



St. Paul's Hospital Millennium Medical College

Graduate Study Program

Mortality and associated factors in Intensive Care Unit of Addis Ababa Burn, Emergency, and Trauma Hospital: A two year Hospital based Cross-sectional study

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Addis Ababa, Ethiopia

December, 2023

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study**

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Acknowledgment

Above all, I would like to thank God for helping me go through the challenges and reach this time. I would also like to express my gratitude to my advisors for the invaluable time and constructive guidance they gave me from the start to the end of this work. My appreciation and thankfulness also goes to my wife. Finally, my special thanks also go to the SPHMMC/EMCC department for giving me this chance to practice research.

Abbreviations

AaBET: Addis Ababa Burn, Emergency and Trauma Hospital
AKI: Acute Kidney Injury
AOR: Adjusted Odds Ratio
CI: Confidence Interval
COR: Crude Odds Ratio
CT: Computerized Tomography
DAI: Diffuse Axonal Injury
EDH: Epidural Hematoma
FMOHE: Federal Ministry of Health Ethiopia
GBS: Guillain Barre Syndrome
HAI: Hospital Acquired Infection
HIV: Human Immunodeficiency Virus
HUCSH: Hawassa University Comprehensive Specialized Hospital
IRB: Institutional Review Board
JUSH: Jimma University Specialized Hospital
LoS: Length of Stay
MoA: Mode of Arrival
MOF: Multi-Organ failure
MV: Mechanical ventilator
NTS: Non-Trauma Surgical
OR: Operation Room/Theatre
RTA: Road traffic accident
SD: Standard Deviation
SDH: Subdural Hematoma
SPHMMC: Saint Paul's Hospital Millennium Medical College
SPSS: Statistical package for social sciences
TASH: Tikur Anbessa Specialized Hospital
TGSH: Tibebe Ghion Specialized Hospital
WHO: World Health Organization

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Abstract

Introduction: Intensive care unit services are on the rise across the globe despite issues of inadequacy in the quality of care and accessibility and outcome is still poor being at its worst in developing countries, like Ethiopia. But, still data to improve these gaps is lacking. Hence, this study intended to investigate the mortality and associated factors among patients admitted to Addis Ababa burn, emergency and trauma Hospital.

Methods: A 2 year single center cross-sectional study was conducted on 480 patients admitted to the Intensive Care Unit of Addis Ababa Burn, Emergency and Trauma Hospital from January 1, 2021 to December 31, 2022 using systematic random sampling technique. Data was gathered from patient charts and Intensive Care Unit register using a checklist and exported to SPSS version 24 for analysis aimed at investigating the mortality and associated factors among admitted cases. Bivariate and multivariate logistic regressions were used for association with a P-value of ≤ 0.05 at 95% confidence interval taken as statistically significant.

Results: Among 368 sampled cases, 75% of them were males; with median age being 30yrs. Average length of ICU stay was 16.4days. 63.3% of patients came from Oromiya with trauma and road traffic accident as mechanism of injury accounting for 260(70.7%) and 140(52.1%), respectively. 93.2% of the patients have had intubation with an average 10.9 days of mechanical ventilator use. The overall mortality was 31.8%. Admission Glasgow coma scale of ≤ 8 , Hospital acquired infection, post-cardiac arrest, acute kidney injury, intubated patients, shorter ICU LOS, and sodium disorders were found to have significant association with intensive care unit mortality.

Conclusion: The overall mortality was low. Admission Glasgow coma scale of ≤ 8 , Hospital acquired infection, post-cardiac arrest, acute kidney injury, intubated patients, shorter ICU LOS, and sodium disorders were found to have significant association with intensive care unit mortality. There should be devotion and commitment to decrease rate of complications by giving emphasis to evaluation of patients meticulously to prevent complications.

Key words:-Mortality, Intensive Care Unit, AaBET, Addis Ababa, Ethiopia

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Introduction

Background

An ICU is an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency. Although an ICU is based in a defined geographic area of a hospital, its activities often extend beyond the walls of the physical space to include the emergency department, hospital ward, and follow-up clinic(1).

There are three levels of ICU:

- Level 1 ICU: capable of providing oxygen, noninvasive monitoring, and more intensive nursing care than on a ward
- Level 2 ICU: provides invasive monitoring and basic life support for a short period
- Level 3 ICU: provides a full spectrum of monitoring and life support technologies; serves as a regional resource for the care of critically ill patients and plays an active role in developing the specialty of intensive care through research and education

Statement of the problem

The ICU mortality rate in any hospital is the highest compared to other units. Despite the fact that medical care has significantly improved over the last century, mortality, morbidity and functional disability in intensive care units remains a global public health issue. The mortality rate in critical care units across the world ranges from 9 to 61% (2). In comparison to the rest of the globe, the ICU mortality rate in North America, Oceania, and Europe is comparatively low at

9.3%, 10.3%, and 18.7%, respectively; however, in South America and the Middle East, it is 21.7% and 26.2% respectively (2, 3). In Africa, the ICU mortality rate is high, ranging from 32.9 to 54%, compared to the other developed continents (4-6).

Let alone satisfying the health needs of the critically ill patients, regular access to potable water, electricity and reliable oxygen supply could not be guaranteed for hospitals in developing countries (7).

Low-income countries lack ICU beds, and more than 50% of these countries lack any published data on ICU capacity. Most ICUs in low-income countries are located in large referral hospitals in cities (8).

The burden of life-threatening conditions requiring management in the intensive care unit has grown substantially in the last couple of decades in low and middle-income countries because of an emerging pandemic, urbanization, and hospital expansion. However, the advancement of ICU care is very limited in these countries due to the high cost of infrastructure, training medical staff, failure to incorporate international guidelines for evidence-based care, and availing medical supplies (9).

Over the past two decades, there has been an increased focus on the state of intensive care medicine in middle- and low-income countries. At present, it is recognized that intensive care medicine is a young, underdeveloped and under-resourced medical specialty in many of these areas. Lack of trained staff, equipment and supply materials represent major challenges. Mortality rates of critically ill patients cared for in resource-limited ICUs are frequently high. To date, only limited information on the epidemiology of critical illness in resource-limited areas is available. Although some data from Asia have been published, little is known of the causes and mortality of critical illness in resource-poor settings in sub-Saharan Africa (10).

An international study recruiting 13, 796 patients from 75 countries and 1,265 ICUs from Africa, Asia, America, Europe, and Oceania revealed that the prevalence of mortality in ICU was 18.2 % (2).

There is growing critical care capacity in Addis Ababa, Ethiopia with 103 ICU beds in public hospitals; All ICUs in public hospitals in Addis Ababa were able to provide basic support for patients with life-threatening organ failure but demonstrated marked heterogeneity in critical care capacity. However, many ICUs in public hospitals in Addis Ababa lacked formally trained intensivists and had no access to other medical specialties for consultation or supporting services. Access to advanced interventions to support organ failure was also highly limited (11).

Ethiopia, the second highest populated country in Africa, home to more than 114 million people have only 51 ICUs with 324 ICU beds making the ratio 3beds for a million people, which are often poorly equipped with necessary equipment and well-trained health personnel. The Ethiopian national pooled prevalence of ICU mortality was 39.7% in a systemic review- meta analysis done on 14 articles where mechanical ventilator use, length of ICU stay >2 weeks, GCS <9 and ARDS had significant association with mortality (12).

Knowledge of the epidemiology and outcome of critical illness in these settings could help to better define patients' needs and guide interventions to improve care. This cross-sectional study was designed to investigate the mortality and associated factors of mortality in ICU.

