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ORIGINAL RESEARCH

Determinants of in-Hospital Mortality Among Patients with Acute Coronary Syndrome at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia: unmatched Case Control Study

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Background: Acute coronary syndrome causes significant mortality and morbidity. Patients with acute coronary syndrome continue to have a significant in-hospital mortality rate. The evidence on factors contributing to in-hospital mortality in resource-limited setups remains scarce. The goal of this study was to assess determinants of in-hospital mortality among patients with ACS at University of Gondar Comprehensive Specialized Hospital; Northwest Ethiopia.

Methods: An institution-based unmatched case-control study was conducted on admitted acute coronary syndrome patients from September, 2018 to May, 2022. We performed bi-variable logistic regression analysis followed by multivariable logistic regression analysis. P value < 0.05 and 95% CI were used to determine the association between independent variables and in-hospital mortality.

Results: The study was conducted on 159 acute coronary syndrome patients, 53 cases and 106 controls. The mean ± SD age of the participants was 59.67 years ± 13.4 and 62.72 years ±15.58 for controls and cases respectively. The determinants of in-hospital mortality were patients not initiated on B-blockers (AOR= 11.39, 95% CI: 2.32–55.96), cardiogenic shock (AOR= 7.23, 95% CI: 1.56–33.49), stroke (AOR = 7.61, 95% CI: 1.81–31.92), oxygen saturation < 90% (AOR = 5.31, 95% CI: 1.25–22.57) and hemoglobin level less than 12 g/dl (AOR=3.43, 95% CI: 1.13–10.35).

Conclusion: Patients not initiated on beta-blockers, development of cardiogenic shock and stroke, low oxygen saturation, and hemoglobin level below 12 g/dl were the determinants of in-hospital mortality. Therefore, early detection and treatment of complications and comorbidities should be routine practice to decrease the in-hospital mortality of patients with acute coronary syndrome.

Keywords: determinants, acute coronary syndrome, in-hospital mortality, Ethiopia, resource limited setting

Introduction

Acute coronary syndromes continue as a major cause of mortality and morbidity in industrialized countries[1] and are becoming an important problem in developing countries.[2]

According to World Health Organization (WHO), cardiovascular diseases (CVD) are the leading cause of morbidity and mortality in 2020 worldwide and will continue to be the leading cause of mortality globally up to 2030, of which

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ACS is one of the main challenges.[3] Acute coronary syndrome is the major cause of mortality and morbidity, accounting for 50% of all CVD deaths and more than 2.5 million hospitalizations worldwide each year.[1]

Although acute coronary syndrome morbidity and mortality rates are declining in most developed nations, it is increasing at an alarming rate in developing nations. A major factor that is contributing to the poor clinical outcomes among developing nations is mainly due to prehospital treatment delays, limited primary emergency facilities, and limited emergency medical service.[2,4,5]

Studies conducted in many African countries showed that the prevalence of acute coronary syndrome ranged from 0.1 to 13.5% with in-hospital mortality of 10%.[6] In Ethiopia, different cross-sectional studies showed that the prevalence of in-hospital mortality among ACS ranges from 20.4% to 29.4%,[7–9] which is higher than in the developed countries, as shown in the OPERA registry.[10]

According to Global Registry of Acute Coronary Events (GRACE); older age, higher KILLIP class, systolic blood pressure, ST-segment deviations, cardiac arrest during the presentation, serum Creatinine level, positive initial cardiac enzyme finding, and heart rate accounted for 89.9% of the prognostic information. Among these, KILLIP class was the most powerful prognostic indicator with a two-fold increas in death with each increment in KILLIP class.[11]

Studies piloted in developed nations showed that independent predictors of death among ACS patients were increased age, presence of comorbidity (diabetes mellitus, dyslipidemia, and heart failure), patient clinical presentation (nausea and/or vomiting, fast breathing, low oxygen saturation, high heart rate, and low blood pressure), and ECG changes (ST-segment changes, right bundle branch block and left bundle branch block).[10,12–14] Studies conducted in sub-Saharan Africa showed that high in-hospital mortality of ACS patients was found in those with delayed treatment initiation, limited emergency facilities, being from rural areas, and limited emergency medical services.[5,15]

