HAWASSA UNIVERSITYCOLLEGE OF MEDICINE AND HEALTH SCIENCES SCHOOL OF NURSING

ADMISSION OUTCOMESAND ASSOCIATED FACTORS OF ADULTS ADMITTED TO INTENSIVE CARE UNITS OF SELECTED GOVERNMENTAL HOSPITALS IN SIDAMA REGION, ETHIOPIA, 2023

MSc. THESIS

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NOVEMBER, 2023

ADMISSION OUTCOMES AND ASSOCIATED FACTORS OF ADULTS ADMITTED TO INTENSIVE CARE UNITS OF SELECTED GOVERNMENTAL HOSPITALS IN SIDAMA REGION, ETHIOPIA, 2023

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RESEARCH PAPER SUBMITTED TO HAWASSA UNIVERSITY,COLLEGE OF MEDICINE AND HEALTH SCIENCE, SCHOOL OF NURSING, GRADUATE STUDY.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN EMERGENCY AND CRITICAL CARE NURSING.

NOVEMBER, 2023

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ACKNOWLEDGEMENT

Praise and thanks to the Almighty God who made it possible to reach this day and accomplish this research paper.

I would like to acknowledge Hawassa University, College of Medicine and Health Science, School of Nursing for giving me a chance to conduct this research.

My deepest gratitude goes to my advisors: Mr.ThomasFako and Mr.GezahegnBekelefor their unreserved guidance and constructive advice from the very beginning of the proposal development to the end of this research report.

Moreover, I would like to acknowledge hospital administrators and, ICU head nurses for their support during data collection.

I am indebted to friends who have helped me by giving valuable suggestions.

Last but not least I would like to thank, my data collectors for their commitment during such tiresome data collection.

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ABBREVIATION AND ACRONYM

ACS	Acute Coronary Syndrome
AOR	Adjusted odd ratio
ARDS	Acute respiratory distress syndrome
BGH	Bona General Hospital
BSc	Bachelor of sciences
BPM	Beat/breath per minute
CVS	Cardiovascular system
CI	Confidence interval
CHF	Congestive heart failure
DKA	Diabetic ketoacidosis
DVT	Deep Vein Thrombosis
ECCN	Emergency and critical care nurse
HUCSH	Hawassa University comprehensive specialized Hospital
HIV	Human immunodeficiency virus
ICU	Intensive care unit
MICU	Medical intensive care unit
MRN	Medical registration number
MOH	Ministry of health
MVA	Motor vehicle accident
PE	Pulmonary embolism
SPO2	Peripheral oxygen saturation
SPSS	Statistical package for social sciences
TBI	Traumatic brain injury
YGH	Yirgalem General Hospital

ABSTRACT

Background: Intensive care ismultidisciplinary and inter-professional specialty dedicated to the total management of patients with acute life-threatening conditions. Patientsadmitted to the intensive care unit need frequent assessments of their vital signs, invasive hemodynamic monitoring, intravenous drugs and fluid management, ventilatory assistance, and dietary support. The overall goal is to increase the patient chance of survival.In resource-limited settings, mortality is still higher due to various reasons.

Objective:To assess admissionoutcomes, andassociated factors of adults admitted to intensive care units of selected governmental hospitals in theSidama region, Ethiopia, 2023.

Materials and methods: After obtaining ethical clearance,a cross-sectional study was conducted on 401adult patients admitted to ICUfromMarch 2020 to February 2023. Patient's chart was selected by systematic randomsampling; needed information was retrieved by a pretested data abstraction tool and analyzed with SPSS version 26.Furthermore,to support this study ICU director and/or chief nurse were surveyed regarding ICU characteristics.A binary and multivariable logistic regression was conducted to see if variables were associated with outcomes.

Results: The emergency department was a common source of admission (65.4%) to the ICUs. Cardiovascular diseases107(27.4%) were common causes of ICU admission.The mortality rate was 39.5%.Patients who were within the 56-65(AOR=3.6, CI,1.130-11.408), and >65 (AOR=4.3,CI,1.125-16.625) age category, mechanically ventilated(AOR=4.3, CI,2.117-8.837), high serum creatinine (AOR=2.4, CI,1.186-4.668), lowsodium(AOR=2.6, CI,1.344-5.188), lowpotassium (AOR=2.1, CI, 1.038-4.097),anemicat admission (AOR= 3.6, CI,1.908-6.636), and supported with a vasopressor (AOR= 6.2, CI, 3.212-12.131)were at higher risk of mortality whereasthose treated in general hospitals (AOR=0.5, CI,0.239-0.950)were at lower risk of mortality.

Conclusion and Recommendation: The overall mortality observed in this study was high. ICU to hospital bed ratio should be improved and clinicians should give due attention to patients who had these associated factors of mortality at admission.Overall there is a need to strengthen action to improve critical care services in the region.

Key words:Admission outcomes, Adult intensive care units,Sidama regional state

CHAPTER ONE:1.INTRODUCTION

1.1.Background

Identification, monitoring, and treatment of patients with critical illness through the initial and sustained support of vital organ functions is called intensive care(Kayambankadzanja *et al.*, 2022).An intensive care unit (ICU) is an organized system for providingintensive and specialized medical and nursing care, enhanced monitoring capabilities, and multiple modalities of physiologic organ support to sustain life during a period of potentially fatal organ system insufficiency (Marshall *et al.*, 2017).The provision of intensive care services is a global enterprise and should be given to all critically ill patients in all hospitals in the world (Schell *et al.*, 2018).Intensive care medicine started in 1953 in Denmark (Ibsen, 1954) and the concept of an ICU in Ethiopia began in 1956 at the LeelitTsehay Hospital (Kifle *et al.*, 2022).Patients admitted to the intensive care unit need frequent assessments of their vital signs, invasive hemodynamic monitoring, intravenous drugs and fluid management, ventilatory assistance, and dietary support (Nates *et al.*, 2016).

The most prevalent reasons for ICU admission are acute abdomen, trauma, stroke, sepsis, renal failure, cancer, and acute diabetic complications (Eze *et al.*, 2020).Worldwide ICU mortality was 16.2% and there was a stepwise increase in the risk of death according to a decrease in global national income. ICU mortality rates in patients with sepsis varied between 11·9% (Oceania) to 39·5% (Africa) respectively (Vincent et al., 2014)

To develop an international picture of the types of critically ill patients admitted to ICUs, the World Federation of Societies of Intensive and Critical Care Medicine encourages an audit of data from ICUs around the world with a special emphasis on sepsis and organ failure (Vincent *et al*., 2014).The journey toward excellent global critical care by 2050 is difficult with limited global epidemiological data regarding the outcomes of ICU patients (Arabi *et al.*, 2017).The majority of intensive care units in Ethiopia had no access to audit, research, or quality improvement activities (Kifle *et al*., 2022).

The rate of ICU mortality in Ethiopia varies from region to region,and one should be aware of the prevalent conditionsand set up the facilities and prepare treatment (Mohammed *et al*., 2017,Tesema *et al*., 2021).For this reason, there has been ample interest instudying the outcomes of ICU care.Therefore, this study examined admission outcomes, and associated factors of adults admitted to intensive care units of selected governmental hospitals in Sidamaregion, Ethiopia, 2023.

1.2. Statement of problem

There is a large and growing burden of critical illness globally(Crawford *et al.,* 2023). Each year, approximately 4 million ICU admissions occur in the United States(Halpern NA, 2017).Similarly, approximately176,000 patients are admitted to ICUs in England, Wales, and Northern Ireland,and 80.8% of these patients survived to be discharged ("Key Statistics from the Case Mix Programme — Adult, General Critical Care Units 2019-2021," 2022). Mortality in ICUs is a worldwide issue.It is relatively low in industrialized regions like North America, Oceania, and Europe, with rates of 9.3%, 10.3%, and 18.7%, respectively (Vincent *et al*., 2014).

The highest burden lies in the low- and middle-income countries where data are scarce (Crawford *et al*., 2023). In comparison to other developed continents, Africa has a higher-than-average ICU mortality rate(Vincent *et al.,* 2014).Malawi,South Africa,Uganda, Kenya, and Nigeria all had death rates of 60.9%,19.7%,32.9%,53.6%, and 40.1% respectively (Gundo et al., 2014,Wise *et al*., 2017,Lalani *et al.,* 2018, Salami *et al*., 2022).ICUs in sub-Saharan Africa have various levels of infrastructure, which are mostly influenced by the nation's economic development(H.R. *et al*., 2014). In addition to a lack of ICU workers, Ethiopia also suffers from a paucity of ICU supplies and equipment, which causes the level of ICU services to be below standard (Kifle *et al*., 2022). In Ethiopia, ICU mortality ranges from 38.7 to 46.4 % (Kedir *et al*., 2017, Mohammed *et al*., 2017, Tesema *et al*., 2021).

Expensive equipment, drugs and procedures, and highly skilled personnel are needed to manage critically ill patients (Siddiqui, 2015).In the United Statesannual critical care expenditures amount to $81.7 billion, or 0.66% of the gross domestic product(Halpern NA, 2017). It is estimated that the cost of the first day in the ICU ranges between 999 and 1590 € depending on whether the patient is mechanically ventilated or not(Kaier et al., 2020).In India, 45% of ICU-admitted patients left against medical advice due to various reasons including financial constraints(Paul et al., 2019). In addition to its cost ICU mortality was high inpatients under the age of 40, who are the most productive age group in the community(Gundo *et al.,* 2014).Compared to developed countries maternal mortality associated with critical illness is significantly higher in under‐ resourced countries(Sultan *et al*., 2013).ICU survivors have important physical and mental health consequences, increased ICU stay, and disability following the resolution of critical illness (Herridge *et al.,* 2016). Moreover,most caregivers of critically ill patients reported high levels of

depressive symptoms, which commonly persisted for up to 1 year and did not decrease in some caregivers (Cameron *et al*., 2016).

Critical care is under‐ prioritized. It must be prioritized by professional societies, national and regional societies, and healthcare institutions to inform and collaborate with all stakeholders(Crawford et al., 2023).Training and abilities of medical staff, nurse-to-patient ratio, infrastructure, a lack of necessary medications and equipment, and scarce data on patient outcomes are factors that affect the mortality of patients in ICU (Hunie *et al*., 2020).In addition toa lack of resources,Ethiopia has 114 million people(United Nations,2020) and 51 ICUs with only 324 beds, resulting in a national ICU bed-to-population ratio of 0.3 per 100,000 (Kifle *et al*., 2022).Due to the lack of appropriate laboratory services, resource-constrained countries frequently have high mortality rates as a result of weaknesses in scoring the severity of illness (Gundo *et al*., 2014). Many reports showedthat even if critically ill patients were admitted to the ICU to reduce morbidity and mortality associated with acute illness, trauma, or surgical procedures there were poor outcomes for patients admitted to the ICU(Mohammed *et al*., 2017,Gidey *et al*., 2018,Tesema *et al.*, 2021).

Improving ICU outcomes globally will require a better understanding of the burden of critical illness in resource-limited settings with a focus on regional and local data about ICU processes and outcomes (Diaz *et al.*, 2019).A holistic approach to critically ill patients and the identification of risk factors associated with ICU mortality is required to predict and reduce mortality rates in the ICU (Arabi *et al*., 2017, Soares Pinheiro *et al*., 2020).Prioritizing the available scarce resources in the ICU based on the local needs driven by available data is imperative (Patrick, 2022). Moreover, multi-center ICU data are imperative in designing future critical care delivery models that reflect the needs of the patient and address barriers to their care (Nawaz et al., 2022).

