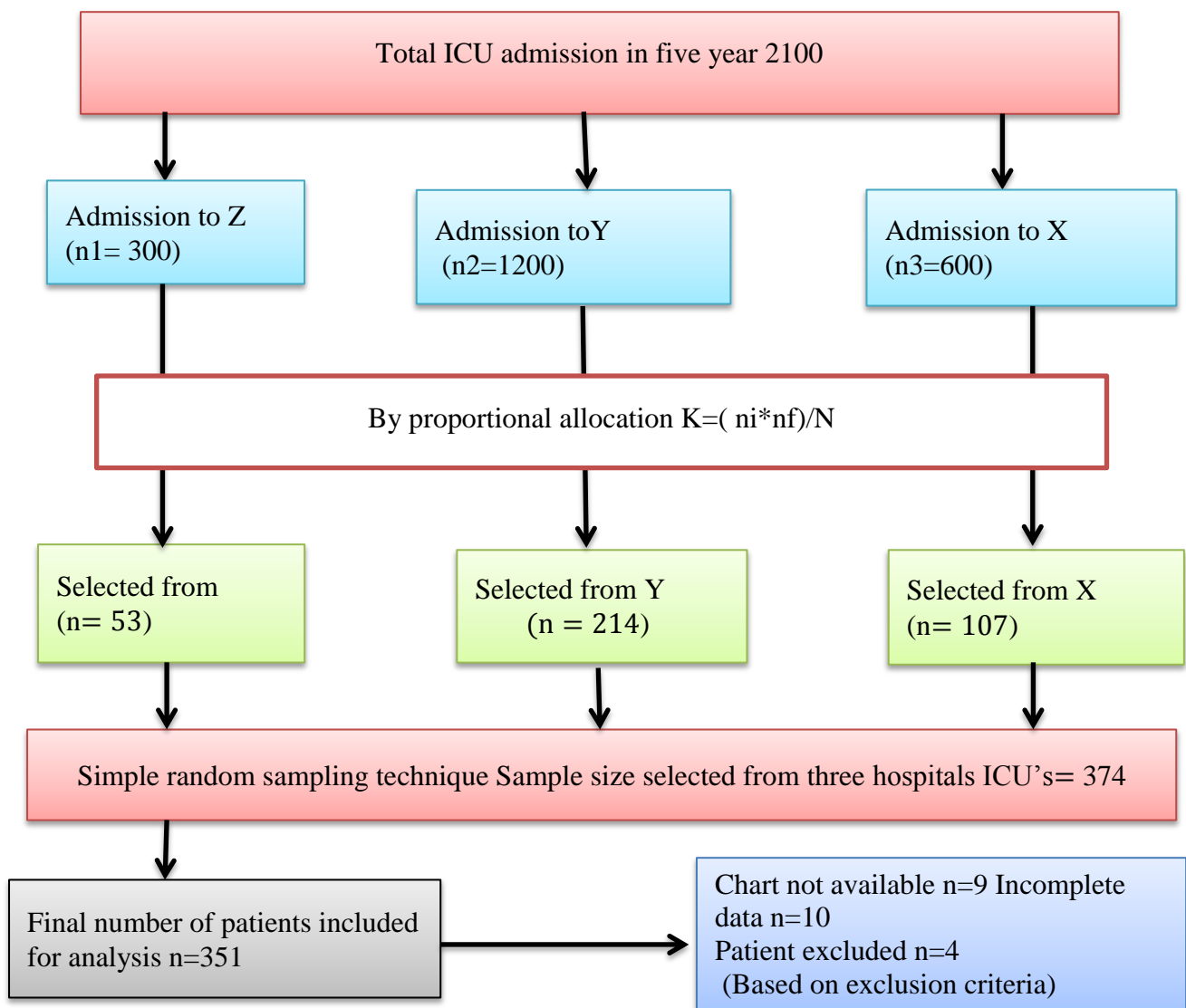


figure 3. Strobe flow chart of the sampling procedure.

4.4.3. Inclusion and exclusion criteria

4.4.4. Inclusion criteria

All adult trauma patients aged > 18 admitted to the intensive care unit of selected Hospitals between December 2017 and December 2022 were included.

4.4.5. Exclusion criteria

Patients who had missed key variables or incomplete records were excluded from the study. Any trauma related to burns and poisoning, since these are considered specific types of trauma requires differentiated intensive care(2).

4.5. Variables of the study

4.5.1. Dependent variable

Time to death

4.5.2. Independent variable

Sociodemographic factors: age, Sex, and Place of residence

Reason for admission factors: area of injury, and, Cause of trauma

Pre-ICU admission care: - Basic respiratory and circulatory support, Advanced respiratory and circulatory support, Vasoactive drugs, and surgical intervention.

Condition at admission: Pre-existing comorbidities, Level of consciousness, Lab values at admission, care given at emergency trauma center, time duration of admission, type of trauma, and Vital signs at admission

Post-admission factors: Complications in the ICU, Interventions in the ICU, and length of stay in the ICU

4.6. Data collection analysis and quality control

4.6.1. Data collection procedures

Data collectors: A data extraction checklist was prepared by reviewing literature in English. Three healthcare professionals was collect the data under the supervision of three health

professionals having a minimum qualification of BSc degree at Tikur Anbessa Hospital surgical ICU, AaBET Hospital ICU, and ALERT Hospital ICU. The data clerks assist them by recognizing the patient cards.

4.6.2. Data quality control

At St. Peter's Specialised Hospital in Addis Ababa, a pre-test was conducted on 38 participants (10% of the calculated sample size) to confirm data quality, and corrections were made as necessary. Before data collection started, one day of training was provided to the supervisor and data collectors on the purpose of the study as well as how to review the documents using the format for data extraction. The principal investigator, with another supervisor, supervised the overall process. The filled formats were checked for completeness by the principal investigator and the supervisor daily.

4.6.3. Data processing

The data from the completed structured data retrieved form were examined for completeness and accuracy. After ensuring data quality, forms were gathered, and sequential numbers (code) were issued to facilitate data input. The data were inserted using EpiData version 3.1 and clean-up was performed to ensure correctness and consistency and correct any mistakes. After ensuring that the data was entered correctly, it was exported to STATA/MP V.17 for analysis. Additional data cleansing and frequency checks were performed to examine the precision, consistency, and missing values and variables. The study population's key variables were described using cross-tabulations and summary statistics

4.7. Data analysis

Utilizing exploratory data analysis, missing values and outliers were examined. Using a variance inflation factor (VIF) with an acceptable cut-off VIF of less than 10, multicollinearity was examined. The median with interquartile range for nonnormally distributed data was used for continuous variables. Normal data distribution was checked by histogram. Frequency and percentages were used to describe categorical variables. The probability of death over time was estimated using a life table. The KM failure curve was used to estimate the median survival time and cumulative probability of death. The presence of differences in the probability of mortality among the categorical variables was examined using the KM survival curve and the log-rank test. Before fitting the Cox regression model to

the data, its data fitness and proportional hazard assumptions were evaluated both graphically and statistically using the log-log plot($\log(-\log(\text{survival probability}))$ Vs $\log(\text{survival time})$) and Schoenfeld residual test, respectively, and it was satisfied ($p=0.2733$). In addition, shared frailty was checked to see unobserved heterogeneity between hospitals and the p-value for the likelihood ratio test for theta was non-significant at $p > 0.05$ which showed the classical Cox regression model was the best-fitted model over the Cox frailty model for the sake of model parsimony. The Cox proportional hazard regression was used to explore the association between each independent variable with the outcome variable. The model's fitness was checked by using Cox-Snell residuals test and the hazard function follows 45° close to the baseline hazard which indicated that the model was well fitted. For the residual test, it was possible to conclude that the final model fit for data well. To determine the impact of each independent variable on the dependent variable, a bivariate Cox regression analysis was used. In the multivariable Cox regression analysis, variables with a P-value of less than 0.2 in the bivariable Cox regression analysis were used to identify the independent mortality predictors and candidates for the multivariable analysis. The strength of the association between the factors and the predictors of mortality among trauma patients was assessed using the adjusted hazard ratio (AHR) with 95% confidence intervals (CI), and variables with a p-value of less than 0.05 were deemed statistically significant.

4.8. Operational definitions

Censored: Trauma patients admitted to ICU but recovered and discharged to wards, discharged against medical advice, and transferred out to other health institutions or to home without knowing the outcome. Or patients survived until the end of follow-up, but don't know how much longer they will survive(right censoring)(43).

Survival status: Is the outcome of trauma patient admitted to the ICU either death or censored

Event: Death in ICU

Incomplete records: If the date of admission, date of discharge, and outcome are not recorded on the patient chart.

Survival time: Measures the follow-up of time from a defined starting point/from the admission of a trauma patient admitted to ICU up to the event's occurrence.

Length of stay: The total number of days the patient was admitted to the ICU before the event or being censored.

Readmission: patients readmitted to the ICU during the same hospital stay.

Anemia: level of hemoglobin < 12.0(g/dl) and < 13.0(g/dl) for women and men respectively (44).

Hypoxia: SpO₂ < 90 % (45).

Glasgow coma scale (GCS): mild (GCS of 13–15), moderate (9–12) & severe (3–8)(46).

Complications at ICU: Diseases like cardiac arrest, anemia, arrhythmia, infection, hypotension, hypertension, aspiration, and ARDS that manifested during a patient's stay in the intensive care unit but were not disclosed at admission.

Trauma severity score

Trauma severity was computed using the "Revised Trauma Severity Score (RTS)" which is a physiologic evaluation criterion to predict the outcome of trauma patients. Which is based on three indicators, those parameters are GCS, respiratory rate (RR), and systolic blood pressure(SBP)(46,47). According to the revised trauma score, these three parameters are coded and added and the result is divided into four from 0(worst) to 4(best). By using our analysis software. Association of trauma scores with mortality, stratified by low (RTS >7.7), medium(RTS 4 - 7.7), high risk(RTS < 4) for death, and(RTS < 3) non-survivor(46,48).

Table 2. Revised trauma score

GCS	Code	SBP	Code	RR	Code
13-15	4	> 89	4	10-29	4
9-12	3	76- 89	3	>29	3
6-8	2	50-75	2	6-9	2
4-5	1	1-49	1	1-5	1
3	0	0	0	0	0

$$\mathbf{RTS = 0.9368 GCSV + 0.7326 \times SBPV + 0.2908 \times RRV, Where v is the value(0 - 4)}$$

4.9. Ethical consideration

Ethical clearance was approved and obtained from the Institutional Review Board (IRB) of the Department of Anesthesia, College of health science, Addis Ababa University, SPHMMC, ALERT Hospital, and SPSH. Each client did not need to give their informed consent because this is secondary data; instead, a request for waiver of informed consent was sent to the administrator of the relevant institution. The confidentiality of the patients was respected, their identities were not disclosed, and questionnaires were kept locked.