Studies done in Ethiopia showed that in-hospital mortality was high in those with old age, delayed time of presentation, being from rural areas, history of hypertension, higher KILLIP class, cardiogenic shock, diagnosed with STEMI, reduced LVEF of <30% and non-use of beta blocker.[7–9]

Ischemic heart disease (IHD) is the leading cause of mortality and morbidity worldwide and a growing problem in developing countries like Ethiopia[16] but there are no adequate data about the outcome and determinants of outcome among ACS patients. This case control study aimed to assess risk factors, management practice, and other associated factors that will predict in-hospital mortality for ACS, which is important in order to determine the factors associated with in-hospital mortality and might help the care giver to optimize medical care and also intensify follow up for those patients with a high risk of mortality, which may eventually lower in-hospital mortality of patients with acute coronary syndrome. The study aims to reveal insight and to comprehend the specific issues impacting mortality rates by considering factors including comorbidities, demographic differences, long transportation time, absence of prehospital care, and limited healthcare infrastructure like PCI center, thrombolytic therapy.

Objective

To identify determinants of in-hospital mortality among patients with ACS at University of Gondar Comprehensive Specialized Hospital; Northwest Ethiopia, 2022.

Materials and Methods

Study Settings and Design

Institution-based unmatched retrospective case control study was conducted among patients with myocardial infarction who were admitted to the hospital for the treatment of ACS from September 2018 G.C to May 2022 G.C. The hospital is located at Gondar town, which is 657 km from Addis Ababa. The hospital has a bed capacity of around 950 beds and serves a catchment area of nearly 13 million people. The hospital has an emergency unit and general medical ICU. Necessary investigation modalities for the diagnosis of ACS are available including ECG, troponin and echocardiography but there is no cardiac unit.

Population

The source population was all patients who were admitted to the UOGCSH with the diagnosis of acute coronary syndrome and the study population was all patients who had been admitted with the diagnosis of acute coronary syndrome during the study period at the UOGCSH, Gondar; Northwest Ethiopia. Cases were patients with ACS who had passed away during admission and controls were patients with ACS who had been discharged after improving.

Sample Size and Sampling Procedure

The sample size was calculated using EPI Info software version 7.2 with the following parameters: significance = 95%; power = 80%; CI of 95%; and an assumed two to one allocation ratio of controls to cases (2:1). The presence of hypertension with an odds ratio of 5.1, exposure proportions of controls of 63.2% and cases of 36.8%, and the addition of 10% for non-response, which resulted in a sample size of 119 (79 for controls and 40 for cases), was determined to have the highest number of sample size from all significantly associated factors.[8] To maximize the sample size and strengthen the association, all patients (159) admitted during the study period who fulfilled inclusion and exclusion criteria were recruited using convenience sampling procedure.

Data Collection

The registration books at emergency and MICU were revised to get the hospital chart numbers of ACS patients who were admitted during the study period. After getting hospital chart numbers, patient charts were retrieved from record and documentation office. These data were accessed and data were collected at documentation office from June 18, 2022 to September 14 2022. For data collection, a structured questionnaire was employed, and pertinent medical information was collected from patients' medical records by a trained medical doctor following training, and a pretest was performed prior to data collection. Patients' records were reviewed to acquire important medical information such as sociodemographic history, alcohol history, smoking history, presenting symptoms, length of symptoms, type of ACS and KILLIP class, time of presentation, management offered, recorded complication and comorbidity, and so on. Findings from ECG and echocardiogram, as well as laboratory data such as troponin, creatinine, lipid-profile (LP) and serum electrolytes were also collected for analysis. There was no access to individual patients during data collection, only medical records which had been archived.

Data Quality Assurance

Before the study, the data extraction tool was pretested in 10% of the study sample, and the final tool was corrected accordingly. Patients who participated in the pretesting were excluded in the real data collection. The quality of data was ensured by reviewing the completion of questionnaires and using a specific marker on a chart following data collection to minimize duplication. The collected data were cleaned and validated for validity before being processed and analyzed.