Admission outcomes and their associated factors are not well investigated in the Sidama regional state. Currently, even though ICU service in general hospitals is becoming common, most ICU outcomes studies in our country were from single referral hospitals. To my bestknowledge, few studies considered institutional factors and analyzed the usefulness of admission laboratory value as a prognostic marker.The results of this review will be used to evaluate critical care services in the region and to comprehend the key factors that affect ICU outcomes.

1.3. Significance of the study

Assessing outcomes of ICU admission is a way of measuring the effectiveness of care and this may help patients admitted to the ICU to receive quality critical careservices.May provide general knowledge for clinicians on the magnitude and causes of mortality in these institutions. Moreover, it helps them to give due attention to patients who have associated factors of mortality.It is also essential for health care planners as it identifies areas of priority for ongoing service development. Furthermore, the study will be used as up-to-date information for those who need to conduct further investigations in the area.

This study may contributes to the achievement of the plan entitled ‘’journey toward Excellent Global Critical Care by 2050’’ It also helps us to fully understand the problem, and to make new recommendations sothat we can better deal with it. Conducting this research is important because ICU mortality varies from region to region in Ethiopia. Each study conducted can be summarized by systematic review and give an overall picture of patients admitted to ICU at the national level.I hope an effort to understand the admission outcomes of patients admitted to these ICUs will help to improve the quality of care and outcomes of adult patients.

The study of admission outcomes of patients admitted to the ICU aids in the identification of priorities and the resources needed. An audit of ICU outcomes provides important feedback for improvement in care and improvements in care have the potential to decrease the mortality associated with criticalillnesses. The results of this study might help in evaluatingthe effectiveness of this fragile, highly costly, and demanding healthcare system in the given institutions, to make better decisions, improve the quality of care, standardize conduct, and optimize scarce resource utilization.

Evaluating associated factors of outcomes could help to improve the prognosis of critically ill adult patients by improving the quality of the care provided, and targeting an eventual preventive action.

CHAPTER TWO

2. OBJECTIVES

2.1. General Objective

To assess admissionoutcomes and associated factors of adults admitted to intensive care units of selected governmental hospitals in Sidama region,Ethiopia, 2023.

2.2. Specific Objectives

1) To investigate admission outcomes of adults admitted to intensive care units of selected governmental hospitals in the Sidama region, Ethiopia, 2023.

2) To identify factors associated with outcomes of adults admitted to intensive care units of selected governmental hospitals in the Sidama region, Ethiopia, 2023.

CHAPTER THREE

3. LITERATURE REVIEW

3.1Admission Patterns in ICU

Some epidemiological data have been provided by previous studies at the national and local levels regarding the types of patients and outcomes of adults admitted to intensive care units.

Assessment of the worldwide burden of critical illness showed that 2973 patients (29.5%) had sepsis on admission or during the ICU stay (Vincent *et al*., 2014).A study done in Pakistan showed that hepatic diseases (12.9%), Cerebral Vascular Accident (11.6%), Sepsis (10.4%), Respiratory issues (9.5%), Central nervous system infections(7.9%), and acute gastroenteritis with complications (5.8%) were major diagnosis during ICU admission (Rajput, 2018).A study conducted in Guyana to review admissions to the Intensive Care Unit revealed that 734 patients were admitted, and trauma was the largest diagnosis (24%) of the patients' admissions(Henry *et al*., 2017).A study done in South Africa showed thatapproximately half of admissions were for noncommunicable disease (49.6%), followed by trauma (29.0%), and infectious disease (21.5%) (Wise *et al*., 2017).A 5-year analysis of 137 patients admitted to the ICU of Babcock University Teaching Hospital,Nigeria showed that the most common cases admitted were general surgery patients (42.6%) (Salami *et al*., 2022).A retrospective Study of 100 Cases admitted to ICU in Morocco revealed thatthe majority of patients (61%) were admitted after a scheduled surgical intervention or for urgent surgery while 30% of patients were for medical pathology and 9% for traumatic pathology(Chaker *et al*., 2023)

A study conducted at the Ayder Comprehensive Specialized Hospital in Tigray, Ethiopia, showed that a total of 1,211 patients were admitted to the ICU. The commonest admissions were patients with cardiovascular diseases (26%), followed by infectious diseases (20%), and neurological diseases (19.8%). The specific causes of admission to the Unit were diabetic ketoacidosis and heart failure (16% each), followed by stroke (15.2%) (Gidey *et al*., 2018). A study conducted at the University of Gondar Comprehensive Specialized Hospital on 504 patients showed that 299 (59.3%) were admitted from the medical ward and Cardiovascular diseases182(36.1%) were the commonest categorical admission diagnosis (Tesema et al., 2021).A study conducted at Wollega University Referral Hospital

among ICU-admitted patients revealed that324(65.3%) admissions were from emergency department,and Meningitis (10.7%), Bronchial Asthma (9.7%), CHF (8.5%), Stroke (8.1%), andEclampsia (7.3%) were the five commonest causes for ICU admission (Nega Desalegn, 2021).

A retrospective review of 1256 patients in the intensive care unit of St. Paul's Hospital Millennium Medical College revealed that diabetic ketoacidosis 187 (14.9%) was the leading cause of admission, followed by all Strokes 103 (8.2%)(Kedir*et al.*, 2017).

3.2. Outcomes of adult ICU admission

A two-year review of admissions to the Intensive Care Unit of the Georgetown Public Hospital Corporation revealed that the ICU mortality rate was 48% (Henry *et al.*, 2017).A study conducted in a Brazilian public teaching hospital showed that the ICU mortality rate was 22.9% (Silva *et al*., 2018).A finding of study in Pakistan revealed that out of 421 adults admitted to the ICU, 39(16.2%) died, and 146 (60.6%) improved and were subsequently discharged (Rajput, 2018).

The study recruited data from253 patients admitted to the ICU in Malawi revealedan overall mortality of 60.9%(Gundo et al., 2014).A study done in South Africa to assess outcomes after 30 days of ICU admission showed that in-ICU mortality was 19.7% andthirty-day survival was known for 174 (76.3%) admissions (Wise *et al*., 2017).A 5-year reviewin Nigeria such as Enugu, and Babcock University Teaching Hospitals showed that the overall ICU mortality rates were 34.1%, and 27.2% respectively(Eya *et al*., 2022, Salami *et al.*, 2022).

A retrospective cohort study conducted in Amhara regional state, Northwest Ethiopia showed that the overall mortality rate of the ICU-admitted patients was 29.6% (95% CI: 26%, 33%)(Demass, 2022). A retrospective review of ICU-admitted adult patients at Wollega University Referral Hospital found that themortality rate was 29.0%(Nega Desalegn.,2021).A five-year retrospective study on admission patterns and outcomes in the medical intensive care unit of St. Paul's Hospital Millennium Medical College showed that the mortality in the MICU was 39%(Kedir *et al*., 2017). A study done to audit theclinical outcomes of patients admitted to the intensive care unit of NigistEleni Mohammed Memorial Hospital of Hosanna, Southern Ethiopia, revealed that a total of 280 clients were enrolled in the study, of whom 46.42% died (Mohammed *et al*., 2017).

3.3. Factors Associated with Outcomes of Adult ICU Admission

A prospective observational study conducted in the medical ICUs of a tertiary care hospital located in southern India showed that a low platelet count along with the need for invasive mechanical ventilation was found to be a clear predictor of mortality in severely septic patients (Ajay Handa *et al*., 2018).A prospective cohort study conducted in Korea showed thathealth insurance status was not independently associated with mortality in multivariate analysis(Wang *et al.*, 2021). A prospective, observational study conducted in the United States of Americarevealed a risk of increased mortality among patients admitted during the daytime(Orsini *et al*., 2016).

A meta-analysis conducted in China to examine the association between anemia and clinical outcomes revealed an increased risk of all-cause mortality in patients with anemia compared to a non-anemic population(Song *et al*., 2021).A prospective cohort study that involved patients admitted to the medical intensive care unit (ICU) of Siriraj Hospital showed that in multivariate analysis, the requirement for vasopressor administration was the factor significantly associated with ICU mortality(AOR =5.8, p=0.02)(Tongyoo & Viarasilpa, 2018). A retrospective review of unselected adult patients admitted to the cardiac intensive care unit revealed that after multivariate adjustment, hyponatremia was significantly associated with mortality (AOR, 1.42; 95% CI, 1.14–1.76; P=0.002)(Barsness & Jentzer, 2020).

In a large heterogenous cohort of critically ill patients, low admission creatinine concentrations were independently associated with an increased risk of mortality(OR2.03; 95% CI, 1.86–2.21, p< 0.01)(Udy *et al*., 2016).A retrospective cohort study of 9644 Cardiac ICU patients, with hemoglobin levels measured at admission reported that on multivariable regression, admission anemia (p > 0.99) was not associated with hospital mortality (Rayes *et al*., 2020).

Across-sectional study conducted in two clinical and surgical ICUs in the state of Sergipe, north-eastern Brazil, showed that older age (53±17, p<0.01),nasogastric tube feeding(p =0.01), and use of a mechanical ventilator(p =0.035) were associated with mortality (Soares Pinheiro *et al.*, 2020). A prospectivestudy in a mixed sample of critically ill subjects, including patients with and without pre-existing diabetes, revealed that hypoglycemia and hyperglycemia were independently associated with increased mortality (Bellaver *et al*., 2019).Retrospective analysis of 2171 patients showed that in multivariate analysis,hyponatremia at admission (AOR= 3.82,CI,1.47–9.91,p= 0.006) and age above 65

years were associated with mortality independently of the underlying condition (Sturdik *et al*., 2014).

A prospective observational study of a series of ICU patients over12 months showed that hyponatremic patients had a longer ICU stay, had longer ventilator days, and had increased mortality (Padhi *et al*., 2014). A retrospective study involving 100 patients hospitalized in the surgical intensive care unit of Avicenne Hospital revealed in a multivariate analysis the predictive factors of mortality in the ICU were represented by the existence of neoplastic disease, admission for a medical reason, the use of vasoactive drugs, the use of mechanical ventilation, blood transfusion, and length of stay in the ICU(Chaker *et al*., 2023). A retrospective cohort study of medical patients admitted to St James's Hospital (Dublin, Ireland) revealed an association between hypokalemia (AOR=1.30, CI, 1.16–1.45,p= <0.001) and hyperkalemia at admission(AOR=2.22,CI, 2.00–2.48,p <0.001)(Conway *et al*., 2015).A retrospective observational cohort study performed at the adult ICU revealed in a multivariate analysisthat admission hypokalemia and hyperkalemia had an independent association with mortality(Hessels *et al*., 2015).