Dissemination of result

The final result of the research will be submitted to the Department of Anesthesia, College of Health Science, Addis Ababa University, SPHMMC, and ALERT Hospital. Next, the study findings will be disseminated to the regional health bureau and respective health facilities. Lastly, an attempt will be made to publish the findings in a peer-reviewed scientific journal.

5. RESULT

5.1. Socio-demographic characteristics of the participants

Between December 2017 and December 2022, 2100 trauma patients were admitted to the ICU of the selected three governmental hospitals. Of 374 randomly selected study subjects, 23 study subjects were excluded based on the predetermined exclusion criteria (10 had incomplete data, 9 had lost charts, 1 had poison, 1 had burned, and 2 were pediatrics). A total of 351 patients were recruited, and included in the analysis, with a response rate of 93.9%. The majority of the study subject were males accounting for 303 (86.3%) of the total sample. The median age of the study participants was 30 years with an IQR of (25-41). More than two-thirds (69.5%) of the study subjects were urban residents. Most patients admitted to ICU were between the age of 18 – 39 years.

Table 3. Socio-demographic characteristics of trauma patients admitted to ICU of selected hospitals in Addis Ababa, December 2017 – December 2022(N=351)

Variable	Category	Censored (n=245)	Event (n=106)	Total (N=351)
		n(%)	n(%)	n(%)
Age in years	18 – 39	188(53.56)	58(16.52)	246(70.09)
	40 – 59	43(12.25)	33(9.40)	76(21.65)
	≥60	14(3.99)	15(4.27)	29(8.26)
Sex	Female	33(9.40)	15(4.27)	48(13.68)
	Male	212(60.40)	91(25.93)	303(86.32)
place of residency	Rural	82(23.36)	25(7.12)	107(30.48)
	Urban	163(46.44)	81(23.08)	244(69.52)

5.2. Injury Patterns and Characteristics of Patients

Out of the total 351 trauma patients admitted to ICU, 239(68.1%) had received pre-ICU admission care. Three-fourths (75%) of the total patients had encountered blunt injuries. Whereas the rest 24.2% and 0.85% of patients were admitted secondary to penetrating and

both penetrating and blunt injury respectively, RTA was the leading cause of injury (50.7%), of this majority of them were pedestrian (60.2%). Nearly half (47.9%) of patients had isolated head injuries, followed by polytrauma (36.8%) (figure 4).

We computed the injury severity score using the revised trauma score. Accordingly, the median with IQR revised trauma score (RTS) was 6.61(5.67-7.55) The injury severity score ranges from 2.33 to 7.55. According to our data, an RTS of < 3 (non-survivable injury score) was observed in 4 (1.14%), and a score of less than 4 (high risk of mortality) was recorded among 31 (8.83%). Based on the Glasgow coma scale score, 173 (49.29%) had a severe head injury, 62 (17.66%) had a moderate head injury and 116 (33.05%) had mild head injuries. Moreover, the rate of mortality was 84 (23.93%) for severe, 13(3.%) for moderate, and 9 (2.56%) for mild head injuries.

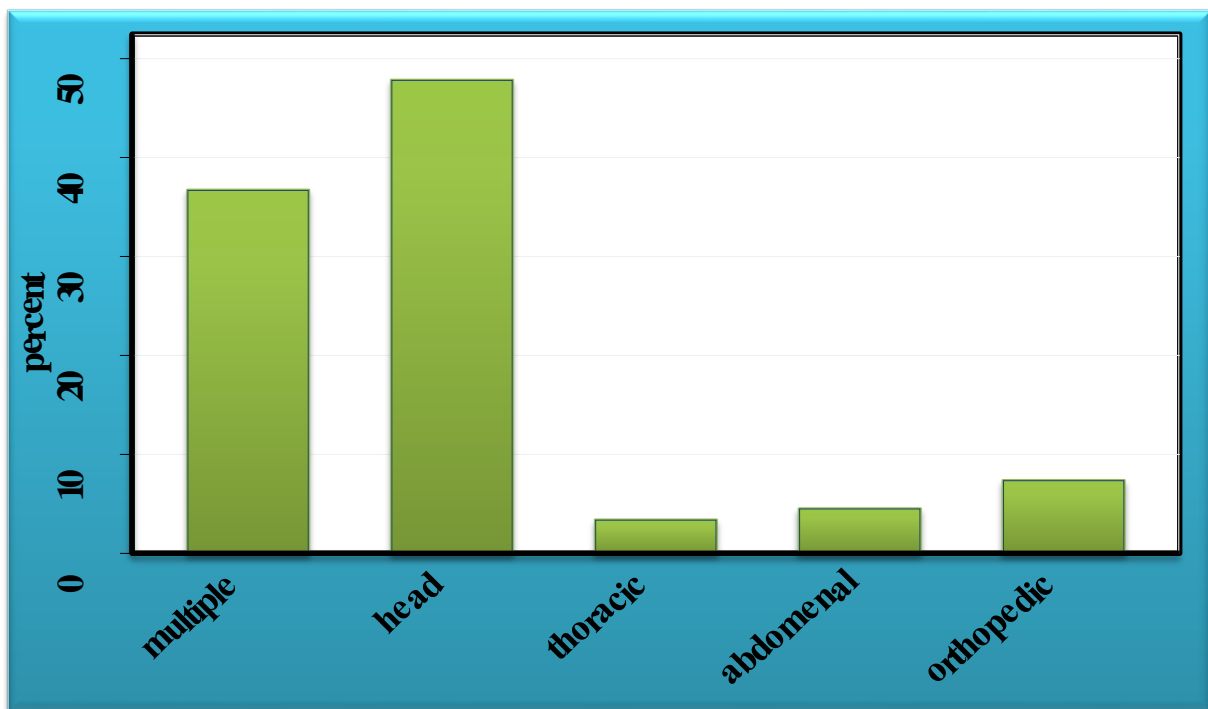


figure 4. Type of trauma during admission to ICU among trauma patients at selected hospitals in Addis Ababa, December 2017 – December 2022 (N= 351)

Table 4: summary statistics for RTS among trauma patients admitted to ICU of selected hospitals in Addis Ababa, December 2017- December 2022(N=351)

Survival status	RTS			
	Min	Max	Median	IQR
Censored	3.80	7.55	7.55	(5.68-7.55)
Event	2.34	7.55	5.68	(4.74-6.61)
Overall	2.34	7.55	6.61	(5.67-7.55)

RTS=Revised trauma score, IQR= Interquartile Range, Min= minimum, Max= maximum

5.3. Clinical characteristics of patients during and following admission to the ICU

In this study 10.3% of patients had comorbidity and more than two – third of (67%) of patients were anemic. Thirty-four (9.7%) patients out of total patients were hypoxic with Spo₂ below 90%, and 43%, 9.4%, 68.8%, 10.8%, and 49.3% patients had HR >100(bpm), systolic blood pressure < 90(mmHg), temperature < 36.5⁰c serum creatinine level >1.3(mg/dl), and GCS < 9 during admission to ICU respectively.

Out of 351 patients 278 (79.2%) of patients were supported by mechanical ventilation, of this 26.2% of the patients supported more than 10 days, and 24.2%, 31.7% and 27.4% of the patients had received intervention with vasoactive drugs, blood transfusion and surgical intervention in ICU respectively.

More than half of patients 202(57.6%) developed complications during their ICU stay, Among complications developed by patients shock, sepsis, and pneumonia were the most common complications(19.1%, 21.1%, and 19.2%) followed by hypotension(16.8%) and 14.8%) respectively. Furthermore, cardiac arrest, aspiration, hypertension, arrhythmia, infection, and fat embolism were 6.84%, 2.85%, 6%, 7.4%, 7.1%, % and 0.85% respectively and nearly half 103(48.5%) of patients develop other complications.

The median total pre-hospital time was 3 hr (IQR 2-10) and Greater than 20.5% of the patients had a total pre-hospital time of greater than 12 hr, and half of the patients (50%) had greater than 7 days of admission in the ICU.

5.4. Survival status of trauma patients admitted to the ICU

In this study, patients were followed for a variety of lengths of time, with a median follow-up of 8 days (IQR= 3-18) ranging from a minimum of 3 hours to a maximum of 85 days based on this the total observation was 4550.6 person–days. In this study, 106 (30.2%) trauma patients died in the ICU (95% CI= 25.4-35.2), about 245 (69.8%) trauma patients admitted to the ICU were censored, 174(49.6%) were transferred to wards,46(13.1%) were referred to other hospitals, 24(6.8%) were transferred to home, 1(0.28) discharged against medical advice.

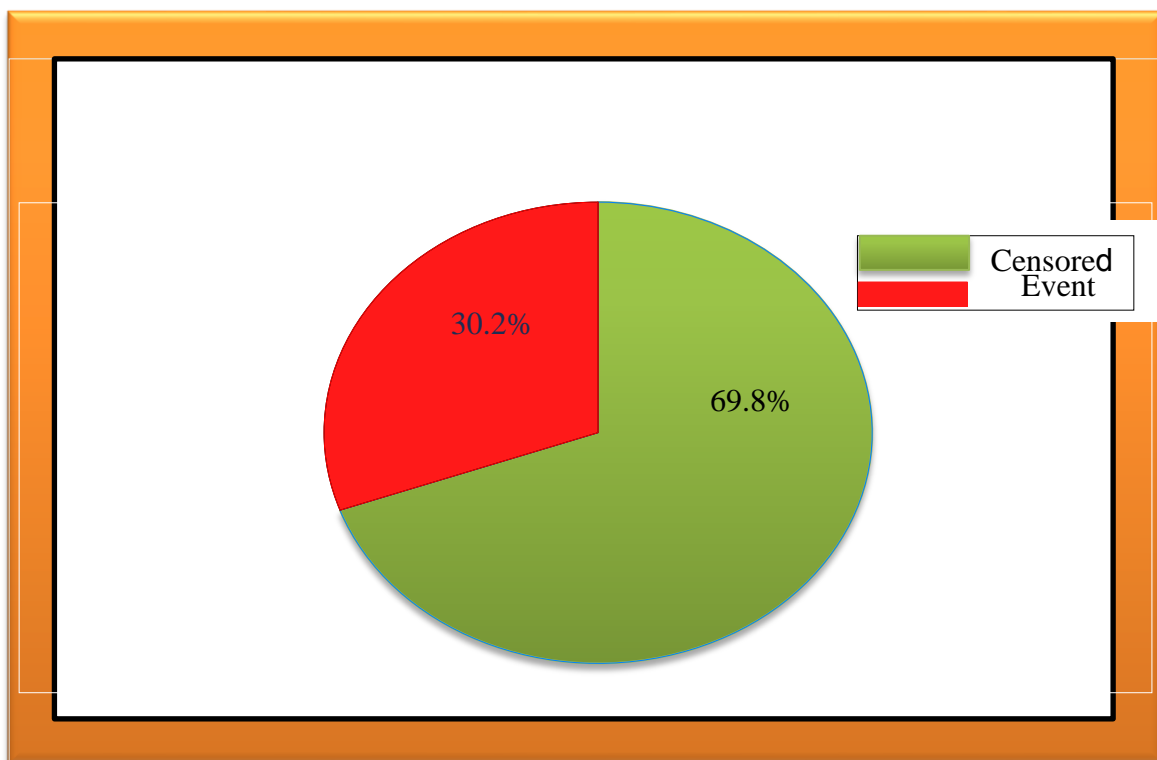


figure 5. Pie chart of the proportion of survival status among trauma patients admitted to ICU at three selected hospitals in Addis Ababa from Dec 2017 to Dec 2022(N=351)

The incidence of death among trauma patients in the ICU was found to be 2.3 cases (95 CI= 2.1 – 2.5) per 100 person–day observation. Among deaths reported half of 175 (49.9%) of

mortality was observed in the first week after admission. The cumulative probability of death at the end of 1, 7, 14, 20, 30, 40, and 85 days was 1.4%, 18.3%, 37.1%, 47.1%, 62.4%, and 78.4% respectively. The median time of survival was found to be 33 days with IQR (10-68).