Significance of the Study

The need for an ICU increases as the population rises worldwide. Since the treatment is expensive and the number of beds is limited, the patients who may benefit from the intensive

care hospitalization should be chosen cautiously. Moreover, determining the factors that increase the rate of mortality in patients hospitalized in the ICU will decrease mortality.

In Ethiopia, population is growing rapidly; ICU mortality is high; number of trained staff to care for critical patients is relatively few; little preparation and capacity to handle epidemics as seen from COVID-19 pandemic; and increases in noncommunicable diseases with growing needs for ICU care; all these show that there is a clear gap in critical care capacity of the country (FMOHE, ICU implementation guideline, 2018). In addition, AaBET ICU, despite being a general ICU, trauma or burn cases makes it different from other ICUs in the country. Moreover, it is led by emergency and critical care physicians who make rounds at least twice per day which will considerably impact the quality of care given to patients.

For these and many other reasons, determining the mortality and associated factors of mortality in ICU will have significant impact on improving outcomes of ICU admissions. It adds knowledge regarding the predictors of mortality of patients admitted to ICU; provides information for further quality improvement of AaBET hospital ICU and serves as a baseline source and an inspiration for further research.

Literature Review

In a retrospective study done in Istanbul, Turkey between January 2008 and 2013 where 3945 patients were enrolled, the mortality rate in the ICU was 32.5%. In patients who died in the ICU, elderly, presence of an operation history, and hospitalization time in the ICU were statistically significant (13).

Another retrospective study done in Göztepe Training and Research Hospital, Turkey, from May , 2012 up to January, 2013, a total of 111 patients aged >18 years who were hospitalized in ICU

of Department of Internal Medicine, overall mortality rate was 52.3%, of which 85.7% were intubated. The common indications for ICU admission were hemodynamic instability (48.6%), respiratory failure (27.9%) and sepsis (15.3%). Hypertension, heart failure and diabetes Mellitus were the most common comorbidities accounting for 46.8%, 32.4% and 25.2%, respectively (14).

The prevalence of death was 21% in a cross-sectional study conducted in two clinical and surgical ICU in the state of Sergipe, northeastern Brazil that enrolled 316 patients with at least 48 hours of hospitalization, minimum age of 18 years old, between July 2017 and April 2018. Patients with electrolyte disturbance, in need of mechanical ventilation, and elderly were found to have increased mortality (15).

The all cause ICU mortality was 35.4% in a 12year(2006-2017) retrospective cohort study done among 905 mechanically ventilated ICU admitted cases aged >16years in Beijing, China where men account for 67.4% and median age was 78years. HAI and mechanical ventilator days <2 weeks and AKI were significantly associated with increased ICU mortality(16).

A prospective cohort study done in Sao Paulo, Brazil over 11 month period in 2013 on 525 patients whose age is greater than 18years where 298 and 227 were admitted to surgical and medical ICUs, respectively showed that mortality is higher in medical cases(35.1%) compared to the surgical cases (26.2%). Mechanical ventilator use and infection were found to have significant association with in-hospital ICU mortality in surgical ICU admitted cases (17).

A 3year prospective study done in United Arab Emirates (UAE) among 202 trauma cases admitted to ICU where 181 were males RTA followed by FDA as the main mechanisms of injury the overall ICU mortality was 13.9%. More than two-thirds(72%) got ambulance service and

mean ICU LOS was 5.7($\pm$ 6.7) days. Low GCS, increased age and mechanism of injury were found to have predictive role in ICU mortality(18).

The combined retrospective and prospective study on adult ICU, tertiary hospitals in Malawi conducted over two year period from 2017 to 2019 involving 822 cases showed that median age of patients was 31years where 50% were males. Patients who have history of vasopressor use, post-cardiac arrest and mechanical ventilator use had increased mortality whereas those with history of operation had lower rate of mortality(19).

ICU acquired sodium disorders were common and were associated with increased ICU LOS and increased odds of ICU mortality in a multicenter cohort study done in Canada. There were 8162 patients admitted between years 2000 to 2006 in both medical and surgical ICUs where 11% and 26% had Hyponatremia and hypernatremia, respectively(20).

Among 338 patients admitted to medical and surgical ICUs in Kenya the mortality rate was 31% (104patients). The median age of patients was 42years and males accounted for 61%. 59% used mechanical ventilator and 35% had vasopressor use. GCS less than 9, burn cases with total body surface area burnt greater than 40%, and brain tumor cases were associated with increased mortality(21).

A retrospective cohort study of 450 patients admitted at a National Referral Hospital in Western Kenya from January 1, 2013, to April 5, 2015, showed that the overall ICU mortality was 53.6%. Most patients who died were male (61%) and patients who had acute stroke, acute respiratory failure, in need of mechanical ventilator and vasopressors whereas drug/alcohol poisoning was associated with lower adjusted odds of mortality(22).

A multi-center retrospective cohort study was conducted among three teaching referral hospital ICUs in Southern Ethiopia from June 2018 to May 2020. 517 adult ICU patients were selected. The mean age of the patients was 34.25($\pm$ 5.25). The overall ICU mortality rate was 46.8%. The study identified that cardiac arrest, aspiration, infection, unstable vital signs at admission, and mechanical ventilator use as predictors of mortality(23).

A multicenter retrospective study done in northwestern Ethiopia on 392 trauma cases admitted to ICU of five hospitals in Amhara region from 2019 to 2022 indicated a mortality rate of 42.1% where GCS <9, presence of ICU complications, admission hypothermia and hypotension were associated with increased mortality. 46.4% had admission GCS <9, 47.7% were operated, and 60.5% used mechanical ventilator. Majority (83.2%) were males; more than half of patients were in the age range of 15 to 30 years; 45.4% used taxi and only 28.6% used ambulance; and majority (70.9%) did not get prehospital care despite 41.1% were referred from hospitals. Violence accounted for 58.9% of the mechanism of injury where RTA affects only 25.5% of cases. Sites of trauma were head (44.7%), abdomen (15.3%), chest (6.1%) and multiple sites(30.1%)(24).

Another multicenter retrospective study done in Addis Ababa hospitals on 378 patients admitted to surgical ICUs from 2017 to 2020 showed that mortality rate of 44.9% and trauma, GCS<9, readmitted cases, mechanical ventilator use, and AKI had significant association with mortality(25).

A retrospective study based on a record review of logbook and charts of 310 adult patients admitted to general ICU of Hawassa university comprehensive specialized hospital (HUCSH) between April 2012 and April 2017 showed that the overall mortality rate was 45.8%; the average age of patients was 41 $\pm$ 17.9 years and males accounted for 51.6%. The average length

of stay in the ICU was 5.3 ± 6.7 days. Cardiovascular, neurological and trauma related disorders were causes of admission in 22.9%, 17.7%, and 13.9%, respectively. 23.1% required mechanical ventilator support and 5.3% developed Hospital acquired infection. The presence of aspiration pneumonia, need for ventilator support, acute kidney injury, hospital acquired infection, and short ICU stays were associated with ICU mortality(26).

In another retrospective cohort study done at Tibebe Ghion specialized hospital, from February, 2021 to January, 2021, a total of 568 study participants' charts were reviewed. The overall mortality rate was 29.6%. The median length of ICU stay was 4 days. Nearly 64% of the admitted patients were medical patients. The commonest specific diagnosis at medical ICU admission was head trauma (16.9%) followed by general surgical cases (16.2%). Shock (19.1%) was the predominant cause of ICU death followed by head trauma (17.9%). Having altered mentation, mechanical ventilator use, and stay < 5 days in the ICU were significantly associated with ICU mortality(27).