Study Variables

In this study, the dependent variable was in-hospital mortality whereas the independent variables were sociodemographic characteristics (age, sex, religion, marital status, residency), life style related characteristics (alcohol drinking, chat chewing, drug use and smoking), co-morbidities (DM, cardiovascular disease, chronic lung disease, malignancy, chronic liver disease, HF), previous history of MI, time of presentation, hospital stay, type of ACS diagnosis (STEMI, NSTEMI and UA), laboratory findings (CBC, RFT, LFT, RBS, serum electrolytes, lipid profile), duration of symptoms and presenting symptoms, duration of hospital stay and medications used, KILLIP class, degree of troponin elevation, ECG findings, ECHO findings and ejection fraction (EF) and chest X-RAY.

Operational Definitions

In-hospital mortality: patients who died during their hospital stay. Cases: patients who died in the hospital after being diagnosed with ACS in the university of Gondar comprehensive specialized hospital. Control: patients who clinically

improved and were discharged from hospital after being diagnosed with ACS in the University of Gondar comprehensive specialized hospital.

Parameters for ACS diagnosis; symptoms of myocardial ischemia, laboratory measurement like a change in cardiac biomarker levels (cardiac troponin), ECG changes like new or presumed new significant ST-segment T-wave changes, new left bundle branch block, development of pathological Q-waves, imaging evidence of loss of viable myocardium or new regional wall motion abnormality.[17]

Cigarette smoking: smoked more than 100 cigarettes in their life-time.[18] Alcohol drinking: history of ingestion of more than 3 standard drinks daily (for males) or 2 standard drinks daily (for females).[19] Chat chewing: defined as past or current regular use of chat.

Previous myocardial infarction (MI): patient has had at least 1 previous history of MI before admission. Previous stroke/TIA: patient has had at least 1 episode of physician-diagnosed previous history of neurologic deficit which may or may not have resolved.

KILLIP class: KILLIP class of the patient at the time of hospital admission: Class 1: no evidence of heart failure, Class 2: findings consistent with mild to moderate heart failure (S3 gallop, lung rales <1/2 way up the posterior lung fields, jugular venous distension), Class 3: overt pulmonary edema, Class 4: cardiogenic shock.[20]

Sgarbossa criteria: an ECG criteria used to diagnose acute myocardial infarction in patient with previous LBBB and has 3 criteria: ST segment elevation of 1 mm or more that was in the same direction (concordant) as the QRS complex in any lead-score 5, ST segment depression of 1 mm or more in any lead from V1 to V3-score 3, and ST segment elevation of 1 mm or more that was discordant with the QRS complex (that is associated with a QS or *RS* complex) score 2.[21] Conventional cardiovascular risk factors: refer to smoking, hypertension, diabetes and dyslipidemia.[22]

Data Processing and Analysis

After data were entered and cleaned by Epidata version 4.6.0.2, it was transferred to SPSS software for descriptive statistics, bi-variable logistic regression and multivariable logistic regression analysis. Multivariate analysis was done for those variables with p value less than 0.2 in bi-variable analysis. Variables with p- value of less than 0.05 were taken as statistically significant predictors for in-hospital mortality. The degree of association between independent and dependent variable was presented by odds ratio (OR) and 95% confidence interval (CI).

Ethical Consideration

Ethical approval was gained from the College of Medicine and Health Sciences at the University of Gondar with ethical clearance reference number SOM/1615/2022. Since the data were collected retrospectively, no consent was required from study participants. Participants' identity remained confidential. Individuals' anonymity is protected. Ethical principles of the Declaration of Helsinki were respected during all processes of the study.

Results

Sociodemographic and Behavioral Characteristics of Participants

A total of 159 ACS patient charts' data (106 control and 53 cases) which fulfilled the inclusion criteria were collected and analyzed. When we compared the two groups, majority of the patients were male constituting 60.4% for controls, 52.8% of cases. Majority of the patients were from the urban area of the country of which 77.4% and 64.2% was control and cases respectively. The mean age ± [SD] was 59.67 years ± 13.4 and 62.72 years ±15.58 for controls and cases respectively (Table 1). From all, 22(13.8%) patients had history of alcohol drinking, 15(9.4%) had smoking history, 6 (0.6%) had chat chewing history and only one patient had drug use history (Figure 1).