A retrospective cohort study conducted in Denmark showed that multivariable-adjusted risk for death was statistically significant for patients with hypokalemia (Hazard Ratio: 1.91,95%CI: 1.14–3.19] and hyperkaliemia (Hazard Ratio: 2, CI: 1.25–3.18)(Eggers-kaas *et al*., 2015). A cross-sectional study at Sardjito General Hospital showed that in multivariable logistic regression analysis, male gender (OR: 2.67, CI, 1.23- 5.78), acute heart failure (OR: 2.86, CI,1.40 -5.8),pneumonia (OR: 2.71,CI, 1.26- 5.86), baseline creatinine>1.5 mg/dL (OR: 2.27,CI, 1.06 -4.88), and the use of mechanical ventilator (OR: 5.54,CI, 1.70- 17.9) were predictors of mortality(Bagaswoto *et al*., 2022).Retrospective analysis of Acute coronary syndrome (ACS) patients admitted and treated in an ICU revealed that in the multivariate model, anemia on ICU admission remained an independent risk factor for adverse outcomes[2.55 (1.99–3.27)] and remained significant after adjustment for admission disease severity(Wischmann *et al*., 2022).

A retrospective cohort study of 57,160 adults admitted to any ICU at 2 academic tertiary care centers in the United States of Americarevealed thatolder patients had an increase in overall mortality even after correcting for the increasing comorbid illness that accompanies aging(AOR= 3.33,95% CI, 2.90-3.82)(Seethala *et al*., 2017).Retrospective analysis of all adults admitted to intensive care units in Poland showed that variables associated with ICU mortality were hospitals with tertiary level of care(RR=0.86,CI,0.8-0.92),younger

age(Relative Risk=1.025,CI,1.024 to 1.026) and female sex (Relative Risk=0.92,CI,0.88 to 0.96)(Wojciech*et al*., 2018). A retrospective study in France showed that after adjustment for the other variables, ICU mortality was significantly higher among patients hospitalized in a teaching hospital (adjusted Odds Ratio 1.050 [1.003–1.050])(Allyn*et al*., 2022).

Weekly 45-minute case-based tele-education rounds conducted in Banja Luka, Bosnia and Herzegovina showed changes in standardized admission, rounding practices, incorporation of multidisciplinary care,daily sedation interruption, protocolized mechanical ventilation management, and liberation. Moreover,the intervention was associated with a reduction in ICU and hospital mortality, length of stay, cost savings ($400,000 over 2 years), and a high level of staff satisfaction and engagement with the tele-education program (Kovacevic *etal*., 2019).A retrospective cohort study of 59,693 patientsin Brazilian intensive care units showed in multivariable analysis, the number of protocols was the only organizational characteristic associated with mortality (OR = 0.944 (95 % CI 0.904–0.987)(Angus *et al*., 2015).A multicenter observational study conducted in France showed that the ICU risk of death increased by a factor of 3.5 (1.3–9.1) when the number of patients was above 2.5 per nurse and by a factor of 2.0 (1.3–3.2) when the number of patients was above 14 per physician(Antoine*et al*., 2018).

A retrospective cohort of adult trauma patients admitted to the general ICU of a public teaching hospital in southern Brazil showed that age over 55 years was a predictive factor of mortality compared with those younger than 55 years(Silva *et al.*, 2018).A descriptive and analytical retrospective study carried out in the medical intensive care unit of the University Hospital Center in Marrakech did not show a significant association between hyponatremia and death (p=0.214)(Elarras *et al*., 2023). A2-year retrospective cohort study conducted in Kenya found that ages 35–49 (aOR, 3.13; P = 0.002) and age above 50 (aOR, 2.86; P = 0.004), sepsis (aOR, 3.39; P = 0.01), acute stroke (aOR, 8.14; P = 0.011),acute respiratory failure, mechanical ventilation (aOR, 6.37; P=0.001),and vasopressorsupport (aOR, 7.98; P=0.001) were factors associated with mortality with a high adjusted odd ratio. Poisoning with drugs/alcohol (aOR, 0.33; P = 0.005) was associated with mortality(Lalani e*t al*., 2018).A retrospective audit of 253 admissions to the Intensive Care Unit (ICU) of Kamuzu Central Hospital in Lilongwe, Malawi, showed ayounger age of less than 40 years and increased patients' length of stay in the unit were significantly and positively associated with mortality (P < 0.05)(Gundo *et al.*, 2014).

According to a study done at Ayder Comprehensive Specialized Hospital, older age, HIV positivity, acute respiratory distress syndrome, septic shock, and status epilepticus were independent predictors of death(Gidey *et al.*, 2018).A retrospective cross-sectional study at the University of Gondar Comprehensive and Specialized Hospital, Northwest Ethiopia, showed that in the multivariate analysis, mortality was associated with abnormal mental status at admission (AOR = 2.8.8, 95% CI: 1.83-4.29),need for mechanical ventilation (AOR=5.87, 95% CI: 3.24 - 10.65),and ICU stay less than four days (AOR= 5.58, 95% CI: 3.58- 8.69),but not with abnormal vital signs at admission(Tesema *et al.*, 2021). Findings of the study at TibebeGhion specialized hospital in Northwest Ethiopia found that having altered mentation (AOR=13.44; 95%CI: 5.77, 31.27), mechanical ventilator use (AOR = 4.11; 95%CI: 2.63, 6.43), and stayed < 5 days in the ICU (AOR = 3.74; 95%CI: 2.31, 6.06) were significantly associated with ICU mortality(Demass,2022).

A retrospective cohort study conducted at Ambo University Referral Hospital revealed that mortality was significantly associated with Glasgow coma scale < 9 (AOR = 3.7, P value < 0.001), patients with coexisting disease (AOR = 2.2, P= 0.001), mechanical ventilation requirements (AOR = 2.6, P=0.001), and patients who stayed less than four days in intensive care unit (AOR = 2.4, P= 0.001)(Haile, 2022).A study conducted to assess the clinical outcomes of 280 patients admitted to the intensive care units of NigistEleni Mohammed Memorial Hospital in Hosanna, Southern Ethiopia, showed that patient with head injury is about six times more likely to die than patients with small bowel obstruction (AOR 6.620 (95% CI (0.468-93.584)(Mohammed *et al*., 2017).

CONCEPTUAL FRAMEWORK

Outcomes of adult patients admitted to the intensive care unit are potentially related toa varietyoffactors.This conceptual framework was constructed based on findings from previous studies. Independent variables that are related to the major variables of the study were taken. Male sex,abnormal mental status at admission, older age,ICU stay<1 week, use of a mechanical ventilator, vasopressor support, cardiac arrest, head injury, and laboratory results at admission are expected to affect the dependent variable of the study(Lalani *et al.*, 2018, Yoan *et al.*, 2020,Tesema *et al.*, 2021,Demass, 2022).

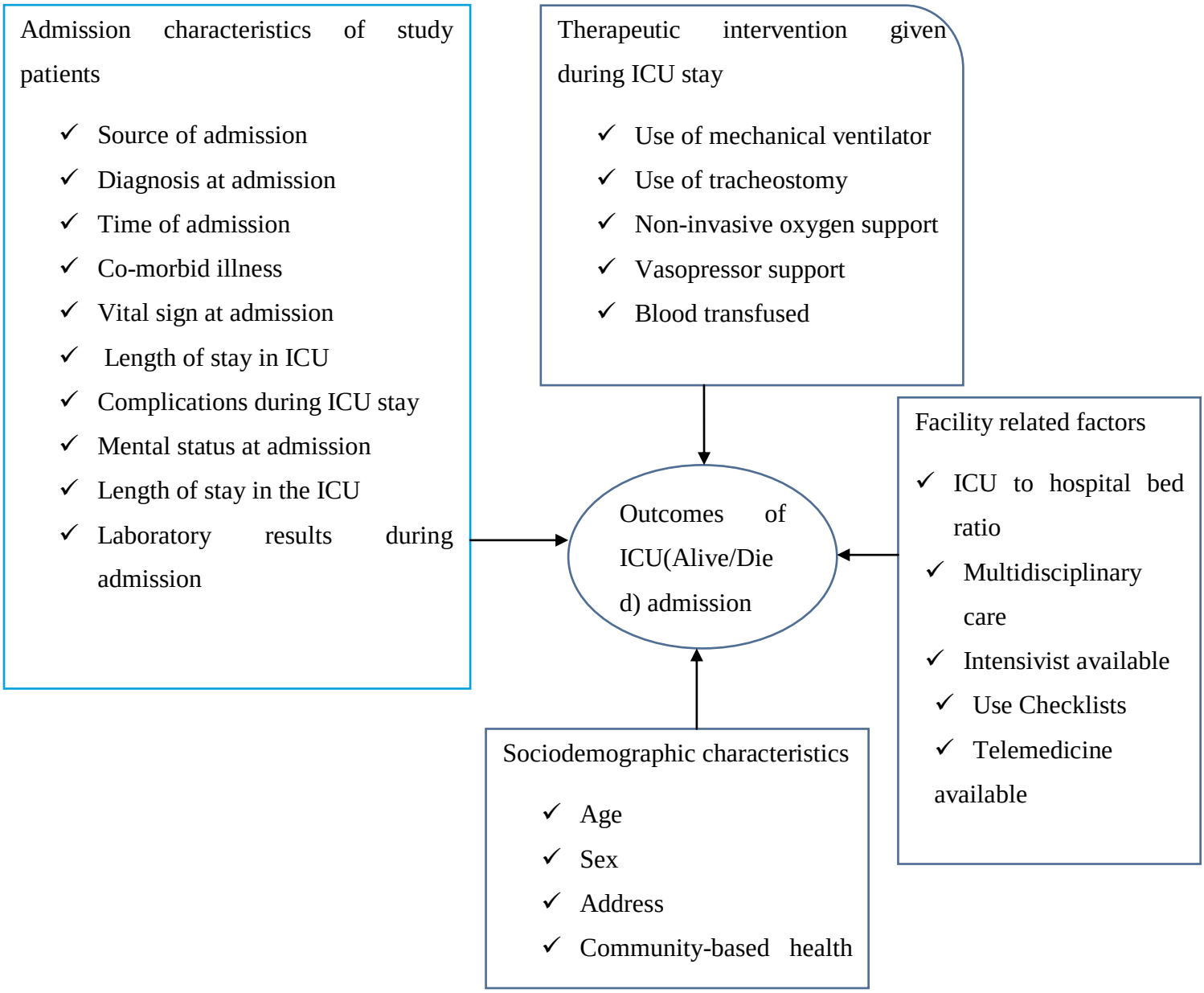


Figure 1: Conceptual framework reflects expected relationship b/n dependent and independent variables.

CHAPTER FOUR

4. MATERIALS AND METHODS

4.1. Study Period and Area

The study was conducted at the general ICU of selected governmental hospitals in Sidama regional state.Sidama regional state is one of the twelveregions in Ethiopia and is located 275 kilometers south of Addis Ababa, the capital city of the country. The region consisted of six town administrations and thirty districts with an overall of 576 kebeles.Based on the Ethiopian Population Census 2007 estimates, the overall population of the region in 2020 has reached 5,493,516. The Sidama regional state has an overall of 5,806 health professionals of diverse disciplines and 624 health posts, 127 health centers, 13 primary hospitals, three general hospitals, and 1 comprehensive and specialized hospital owned by the government. HawassaCity is the capital city of the Sidama regional state(Sidama administration, 2020).