A retrospective cohort study done in Ambo university hospital showed that among 390 patients who were admitted to the ICU, majority 203 (52.1%) of participants were men. The overall mortality rate was 46.9%, and significantly associated with Glasgow coma scale < 9, patient with coexisting disease. Mechanical ventilation requirements and patients who stayed less than four days in intensive care unit are more likely to die than patients who stayed longer than four days(28).

Review of the registries and clinical charts of 1,211 patients admitted to Medical ICU of Ayder Comprehensive Specialized Hospital in Mekelle, Tigray, during the period, November 2011 - February 2015 showed that males constituted a higher proportion (55.6%) than females (44.4%);

the commonest admissions were patients with cardiovascular diseases (26%), followed by infectious diseases (20%) and neurological diseases (19.8%). The commonest specific causes of admission to the Unit were diabetic ketoacidosis and heart failure, constituting 16% each, followed by stroke (15.2%). The overall mortality was 27%. The commonest cause of death was stroke (17%), followed by septic shock (11%). older age, HIV positive, acute respiratory distress syndrome, septic shock and status epilepticus were independent predictors of death(29).

Conceptual framework

The conceptual framework below was intended to show the factors that can affect the mortality of patients admitted to ICU; and it was developed by the principal investigator after reviewing studies done across the globe on ICU mortality.

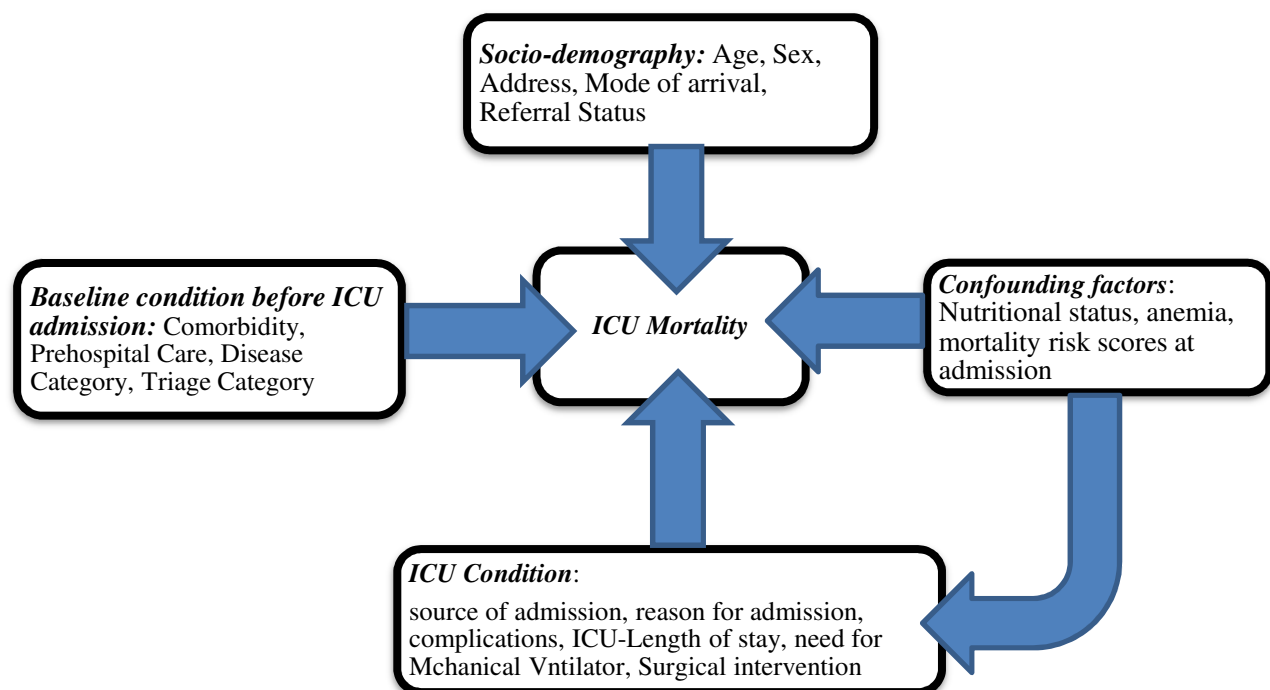


Figure 1: A conceptual framework of factors that possibly affect mortality among ICU-admitted patients

Objectives

General Objective

- ✧ To determine the mortality and associated factors of mortality among ICU admitted cases at AaBET Hospital, Addis Ababa, Ethiopia from January 1, 2021 - December 31, 2022

Specific Objectives

- ✧ To determine the mortality among AaBET Hospital ICU admitted cases from January 1, 2021 - December 31, 2022
- ✧ To identify associated factors associated with mortality in ICU admitted cases from January 1, 2021 - December 31, 2022

Methods and materials

Study area:

- ✧ The study will be conducted in the intensive care unit of Addis Ababa burn, emergency and trauma (AaBET) hospital, affiliate of SPHMMC, in Addis Ababa, Ethiopia. It was inaugurated in July 15, 2015 mainly to serve as burn and trauma center. AaBET ICU is a general ICU with an open system. The ICU is comprised of two rooms with a total of 11 beds a nurse to patient ratio of 1 to 1 and a semi-ICU with 2 beds to care for subcritical patients as an intermediate/transition ward. It is governed by the department of emergency and critical care medicine where twice daily ICU clinical rounds are being made. The ICU lacks ICU protocol and management guideline and it has no separate rooms for caring pediatric, tetanus, patients,

Study period:

- ✧ The study will be conducted from September 1, 2023 to October1, 2023.

Study design:

- ✧ Hospital based single center cross-sectional study over a period of two years from January 1, 2021 to December 31, 2022

Population:

Source Population:

- ✧ Records of all patients admitted to AaBET Hospital ICU from January 1, 2021 to December 31, 2022

Study Population:

- ✧ All sampled patient records admitted to the AaBET ICU over a period of two years from January 1, 2021 to December 31, 2022 were included.

Eligibility criteria:

Inclusion criteria:

- ✧ Patients admitted to AaBET ICU during the study period were eligible and included in this study, regardless of their age, sex, or disease condition.

Exclusion criteria:

- ✧ Those patients with a second/new chart where the initial chart is lost and relevant information for the study objectives could not be found or patients whose charts are lost will be excluded from study.

Study variables:

Dependent variables:

- ✧ Outcome (survived or died)

Independent variables:

- ✧ Age, sex, admission diagnosis, length of ICU stay, need of and length of days on mechanical ventilator, comorbidity, complications, initial GCS, disease category

Confounding variables:

- ✧ Nutritional status, Anemia, and undiagnosed diseases and complications due to poor laboratory and imaging setup that could affect both the dependent and independent variables.

Operational definitions:

- ✧ **Outcome:** patient condition at time of leaving ICU either with sign of life or dead.
- ✧ **Alive:** patient who is discharged home improved, left against medical advice, transferred to other ICU or ward but with sign of life at time of leaving the ICU
- ✧ **Incomplete charts:** relevant data for the study objectives are not available either in the patients' charts or ICU register.
- ✧ **Complications at ICU:** Diseases developed during stay in the ICU which is not reported upon admission such as cardiac arrest, anemia, infection, hypotension, aspiration, electrolyte disturbance, AKI etc.
- ✧ **Disease category:** patient whose disease condition as primary reason for ICU admission was traumatic injuries, medical conditions, burn or non-trauma surgical cases.
- ✧ **Triage to OPD:** patients that are seen at OPD, admitted to ward, and the transferred to ICU without evaluation and management at ED.