Clinical Characteristics of Participants

The median time required from onset of symptoms to hospital arrival was 72 hours with interquartile range (IQR) between 24–72 hours for both cases and controls. More than half of patients presented after 48 hours of being symptomatic. The average duration of hospital stay was 9.77 days [SD ± 8.1] and 6.04 days [SD ± 6.95] for controls and cases respectively

Table 1 Socio-Demographic Characteristics of Patients Admitted with ACS at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variables		Control Frequency (%)	Case Frequency (%)	Total Frequency (%)
Sex	Male	64 (60.4)	28 (52.8)	92 (57.9)
	Female	42 (39.6)	25 (47.2)	67 (42.1)
Residency	Urban	82 (77.4)	34 (64.2)	116 (73.0)
	Rural	24(22.6)	19(35.8)	43(27.0)
AGE	<55	32(30.2)	14(26.4)	46(28.9)
	55–64	31(29.2)	13(24.5)	44(27.7)
	≥ 65	43(40.6)	26(49.1)	69(43.4)

with the shortest stay being one day and the longest 72 days. More than half (59.8%) of patients were discharged from hospital within seven days, and 20.1% of patients stayed for more than 10 days. The mean SBP was 135.46 mmHg [SD ± 31.58] for controls and 105.36 mmHg [SD ± 34.1]. The mean DBP was 83.18 mmHg [SD ± 19.69] and 63.4 mmHg [SD ± 18.68] for controls and cases respectively. The average heart rate during admission was 92.82 beats per minute (bpm) [SD+ 27.046] with minimum of 32 bpm and maximum of 216 bpm for controls and 93.32 bpm [SD+ 30.62] with minimum of 32 bpm and maximum of 160 bpm for cases. The mean oxygen saturation of the controls was 91.89% [SD+ 5.68] and for the cases it was 85.42% [SD+ 9.89]. With respect to the final assessment of ACS, majority of patients had STEMI followed by NSTEMI and then UA for both cases and controls. Patients in the control group were predominantly KILLIP class 1 (58.4%) but cases were predominantly KILLIP class 4 (35.6%). Symptom wise, the most frequent complaints reported during admission were typical chest pain (75.5%) followed by dyspnea (71.7%) and diaphoresis (57.5%) for controls. Unlike that of controls, for cases the commonest symptom at presentation was shortness of breath (64.2%) followed by atypical chest pain and epigastric pain, typical chest pain and diaphoresis (Table 2).

Medication Related Characteristics of Participants

Regarding in-hospital management, aspirin was administered to all patients and clopidogrel was given to 46(86.8%) patients who were cases and all patients in the control group. Heparin derivatives were started for 52 (98.1%) of the cases and all of the controls during hospital stay, while only four patients were initiated on enoxaparin and the other patients were on unfractionated heparin. Ninety five percent (95.3%) of patients from the control group and only 30(56.6%) of the cases were started on beta-blockers during admission and the drug of choice was metoprolol. Angiotensin converting enzyme inhibitors/angiotensin receptor blockers (ACEI/ARBs) were used in 81(76.4%) controls and 18(34.0%) cases, all were on enalapril. Nitrates were administered to 21(19.8%) control patients and 5(9.4%) cases. All patients were taking statins (high intensity dose of atorvastatin). The choice of analgesic drug was morphine and it was administered to 96 (90.6%) and 33(62.3%) controls and cases respectively. CCB was used only for 5% of patients - all from control group (Table 3).

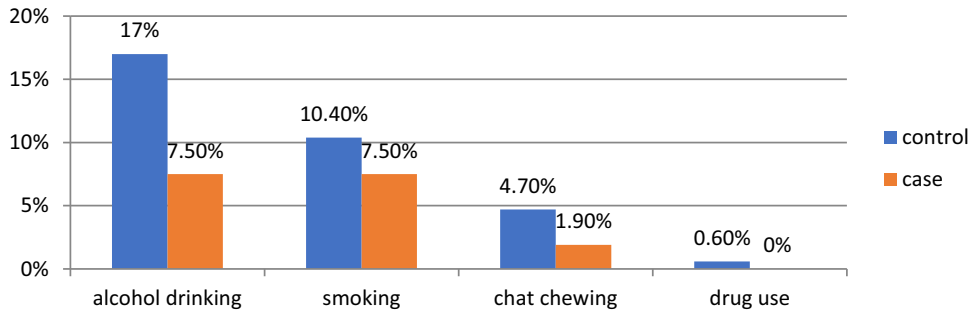

Figure 1 Behavioral characteristics of patients admitted with ACS at UOGCS, Northwest Ethiopia, 2022 (N=169).