Kaplan-Meier failure curve was used to describe the median survival time and cumulative probability of death over the follow-up period.

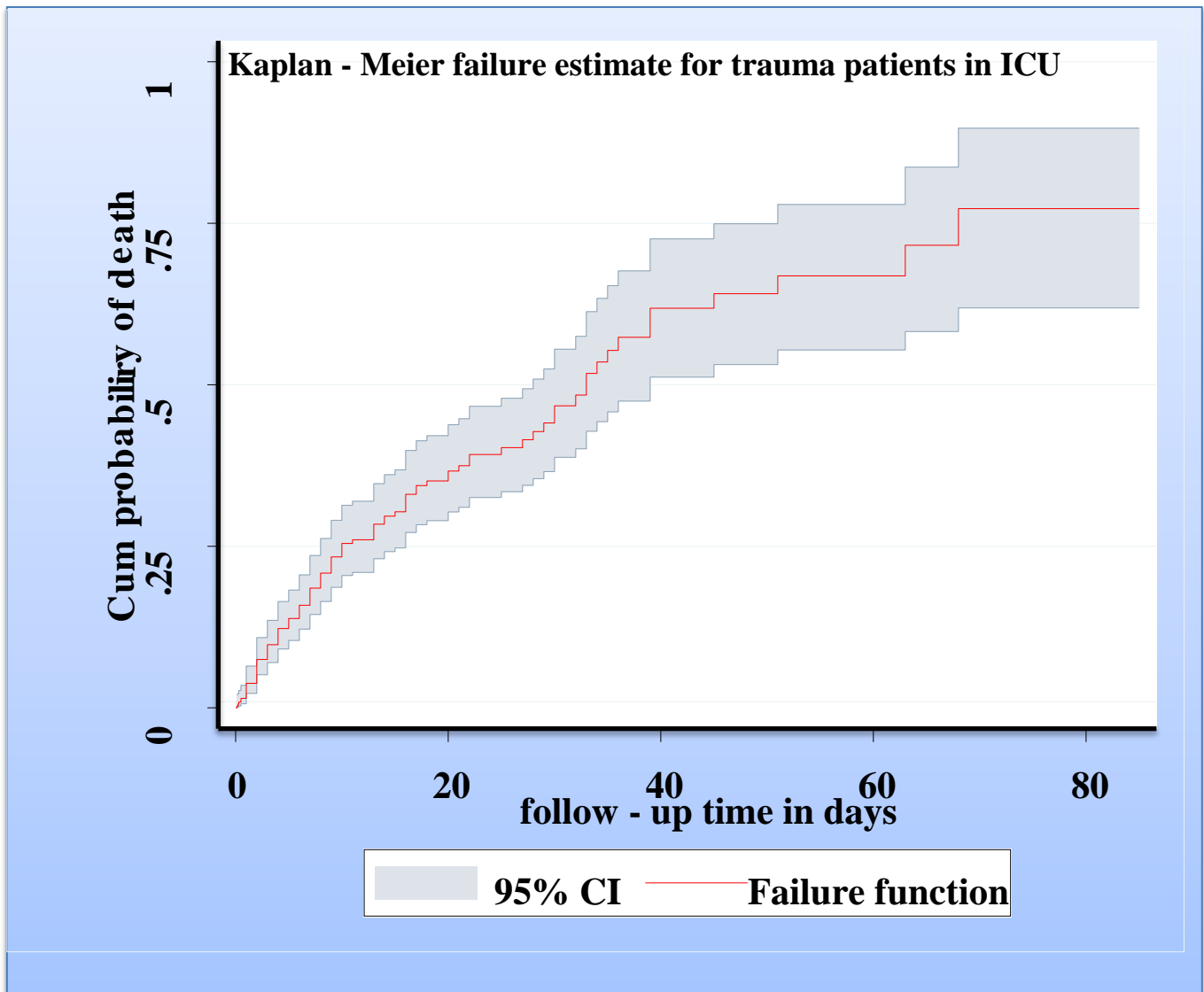


figure 6. Kaplan Meier failure estimate for trauma patients in three ICU selected hospitals in Addis Ababa, December 2017 – December 2022 (N=351)

5.5. Predictors of mortality among trauma patients admitted to ICU

For each category variable, a unique graph representing the failure estimates of Kaplan Meier survival functions was generated. This made it possible to distinguish between individuals in the designated groups who had different levels of survival experience. Overall the arrangement of one failure function resting above another suggests that the group represented by the lower curve has a higher survival rate than the group represented by the higher curve.

The log-rank test was used to determine if there is a statistically significant difference between the survival functions of groups shown by Kaplan-Meier estimates. According to the log-rank test result, there was a significant difference in survival among categories of heart rate, Spo2, GCS score, vasoactive, complication, and creatinine. However, there is no significant difference among categories of most physiologic factors such as anemia, respiratory rate, SGOT, SGPT, and platelet. Patients with no history of complications during ICU stay better survival experience than those with complications, which is supported by the log-rank test (log-rank $\text{Chi}^2(1) = 31.17$, $p\text{-value} < 0.0001$)

Table 3. Results of the Log-rank test for the categorical variables determining mortality in ICU by age, gender, residency, and Co-existing illness of selected hospitals in Addis Ababa, December 2017 —December 2022.

Variables	df	Chi-square	P-value
Age	2	8.63	0.0134
Gender	1	0.00	0.9672
Residency	1	4.51	0.0336
Co-existing illness	1	0.06	0.8036

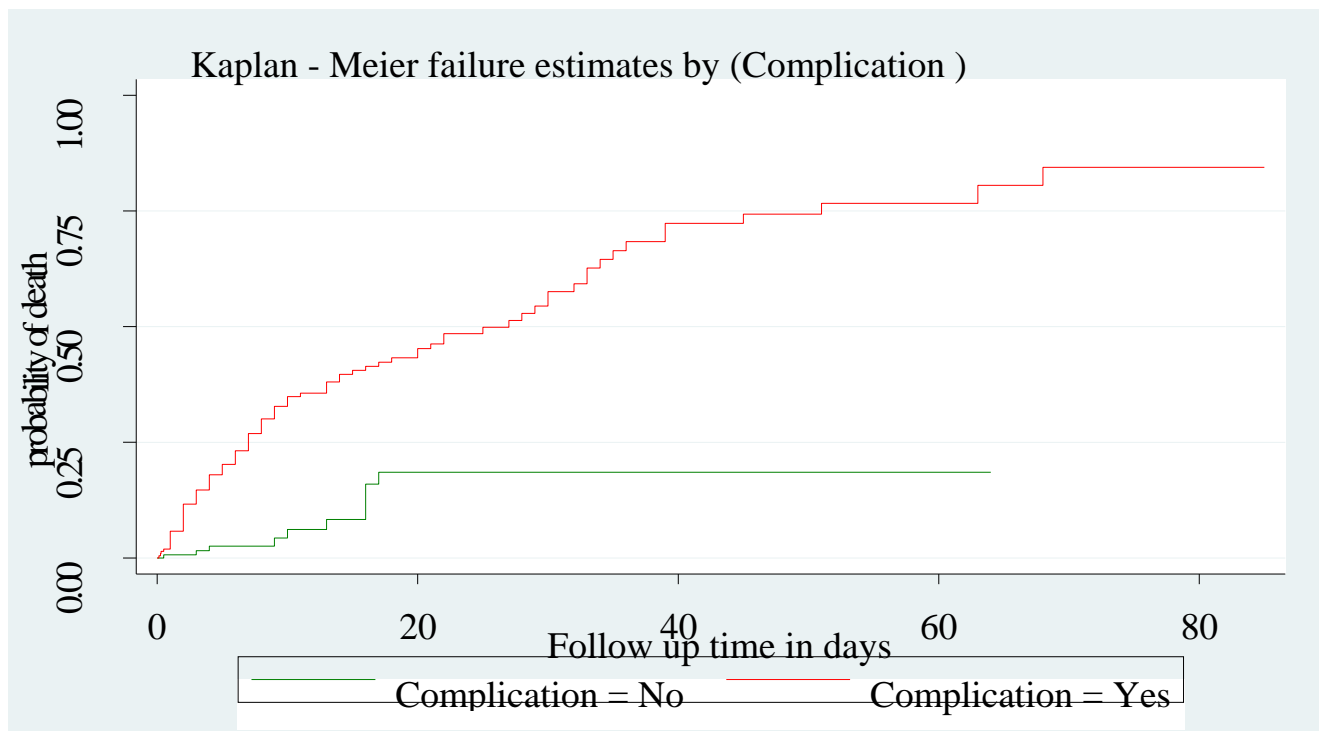


figure 7. A Kaplan Meir failure curve showing the hazard of death associated with complications in the ICU among trauma patients admitted to ICU in selected hospitals at Addis Ababa, December 2017 –December 2022(N=351)

5.6. Assessing the proportional hazard assumption

The model's requirements must be evaluated before it can be fitted, implying the model must be evaluated to see if it accurately depicts our data. The primary objectives are testing the assumption of proportional hazard and assessing the model's overall fit. The proportional hazard assumption stipulates that the study subjects' risk of failure must be the same regardless of how long they are followed. Based on the results of the global proportional-hazards test using Schoenfeld residuals, all covariates, and the entire model met the proportional-hazards assumption (Chi square= 9.88, p-value= 0.2733).

After fitting a univariate Cox proportional hazard model, it was determined that all predictor variables had p-values of 0.2. Next, a multivariable model was fitted, and covariates such as complication in the ICU, intervention with vasoactive drugs, GCS score, and creatinine level at admission to ICU were found to be significant predictors for time to death among trauma patients admitted to ICU at a 5 % level of significance.