Sample size determination

Assumptions considered in calculating the sample size

- ✧ A systematic review and meta-analysis conducted in 2022 showed that Ethiopia's pooled national prevalence of adult ICU mortality was 39.7% (12).

- ✧ The sample size was determined by using single population proportion formula
- ✧ 95% confidence interval was used, with 5% margin of error tolerated
- ✧ $n = (Z_{\alpha/2})^2 p (1-p)/d^2 \rightarrow n = (1.96)^2 * 0.397(1-0.397)/(0.05)^2 = 368$
- ✧ The final sample size calculated was 368 patients. Systematic random sampling method was used.
- ✧ A chart with incomplete data was replaced by the immediate next chart.

Sampling Procedure

List of patients who were admitted to ICU was taken from the database and K value was calculated as, $K = [\text{Total admitted} / \text{Sample size}] = 480/368=1.3$ and systematic random sampling method was used to select the sample by every 1.3 interval (but for convenience 3 consecutive charts out of 4 will be selected) according to the registration order and the first number was selected by lottery method. So, every 1.3rd interval (or 3 out of 4) was selected until the completion of sample size. Incomplete and lost charts will be discarded and the next sample will be selected, rather.

Data collection tool and procedure

A checklist was prepared in English version after reviewing literatures related to the objectives of this study prior to start of data collection modified to suit the local condition. It was modified further after a pre-test and before the data collection, then followed and reviewed during data collection. Two general practitioners were recruited for data collection. Brief training was provided for the data collectors about the objectives and relevance of each item included in the study tools and the whole process of data collection before the process of data collection. Data was then collected from ICU register medical records by using pretested structured data retrieval checklist.

Data processing and analysis:

The data were cleared, coded, and exported to SPSS version 24 for analysis. Descriptive statistics including frequency, percentage, and mean were derived. Crude odds ratio (COR) and adjusted odds ratio (AOR) were used for analysis with a 95% confidence interval (CI). Binary logistic regression was used to see the association between dependent and independent variables. Those variables with a P-value of ≤ 0.25 on binary logistic regression were further considered for multivariate logistic regression to determine the independent associations of each variable and

control confounding variable where $P\text{-value} \leq 0.05$ was considered to have statistically significant association with ICU mortality.

Data quality control:

An English version and a pretested checklist on 18 charts were used to collect data. Brief training for the data collectors about the process of data collection was given before the process of data collection. Close supervision was maintained during data collection and filled checklists were double-checked daily for consistency and completeness by data collectors and the principal investigator before analysis.

Ethical consideration:

Ethical clearance and approval to conduct this research were obtained from St. Paul's hospital millennium medical college institutional review board (IRB). To ensure confidentiality names and other personal identities were not used during data collection and manuscript writing. The need for informed consent for research and publication was waived by SPHMMC IRB due to the retrospective nature of the study with Ref. No. of pm 21/384. The author declares that all the methods included in the study are in accordance with the declaration of Helsinki. Since this is a secondary data, informed permission was not required from each client. Then, data collection begun after ethical clearance was obtained from the study hospital.

Dissemination of Results:

The result of this study will be presented for partial fulfillment of the residency program. The manuscript will also be sent to journals for possible publication and presentations at conferences and workshops.

Results

Socio-demographic characteristics

Among the 368 patients, nearly three-fourths of the cases were males with a median ($\pm$ IQR) age of the patients being 30 ($\pm$ 23.75) years ranging from 1 to 80 years. More than 70 % of patients were in the age range 20 to 60 years. About two-thirds of the patients came from Oromiya (table1).

Table 1.Socio-demographic characteristics of patients admitted to the ICU

<i>Socio-demographic characteristics</i>	<i>Category</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Sex	Male	275	74.7
	Female	93	25.3
Address	Addis Ababa	87	23.6
	Oromiya	233	63.3
	Amhara	35	9.5
	Others	13	3.5

Clinical condition before ICU admission

Hospitalization condition

Two-thirds of patients were triaged to red side at AaBET ED whereas only 15 cases were initially triaged to outpatient department (figure1).

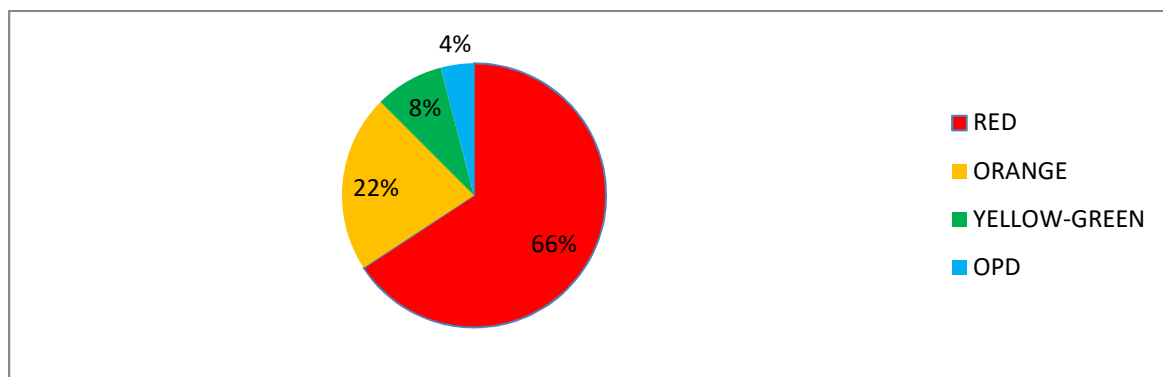


Figure2: pie-chart showing triage category of patients at AaBET ED

Majority (331) of patients came with referral paper, of which 298 patients got ambulance service. Around 70% of the cases were trauma patients; burn cases constitute 5% of ICU admitted cases (table2). Only 56 patients had comorbidity where hypertension (31) is the most common

followed by DM (12), asthma/COPD (9) and HIV (6), respectively. Two of the patients had more than one comorbidity.

Table2: Hospitalization characteristics of the patients

General condition	Response	Frequency	Percentage (%)
Was the patient referred?	Not	37	10.1
	Yes	331	89.9
Mode of arrival	Other means	12	3.3
	Private car	58	15.8
	Ambulance	298	81
Disease category	Trauma	260	70.7
	Burn	18	4.9
	NTS	36	9.8
	Medical	54	14.7

NTS: Nontrauma surgical cases

Specific disease condition

Among the 260 **trauma** cases, RTA accounts for 140(53.8%) followed by assault 53(20.1%), FDA 40(15.4%) and bullet 25(9.6%), respectively. More than 75% of the patients sustained traumatic brain injury (199), of which 101 of them had more than one brain CT-scan finding and DAI in 36, SDH in 27, EDH in 20 were among the common isolated findings. Around 80% of trauma cases have got some form of prehospital care.

Among the 54 **medical** cases, stroke cases were 20(37.5%), cardiac cases 8 (14.8%), chest infection 7(13%), and GBS, Tetanus and CNS infection each account for 4(7.4%). There were 3 poisoning cases (1 carbon-monoxide, one 2-4D and 1 OPP).

The mechanism of injury for the **burn** cases were electrical in 8, flame in 8 and scald in 2 of the cases where total body surface area burnt range from 6% (electrical) to 80% (scald). 2 of the scald burns occurred in children <10years whereas 7 of the flame burns in <30years, and 6 of

electrical burns in those above 30 years. Around 80% (28) of *non-trauma surgical* cases were brain tumor.