Table 2 Clinical Characteristics of Patients Admitted with ACS at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variables		Control Frequency (%)	Case Frequency (%)	Total Frequency (%)
Typical chest pain	Yes	80(75.5)	21(39.6)	101(63.5)
	No	26(24.5)	32(60.4)	58(36.5)
Non-specific chest pain	Yes	23(21.7)	21(39.6)	44(27.7)
	No	83(78.3)	32(60.4)	115(72.3)
Shortness of breath	Yes	76(71.7)	34(64.2)	110(69.2)
	No	30(28.3)	19(35.8)	49(30.8)
Vomiting and nausea	Yes	43(40.6)	18(34.0)	61(38.4)
	No	63(59.4)	35(66.0)	98(61.6)
Diaphoresis	Yes	61(57.5)	21(39.6)	82(51.6)
	No	45(42.5)	32(60.4)	77(48.4)
Easy Fatigability	Yes	43(40.6)	16(30.2)	59(37.1)
	No	63(59.4)	37(69.8)	100(62.9)
Syncope	Yes	0(0.0)	3(0.0)	3(1.9)
	No	106(100.0)	50(94.3)	156(98.1)
Cough	Yes	21(19.8)	17(32.1)	38(23.9)
	No	85(80.2)	36(67.9)	121(76.1)
Change in mentation	Yes	2(1.9)	12(22.6)	14(8.8)
	No	104(98.1)	41(77.4)	145(91.2)
Body weakness	Yes	3(2.9)	9(17.0)	12(7.6)
	No	102(97.1)	44(83.0)	146(92.4)
Other*		14(13.1)	20(37.8)	34(21.4)
Duration of symptom	1hrs-2hrs	5(4.7)	0(0.0)	5(3.1)
	2hrs-12hrs	16(15.1)	9(17.0)	25(15.7)
	12hrs-48hrs	22(20.8)	12(22.6)	34(21.4)
	> 48hrs	63(59.4)	32(60.4)	95(59.7)
Duration of hospital stay	< 5 days	19(17.9)	35(66.0)	54(34.0)
	5days-7days	36(34.0)	5(9.4)	41(25.8)
	7days-10days	27(25.5)	5(9.4)	32(20.1)
	> 10 days	24(22.6)	8(15.1)	32(20.1)
History of previous ACS	Yes	21(19.8)	11(20.8)	32(20.1)
	No	85(80.2)	42(79.2)	127(79.9)
Type of ACS	STEMI	45(42.5)	25(47.2)	70(44.0)
	NSTEMI	31(29.2)	20(37.7)	51(32.1)
	UA	30(28.3)	8(15.1)	38(23.9)
KILLIP class	CLASS 1	45(58.4)	13(28.9)	58(47.5)
	CLASS 2	7(9.1)	5(11.1)	12(9.8)
	CLASS 3	21(27.3)	11(24.4)	32(26.2)
	CLASS 4	4(5.2)	16(35.6)	20(16.4)
Pulse rate	< 60	4(3.8)	6(11.3)	10(6.3)
	60–100	75(70.8)	30(56.6)	105(66.0)
	> 100	27(25.5)	17(32.1)	44(27.7)
Respiratory rate	< 24	67(63.2)	27(50.9)	94(59.1)
	≥ 24	39(36.8)	26(49.1)	65(40.9)
Temperature (^{0}C)	< 36.5	58(54.7)	22(41.5)	80(50.3)
	36.5–37.5	45(42.5)	20(37.7)	65(40.9)
	≥ 37.5	3(2.8)	11(20.8)	14(8.8)
Oxygen saturation (%)	< 90	24(22.6)	35(66.0)	59(37.1)
	≥ 90	82(77.4)	18(34.0)	100(62.9)

(*Continued*)

Table 2 (Continued).