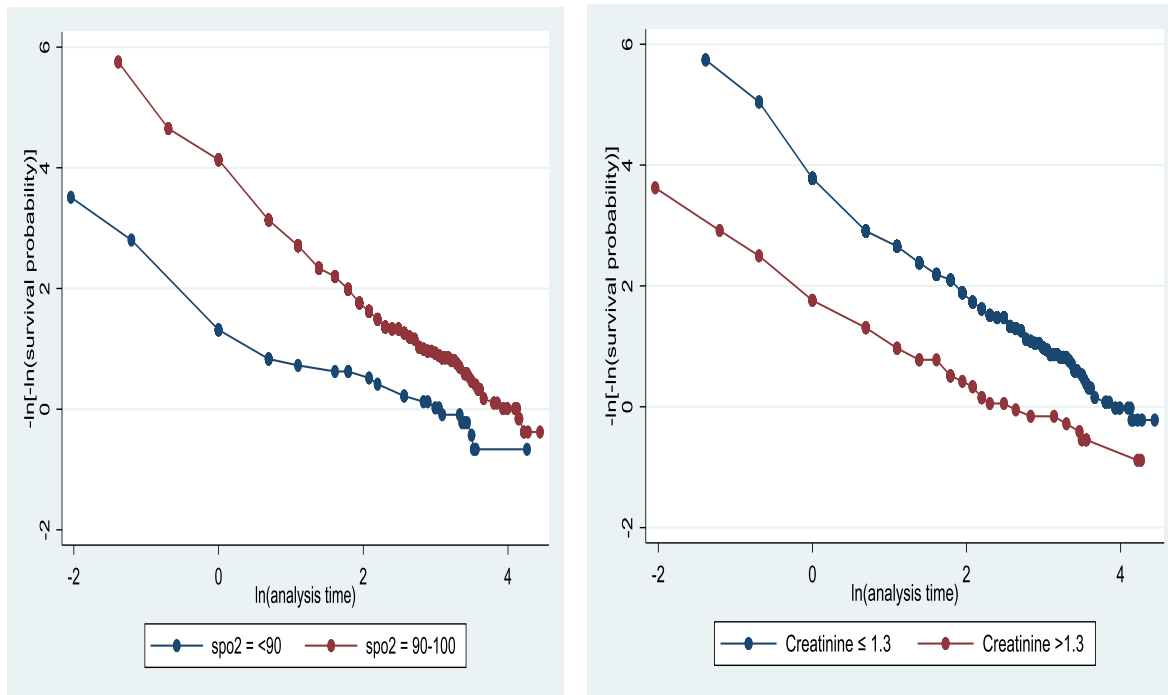


figure 8. log (-log(survival probability)) log (survival time) plot by Spo2 and creatinine level upon admission for trauma patients admitted to ICU at selected hospitals in Addis Ababa, December 2017 –December 2022(N=351)

Keeping all other variables constant, patients with severe head injury (GCS < 9) had a 92% higher mortality hazard than those patients with mild brain injury (GCS 13-15) (AHR = 3.92, 95% CI 1.95, 7.92). The hazard of mortality among trauma patients with tachycardia(HR > 100 bpm) upon admission is 5.22 times higher than the hazards of patients with normal heart rates (60-100 bpm)(AHR = 5.22, 95%CI: 2.82, 9.65). Similarly, patients with bradycardia(HR<60 bpm) upon admission were 4.36 times higher than the hazards of those with normal heart rate (AHR = 4.36, 95%CI: 1.94, 9.79).

Patients with hypoxia (Spo2<90%) had a 78% higher mortality hazard than those without hypoxia(spo2 90-100%) upon admission (AHR=1.78, 95% CI: 1.12, 2.84).

The mortality hazards for patients who had received vasoactive in ICU is 2.03 times higher than the hazards of patients who did not receive vasoactive. keeping other variables constant(AHR=2.03, 95% CI:1.31, 3.21).

The hazard of death for patients who had developed complications after ICU admission is 2.08 times higher than for those who did not develop a complication(AHR = 2.08,95%CI:1.01, 4.32).

Table 5. Multivariable analysis using Cox proportional hazard model for mortality predictors among trauma patients admitted to ICU of selected hospitals in Addis Ababa, December 2017 –December 2022(N=351)

Variable	Survival status		Crude HR (95%CI)	Adjusted HR (95%CI)	
	Event	Censored			
Heart rate	<60	13	31	4.83(2.23, 10.52)	4.36(1.94, 9.79)***
	60-100	14	142	1	1
	>100	79	72	7.72(4.27, 13.95)	5.22(2.82, 9.65)***
SPO2	<90	24	10	2.67(1.69, 4.22)	1.78(1.12, 2.84)*
	≥ 90	82	235	1	1
Creatinine	>1.3	28	10	3.02(1.95, 4.68)	2.47(1.56, 3.93)***
	≤1.3	78	235	1	1
Vasoactive	Yes	65	20	4.98(3.37, 7.38)	2.03(1.31, 3.21)**
	No	41	225	1	1
Complication	Yes	96	112	5.21(2.71, 10.01)	2.08(1.01, 4.32)*
	No	10	133	1	1
GCS	< 9	84	89	6.59(3.31, 13.12)	3.92(1.95, 7.92)***
	9 – 12	13	49	2.31(0.99, 5.41)	1.98(0.83, 4.78)
	13–15	9	107	1	1

LR test $\chi^2(8) = 156.45$, Prob > $\chi^2 = 0.0000$, *** p-value < 0.001, **p-value < 0.01, *p-value < 0.05

6. DISCUSSION

This study examined the incidence and predictors of mortality among trauma patients hospitalized in ICUs of three selected governmental hospitals in Addis Ababa, Ethiopia. Other studies have shown various risk factors for mortality in the ICU; this study evaluates likewise the patients' sociodemographic, clinical, and physiologic data from their medical records. Consequently, characteristics such as low GCS level, hypoxia, high or low heart rate, creatinine level, vasoactive requirement, and develop complications in ICU were identified to be significantly associated with mortality in the ICU.

The overall incidence of mortality in ICUs of three Hospitals in Addis Ababa is found to be 30.2 %. This result is higher than the previous study done in southern Ethiopia(12.4%), but lower than the study done in northwest Ethiopia(41.2%). All ICU-admitted patients were included in the study done in Southern Ethiopia, and the study's low proportion of trauma patients may have contributed to the reduced mortality rate, the discrepancy with the Northwest Ethiopia study might be explained by the difference in the study population. Moreover, it is also higher as compared to Ethiopian HSTP II targeted that all types of trauma mortality should be 73 per 100,000 population in 2022(24). This result was consistent with the findings of studies done in Yemen (28.1%), Tanzania (32.7%), and Brazil(28.2%) (2,27,29). Our result is also higher than studies conducted in most high and high-middle-income countries, including the United States (11.2%, Brazil(22.9%), Spain (5.63%), and Turkey (15.3%)(3,49–51). This discrepancy might have resulted from a lack of pre-hospital care, the shortage of essential medications and equipment, the scarcity of ventilators, the differences in the level of ICU setup, and the quality of service provided(8).

According to this study, trauma patients admitted to ICU who have a low GCS score are considerably more likely to pass away. This result is in line with a study done by Pogorzelsk et al. The possible cause might be, the likelihood of hypoxia in patients with low GCS scores is increased, due to compromised airway patency, which raises the mortality risk in the intensive care unit. In addition, these patients had a higher incidence of complications, such as ARDS and ARF, and in a decompensated illness process, cerebral hypoxia from hypotension is an indication of multiorgan failure, where survival will be significantly impacted(49). Studies were carried out in Ethiopia(8), Egypt(52), Greece (53), Turkey(3), and Spain(54). All backed up this conclusion.

Heart rate was also another independent factor which is consistent with a study done by Gerdin et al.(64). The possible justification might be inadequate pain management(tachycardia), and compromised cardiovascular response(bradycardia)(65). Inadequate pain management may be made worse by several ICU procedures, the use of sedatives before adequate pain management, and the challenge of pain evaluation in the ICU. Hence, untreated pain may worsen a serious medical condition by adding psychological and physiological stress(66). On the other hand, bradycardia can produce a decrease in cardiac output, which can impede renal perfusion, leading to renal failure and electrolyte imbalance, which may affect survival(67).

Hypoxia upon admission to ICU was an independent predictor of mortality. This finding is consistent with the study done by Da Costal et al. (60). This can be supported by clinical evidence that hypoxia exacerbates secondary brain injury which is a hypoxic brain insult, may prolong neuroinflammation, raise blood biomarker levels, and impair the outcome (61,62).

This study showed that increased creatinine levels would affect trauma patients' survival in ICU. The hazard of death among patients with creatinine levels > 1.3 (mg/dl) was 2.5 times higher as compared to those who had creatinine levels ≤ 1.3 (mg/dl). These findings are in line with the study conducted by Samuels et al.(55), despite the lack of sensitivity and specificity to predict mortality using creatinine levels. The cause might be that patients with increased creatinine levels suggest renal damage, which causes the metabolism to be severely impaired, electrolyte imbalance, and metabolic acidosis, all of which have a significant negative impact on mortality(56). Additionally, individuals with poor kidney function indicated by elevated creatinine levels may also have sepsis and concomitant illnesses, which lower the chance of survival(57). Another potential reason might be Patients who already have some kind of kidney damage are more likely to also have lung and liver damage, which can lead to respiratory and liver failure and further reduce a patient's probability of survival(58). Also, patients with some form of renal damage, which increased the length of ICU stay and mechanical ventilation might result in developing complications in the ICU(5,59).

The results of this study revealed that those patients who had developed complications such as sepsis, pneumonia, hypotension, and ARDS were found to have significantly higher rates

of mortality risk compared with those patients who did not develop complications. The study was carried out in Northwest Ethiopia(8), Brazil(49), and Spain(50) lends support to the findings of this study. The potential cause could be complications that result in multiple organ failures and cellular damage, which ultimately result in death(8).

Trauma patients who received vasoactive drugs during ICU stay had a high risk of mortality than patients who were not received vasoactive drugs. This result is in line with studies done in western Kenya (63) Turkey(41), and Brazil(2). The best explanation for this might be an early use of vasoactive after traumatic injury highlights that, in addition to the benefits, some damage from vasopressor therapy in the early phase of trauma is also reported, including the risk of bleeding, coagulopathy, and compartment syndrome(2).

7. STRENGTHS AND LIMITATIONS OF THE STUDY

7.1. Strength

- ✚ The study is a multi-center study
- ✚ Utilization of random sampling

7.2. Limitations

- ✚ Due to incomplete data on the patient's charts and ICU log book, variables related to physiologic, anatomic, and laboratory parameters necessary to predict mortality such as Acute Physiologic and chronic health evaluation(APACHE), simplified acute physiology score(SAPS), and other trauma scores like trauma and injury severity score(TRISS), were not analyzed.
- ✚ Some important factors, such as body mass index (BMI), were not included because the study was retrospective.