Condition of patient at ICU

Condition of patient at time of admission to ICU

About 95% (346) of patients were admitted either from OR/recovery (48.6%) or ED (45.4%). Primary reason for ICU admission was low GCS in 128 cases (34.8%), followed by respiratory failure in 106 (28.8%) and postoperative care in 100 (27.2%); hemodynamic instability, cardiac arrest and burn with complications account for only 12(3.3%), 12 (3.3%) and 10(2.7%) patients, respectively.

Condition of patient during ICU stay

Nearly two-thirds (232) of patients has had at least one major surgery. From the 368 admitted cases, 343(95%) cases needed mechanical ventilator and 97 cases required re-intubation; the average ($\pm$ SD) duration of MV use was 10.9days ($\pm$ 11.6days). There were 197(53.5%) patients who had admission/post-sedation GCS of ≤ 8 . The average ($\pm$ SD) length of ICU stay was 16.4days ($\pm$ 18.6days) ranging from 1 to 114days.

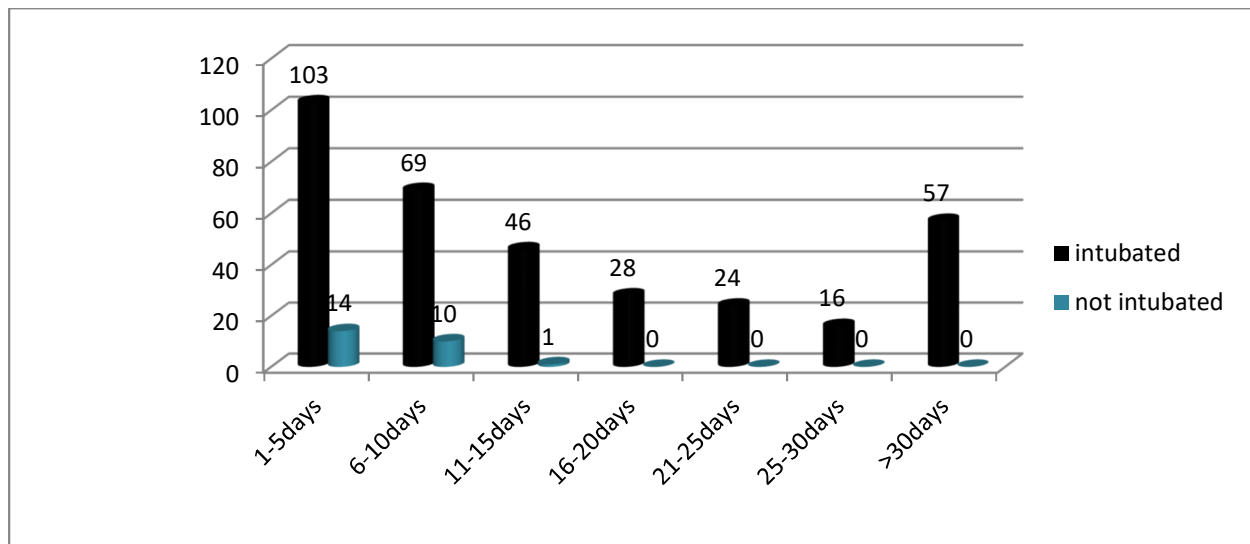


Figure3. Bar chart showing relationship between intubation status and ICU length of stay

Infection was, by far, the most common complication which patients developed after admission to ICU followed by sodium disorders, acute kidney injury, Covid pneumonia, and cardiac arrest, respectively. About two-thirds (252) of patients developed some form of hospital acquired infection (HAP/VAP, CAUTI, ventriculitis, brain abscess, soft tissue infection or a combination of these). More than 10% of patients developed acute kidney injury and 25% of cases developed sodium disorders after admission to ICU. There were 17 post-cardiac arrest cases where only 5 happened after admission to ICU. There were 17 Covid-19 cases diagnosed after ICU admission.

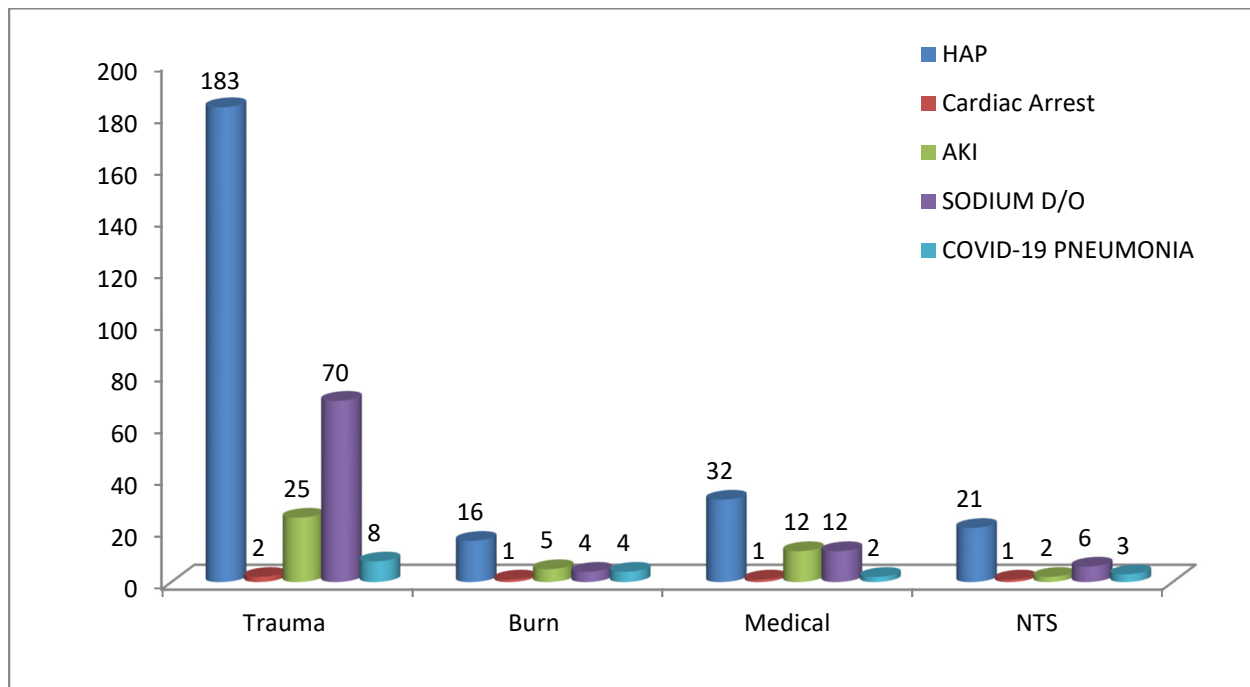


Figure4: Bar chart showing magnitude of ICU complications in each disease category

Outcome of patients and immediate cause of death

The overall mortality of patients was 31.8% (117). The case fatality rate was highest per category for burn cases (61%), post-cardiac arrest patients (70.5%), covid-19 pneumonia (47%), AKI (61%), and those admitted from ward (68%) (Figure5, figure6). Among medical cases, the highest case fatality rate was seen in stroke (50%) and chest infection (57.1%) cases. About half (50%) of the deaths occurred in the first five days of admission. Only 57 cases stayed more than one month, of which only 10 died (table3 and table4).

Table3: Baseline characteristics of patients and their outcome

Baseline condition	Category	Outcome		Total
		Died	Survived	
Sex	Male	83	192	275
	Female	34	59	93
Patient was referred	Not	12	25	37
	Yes	105	226	331
Mode of arrival	Supported	3	9	12
	Private car	18	40	58
	Ambulance	96	202	298
Comorbidity	Yes	21	35	56
	No	96	216	312

There were a total of 18 burn cases where the mechanism is 8 electrical, 8 thermal, and 2 scald burns. With the exception of 1, all were intubated and 11 died (61%). Both scald burn cases were females, less than 9years who stayed less than 5days and died. Those who sustained electrical burn were males aged more than 20 years; of these 50% died and all were intubated with 2 of them being post-cardiac arrest.