Variables		Control Frequency (%)	Case Frequency (%)	Total Frequency (%)
SBP (mmHg)	<90	5(4.7)	25(47.2)	30(18.9)
	90–129	39(36.8)	12(22.6)	51(32.1)
	130–139	11(10.4)	7(13.2)	18(11.3)
	140–159	23(21.7)	4(7.5)	27(17.0)
	160–179	17(16.0)	3(5.7)	20(12.6)
	≥ 180	11(10.4)	2(3.8)	13(8.2)
DBP (mmHg)	<60	7(6.6)	23(43.4)	30(18.9)
	60–79	35(33.0)	15(28.3)	50(31.4)
	80–89	18(17.0)	8(15.1)	26(16.4)
	90–99	19(17.9)	4(7.5)	23(14.5)
	100–109	11(10.4)	2(3.8)	13(8.2)
	≥ 110	16(15.1)	1(1.9)	17(10.7)

Note: *others = leg edema, abdominal distension, fever, joint pain.

Table 3 Medication Related Characteristics of Patients Admitted with ACS at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variables	Controls Frequency (%)	Cases Frequency (%)	Total Frequency (%)
Nitrates	21(19.8)	5(9.4)	26(16.4)
Aspirin	106(100.0)	53(100.0)	159(100.0)
Clopidogrel	106(100.0)	46(86.8)	152(95.6)
Anti-coagulant	106(100.0)	52(98.1)	158(99.4)
B blocker	101(95.3)	30(56.6)	131(82.4)
ACEIs/ARBs	81(76.4)	18(34.0)	99(62.3)
Morphine	96(90.6)	33(62.3)	129(81.1)
Statin	106(100.0)	53(100.0)	159(100.0)
CCB	8(7.5)	0(0.0)	8(5.0)

Complications, Comorbidities and Concomitant Illnesses Detected

From the cases, 90.6% of the patients had at least one complication but only 51.9% of patients from control group had complications. Heart failure was the commonest complication for both groups and cardiogenic shock and stroke were predominant for the cases (Table 4).

The commonest identified comorbidity for control patients was hypertension (48.1%) followed by cardiac disease (26.4%), and diabetes (26.4%), but for cases cardiac disease (30.2%) was the commonest followed by HTN (24.5%) and DM (22.6%) (Table 5). About 23.6% and 60.4% of patients from control and cases respectively had concomitant illnesses during their presentation and hospital stay, of which severe community acquired pneumonia was the commonest accounting for 14.2% for controls and 26.4% for cases (Table 6).

Selected Biochemical and Radiological Parameters of Participants

All of the patients had at least one Troponin I determination and 71.7% of patients from the control and 84.9% of patients from the cases had elevated Troponin I measurement. The level of rise in troponin from the upper limit was a mean of 312 times ± 660.7 for the control group, with a median of 38 times as compared to cases with mean troponin level of 240.9 times ± 395.12 and a median of 32 times (Table 7). ECG was done for all of the patients, and 19.8% of the controls and 7.5% of the cases had unremarkable ECG finding, and the rest [134(84.3%)] of patients had different ECG findings

Table 4 Complications Detected During Admission of Patients with ACS at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variables	Controls Frequency (%)	Cases Frequency (%)	Total Frequency (%)
Complications	55(51.9)	48(90.6)	103(64.8)
Arrhythmia	19(17.9)	10(18.9)	29(18.2)
Mechanical complication	2(1.9)	2(3.8)	4(2.5)
Thrombus	1(0.9)	2(3.8)	3(1.9)
HF	40(37.7)	29(54.7)	69 (43.4)
Pulmonary edema	26(24.5)	23(43.4)	49(30.8)
Cardiogenic shock	5(4.7)	25(47.2)	30(18.9)
Stroke	6(5.7)	13(24.5)	19(11.9)
Pericarditis	1(0.9)	1(1.9)	2(1.3)

Table 5 Comorbidities Among Admitted ACS Patients at UOGCSH Northwest Ethiopia, 2022 (N=169)

Variables	Controls Frequency (%)	Cases Frequency (%)	Total Frequency (%)
Comorbidity	73(68.9)	31(58.5)	104(65.4)
HTN	51(48.1)	13(24.5)	64(40.3)
DM	28(26.4)	12(22.6)	31(19.5)
Cardiac disease	28(26.4)	16(30.2)	44(27.7)
CKD	2(1.9)	5(9.4)	7(4.4)
Cerebrovascular disease	1(0.9)	2(3.8)	3(1.9)
HIV	3(2.8)	1(1.9)	4(2.5)
CLD	0	1(1.9)	1(0.6)
COPD	2(1.9)	1(1.9)	3(1.9)
Asthma	3(2.8)	0	3(1.9)
Thyrotoxicosis	4(3.8)	3(5.7)	7(4.4)
AF	5(4.7)	2(3.8)	7(4.4)