8. CONCLUSION AND RECOMMENDATION

8.1. Conclusion

According to this retrospective cohort study the total mortality rate among trauma patients admitted to the ICU of three governmental hospitals in Addis Ababa was high, despite the expected national goal of 73 per 100,000 population in 2022. hypoxia, low GCS score, and creatinine level were the most significant risk factors for ICU mortality among trauma patients.

8.2. Recommendation

Recommendations based on the findings of this study are listed below:

For health professionals:

- ✚ It is important to identify and treat patients with elevated creatinine levels when they are admitted to the intensive care unit because doing so will reduce the consequences associated with acute renal injury.
- ✚ Early identification and management of complications are important for clinical practice before being irreversible.

For stakeholders: (Addis Ababa Health Bureau, selected hospitals, and NGOs acting on health care service)

- ✚ Better to strengthen ICU services, and monitor the quality of services in the ICU.

For researchers:

- ✚ Despite this study finds valuable predictors of mortality in the ICU, There is a need for more studies on diverse regions of the country, including other trauma severity scores, nutritional status such as the APACHE, TRISS, simplified acute physiology score(SAPS), and sepsis-related organ failure(SOFA) to comprehend ICU mortality predictors better.

- ✚ Large-scale studies with a prospective design are in demand to better estimate the probability of mortality and its predictors among trauma patients in ICU.

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ANNEX I: Data extraction checklist

This data extraction checklist is prepared to collect Sociodemographic, clinical, treatment, and outcome-related information that is important for assessing outcomes and predictors of trauma patient mortality in ICU in Tikur Anbessa, AaBET, and ALERT hospitals. All this information will be retrieved from individual patient cards without mentioning the name of clients. This information will be collected by health care providers (BSc nurse or BSc anesthetist or Health Officer) **Contact Information: [251929509633](tel:251929509633)**

101	Age	-----years
102	Sex	1. Male 2. Female
103	Place of residency	1. Urban ----- 2. Rural
201	Pre-ICU admission care	a, yes b, no
202	If yes for question no 201...what was the type of care	1. Basic respiratory and circulatory support 2. Advanced respiratory and circulatory support 3. Vasoactive drugs 4. Surgical procedures
301	Mechanism of injury	1. Blunt trauma 2. Penetrating 3. both
	Cause of injury	1. Road traffic accident 2. Falling Injury 3. Stab injury 4. Stick injury 5. Sharp injury 6. Bullet injury 7. other
	Type of RTA	1. Motorcycle rider

		2. Motorcycle pillion 3. Driver Front seat passenger 4. Back seat passenger 5. Bicyclist 6. Pedestrian			
302	Type of trauma at admission	1. Multiple trauma 2. Head trauma 3. Thoracic trauma 4. Abdominal trauma 5. Orthopedic trauma 6. Other _____			
303	Presence of coexisting illness:	1. Hypertension	6. Cardiac illness,		
		2. DM	7. Renal illness,		
		3. Asthma	8. infectious disorder,		
		4. COPD	9. psychiatric disorder,		
		5. Cancer	10. Neurologic disorder		
304	Vital sign at admission	Heart rate			
		RR			
		Blood pressure			
		SpO2			
		Temperature			
		GCS			
305	Laboratory results at admission	WBC		SGPT	
		Hgb		Cr,	
		HCT			
		Plt		Na ⁺ ,	
		SGOT		K ⁺	
401	Intervention at ICU	Mechanical Ventilation 1. Yes, 2. No if yes for how many days,,,,,,,,,,,,,		Surgery 1. Yes, 2. No	

		Inotropes 1. Yes, 2. No	Vasopressors 1. Yes 2. No
		GIT prophylaxis 1. Yes 2. No	Parenteral nutrition 1. Yes 2. No
		Antibiotics 1. Yes, 2. No	Enteral nutrition 1. Yes 2. No
		Blood Transfusion 1. Yes 2. No, if the answer is yes a) Packed RBC b) Fresh frozen plasma Platelet c) Whole blood d) Cryoprecipitate	Other interventions.....
402	Complications at ICU:	a) Yes b) No	
		If yes what type of complication	(1) Cardiac arrest 1. Yes, 2. No
		(3) Aspiration 1. Yes, 2. No	(4) Hypertension 1. Yes, 2. No a) $140 - 159/90 - 99$ b) $160 - 179/100 - 109$ c) $\geq 180/110$
		(5) Hypotension	(6) Arrhythmia a) yes b) No

		If yes what was type of Arrhythmia	1. Atrial fibrillation 2. Ventricular fibrillation 3. Ventricular tachycardia 4. Bradycardia 5. Other.....
		(7) Infection 1. Yes, 2. No	(8) Other-----
		(9) Acute kidney injury (AKI) (11) Fat embolism	(10) pneumonia
		(12) Sepsis	
403	Type of pneumonia		
404	Type of shock		
501	Date of admission to ICU	Date -----/-----/-----	Time of ICU admission after hospitalization
502	Diagnosis time for the first event	Date -----/-----/----- --	Total pre-hospital time.....
503	ICU admissions	a) < 7 days b) 7-14 day c) >14	
504	Last status of the patient	1. Discharged towards 2. discharged to home 3. Discharge against medical advice 4. Refereed 5. Died	Date -----/-----/--

ANNEX II A request for waiver of informed consent

PI: SAMRAWIT NEGA SHIFERAW

Research topic: survival status and predictors of mortality among trauma patients admitted to intensive care unit of selected governmental hospitals in addis ababa, Ethiopia, 2022/23: multicentre retrospective cohort study.

STUDY AREAS: Selected public hospitals in Addis Ababa

The researcher plans to determine the incidence of mortality in the ICU and factors related to mortality in trauma patients who are admitted to the ICU. Identification of factors will improve trauma care.

The proposed research plan is to:

The purpose of the study is to investigate trauma care providers to develop an appropriate strategy to improve trauma care preparedness, coordination, and continuum in study sites and other parts of Ethiopia

Data to be collected:

- Socio-demographic data of the patient
- The type of injury
- The care is given before and after admission to ICU
- Vital sign upon admission
- Diagnostic and therapeutic procedures upon admission.
- Complications after admission to ICU
- Presence of co-existing illness
- Complications during ICU stay
- Length of ICU stay
- Last status of the patient

The total number of ICU admission in the three study centers was 2100 patients. The researcher will select 374 patients card study populations are taken from each ICU with proportional allocation formula. Computer generated simple random sampling technique will

be employed to choose the needed number of participants from all newly admitted trauma patients in the given recruitment period from the log book and they will be coded. The data so that only the researcher/data collector knows the patient's medical record in the unlikely event the data must be verified for accuracy. The results of the research will not affect the clinical care of the individuals because the information will not be examined until after the subjects leave the hospital.

Is there sufficient justification for IRB to approve a waiver of informed consent?

the IRB may determine that the criteria have been met based on the following rationale provided by the researcher:

1. **The research involves minimal risk:** as the review of subjects' medical records is for limited information. The information is not sensitive, and the data are derived from clinically indicated procedures. There is an extremely low probability of harm to subjects' status, employment, or insurability. The precaution taken to limit the record review to specified data and double coding of the data further minimizes the major risk, which is a breach of confidentiality. Contacting subjects to obtain their consent could be considered an invasion of privacy and cause subjects undue anxiety.

2. **The rights and welfare of the individual would not be adversely affected** because the clinically indicated clinical procedure and the associated trauma care service were already completed or would be completed, regardless of the research. None of the results of the research would affect the clinical decisions about the individual's care because the results are analyzed after the fact. Subjects are not deprived of clinical care to which they would normally be entitled.

3. **The research could not be practicably carried out without a waiver.** Identifying and contacting the thousands of potential subjects, although not impossible, would not be feasible for a review of their medical records for information that would not change the care they would have already received.

4. **It would not be appropriate to provide these subjects with information about the results of the research** as the results would not affect the subjects. The emergency care procedure and trauma care service have both been completed for these.

Name of CEO/Medical Director Primary Investigator

Samrawit Nega Shiferaw

Hospital

Signature

Signature

Date

Date _____

ANNEX III: Information Sheet

Title of the Research Project: Survival Status and Predictors of Mortality among trauma patients admitted to intensive care units selected governmental hospitals in Addis Ababa, Ethiopia 2022: A retrospective cohort study

Name of Principal Investigator: Samrawit Nega

Name of the Organization: Addis Ababa University, College of Health Science, Department of Anesthesia

Sponsor: Addis Ababa University

Purpose of the Research Project: To estimate the incidence and predictors of mortality among trauma patients admitted to intensive care units of governmental hospitals in Addis Ababa from December 2017 to December 2022

Introduction: This information sheet is prepared for the administration of Tikur Anbessa Specialized Hospital, ALERT Specialized Hospital, Saint Paul Hospital Millennium Medical College and Addis Ababa Burn and Trauma (AaBET) Hospital and the hospital's intensive care unit coordinating office. The form aims to clarify the concerned offices above about the research purposes, data collection procedures, and permission to undertake the research.

Procedure: To achieve the above objectives, cards of selected trauma patients who are admitted to the intensive care unit between December 2017 and December 2022 will be included

Risk or Discomfort: By participating in this research, no risk comes to one whom the document reviewed whereas, the review is of great importance to the research

Benefits: The research has no direct benefit for one whose document/record is included in this research. However, the indirect benefit of the research for the participant and all other clients in the program is straightforward. This is because if program planners are preparing a predicted plan, clients benefit from getting appropriate care and treatment services. Of all, the research work has a paramount direct benefit for healthcare planners and managers, especially for those in trauma and critical care program planning and management.

Confidentiality: The confidentiality of the client's records is assured by collecting and extracting the records by healthcare professionals. The data collectors will review the selected charts. The information collected from this research will be kept strictly confidential, and information reviewed about the clients by this study will be stored in a file without a name, i.e., the investigator uses number codes to the record during the review. The information gathered will not be accessible to anyone except the principal investigator and will be kept locked with passwords and appropriate locks.

Person to contact: This research will be reviewed and approved by the Institutional Review Board of the Department of Anesthesia. College of Health Sciences. Addis Ababa University If you want more information about the research and its undertakings, contact the committee through the advisor or principal investigator below.