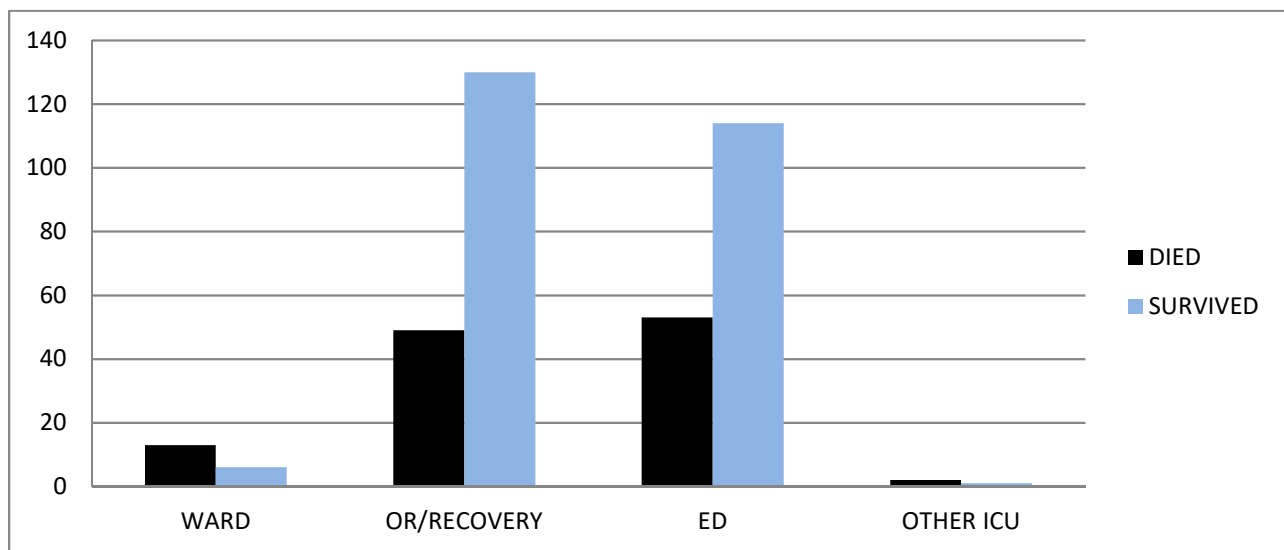


Figure5: Bar chart: Source of admission to ICU and overall Outcome of patients

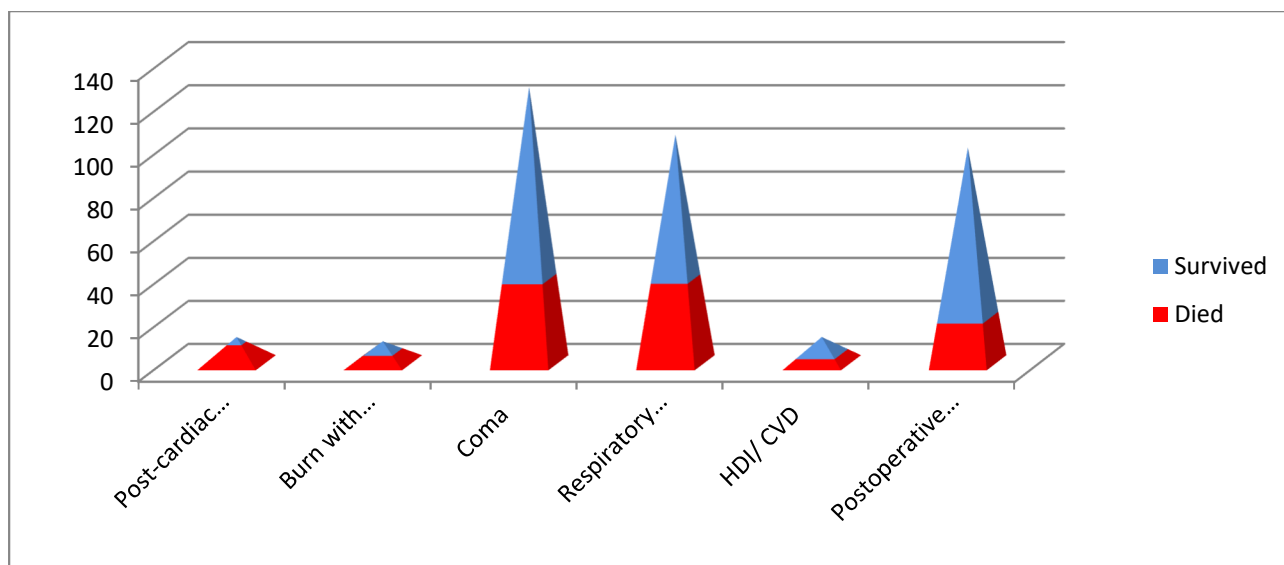


Figure6: Bar chart: primary reason for admission to ICU and overall Outcome of patients

Overall, the immediate causes of deaths were refractory shock (52.1%), brain herniation with multi-organ failure (22.2%), and hypoxia (17.1%), respectively (table 5).

Table4:- Immediate cause of death

<i>Disease category</i>	<i>Immediate cause of death</i>						<i>Total</i>
	<i>PE</i>	<i>Hypoxia</i>	<i>Hypotension</i>	<i>Brain Herniation</i>	<i>Hypo/hyper kalemia</i>	<i>Hypothermia /Acidosis</i>	
<i>Trauma</i>	4	11	39	19	3	0	76
<i>Burn</i>	0	2	8	0	0	1	11
<i>Medical</i>	0	4	11	5	0	1	21
<i>Non-trauma surgical</i>	0	3	3	2	0	1	9
<i>Total</i>	4	20	61	26	3	3	117

Factors associated with ICU mortality

Among the independent variables that were entered into bivariate logistic regression for analysis with a p-value of <0.25 , patients with burn, medical cases, $GCS \leq 8$, HAI, post cardiac arrest, AKI, need of mechanical ventilator, sodium disorders, Covid pneumonia, and ICU length of stay were found to have higher likelihood of dying. These were fitted into multivariate logistic

regression analysis. All except burn and Covid pneumonia cases had increased odds of mortality among ICU admitted cases in the study period($p<0.05$) (table6).

Table5: Bivariate and Multivariate logistic regression analysis of factors associated with ICU mortality