Those hospitals that have ICUs and provided critical care services for 3years and above were selected.These includeHawassa University Comprehensive and Specialized Hospital,YirgalemGeneral Hospital, and BonaGeneral Hospital.HUCSH ICU is a general ICU that has ten beds,ten mechanicalventilators,and ten monitors.Bona general hospital ICU was established 4 years ago and it is a general ICU.It has 4 beds,two mechanical ventilators, two monitor machines,and two infusion pumps. YirgalemGeneral Hospital ICU is also a general ICU that has 4 beds with 3 mechanical ventilators. Regarding their workforce distribution, there are 5 critical care physicians,4anesthesiologists, and 23 nurses (of which 2 are critical care nurses) in HUCSH, two physicians (1 Internist, 1General Practioner), and 10 nurses (no critical care nurses)in YirgalemGeneral Hospital, two physicians(1 Internist, 1 General Practioner), two anesthetics, and 5 nurses (of which two are critical care nurses) in Bona General Hospital.None of the hospitals have physiotherapists, respiratory therapists, psychologists, nutritionists, and clinical pharmacists dedicated to the ICU. This study was conducted from May1 to May 25, 2023.

4.2. Study Design

An institutional-based cross-sectional study was used based on the ICU logbook and charts.

4.3. Population

4.3.1. Source population

Allcharts of adult patients admitted to the ICU of Hawassa University Comprehensive and SpecializedHospital, Bona General Hospital, and YirgalemGeneral Hospital.

4.3.2. Study Population

Selected charts of adult patients admitted tothe ICU of HUCSH, Bona General Hospital, and YirgalemGeneral Hospital from March 2020 to February 2023.

4.3.3. Study unit

Patient chart

4.4. Inclusion Criteria and exclusion criteria

4.4.1. Inclusion criteria

All critically ill adult patients admitted to the ICUs and whose chart was available in the Hospital archieve room

4.4.2. Exclusion Criteria

Patients' charts thatweremissed, incomplete, left against medical advice or referred to other hospitalswere excluded from the study.Moreover; patients who died within 2 hours of admission were excluded.

4.5. Sampling

4.5.1. Sample Size Determination

The sample size for the first objective

The sample size was calculated using a single population proportion formula,

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

Where,

n= minimum sample size

P = prevalence of adult ICU mortality(p=46%),which is taken from research done atNigistEleni Mohammed Memorial Hospital of Hosanna(Mohammed et al., 2017).

d =margin of error (5%), and

$(Z\alpha/2)^2$ = the standard normal variable and using a 95% confidence interval.

$$n = \frac{(1.96)^2\ 0.46\ (1-0.46)}{} = 382$$

$(0.05)^2$

The sample size for the second objective.

Having altered mentation (AOR=13.44; 95%CI: 5.77, 31.27), mechanical ventilator use (AOR = 4.11; 95%CI: 2.63, 6.43), and stayed < 5 days in the ICU (AOR = 3.74; 95%CI: 2.31, 6.06) were significantly associated with ICU mortality (Abebe *et al*., 2020,Demass *et al*., 2022).The sample size was calculated by using Epinfo sample size calculator software.

Table 1: Sample size calculated by using factors associated with outcomes using epi info software.

Variable	CI	Power	% of unexposed with outcome	AOR	Sample size
Use of MV	95%	80%	19.1	4.11	90
Mental status	95%	80%	3.85	13.44	62
Length of stay	95%	80%	32.8	5.62	90

A total of 401patients' charts werereviewed after adding a 5% contingency for incomplete charts. This sample size was allocated proportionally to 3 selected hospitals.

Table 2: Proportional allocation of sample size to the three hospitals

Selected hospitals	HUCSH	YGH	BGH	Total	Source
Admission over 3years	686	573	330	1589	Hospital administration
Sample size	173	145	83	401	

4.5.2. Sampling Technique

Hospitals that have provided critical care services for three or more yearswere purposively selected anda systematic randomsampling technique was used to select 401 patients' charts from the entire admission by using the formula interval size (k) = N/n.A sampling frame was prepared for each hospital independently and samples were selected proportionally. During the study period, 686,573 and 330 cases were admitted to ICUs of HUCSH, YGH, and BGH respectively. Accordingly, 173,145 and 83 cases with the k interval of 3 were selected from HUCSH, YGH, and BGH respectively.

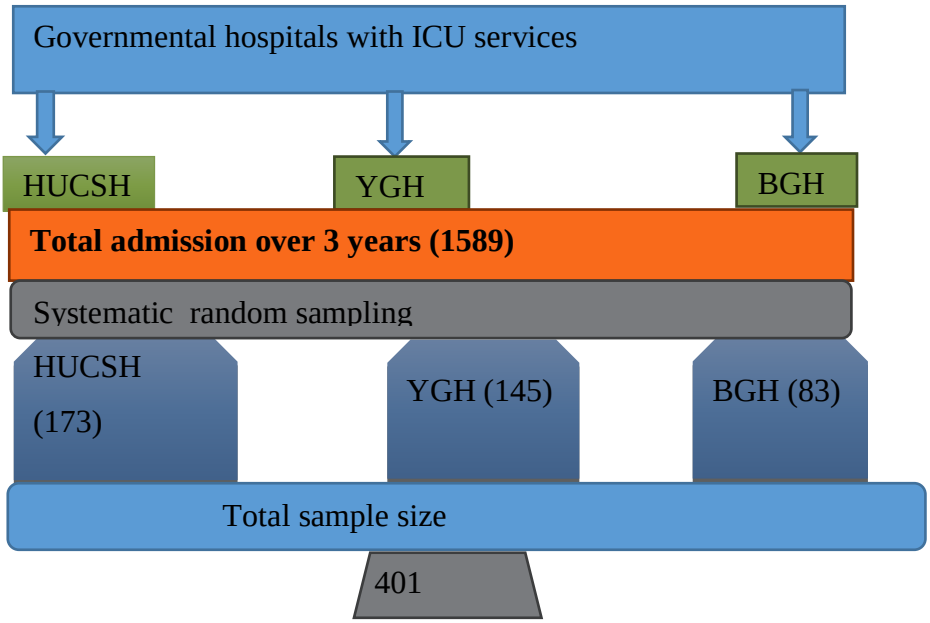


Figure 2: Schematic Representation of Sampling Technique.

4.6. Variables

4.6.1 Dependent Variable

Outcomes (alive or death) of a patient admitted to ICU.

4.6.2 Independent Variables

Socio-demographic data

- Age
- Gender
- Residence area
- Marital status
- Community-based health insurance

Admission characteristics of study patients

- Diagnosis at admission
- Source of admission
- Time of admission
- Underlying disease or co-morbidities
- Frequency of admission
- Vital sign at admission
- Mental status at admission

- Laboratory results during admission (Hemoglobin,white blood cell,platelet,sodium,potassium,random blood sugar,creatinine

Length of stay in ICU

Complications during ICU stay

Intervention during ICU stay

- Non invasive oxygen support
- Mechanical ventilation support
- Nasogastric tube feeding
- Deep vein thrombosis prophylaxis
- Blood transfusion
- Tracheostomy

Characteristics of ICU in which patients were hospitalized

- Tertiary or general hospital's ICU
- ICU to hospital bed ratio
- Presence of intensivist, critical care nurses,telemedicine,multidisciplinary care
- Number of clinical protocols applied in the ICU

4.7. Operational Definitions

Admission outcome: Represent the patient's discharge endpoint of admission. Outcomes of admission can be death, improved, and transferred to wards, left against medical advice, and prolonged stay in ICU. In this study, it was classified as dead and alive(Haile, 2022).

Incomplete chart:Chart in which more than 25% of all necessary information of patients was missed (Debebe et al., 2022).

Adult patient: Age => 16 years admitted to their ICU(Endeshaw et al., 2022).

Admission vital signs: First vital signs taken upon presentation to hospital (within 24 hours of ICU admission).

Admission laboratory values:First laboratory values measured within 48 hours of ICU admission(Yoan et al., 2020).

Hyponatremia was defined as a serum sodium concentration <135 mmol/L and hypernatremia as a serum sodium concentration >145 mmol/L(Sakr *et al*., 2013,Padhi *et*

al., 2014,Barsness & Jentzer, 2015,Judith E. Tintinalli, 2020,Uddin *et al*., 2021,Elarras *etal*., 2023)

Normal serum potassium level: potassium level between 3.5-5.5(Judith E. Tintinalli, 2020)

Anemia: According to the World Health Organization, anemia is defined as hemoglobin (Hb) levels <12.0 g/dL in women and <13.0 g/dL in men(Domenica Cappellini & Motta, 2015).

According to the American Diabetes Association, hyperglycemia in hospitalized patients is defined as blood glucose levels >140 mg/ dL and hypoglycemia is blood glucose levels < 70mg/dL(Soares Pinheiro *et al*., 2020, Care & Suppl, 2021)

Normal platelet count: Platlet count between (Based on the hospital laboratory reference range and published literature(150,000-450,000 cells/μL(Venkata *et al*., 2014,Padilla & Abadie, 2023).

Normal White Bood CellCount: White blood cell count between 4,500-11, 000 cells/μL(Blanco *et al.*, 2019)

High serum creatinine: Serum creatinine ≥1.5mg/dL(Hosten, 1886,Thongprayoon *et al.*, 2017,Bagaswoto *et al.*, 2022)

4.8. Data Collection and Analysis

4.8.1. Data collection instruments

A structured data abstraction tool adapted from similar studies (Lalani et al., 2018, Haile, 2022, Tesema et al., 2021) was incorporated into Kobo toolbox software and used to retrieve needed information.The abstraction tool contains information related to socio-demographic characteristics, admission characteristics, length of ICU stay,treatment given in the ICU, and outcomes of the study population.

4.8.2.Data collection procedure

The data abstraction tooladapted from previous literatures was organized according to the study objective,and incorporated into the Kobo toolbox software.All medical registration numbers of adult patients admitted to the ICU from March 2020 to February 2023 were identified from registration book which is available in the ICU.Based on this frame, 401patients' charts were selected systematically and retrieved from the hospital archive

room.Data from ICU charts were collected by 2 trained BSc nurses and data collection process was supervised by one supervisor.

4.8.3. Data quality control measures

Two data collectors and one supervisor with emergency and critical care background or work experience were selected.Training was given on Kobo toolbox software usage,where to find needed information in charts, and variables of the study. One week before the start of data collection, a pretest was conducted on 5% of the sample size at Adare General Hospital ICU. After the pretest, adjustments were made to the data abstraction tool asappropriate.The supervisor and investigator checked the collected data for consistency, completeness, and redundancy during the data collection period every day.Finally, the data had been coded, entered,cleaned, and meticulously stored before analysis by the investigator.

4.8.4. Data processing and analysis

After being coded, and checked for completeness, the data was entered into EpiData version 4.6.0, and exported to SPSS version 26 for analysis.The data was cleaned as appropriate. Missing values were observed for laboratory tests and since missingness was <5%, complete case analysis (listwise deletion) was used to handle it.The normal physiological cut of value was used to categorize the laboratory results into normal,low, and high.The variables like blood urea nitrogen, Alanine Transaminase,Aspartate Transaminase, and urine output in the first 24 hours were excluded from the analysis as the missing values were excessive.Descriptive statistics were carried out using text, frequency, percentage, graphs, and tables.Variables associated with outcomes at a significance level of less than 0.25 in the univariate analysis were included in the multivariate analysis. Multi-collinearity was diagnosed using the variance inflation factor. For this data, all Variance inflation factors were <5.The model had a good fit since the Hosmer and Lemeshow test could not reject the hypothesis of model appropriateness (chi-square value 7.931 and p=0.440).In this case, 59% change in the dependent variable was accounted for by the predictor variables in the model. The model correctly classified 84.1 percent of cases overall. The strength of association was evaluated using an odds ratio (OR) with a 95% confidence interval (CI).From multivariable logistic regression, a p-value of less than 0.05 was taken as statistically significant with a 95% confidence interval.