Advisors

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Principal investigator

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Permission: Lastly, we are kindly requested to permit and forward the approval to the concerned body in your organization so that the researchers can get Cooperation from the data clerks and other responsible bodies

ANNEX: Tables and figures

Table1. hospitalization and trauma-related characteristics of trauma patients admitted to ICU of hospitals in Addis Ababa, December 2017 – December 2022(N=351)

Variable	Category	Censored (n=245)	Event (n=106)	Total (N=351)
		n(%)	n(%)	n(%)
pre icu admission care	No	74(21.08)	38(10.83)	112(31.91)
	Yes	171(48.71)	68(19.37)	239(68.09)
mechanism of injury	Blunt	187(53.28)	76(21.65)	263(74.93)
	Penetrating	57(16.24)	28(7.98)	85(24.22)
	Both	1(0.28)	2(0.57)	3(0.85)
		3(0.85)	3(0.85)	6(1.71)
Cause Of Injury	Stab	27(7.69)	13(3.70)	40(11.40)
	Stick	19(5.41)	6(1.71)	25(7.12)
Type of RTA	Bullet	32(9.12)	15(4.27)	47(13.39)
	Falling	122(34.76)	56(15.95)	178(50.71)
	RTA	42(11.97)	13(3.70)	55(15.67)
	Other	15(8.29)	11(6.08)	26(14.36)
	Passenger	14(7.73)	5(2.76)	19(10.50)
	MVA	11(6.08)	9(4.97)	20(11.05)
	Driver	79(43.65)	30(16.57)	106(60.22)
Type of trauma at admission	Pedestrian	5(2.76)	2(1.10)	7(3.82)
	Other	21(5.98)	5(1.42)	26(7.41%)
	Orthopedic	12(3.42)	4(1.14)	16(4.56%)
	Abdominal			

Thoracic	7(1.99)	5(1.42)	12(3.42%)
Head	123(35.04)	45(12.82)	168(47.86%)
Multiple	82(23.36)	47(13.39)	129(36.75%)

Table 2. Clinical characteristics of trauma patients during admission to ICU of selected hospitals in Addis Ababa, December 2017 – December 2022(N=351)

Variable	Category	Censored (n=245)	Event (n=106)	Total (N=351)
		n(%)	n(%)	n(%)
Presence of coexisting illness	No	223(63.53)	92(26.21)	315(89.74)
	Yes	22(6.27)	14(3.98)	36(10.25)
Heart rate (beats per minute)	<60	31(8.83)	13(3.70)	44(12.54)
	60-100	142(40.46)	14(3.99)	156(44.44)
	>100	72(20.51)	79(22.51)	151(43.02)
Systolic BP(mmhg)	<90	11(3.13)	22(6.27)	33(9.4)
	90-140	211(60.11)	73(20.00)	284(80.91)
	>140	23(6.55)	11(3.13)	34(9.69)
Temperature(°c)	<36.5	165(47.01)	76(21.65)	241(68.66)
	36.5-37.5	74(21.08)	23(6.55)	97(27.64)
	>37.5	6(1.71)	7(1.99)	13(3.70)
Spo₂(%)	<90	10(2.85)	24(6.84)	34(9.69)
GCS	≤90	235(66.95)	82(23.36)	317(90.31)
	<9	89(25.36)	84(23.93)	173(49.29)
	9-12	49(13.96)	13(3.70)	62(17.66)
WBC(1000 cells/mm³)	13-15	107(30.48)	9(2.56)	116(33.05)
	<4.4	8(2.28)	11(3.13)	19(5.41)
	4.5-11	124(35.33)	45(12.82)	169(48.15)

	>11	113(32.19)	50(14.25)	163(46.44)
Haemoglobin	>11.9	15(4.27)	6(1.71)	21(5.98)
	Female ≤11.9	18(5.13)	9(2.56)	27(7.69)
	>12.9	63(17.5)	25(7.12)	88(25.07)
	Male ≤12.9	149(42.45)	66(18.80)	215(61.25%)
Anaemia	No	78(22.22)	31(8.83)	109(31.05)
	Yes	167(47.58)	75(21.37)	242(68.95)
PLT(1000 cells/ml)	<100	18(5.13)	15(4.27)	33(9.40)
	>100	227(64.67)	91(64.67)	318(90.60)
SGOT(U/L)	≤32	92(26.21)	28(7.98)	120(34.19)
	>32	153(43.59)	78(22.22)	231(65.81)
SGPT(U/L)	≤32	110(31.34)	41(11.68)	151(43.02)
	>32	135(38.46%)	65(18.52)	200(56.98)
Creatinin(mg/dl)	≤1.3	235(66.95)	78(22.22)	313(89.17)
	>1.3	10(2.85)	28(7.98)	38(10.83)
Sodium (mmol/l)	<134	29(8.26)	19(5.41)	46(13.68)
	135-145	188(53.56)	64(18.23)	252(71.79)
	>145	28(7.98)	23(6.55)	51(14.53)
Potassium (mmol/l)	≤3.4	27(7.69)	21(5.98)	48(13.68)
	3.5-5	211(60.11)	79(22.51)	290(82.62)
	>5	7(1.99)	6(1.71)	13(3.70)

Spo₂= Peripheral Oxygen Saturation , GCS=Glascow Coma Score, BP=Blood Pressure

Table 3. Intervention and complication-related characteristics of trauma patients after admission to ICU of selected hospitals in Addis Ababa, December 2017 – December 2022(N=351)

Variable	Category	Censored (n=245)	Event (n=106)	Total (N=351)
		n(%)	n(%)	n(%)
Surgery	No	195(55.56)	60(17.09)	255(72.65)
	Yes	50(14.25)	46(13.11)	96(27.35)
Mechanical ventilator	No	67(19.09)	6(1.71)	73(20.80)
	Yes	178(50.71)	100(28.49)	278(79.20)
Duration of mv (days) (N=278)	<5	98(33.79)	53(18.28)	151(52.04)
	5-10	42(14.48)	21(7.24)	63(21.72)
	>10	46(15.86)	30(10.34)	76(26.21)
Vasoactive	No	225(64.10)	41(11.68)	266(75.78)
	Yes	20(5.7)	65(18.52)	85(24.22)
Vasopressors	No	225(64.47)	44(12.61)	269(77.08)
	Yes	18(5.16)	62(17.77)	80(22.92)
Inotropes	No	231(66.00)	53(15.14)	284(81.14)
	Yes	13(3.71)	53(15.14)	66(18.86)
GIT prophylaxis	No	13(3.71%)	5(1.43)	18(5.14)
	Yes	231(66.00)	101(28.86)	332(94.86)
Parenteral Nutrition	No	238(68.00)	105(30.00)	343(98.00)
	Yes	6(1.71)	1(0.29)	7(2.00)
Antibiotics	No	7(2.00)	2(0.57)	9(2.57)
	Yes	237(67.71)	104(29.71)	341(97.43)
Enteral	No	64(18.29)	19(5.43)	83(23.71)

nutrition	Yes	180(51.43)	87(24.86)	267(76.29)
Blood transfusion	No	185(52.86)	54(15.43)	239(68.29)
	Yes	59(16.86)	52(14.86)	111(31.71)
Complication	No	137(39.03)	12(3.42)	149(42.45)
	Yes	108(30.77)	94(26.78)	202(57.55)
Cardiac arrest	No	237(67.52)	90(25.64)	327(93.16)
	Yes	8(2.28)	16(6.84)	24(6.84)
Aspiration	No	244(69.52)	97(27.64)	341(97.15)
	Yes	1(0.28)	9(92.56)	10(2.85)
Hypertension	No	230(65.53)	100(28.49)	330(94.02)
	Yes	15(4.27)	6(1.71)	21(5.98%)
Hypotension	No	229(65.24)	63(17.95)	292(83.19)
	yes	16(4.56)	43(12.25)	59(16.81)
Arrhythmia	No	238(67.81)	87(24.79)	325(92.59)
	Yes	7(1.99)	19(5.41)	26(7.41)
Infection	No	241(68.66)	85(24.22)	326(92.88)
	Yes	4(1.14)	21(5.98)	25(7.12)
AKI	No	231(65.81)	68(19.37)	299(85.19)
	Yes	14(3.99)	38(10.83)	52(14.81)
Fat embolism	No	244(69.52)	104(29.63)	348(99.15)
	Yes	2(28)	2(0.57%)	3(0.85)
Pneumonia	No	206(58.69)	78(22.22)	284(80.91)
	Yes	39(11.11)	28(7.98)	67(19.09)
Type of pneumonia	VAP	33(42.86)	15(19.48)	48(62.34)
	Aspiration	16(20.78)	13(16.88)	29(37.66)

Sepsis	No	89(58.94)	30(19.87)	119(78.81)
	Yes	10(6.62)	22(34.44)	32(21.19)
Shock	No	94(60.26)	32(20.51)	126(80.77)
	Yes	7(4.49)	23(14.74)	30(19.23)
Type of shock	Hemorrhagic	13(28.89)	4(8.89)	17(37.78)
	Septic	5(11.11)	23(51.11)	28(62.22)
Other complication	No	87(40.85)	23(10.80)	110(51.64)
	Yes	46(21.60)	57(26.76)	103(48.36)
Readmission	No	240(68.38)	101(28.77)	341(97.15)
	Yes	5(1.42)	5(1.42)	10(2.85)
Total pre-hospital time(in hr)	<6	169(48.15)	69(19.66)	238(67.81)
	6-12	24(6.84)	17(4.84)	41(11.68)
	>12	52(14.81)	20(5.70)	72(20.51)
LOS(in days)	<7	121(34.47)	54(15.38)	175(49.86)
	7-14	48(13.68)	20(5.70)	68(19.37)
	>14	76(21.65)	32(9.12)	108(30.77)

Other complications anemia, electrolyte imbalance, bed soar, ARDS, LOS= length of stay, GIT = gastrointestinal