<i>Covariates</i>		<i>Outcome</i>		<i>Crude odds ratio</i>			<i>Adjusted odds ratio</i>		
		<i>D</i>	<i>S</i>	<i>COR</i>	<i>95%CI</i>	<i>P-value</i>	<i>AOR</i>	<i>95%CI</i>	<i>P-value</i>
Disease category	Burn	11	7	0.263	0.098-0.704	0.008	1.721	0.474-6.247	0.409
	Medical	21	33	0.649	0.353-1.193	0.164	2.961	1.330-6.593	0.008
	NTS	9	27	1.239	0.557-2.759	0.600	1.058	0.394-2.841	0.910
	Trauma	76	184	1			1		
GCS at ICU	GCS $\leq$ 8	76	121	1.992	1.266-3.134	0.003	2.407	1.339-4.327	0.003
	GCS>8	41	130	1					
HAI	Yes	92	160	2.093	1.255-3.491	0.005	4.502	2.159-9.386	<0.0001
	No	25	91	1					
Post Cardiac Arrest	Yes	12	5	5.623	1.933-16.360	0.002	6.232	1.523-25.503	0.011
	No	105	246	1					
AKI	Yes	27	17	4.129	2.148-7.939	<0.0001	4.792	2.050-11.197	<0.0001
	No	90	234	1					
Intubation	Yes	116	227	12.264	1.639-91.794	0.015	23.921	2.447-233.845	0.006
	No	1	24	1					
Pre-hospital care given	No	32	62	0.871	0.530-1.433	0.588			
	Yes	85	189	1					
Sodium disorders	Yes	35	57	1.453	0.887-2.380	0.138	2.653	1.323-5.318	0.006
	No	82	194	1					
Covid pneumonia	Yes	8	9	1.973	0.742-5.252	0.173	2.134	0.595-7.654	0.245
	No	109	242	1					
Major surgery	Yes	69	163	0.776	0.495-1.218	0.270			
	No	48	88	1					
Comorbidity	Yes	21	35	0.741	0.410-1.339	0.320			
	No	96	216	1					
Re-intubation	Yes	31	66	1.010	0.614-1.662	0.968			
	No	86	185	1					
ICU LOS (days)	$\leq$ 5	58	59	0.216	0.100-0.469	<0.0001	32.729	11.023-97.176	<0.0001
	6-10	24	55	0.488	0.212-1.123	0.091	5.674	2.116-15.217	0.001
	11-15	10	37	0.787	0.296-2.091	0.631	3.065	0.993-9.458	0.051
	16-20	4	24	1.277	0.362-4.498	0.704	1.037	0.260-4.140	0.959
	21-25	8	16	0.426	0.143-1.265	0.124	4.112	1.235-13.695	0.021
	26-30	3	13	0.922	0.221-3.849	0.911	1.082	0.227-5.165	0.921
	>30	10	47	1					

In the multivariate logistic regression analysis, keeping all other variables constant, the odds of mortality was around 2.5 times higher in those with $GCS \leq 8$ than those with $GCS > 8$ (AOR=2.407, 95% CI: 1.339-4.327). Those patients with **AKI** had 4.792 times increased risk of mortality than those without (AOR=4.792, 95% CI: 2.050-11.197). **Post**-cardiac arrest patients had 6.232 times higher odds of mortality (AOR=6.232, 95% CI: 1.523-25.503) than their counter parts. The hazard of death for patients on **mechanical** ventilator during their ICU stay was 23.921 times higher than their counterparts (AHR = 23.921, 95% CI: 2.477, 233.845). Patients with **HAI** had higher odds of death in the ICU (AOR=4.502, 95% CI: 2.159, 9.386). **Sodium** disorders were independently associated with increased ICU mortality (AOR=2.653, 95% CI: 1.323, 5.318). **Medical** cases had around 3 times higher odds of death compared to trauma cases (AOR=2.961, 95% CI: 1.330, 6.593) and those who **stayed** <10days in ICU were at higher risk of ICU mortality as compared to those who stayed longer.

Discussion

Based on this single center 2year cross-sectional study conducted to assess the mortality and associated factors among ICU admitted cases from January 1, 2021 to December 31, 2022, the overall ICU mortality was 31.8%. This finding is consistent with the studies done in China (35.4%), Kenya (31%), Malawi (35%) and TGSH (29.6%)(16, 19, 21, 27). However, it is lower than the studies done in Turkey (52.3%), Addis Ababa (44.9%), Ambo (46.9%), South Ethiopia (46.8%), HUCSH (45.8%), and northwestern Ethiopia (42.1%)(14, 23-26, 28). This lower mortality might be because young trauma patients with no comorbidity, patients who got prehospital care with better ambulance service, and patients with different indication for admission were admitted in AaBET ICU compared to the Turkish study and the study done in south Ethiopia, and HUCSH. Moreover, patients were managed by full time equivalent emergency and critical care physicians that work in closer relationship with the ER team and with other specialties. The study conducted in Brazil showed lower mortality (26.1%)(17)

compared to this study. This might be due to the difference in the study period (2013, pre-Covid era), the reason for admission where postoperative care accounts for 58.9% compared to 27% in AaBET ICU and low rate of mechanical ventilator use(only 53.9% of patients required vs. 93% in AaBET ICU).

More than two-thirds (70.7%) of the patients admitted to AaBET ICU were trauma cases where RTA contributes for 53.9%, with males accounting for 74.7% and the average age being 34.6 ± 17.4 years in contrast to the cases seen in the Turkish study where males account only for 50%, mean age was 73.8 years and reason for admission being non-trauma cases(13). In HUCSH where medical cases are the main reason for admission, males account for only 50%(26).

Most of the patients who were admitted to AaBET ICU came with referral paper (90%); got ambulance service (81%) and were given some form of prehospital care (85%) which might have contributed to the lower overall mortality compared to the case seen in the multicenter northwest Ethiopian study on trauma ICU admitted cases with proportion of mortality 42.1% that showed absence of prehospital care (70.9%) as a strong predictor of mortality; assault was also the main mechanism of injury(24).

The average length of ICU stay in this study was 10.9 days ± 11.64 days which is longer than studies done in HUCSH (5.3 ± 6.7 Days) and TGCSH (3 Days)(26, 27). The reason for this could be higher intubation rate (93.2%), higher neurosurgical procedures (63% operated), higher complications rates especially infection (68%) compared to others; but needs further study.

In multivariate analysis, admission GCS < 9 (AOR=2.970, 95%CI (1.522, 5.116)), were found to have strong association with ICU mortality. This is consistent with the studies done in UAE and Ethiopia (18, 24, 25, 27, 28). This is because low GCS predisposes patients for aspiration and hence hypoxia, intubation which will prolong length of stay in ICU, and immobilization with increased risk of thromboembolism.

This study also declared that HAI were found to have strong association with in-hospital ICU mortality. This finding is consistent with the studies done in Brazil, China, and Ethiopia (16, 17, 26). The increased mortality associated with HAI could be due to unavailability of microbial culture as needed, difficulty of collecting culture samples on time, and affordability issue for the costly antibiotics to treat resistant species.

Post-cardiac arrest patients have had higher ICU mortality in this study which is supported by the studies done in Malawi and Ethiopia(19, 23). More than half of post-cardiac arrest cases happened prior to ICU admission where there is relatively poor monitoring and follow-up of patients that hinders early detection and intervention which will affect outcome of post-cardiac patients.

Patients who have developed AKI were also found to have strong association with ICU mortality. The effect was also seen in the studies conducted in China, Addis Ababa, and HUCSH (16, 25, 26). Altered metabolism of drugs, complications resulting from the kidney injury like acidosis and electrolyte imbalance, and causes of AKI might have contributed for the increased ICU mortality.

Patients requiring mechanical ventilator were found to have strong association with ICU mortality. This finding is consistent with studies done in Brazil, Malawi, Turkish, and Ethiopia (14, 17, 19, 25, 26). Intubation may predispose patients for infection and longer ICU stay and the indication for admission could also contribute for the increased mortality in intubated patients.

In addition, shorter ICU length of stay were highly likely to die which is consistent with the Ambo university hospital, HUCSH and TGSH medical ICU studies that showed length of stay <5days as strong predictor of ICU mortality(26-28). However, in contrast to our study, the systemic review and meta-analysis study done in Ethiopia showed that length of stay more than 2 weeks have significant association with ICU mortality. These differences might be due to the nature of patients. For instance, the reasons for admission were medical cases in Ambo (medical (39.7%)), in HUCSH (CVD (22.9%)> trauma (13.9%)) and in TGSH (medical (64%)>surgical (33.6%))(26-28).