Assumptions that were used during data analysis

1. The response or dependent variable is binary/dummy (i.e. alive or dead).
2. The observations are independenti.e. observations are not from repeated measurements of the same individual
3. The sample size is sufficiently large (a small sample size within a large number of predictors reduces power).
4. No multicollinearity among explanatory variables.
5. No significant outliers.

4.9. Ethical Consideration

Permission to conduct the study was obtained from Hawassa University College ofMedicine and Health Science,institutional review board.The permission letter was given to each hospital administration, and finally allowed to access the patient's chart.To ensure confidentiality names and any other personal identities werenot used during data collection.

4.10. Plan for Dissemination of the Result

The results of this study will be presented to Hawassa University College of Medicine and Health Science,School of Nursing.Moreover, theseresults will be kept in a library,communicated tothe SidamaRegional Health Bureau,and selected hospitals in the form of softcopy. Finally, it will be submitted to a relevant scientific journal for publication.

CHAPTER FIVE

5.RESULT

5.1. Socio-demographic and admission characteristics of the respondent

A total of 1,589 adult patients were admitted to the three Hospital's ICUs from March 2020 to February 2023. After proportional allocation,four hundred-onepatient records were selected with systematic random sampling from three ICUs. Finally, three hundred and ninety were included in the analysis, making a completion rate of 97.3%.Ofthe total study participants 231 (59.2%) were males, and 103(26.4%) were between ages 16-25 years.The mean±standard deviation age of the study participants was 41.15±18.742. Three hundred thirty three patients333 (85.4 %%) had no community-based health insurance. (table 3).

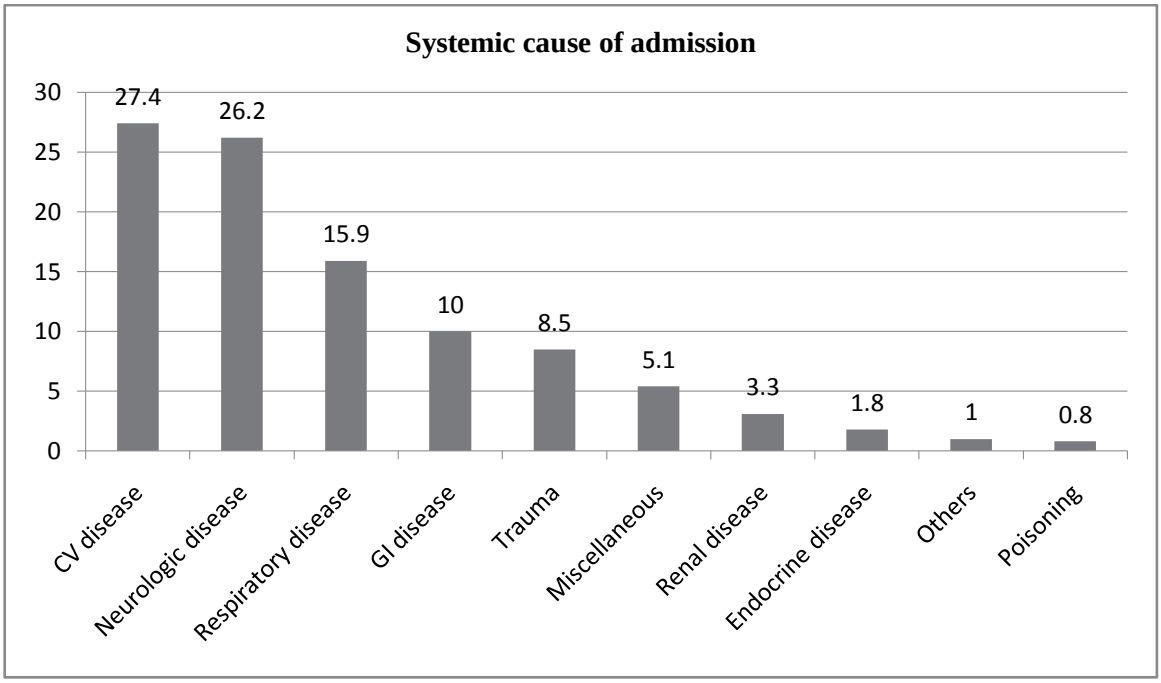
Table 3: Socio-demographic and admission characteristics of adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023(n=390).

Variables	*Category*	*Frequency*	*Percentage*
Sex	*Male*	*231*	*59.2*
	Female	*159*	*40.8*
Age	*16-25*	*103*	*26.4*
	26-35	*79*	*20.3*
	36-45	*52*	*13.3*
	46-55	*53*	*13.6*
	56-65	*55*	*14.1*
	>65	*48*	*12.3*
Residence area	*Urban*	*178*	*45.6*
	Rural	*212*	*54.4*
Marital status	*Single*	*87*	*22.3*
	Married	*289*	*74.1*
	Others	*14*	*3.6*
Community-based health insurance	*Yes*	*57*	*14.6*
	No	*333*	*85.4*
Source of admission	*Medical ward*	*68*	*17.4*

	Emergency Department	*255*	*65.4*
	Surgical ward	*9*	*2.3*
	Gyne and Obstetric ward	*21*	*5.4*
	Operation Room	*37*	*9.5*
Time of ICU admission	*Duty hours*	*139*	*35.6*
	Working hours	*251*	*64.4*
Length of ICU stay	*<1 week*	*310*	*79.5*
	1 to 2 week	*63*	*16.2*
	>2 weeks	*17*	*4.4*
Category of admission	*Emergency medical patient.*	*298*	*76.4*
	Emergency surgical patient.	*75*	*19.2*
	Elective surgical patient.	*17*	*4.4*
Frequency of admission	*New admission*	*387*	*99.2*
	Readmission	*3*	*.8*

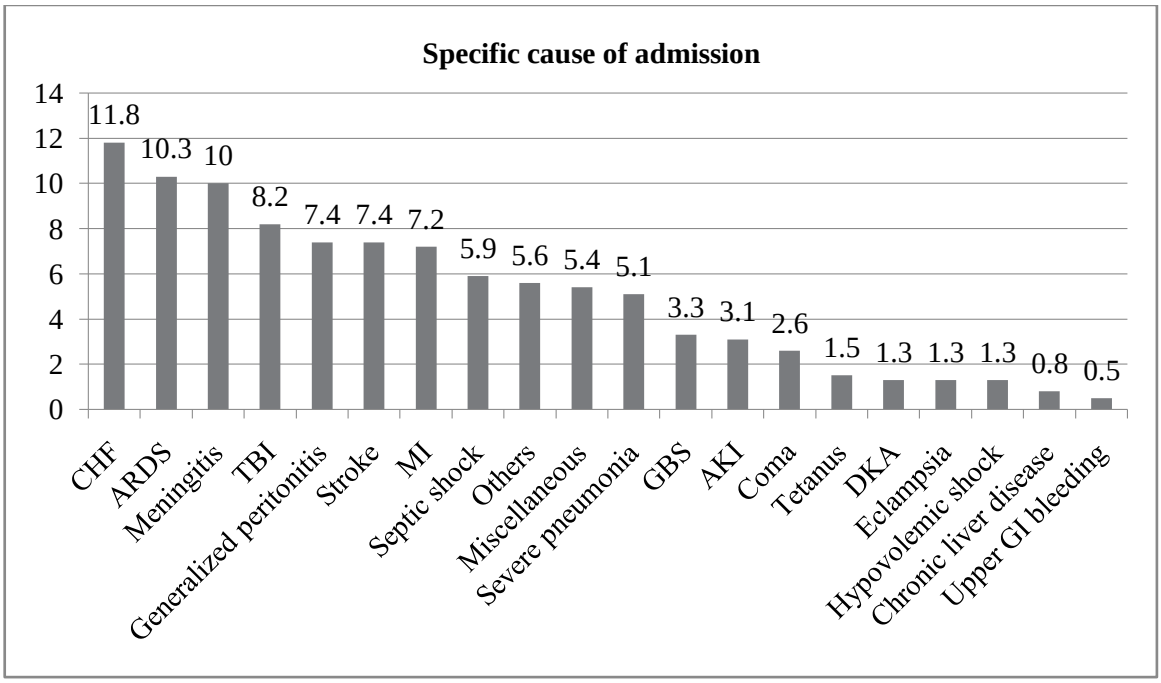
5.2.System-wise and specific diagnosis of adult patients admittedto ICU

According to the findings of this study, the top three system-wise causes of adult ICU admission were cardiovascular diseases 107(27.4%), neurological diseases 102(26.2%), and respiratory diseases 62(15.9%).Regarding to specific causes of admission CHF and ARDS accounted for 11.8% and10.3% respectively.



Others: Reproductive system disease, Immune system disease, Rheumatologic.

Figure 3: System-wise diagnosis of adult patients admitted to the Intensive care unit ofHawassaUniversity Comprehensive and Specialized Hospital, YirgalemGeneral Hospital, and Bona General Hospitalin Sidama regional state, southern Ethiopia, 2023.



Others: Brain abscess, seizure, endometriosis, blunt abdominal injury, Parkinson's disease, hypertensive emergency, acute exacerbation of bronchial asthma, organophosphate

poisoning, cardiogenic shock, Idiopathic lung disease, Uterine rupture, uremic encephalopathy

Figure 4: Specific admission diagnosis of adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023

5.3. Vital signs of adult patients at ICU admission and comorbidity

Regarding admission vital signs, the majority of patients had abnormal pulse rate (53.1%), respiratory rate(61.5%), normal mean arterial pressure (68.5%), normal temperature (63.3 %), and normal saturation(83.3%).

Table 4: Admission vital signs of adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in SidamaRegional State, southern Ethiopia, 2023.

Vital sign	Category	Frequency	Percent
Pulse rate(bpm)	Not palpable	15	3.8
	<60	12	3.1
	60-100	183	46.9
	>100	180	46.2
Respiratory	<12	4	1.0
rate(bpm)	12-20	150	38.5
	>20	236	60.5
Mean arterial	Unrecordable	17	4.4
pressure((mmHg)	<60	25	6.4
	60-100	267	68.5
	>100	81	20.8
Temperature(Celsius)	<36.5	97	24.9
	36.5-37.5	247	63.3
	>37.5	46	11.8
Oxygen saturation	<90	65	16.7
(%)	90-100	325	83.3
Mental status	<8	79	20.3
	9-13	140	35.9
	14-15	171	43.8

Among adult patients admitted to ICU 116(29.7%) had comorbidity of which 59(15.1%) and 39(10%) were hypertension and DM respectively.