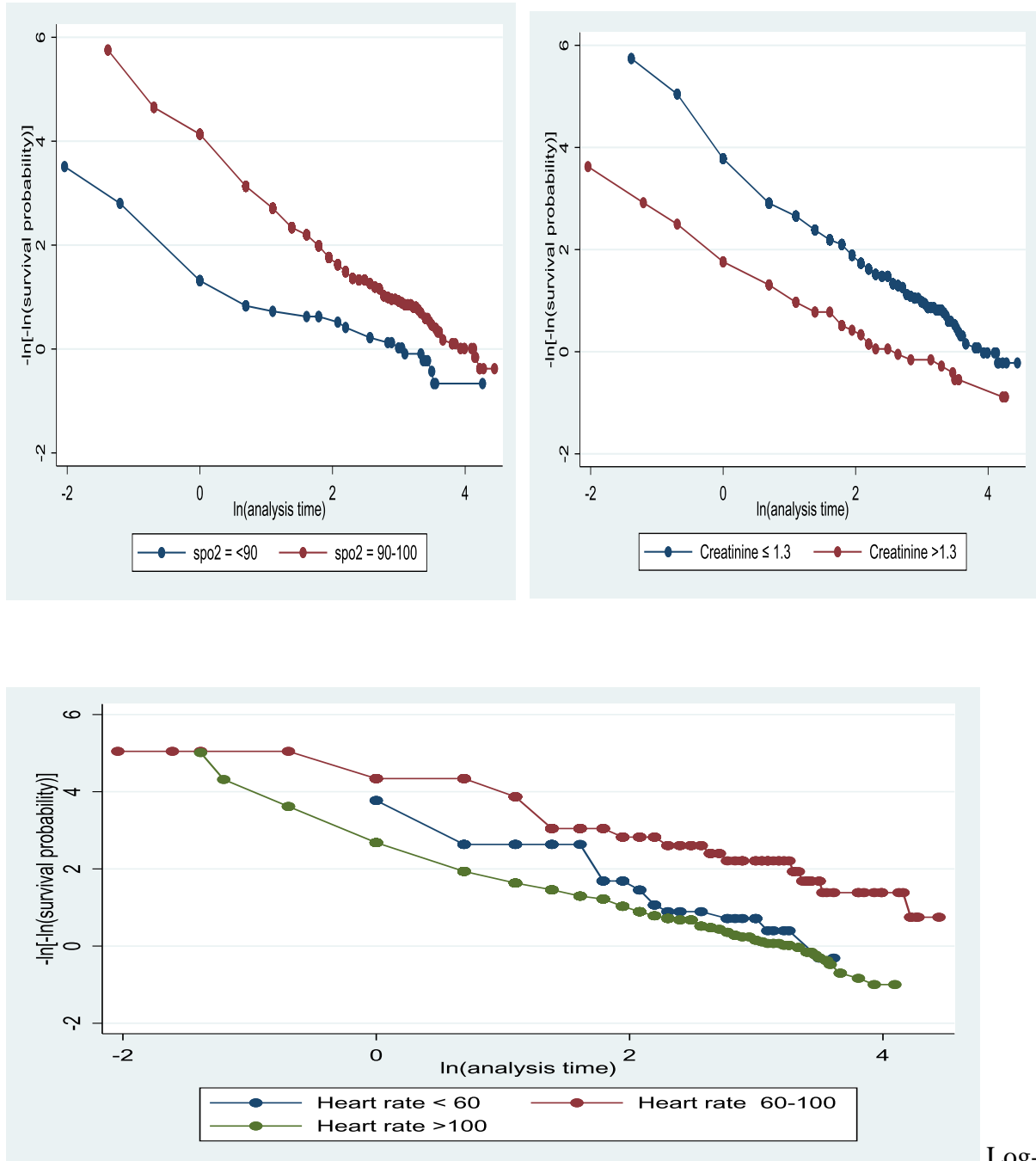
Table 4. Multicollinearity test using VIF for independent variables

Variable	VIF	1/VIF
Vasoactive	1.39	0.719137
Complication	1.31	0.761827
Creatinine	1.10	0.920736
GCS	1.09	0.953509
Spo2	1.08	0.923426
Heart rate	1.05	0.953509
Mean VIF	1.17	

Table 5. Log-rank test for all categorical variables to predict trauma ICU mortality

Variables	df	Chi-square	P-value
Age	2	8.63	0.0134
Gender	1	0.00	0.9672
Residency	1	4.51	0.0336
Co-existing illness	1	0.06	0.8036
Heart rate	2	63.47	0.0000
SBP	2	25.81	0.0000
Saturation	1	19.49	0.0000
Temperature	2	4.47	0.1068
GCS	2	47.66	0.0000
WBC	2	4.59	0.1008
Anemia	1	0.42	0.5186
Platelet	1	5.17	0.0732
SGOT	1	3.21	0.0732
SGPT	1	0.00	0.9679
Creatinine	1	27.81	0.0000
Sodium	2	5.09	0.0784
Potassium	2	2.77	0.2505
Vasoactive	1	80.64	0.0000
Mechanical ventilation	1	3.05	0.0808
Mechanical ventilation duration	2	23.98	0.0000
Complication	1	31.17	0.0000
Length of stay	2	129	0.0000
Frequency of admission	1	0.06	0.8036

Figure 1. Log-log plot byspo2, heart rate, Creatinine Complication, and vasoactive(N=351)



Log-

Figure 2. log plot by GCS, complication, and vasoactive(N=351)

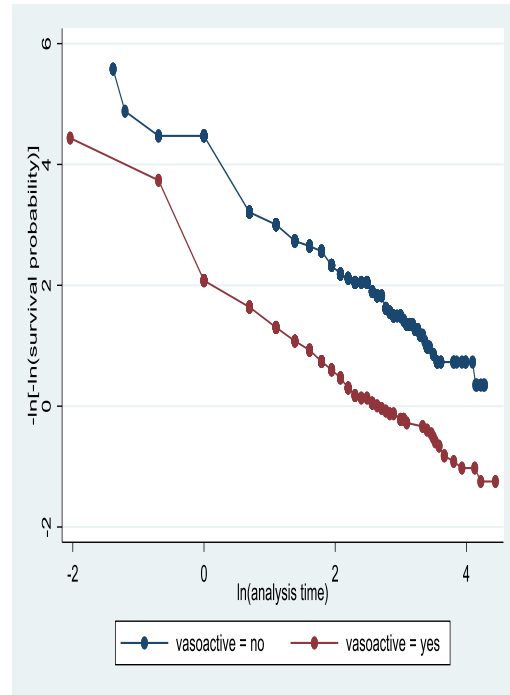
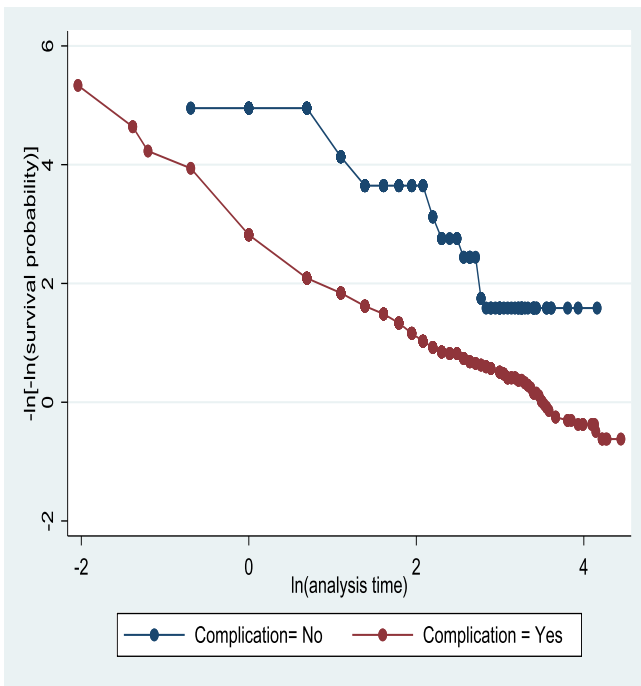
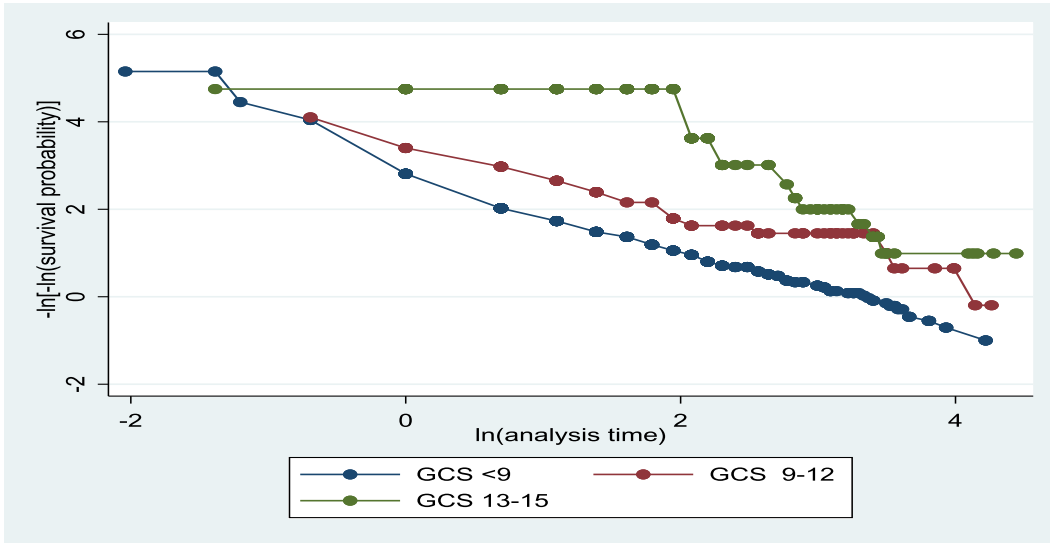


Figure 3. Kaplan Meir failure estimate by GCS, Spo2, and vasoactive(N=351)

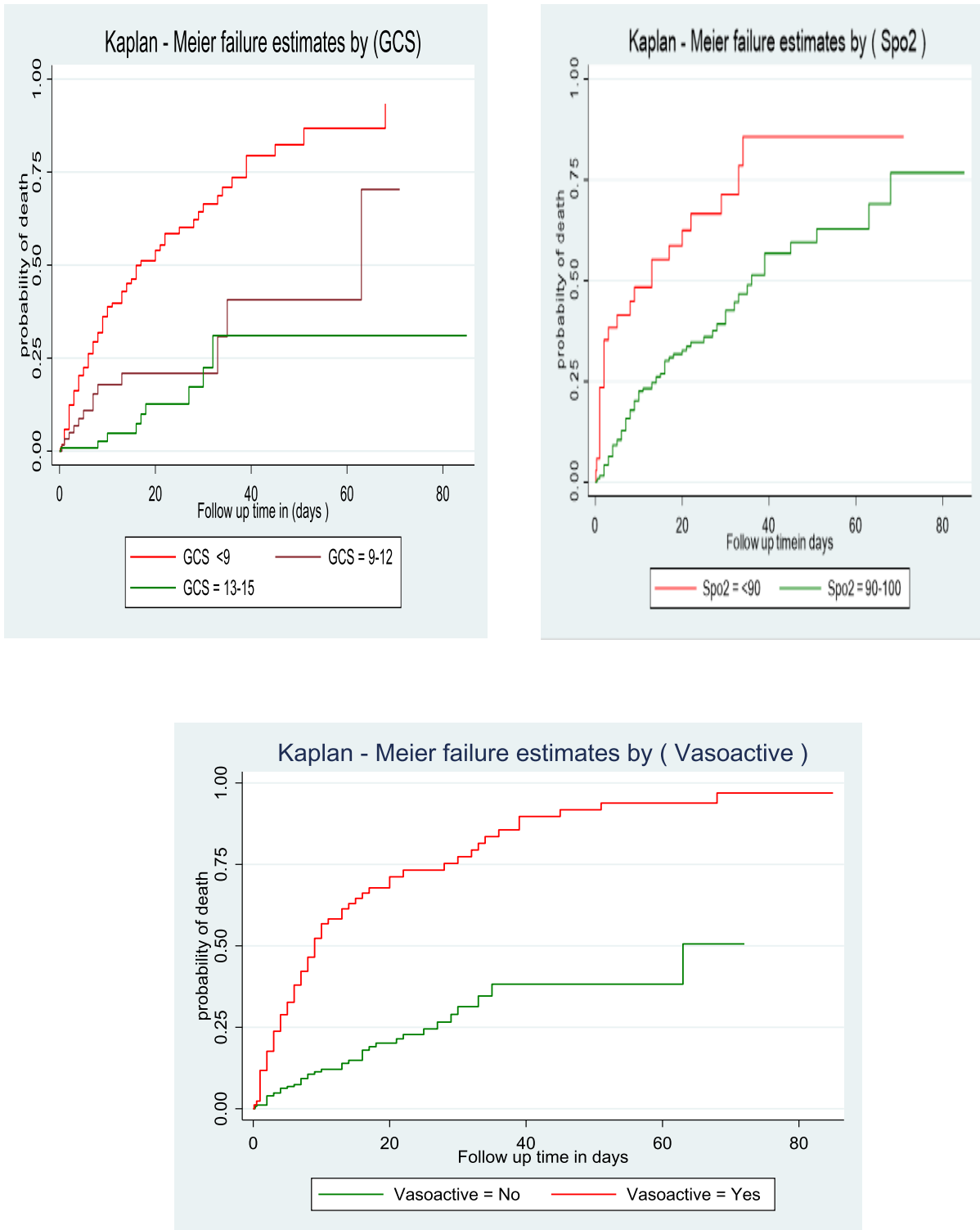


Figure 4. Kaplan Meir failure estimate by complication, heart rate, and creatinine level(N=351)