This study also showed that patients with sodium disorders had higher odds of mortality. This finding is consistent with the study done in Canada and Brazil(15, 20). More than half of the patients admitted to the AaBET ICU had TBI where sodium disorders and their management could result in increased ICP and hence mortality.

Last but not least, medical cases were found to have increased risk of ICU mortality compared to trauma cases which was consistent with the studies done in Kenya and Brazil(17, 22). This might be because medical cases have comorbidities, have longer ICU stay, and delayed presentation to health institution.

Conclusion and recommendations

Conclusion:

The overall mortality of patients who were admitted to AaBET Hospital during the study period was low compared to the national pooled national prevalence of ICU mortality. Low GCS, HAI, AKI, sodium disorders, medical cases, post-cardiac arrest, mechanical ventilator use and shorter length of ICU stay were significantly associated with mortality. Majority of admitted cases were trauma patients with RTA being the main mechanism. Half of those who sustained trauma are young productive citizens in the age range between 20 to 40 years. HAI was the most common ICU complication. Case fatality rate was highest for burn patients, chest infection, stroke, post cardiac arrest patients and admissions from ward. Half of all deaths occurred within the first 5days of admission.

Recommendation:

After carefully analyzing the data and looking at the findings, the investigator comes up with the following recommendations:-

For health institutions:

- To have infection prevention and control protocol and work hard for its implementation as hospital acquired infection was the most common complication and one of the determinants of mortality in this and other studies
- To routinely give feedback to the referring institutions in order to encourage the good deeds and fill the gaps which will improve prehospital quality of care without this, the outcome of this study could

have a different picture as prehospital care was found to have impacted in-hospital mortality in some studies

For those health professionals who are working in ICU

- To strictly adhere to infection prevention and control protocol
- To thoroughly evaluate their patients, prevent or early identify and treat complications. This study showed that patients transferred from wards had higher mortality; post cardiac arrest patients had higher likely of death and also shock was the most common cause of mortality but not the cause of admission.

For future researchers

- To implement risk adjusted ICU mortality studies using different clinical prognostic scoring techniques as imaging and laboratory results take time if at all are done
- To conduct more studies on trauma cases alone which will help to see outcomes of care and compare it with medical and other surgical cases
- To conduct more studies on factors that affect ICU outcome

Strengths

- ✧ Conducted in a unique set-up where:
 - ICU is led by emergency and critical care specialists under the department of EMCC
- ✧ Larger sample size
- ✧ Used both descriptive statistics and logistic regression for analysis

Limitations

- ✧ Being a single center study where generalizability of the outcomes is difficult
- ✧ Comparison of the research findings is difficult due to the heterogeneity of the study population. For instance, all age groups were included in the study; patients of any sort were included be it medical, trauma, burn, or surgical.
- ✧ Difficulty of getting similar studies with similar set-up (difference in the study population, physicians); No other trauma center in the country
- ✧ Lack of laboratory equipment to include prognostic scoring tools and to use risk adjusted mortality in the study

- ✧ Non-computerized data collection methods like manually filled ICU register which is filled by nurses and charts with poor documentation.

Funding

- ✧ The investigator would like to declare that funding was not received for this study. However logistic expenses that covered duplication of the study tools, data collection, and transportation were covered by SPHMMC.

Conflict of interests

- ✧ The investigator declares no competing interests.

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Assurance of Principal Investigator

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide a timely progress report to my advisor and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: _____

Signature: _____

Date: _____

Approval of the Primary Advisor

Name of the primary advisor: _____

Signature: _____

Date: _____

Approval of the Co-Advisor

Name of the primary advisor: _____

Signature: _____

Date: _____

Annex

Checklist:

- ❖ Checklist to collect data for a 2year cross-sectional study on ICU mortality and associated factors in AaBET Hospital

I. Socio-Demographic Variables

- a) Sex: 1. Male 2. Female
- b) Age in years: _____
- c) Address of the patient: 1. Addis Ababa 2. Oromiya 3. Amhara 4. Other

II. Prehospital condition

- a. Referral status: 1. with communication 2. Without communication but with referral paper 3. Without communication and without referral paper(self)
- b. Mode of arrival: 1. Ambulance 2. Private car/taxi/police car 3. Walking/with support
- c. Disease category: 1. Trauma 2. Burn 3. Medical 4. Non-trauma surgical
- d. Duration of illness before AaBET-ED visit was: _____ hrs. (hours=H)
- e. Comorbidity if any? 1. DM 2. Hypertension 3. CKD 4. CLD 5. Cardiac problem 6. Cancer 7. Asthma/COPD/ILD 8. HIV/AIDS/TB 9. Epilepsy 10. None
- f. Was pre-hospital/pre-referral care given? 1. Yes 2. No
- g. If the disease category is trauma,
 - i. What was the mechanism of injury? 1. Road traffic accident 2. Fall down accident 3. Bullet/Blast injury 4. Assault (stick, stab, or stone injury, kicked by animals or another man) 5. Others/ Falling down object injury 6. NA
 - ii. Where was the site of injury? 1. Head 2. Chest 3. Abdomen 4. Extremity/pelvis 5. Spinal cord 6. Poly trauma 7. other

- h. If the disease category is medical, it was: 1. ACS/AMI/CHF 2. Chest infection 3. Pulmonary embolism 4. Status epilepticus 5. Stroke 6. CNS infection 7. GBS 8. Tetanus 9. Poisoning 10. DKA/HHS 11. Other
- i. If the disease category was burn,
- TBSA (%) = _____
 - Mechanism of injury was: 1. Scald 2. Thermal/flame 3. Electrical/lightening 4. Chemical
 - The complication was: 1. Sepsis 2. Electrolyte abnormality 3. AKI 4. Trauma 5. Acute compartment syndrome 6. Respiratory failure/inhalational injury 7. None

III. Emergency department status of the patient

- j. What was the triage category of the patient?
- Red
 - Orange
 - Yellow/green
 - OPD

IV. ICU status of the patient:

- a. What was the source of admission? 1. ED 2. OR/Recovery 3. Ward 4. Other ICU
- b. What was the indication for ICU admission?
- Respiratory failure
 - Cardiovascular problem/ Hemodynamic instability
 - CNS problem
 - Burn with complications

- e) Post-cardiac arrest care
- f) Post-operative care
- c. What was the patient's GCS at admission? 1. ≤ 8 2. >8
- d. Was the patient intubated in his/her stay at ICU? 1. Yes 2. No
- e. If intubated, the length of stay (days) on mechanical ventilator was? _____
- f. Was the patient operated? 1. Yes 2. No
- g. If operated, where was the site of major operation?
 - a. Head
 - b. Abdomen
 - c. Extremity/pelvis
 - d. Other
- h. Which complication has the patient developed throughout his/her ICU stay?
 - a. Hospital acquired infection
 - b. Acute kidney injury
 - c. Sodium disorders
 - d. Cardiac arrest
 - e. Respiratory failure
 - f. Bed sore
 - g. Anemia
 - h. Venous thromboembolism
 - i. Barotrauma
 - j. Other
 - k. None

- i. What was the total length of ICU stay? (in days)
- j. What was the condition of the patient at time of discharge from ICU? 1. Dead 2. Alive
- k. If the outcome is death, what was the immediate cause of death?
 - a. Pulmonary embolism
 - b. Hypoxia
 - c. Hypotension
 - d. Tension pneumothorax/cardiac tamponade
 - e. Brain herniation
 - f. Electrolyte disorders[K+ disorders]/acidosis
 - g. Hypothermia/hypoglycemia
 - h. ACS/AMI