Table 5: Distributions of comorbid illness of adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

Comorbidity	Frequency	Percent
Hypertension	59	15.1
Diabetes Mellitus	39	10.0
Cardiac	23	5.9
Asthma	12	3.1
HIV/AIDS	4	1.0
Others	10	2.6

Others: Epilepsy, psychiatry, cancer,

5.4. Laboratory results at ICU admission

Laboratory tests that are commonly ordered during ICU admission were selected. The first complete blood count and blood chemistry results were recorded for participants and the normal physiological cut of value was used to categorize the result into normal,low, and high.The majority of patients wereanemic at admission 202 (51.8%). Patients with high white blood cell counts accounted for 235 (60.3%). From 390,249 (63.8%) had normal platelets, normal creatinine 213 (54.6%), normal sodium 207 (53.1%), normal potassium237 (60.8%), and normal random blood sugar 221 (56.7%) at admission.

Table 5: Distribution of anemia among adult patients admitted to ICU of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

Variable	Category	Frequency	Percent
Anemia	Yes	202	51.8
	No	188	48.2

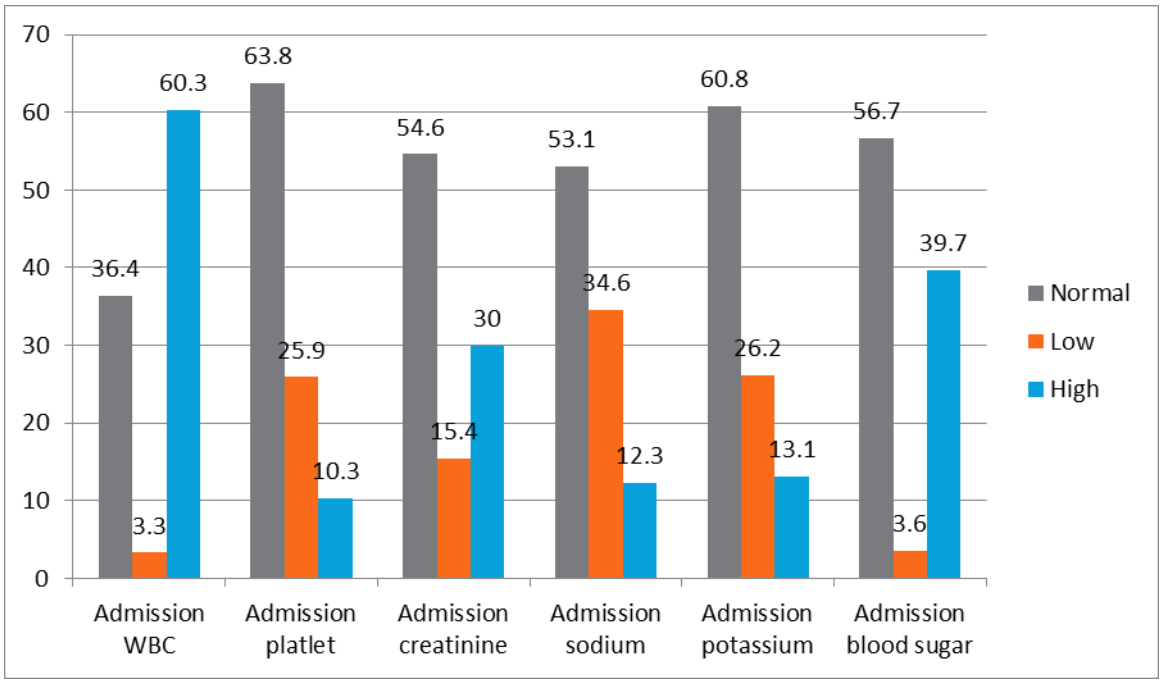


Figure 5: Admission laboratory results of adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

5.5. Treatment given in the intensive care units

Regarding treatment given in the intensive care units 249 (63.8%),251(64.4%), 137(35.1%), and 190(48.7%) adult patients were given nasogastrictube feeding,Deep vein thrombosis prophylaxis,Vasopressor support and mechanical ventilation respectively.

Table 6: A type of treatment given for adult patients admitted to ICU of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

Treatment		Frequency	Percent
oxygen support	Intranasal	175	44.9
	Face mask	115	29.5
	Mechanical ventilation	190	48.7
	No	11	2.8
Use of tracheostomy		11	2.8
Vasopressor support		137	35.1
Deep vein thrombosis prophylaxis		251	64.4
Blood transfused		48	12.3
Tube feeding		249	63.8

5.6. Hospital and ICU characteristics in which the patients were hospitalized

As indicated by a survey from the ICU director and/or chief nurse only HUCSH had an intensivist. All ICUs had formal clinical rounds, admission guidelines, clinical protocols, and a robust written patient handover system, but none of the ICUs had multidisciplinary care, initiated telemedicine, use checklists to assist patient care and arterial blood gas analyzer machine.

Table 7: Characteristics of intensive care units inHawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

ICU characteristics	**Names of hospitals**		
	HUCSH	YGH	BGH
Type of hospital	Tertiary	General	General
ICU to hospital bed ratio	2%	1.8%	4%
Number of critical care nurses	2	0	2
Number of clinical protocols	9	4	2

5.7.Complication during ICU stay

The result of this study revealed that 216 (55.4%) adult patients developed complications during ICU stayof which hypotension 64(16.4%) and hospital-acquired infection 41(10.5%) were common.

Table 8:Complications developed during ICU stay by adult patients admitted to ICU of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023

Category	**Frequency**	**Percent**
Cardiac arrest	19	4.9
Anemia	17	4.4
Arrhythmia	9	2.3
Hospital-acquired infection	41	10.5
Hypotension	64	16.4

Ventilator-associated pneumonia	23	5.9
Acute kidney injury	9	2.3
Electrolyte imbalance	7	1.8
Miscellaneous condition	12	3.1
Others	15	3.8
No	174	44.6

5.8. Admission outcome of adult patients admitted to ICU

Regarding outcomes of ICU admission, 154 (39.5%) patients died while 236 (60.5%) improved and discharged. The majority of dead patients were male and within the >65 age category. The main cause of death weremultiorgan failure 73(18.7%), cardiac arrest 39(10%) and respiratory failure 22 (5.6%).

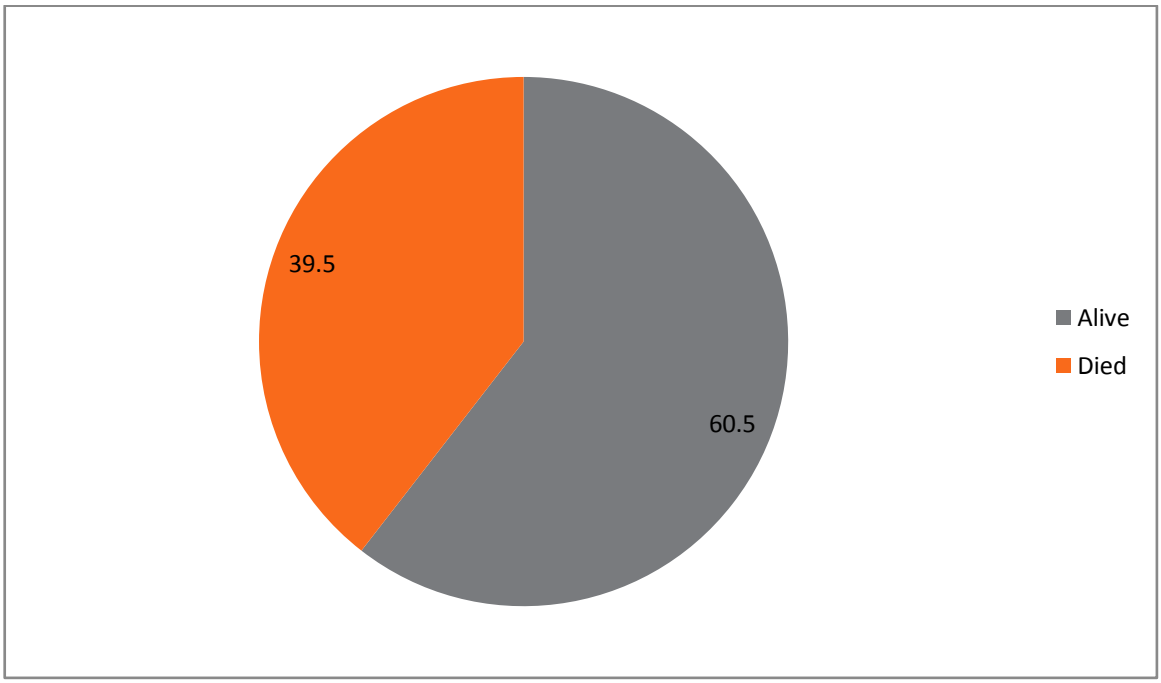


Figure 6: Outcomes of adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023

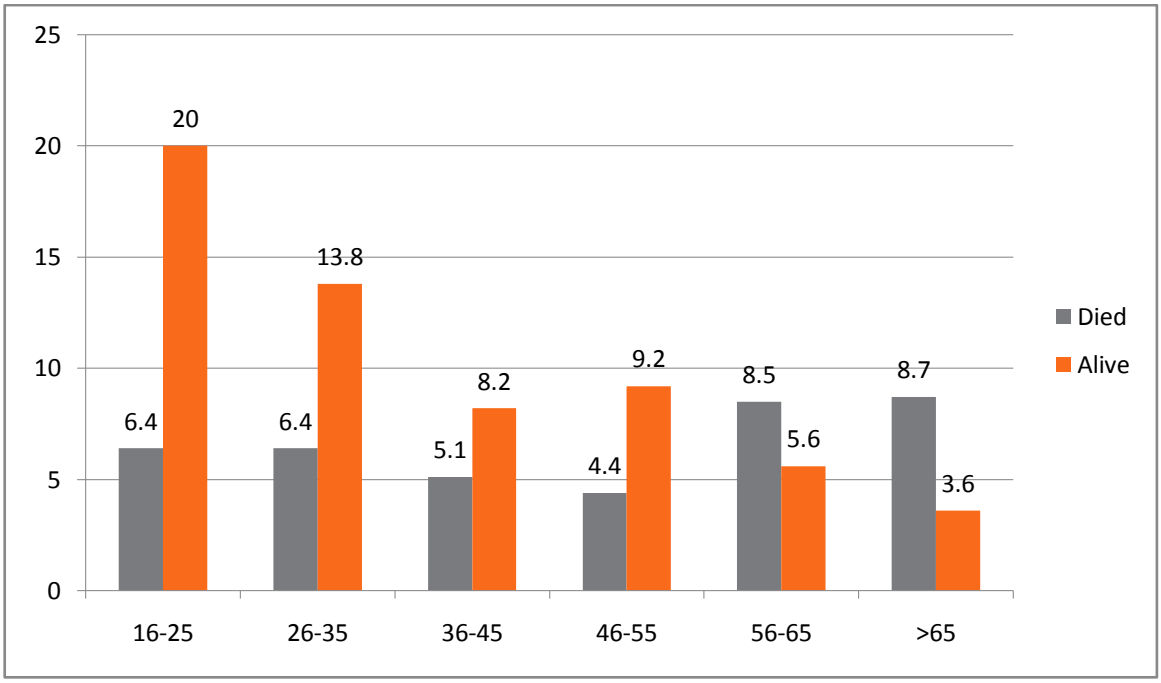


Figure 7: Distribution of outcomes by age categoryof adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

Table 9: Causes of death among adult patients admitted to ICU of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in Sidama regional state, southern Ethiopia, 2023.