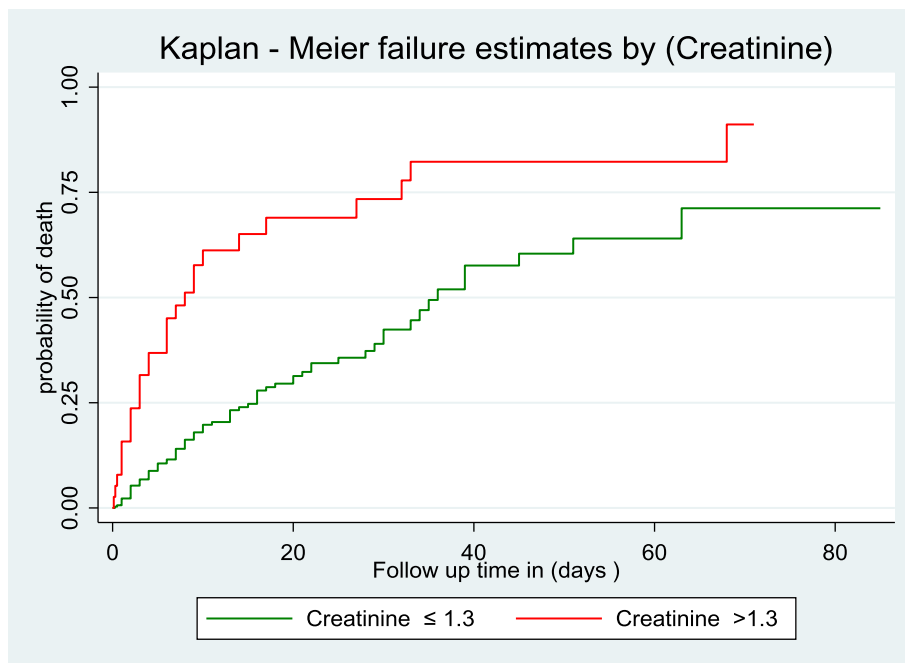
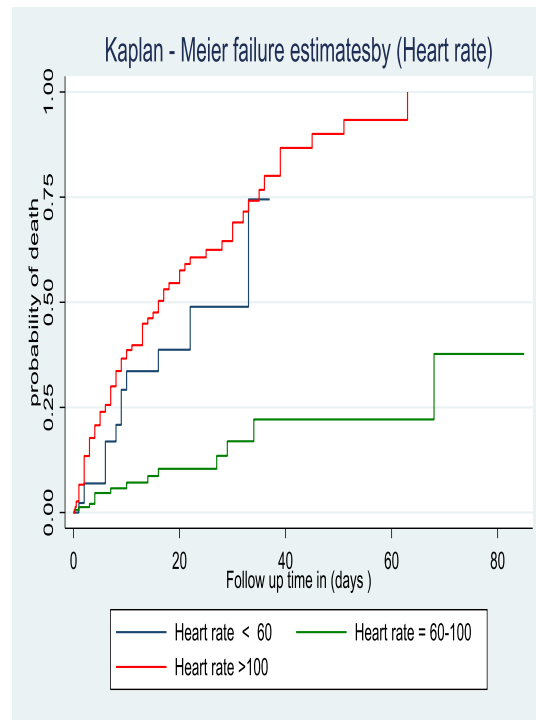
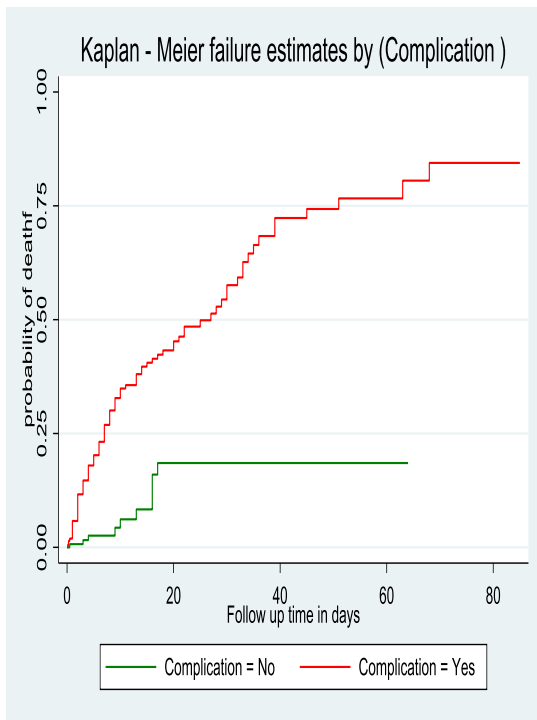


Table 6. Schoenfeld residual

Variable	Rho	Chi2	Df	Prob>chi2
Bradycardia	-0.13469	2.08	1	0.1488
Tachycardia	0.10760	1.47	1	0.2250
Spo2	-0.13628	1.87	1	0.1712
Creatinine	-0.06010	0.38	1	0.5373
Vasoactive	0.00398	0.00	1	0.9669
Complication	-0.07012	0.54	1	0.4625
GCS	- 0.16436	2.88	1	0.0895
Global test		9.88	8	0.2733

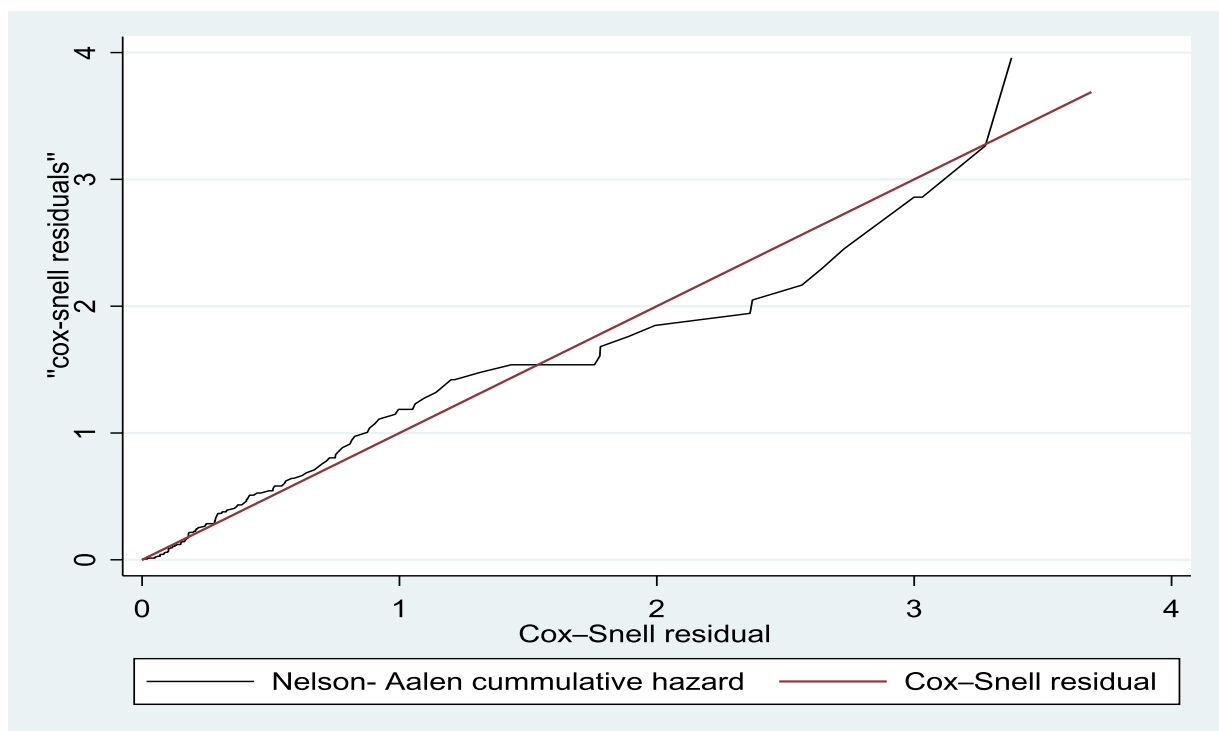


Figure 5. Nelson – Aalen cumulative hazard graph against cox – snell residual on trauma patients admitted in the ICU at selected hospitals in Addis Ababa, December 2017 –December 2022

Table 7. Life table for estimation of mortality among trauma patients admitted to ICU(N=351)

Interval h	Beg. Total	Death	Lost	Survival	Std Error]95% Conf. Int.]	
0 7	351	48	110	0.8378	0.0214	0.7904	0.8752
7 14	193	25	52	0.7124	0.0294	0.6501	0.7656
14 21	116	12	26	0.6294	0.0344	0.5579	0.6926
21 28	78	5	27	0.5806	0.0380	0.5023	0.6510
28 35	46	8	12	0.4645	0.0477	0.3690	0.5544
35 42	26	4	5	0.3854	0.0535	0.2813	0.4884
42 49	17	1	3	0.3606	0.0555	0.2538	0.4682
49 56	13	1	3	0.3292	0.0589	0.2180	0.4447
56 63	9	0	2	0.3292	0.0589	0.2180	0.4447
63 70	7	2	2	0.2195	0.0745	0.0952	0.3762
70 77	3	0	2	0.2195	0.0745	0.0952	0.3762
84 91	1	0	1	0.2195	0.0745	0.0952	0.0952

Annex :

data safety assuring sheet

Code _____

S.No	Tool checked	Yes	No	Data entry
1	Are the inclusion and exclusion criteria done appropriately?			

Data accuracy check sheet

Code _____

S.No	Tools	Yes	No
1	Are all questions on the socio-demographic data field appropriate?		
2	Are all data on clinical and physiologic appropriate?		
3	Are all data about the last outcome filled appropriately?		