Cause of death	**Frequency**	**Percent**
Multiorgan failure	73	18.7
Cardiac arrest	39	10
Respiratory failure	22	5.6
Cardiorespiratory arrest	13	3.3
Brain death	7	1.8

5.9. Factors associated with the outcomes of adult patients admitted to ICU

The bivariate analysis revealed that at a p-value less than 0.25, 20 variables namely age, community-based health insurance,residence area, marital status,length of ICU stay,comorbidity with diabetes mellitus,admission respiratory rate,admission mean arterial pressure,oxygen saturation at admission,glasgow coma scale at admission, use of mechanical ventilator, vasopressor support, deep vein thrombosis prophylaxis, blood transfusion, nasogastric tube feeding, admission anemia, sodium, and potassium,and type of hospital to which ICU belong were identified as candidate variables for multivariable logistic analysis. All candidate variables were entered together into a multivariable logistic regression using a backward variable selection method to identify the final associated factors of outcomes by controlling for potential confounders.

In a multivariable logistic regression, 8 variables were found to be significantly associated with outcomes with a p-value of < 0.05 and at 95% CI. Accordingly, the patient's age (56-65,>65), use of a mechanical ventilator, vasopressor support, anemia at admission, high serum creatinine, low sodium, low potassium, and type of hospital were associated with the outcomes of ICU admission.

Table 10: Bivariate and multivariate analysis to identify factors associated with the outcomesof adult patients admitted to the Intensive care unit of Hawassa University Comprehensive and Specialized Hospital, Yirgalem General Hospital, and Bona General Hospital in SidamaRegional State, southern Ethiopia, 2023.

Variable	Category	Outcome		COR[95%CI]	AOR[95% CI]	p-value
		Death	Alive			
Age	16-25	25	78	1	1	
	26-35	25	54	1.4[0.8-2.8]	0.7[0.209-2.118]	0.490
	36-45	20	32	2[0.951-3.99]	0.9[0.263-3.237]	0.900
	46-55	17	36	1.5[0.7-3.1]	0.7[0.197-2.436]	0.567
	56-65	33	22	4.7[2.3-9.5]	3.6[1.130-11.408]	0.030*
	>65	34	14	7.6[3.5-16.3]	4.3[1.125-16.625]	0.033*
MechanicalVentilator use	No	43	157	1	1	
	Yes	111	79	5.1[3.3-8]	4.3[2.117-8.837]	0.000*
Vasopressor use	No	62	191	1	1	
	Yes	92	45	6.3[4.0-10.0]	6.2[3.212-12.131]	0.000*
Anemic at admission	No	46	142	1	1	
	Yes	108	94	3.5[2.3-5.5]	3.6[1.908-6.636]	0.000*
Admission Creatinine	Normal	70	143	1	1	
	Low	19	41	0.9[0.5-1.8]	0.8[0.316-1.978]	0.616
	High	65	52	2.6[1.6-4.1]	2.4[1.186-4.668]	0.014*
Admission sodium	Normal	55	152	1	1	
	Hyponatremia	77	58	3.7[2.3-5.8]	2.6[1.344-5.188]	0.005*
	Hypernatrmia	22	26	2.3[1.2-4.5]	1[0.406-2.617]	0.949
Admission potassium	Normal k	73	164	1	1	
	Hypokalemia	52	50	2.3[1.5-3.8]	2.1[1.038-4.097]	0.039*
	Hyperkalemia	29	22	3[1.6-5.5]	2.6[0.985-6.715]	0.054
Hospital type	Tertiary	73	83	1	1	
	General	81	153	0.6[0.4-0.9]	0.5[0.239-0.950]	0.035*

1=indicate reference group *significant association at p-value< 0.05

CHAPTER SIX

6.DISCUSSION

The outcomes of patients admitted to the intensive care unit depend on the clinical condition of patients at arrival, the level of training and experience of staff, resources, infrastructure, and capacity of the unit(Vincent *et al*., 2014). This study highlights the admission outcomes and associated factors of adults admitted toselected governmental hospital's ICUs in Sidama regional state.The study of the factors affecting outcomes, as revealed in this study, can be a useful tool in the ICU to prognosticate outcomes of patients.

The findings of this study showed that majority of patients were admitted from the Emergency Department(65.4%). This indicates a high burden of emergency medical conditions in these public hospitals. This finding is similar to previous local and global studies (Rajput, 2018,Nega Desalegn, 2021,Demass, 2022), but not with studies conducted in South Africa(63.2%), Morocco(61%),(in which the majority of the patients were admitted from operation theatre), at Gondor Comprehensive Specialized Hospital 299 (59.3%), and Ambo University Referral Hospital (in which majority of the patients were admitted from medical ward) (Wise *et al*., 2017,Tesema *et al*., 2021,Haile, 2022,Chaker *et al*., 2023).This could be attributed to the predominance of emergency surgical conditions (large trauma burdens, acute abdomen),scheduled surgical cases, and a higher rate of complications in patients admitted to medical wards in these studies.

In this study,cardiovascular diseases(27.4%) were more prevalent diagnoses during ICU admission. This is consistent with studies conducted in Addis Ababa, Tigray, andAmhara regional states(Kedir et al., 2017,Gidey *et al.,* 2018,Tesema *et al.,* 2021).This could be due to the epidemiologic transition frominfectious diseases to noncommunicable diseases like cardiovascular diseases(Gidey *et al.,* 2018).This result was not similar to many local and global studies (Henry *et al*., 2017, Rajput, 2018,Nega Desalegn,2021,Salami et al., 2022)as reflected by the large number of trauma, general surgery cases, and infectious diseases in these studies. Regarding to length of stay in the ICU, 79.5% stayed <1 week and of them, 37.7% died even though it didn't reach statistical significance. This result support the finding of many studies (Nega Desalegn, 2021,Tesema *et al.,* 2021,Haile, 2022, Demass, 2022). The reason could be due to delayed admission to ICU,limited number of beds, shortage of mechanical ventilators, delayed intervention, shortage of

emergency drugs, and airway equipment management apart from the severity of illness(Marshall *et al*., 2017).

The mortality rate found in this study was 39.5 % (95% CI: 35, 44). This figure appears to be similar to that of a study conducted at St. Paul's Hospital Millennium Medical College 39% (Kedir*et al*., 2017) and inAmharaRegional State 38.7% (Tesema *et al.*, 2021).This might be explained by similarity in admission diagnosis or study design.The mortality was higher than the following previous studies(Silva *et* al., 2018,Rajput, 2018,Gidey *et al.*, 2018,Nega Desalegn,2021,Salami *et al*., 2022,Demass, 2022)and that found in developed countries. The relatively higher mortality rate in this study may be due to the effect of COVID-19,low ICU-to-hospital bed ratio,absence of multidisciplinary care and telemedicine,unavailability of intensivists in general hospitals, a limited number of trained ICU staff, and adearth of adequate resources and infrastructure.But it is lower than studies conducted inMalawi (60.9%) (Gundo*et al*., 2014), Guyana (48%)(Henry *et al*., 2017),Ambo University Referral Hospital (46.9%)(Haile, 2022), and Southern Ethiopia (46.42%)(Mohammed *et al*., 2017).This could be due to the presence of the pediatric age group in the first twostudies or general hospital's intensive care units in my study.

In this study, patients in the age category of 56-65 were three point six times more likely to die(AOR=3.6, CI, 1.130-11.408,p=0.030), and those in the category of >65 were four point three times more likely to die(AOR=4.3,CI,1.125-16.625,p=0.033)compared to the 16-25 age category. This is similartofindings from studies in the United States of America(Seethala *et al*., 2017), Slovakia (Sturdik et al., 2014),Southern Brazil(Silva *et al*., 2018),Kenya (Lalani *et al*., 2018),andTigray(Gidey *et al.*, 2018).This is inconsistent with theretrospective study in Malawi (Gundo*et al*., 2014), Poland(Wojciech *et al*., 2018), and the study at Wollega University Referral Hospital (Nega Desalegn, 2021). This may be related to variations in admission diagnosis, the presence of pediatric age groups, the inclusion of merely surgical ICUs, andthe predominance of trauma in these previous studies.

In this study, mechanically ventilated patients were four point three times more likely to die(AOR=4.3, CI, 2.117-8.837, p=0.000).Studies conducted in Morocco (Chaker et al., 2023),Kenya (aOR, 6.37; p, 0.001)(Lalani *et al*., 2018), Gondar(AOR=5.87, 95% CI: 3.24 - 10.65)(Tesema *et al*., 2021),at TibebeGhion (AOR = 4.11; 95%CI: 2.63, 6.43)(Demass, 2022.), andat Ambo University Referral Hospital(AOR = 2.6, P-value 0.001)(Haile, 2022)had similar findings. The possible explanation for this association could be

mechanical ventilation initiated for respiratory failure unable to protect the airway and hemodynamic instability. Moreover, intubated patients were more vulnerable to ventilator-associated pneumonia and other nosocomial infections(Bouadma *et al*., 2015).

According to this study, adults supported with vasopressors were six point two times more likely to die compared with those who didn't receive vasopressor support (AOR= 6.2, CI, 3.212-12.131,p=0.000).This is consistent with reports of studies conducted inThailand (AOR =5.8, P-value 0.02) (Tongyoo & Viarasilpa, 2018),morocco (Chaker *et al*., 2023), and, Kenya (AOR, 7.98; P, 0.001)(Lalani *et al*., 2018).The reason for consistency may be due to greater hemodynamic instability in patients who need vasopressor support. Moreover,vasopressors mainly activate adrenergic receptor agonists and cause a shift of extracellular potassium into intracellular fluid that, in turn, aggravates hypokalemia(Tongyoo & Viarasilpa, 2018).

The findings of this study revealed that patients who had anemia at admission were three point six times more likely to die compared to their counterparts (AOR= 3.6, CI, 1.908-6.636, p=0.000). This agrees with the report of astudy conducted in the United States of America(AOR=2.55,CI,1.99–3.27; P<0.001)(Wischmann *et al*., 2022),andChina to examine the association between anemia and ICU outcomes(Song *et al*., 2021).This similarity could be due to the high prevalence of anemia at ICU admission(60%),association between anemia and new-onset atrial fibrillation,the compensatory response of the body to anemia, the increased risk of re-intubation or weaning failure from a mechanical ventilator, and transfusion-related complications(Rawal *et al*., 2016, Sertcakacilar, 2022). However, this is inconsistent with a report of a retrospective cohort study in the USA in which admission anemia (both p > 0.99) was not associated with hospital mortality(Rayes *et al*., 2020).The observed discrepancy might be related to differences in the study population and the absence of variables such as mean corpuscular cell volume and red cell distribution width in my study.

According to the findings of this study, critically ill patients with high serum creatinine level at admission were two point four times more likely to die (AOR=2.4, CI, 1.186-4.668,p=0.014)compared to those who had normal serum creatinine. This is congruent with the findings of a study fromthe United States of America (OR, 2.5 6; 95% CI, 2.07-3.17) (Thongprayoon*et al*., 2017), and Indonesia(OR: 2.27, CI, 1.06 -4.88, p= 0.035)(Bagaswoto

et al., 2022).But, other studies have shown that low admission creatinine concentrations were independently associated with increased risk of mortality (OR 2.03; 95% CI, 1.86–2.21, p< 0.01)(Udy *et al*., 2016) and OR, 3.29; 95% CI, 2.08-5.00(Thongprayoon *et al*., 2017). The observed differences could be due to the presence of malnutrition and low muscle mass in these two study's population.

In this study, admission hyponatremia was significantly associated with intensive care unit mortality (AOR=2.6, CI, 1.344-5.188, p=0.005). This factor was reported fromSlovakia (AOR= 3.82,CI, 1.47–9.91,p= 0.006)(Sturdik *et al*., 2014),India (Padhi *et al.*,2014),and the United States of America (AOR, 1.42; 95% CI, 1.14–1.76; P=0.002) (Barsness&Jentzer, 2015).This similarity could be due to the preponderance of this hydroelectrolytic disorder in the intensive care unit, being a factor of bad prognosis, and its treatment is a challenge for the resuscitator(Langlois *et al.*, 2016).The study in the literature reported the absence of a significant association between hyponatremia and death (p=0.214) wasa study conducted in Morocco(Elarras *et al.*, 2023).This could be due to a higher proportion of patients with hyponatremia in my study (34.6% vs32.6%).

According to the findings of this study, critically ill adults with hypokalemia were 2.1 times more likely to die when compared with a normal potassium level (AOR=2.1, CI, 1.038-4.097, p=0.039).This is consistent with studies conducted in Ireland(AOR=1.30, CI, 1.16–1.45, p= <0.001)(Conway *et al*., 2015),Denmark(Hazard Ratio=1.91,CI, 1.14- 3.19,p 0.01) (Eggers-kaas *et al*., 2015),and Netherlands(Hessels *et al*., 2015).This is foreseeable since hypokalemia may enhance membrane excitability, increase cardiac automaticity, and predispose patients to re-entrant arrhythmias. Furthermore, low potassium may cause diastolic dysfunction, endothelial dysfunction, and increased rates of thrombosis and platelet aggregation(Weiss *et al*., 2017).

This study showed that treatments (hospitalization) in general hospital ICU were associated with lower ICU mortality (AOR=0.5, CI, 0.239-0.950, p=0.035).This is similar toa study conducted in France (AOR= 1.050,CI [1.003–1.050], p = 0.0369)(Allyn *et al*., 2022).However, this result opposes a previous study conducted inPoland which showed lower ICU mortality at the tertiary level of hospital care (Relative risk=0.86, CI, 0.8-0.92, p<0.001)(Wojciech *et al*., 2018).It is expected that mortality in tertiary hospitals will be lower than that in general hospitals sincetertiary hospitals are usually more adequately staffed and equipped compared to secondary hospitals.However,it is also true that patients with acute and critical illnesses tend to be treated in tertiary hospitals, resulting in a higher

proportion of patients with acute and critical illnesses in tertiary care hospitals(Li *et al.*, 2022).

This study identified eight associated factors of admission outcomes, which were represented by older Age, use of mechanical ventilation, vasopressor support, anemia, high serum creatinine, low serum sodium, low serum potassium at admission, and type of hospital in which the patients were treated. Overall, these are factors consistent with those reported in the literature.

CHAPTER SEVEN

7.CONCLUSION AND RECOMMENDATION

7.1Conclusion

This study shows a high prevalence of ICU mortality among adults admitted to the general intensive care unit of HUCSH, YGH, and BGH. Cardiovascular disorders were the leading cause of adult ICU admissions. Moreover, older age, the presence of anemia, low sodium, low potassium, high creatinine, need for mechanical ventilation, vasopressor support, and treatment in general hospitals were significantly associated with ICU mortality.

7.2 Recommendations

There is a need to strengthen intensive care services to improve outcomes of adult patients admitted to the ICU of the facilities.Based on the result of this study; the concerned bodies should do the following:

Hospital administrators should improve ICU to hospital bed ratio.NationalIntensive Care Unit Implementation Guideline recommendsat least 5-10% of total hospital beds.

Health workers should emphasize the importance of educating patients and their families on risk reduction, early screening with regular follow-up,and good drug adherence to prevent the occurrence and complications of cardiovascular diseases.

The regional health bureau in collaboration with hospital administration should better fulfill laboratory equipment sothat disease severity will be scored.

Telemedicine should be initiated and strengthened by the joint effort of **FMOH, the regional health bureau, and hospital administration** to improve outcomes.

Clinicians should give due attention to patients who have these associated factors of mortality.

Hospital administration with other stakeholders will better improveintensive care services through the expansion of care to the other wards, the provision of adequate supplies, and human resources from different disciplines.

Further studies are needed to determine the potential mechanisms underlying an association between admission laboratory values and mortality in ICU patients and whether correcting abnormal admission laboratory values can improve patient outcomes.

Critical care teams should establish outreach teams to provide consultative services on the wards because more intensive, timely, and coordinated interventions can prevent sudden deterioration and a need for ICU admission.

Hospital administrators should increase the number of critical care providers and train our noncritical care providers about these interventions.

7.3. Strength of the study

This multicenter study at public Hospitals' general ICUs provides a sufficiently robust picture of the ICU population characteristics in the region.

Founda significant association between admission laboratory values, types of hospital, and patient outcomes which were not considered by previous studies conducted in our country. This quantitative study will be used as baseline for many other research ideas.

To my best knowledge, no study has considered ICU characteristics and considered the usefulness of admission laboratory value as a prognostic marker in our country.

7.5. Limitation of the study

One of limitations of this study was its retrospective nature.i.eIt could not provide the same level of evidence as a prospective study.

The results of this study cannot identify and account for other factors, which may have influenced the outcome.

Most importantly,lacks data on disease severity scoring by using internationally validated disease severity scoring systems such as the Acute Physiologic and Chronic Health Evaluation score, Quick Sequential Organ Failure Assessment, and Simplified Acute Physiologic score.

Handling missing values with complete case analysis reduces sample size

There is variability in cut-off points while categorizing laboratory results.

However, within these limitations, it provides crucial information regarding adult ICU admission outcomes and associated factors.

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ANNEX

Data abstraction tool adapted from previous literature with modification for assessment of admission outcomes and associated factors of adults admitted to intensive care units of selected governmental hospitals in Sidama regional state, Sidama, Ethiopia, 2023.

Part one: Socio-demographic characteristics

1	Sex	1.Male 2.Female
2	Age in years	----------Years
3	Residence area	1.Urban 2.Rural
4	Marital status	1. Single 2. Married 3. Others
5	Community-based health insurance (CBHI)	1.Yes2. No

Part two: study participant's Clinical characteristics

1	Source of admission	1. Medical ward 2. Emergency department 3. Surgical ward 4. Gynecology and obstetrics ward 5. Operation room 6. Transfer from other hospitals
2	Time of admission to ICU	1. Duty hours 2. Working hours
3	Length of stay in the ICU	----------days
4	Co-morbidities	1. Yes2. No
5	If yes specify	----------
6	Category of admission	1. Emergency medical patient 2. Emergency surgical patients
7	Frequency of admission	1. New admission 2.Readmission (≥ 2)
8	Pulse rate (bpm) at admission	1. No pulse 2.<60

		3.60-100 4.>100
9	Respiratory rate (bpm) at admission	1.<12 2.12-20 3. >20
10	Mean arterial pressure (mmHg) at admission	1. Unrecordable2.<60 3.60-100 4. >100
11	Temperature (degree Celsius) at admission	1.< 36.5 2.36.5 - 37.5 3.>37.5
12	Peripheral oxygen saturation	1.<90% 2.90%-100%
13	Mental status at admission	1. ≤ 8 2. 9-13 3. 14-15
14	Systemwise diagnosis during ICU admission	1. Cardiovascular disease 2. Respiratory disease 3. Trauma 4. Renal disease 5. Neurologic disease 6. Endocrine disease 7. Gastrointestinal disease 8. Poisoning 9. Miscellaneous conditions 10.Others
15	Specific causes of ICU admission	1.CHF
		2.ARDS
		3.Meningitis
		4.Traumatic brain injury

		5.Generalized peritonitis
		6.Stroke
		7.Myocardial infarction
		8.Septic shock
		9.Severe pneumonia
		10.Gullian barrein syndrome
		11.Acute kidney injury
		12.Coma
		13.Tetanus
		14.DKA
		15.Eclampsia
		16.Hypovolemic shock
		17.Chronic liver disease
		18.Upper gastrointestinal bleeding
		19.Miscellaneous condition
		20.Others----------
16	Complications during ICU stay	1. Cardiac arrest 2.Anemia 3.Arrhythmia 4.Hospital-acquired infection 5.Hypotension 6.Ventilator-associated pneumonia 7.Acute kidney injury 8.Electrolyte imbalance 9.Miscellaneous condition 10.Others 11.No

Part three: Therapeutic intervention given during ICU stay

1	Intubation and mechanical ventilation	1. Yes 2. No
2	If yes length of mechanical ventilation	----------days
4	Use of Mechanical ventilation on day 1	1. Yes 2. No
5	Use of tracheostomy	1. Yes 2. No
6	Non-invasive ventilation	1. Yes 2. No

7	Vasopressor support	1. Yes	2. No
8	DVTprophylaxis	1. Yes	2. No
9	Blood transfused	1. Yes	2. No
10	Tube feeding	1. Yes	2. No
11	Others	----------	

Part four: Laboratory investigation results at ICU admission

1	White blood cell count	----------10^3/µL
2	Hemoglobin	----------g/d
3	Platelet	----------103/µL
4	Creatinine	---------- mg/Dl
5	Sodium	---------- mmol/L
6	Potassium	---------- mmol/L
7	Random blood sugar	---------- mg/dL

Part five: Information at discharge

1	Outcomes of ICU admission	1. Alive 5. Died
2	Causes of death	1.Multiorgan failure 2.Cardiac arrest 3.Respiratory failure 4.Cardiorespiratory arrest 5.Brain death

Part six. ICU characteristics

1	Type of hospital	1. General 2. Tertiary and teaching hospital
2	Intensive care unit admission guideline/protocol is present	1. Yes 2. No
3	Total number of physicians working in the ICU	----------
4	Physician bed ratio	----------
5	Intensivist available	1. Yes 2. No
6	Number of nurses working in the ICU	----------

7	Nurse/bed ratio during shifts	----------
8	Number of critical care nurses	----------
9	ICU to hospital bed ratio	1.Yes2. No
10	Formal clinical rounds(>5 days/week)	1. Yes 2.No
11	Checklists to assist patients' care	1. Yes 2. No
12	Number of clinical protocols fully implemented in the ICU	1. Therapeutic hypothermia CA patients 2. Cerebrovascular accident management 3. Acute coronary syndromes 4. Liberation from mechanical ventilation 5. Central-line associated bloodstream infection 6. Ventilator-associated pneumonia prevention 7. Lung-protective ventilation in acute lung injury 8. Sedation in Mechanical ventilation patients 9. Early mobilization
13	Tele-ICU available	1. Yes 2. No
14	ABG machine is available	1. Yes 2.No
15	Multidisciplinary care	1. Yes 2.No
16	A robust written handover system is available	1. Yes 2.No