Table 6 Concomitant Illness at Admission Among Admitted ACS Patients at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variables	Controls Frequency (%)	Cases Frequency (%)	Total Frequency (%)
Concomitant illness	25(23.6)	32(60.4)	57(35.8)
SCAP	15(14.2)	14(26.4)	29(18.2)
Aspiration pneumonia	3(2.8)	8 (15.1)	11(6.9)
COVID 19 Pneumonia	1(0.9)	8(15.1)	9(5.7)
HAP	0	2(3.8)	2(1.3)
DKA	0	1(1.9)	1(0.6)
Thyroid storm	0	2(3.8)	2(1.3)
UTI	2(1.9)	1(1.9)	3(1.9)
Other(illness)	5(4.7)	6(11.3)	11(6.9)

as shown in Figure 2 . ST elevation accounted for 39.6% for controls and T wave inversion accounted for 39.6% for the cases group (Figure 2). Transthoracic echocardiography was done for 134 patients and the commonly identified finding suggestive of ACS was wall motion abnormality for both groups (74.4% of patients in the control group and 63.3% of

Table 7 Biochemical Parameters of Patients with ACS at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variables		Controls Frequency (%)	Cases Frequency (%)	Total Frequency (%)
Troponin	Elevated	76(71.7)	45(84.9)	121(76.1)
	Normal	30(28.3)	815.1 ()	38(23.9)
Hemoglobin	< 12	15(14.2)	19(35.8)	34(21.4)
	12–16	71(67.0)	29(54.7)	100(62.9)
	> 16	20(18.9)	5(9.4)	25(15.7)
WBC	< 4000	4(3.8)	3(5.7)	7(4.4)
	4000–11,000	66(62.3)	23(43.4)	89(56.0)
	> 11,000	36(34.0)	27(50.9)	63(39.6)
Platelet	<150,000	11(10.4)	11(20.8)	22(13.8)
	150,000–450,000	91(85.8)	33(62.3)	124(78.0)
	>450,000	4(3.8)	9(17.0)	13(8.2)
RBS	< 70	2(1.9)	2(3.8)	4(2.5)
	70–140	69(65.1)	19(35.8)	88(55.3)
	140–180	18(17.0)	11(20.8)	29(18.2)
	> 180	17(16.0)	21(39.6)	38(23.9)
SGPT_	≤ 40	48(45.3)	13(24.5)	61(38.4)
	> 40	58(54.7)	40(75.5)	98(61.6)
SGOT	≤ 42	65(61.3)	25(47.2)	90(56.6)
	> 42	41(38.7)	28(52.8)	69(43.4)
Creatinine	< 1.2	72(67.9)	30(56.6)	102(64.2)
	≥ 1.2	34(32.1)	23(43.4)	57(35.8)
NA	< 135	31(29.2)	15(28.3)	46(28.9)
	135–145	66(62.3)	29(54.7)	95(59.7)
	> 145	9(8.5)	9(11.3)	18(11.3)
K	< 3.5	10(9.4)	12(22.6)	22(13.8)
	3.5–5.5	95(89.6)	38(71.7)	133(83.6)
	> 5.5	1(0.9)	3(5.7)	4(2.5)
EF	< 40	24(26.7)	12(40.0)	36(30.0)
	40–50	24(26.7)	4(13.3)	28(23.3)
	≥ 50	42(46.7)	14(46.7)	56(46.7)
HDL	< 40	23(43.4)	6(46.2)	29(43.9)
	≥ 40	30(56.6)	7(53.8)	37(56.1)
LDL	< 100	27(49.1)	8(57.1)	35(50.7)
	≥ 100	28(50.9)	6(42.9)	34(49.3)
TC	< 200	48(67.6)	16(80.0)	64(70.3)
	≥ 200	23(32.4)	4(20.0)	27(29.7)
TG	< 150	45(62.5)	17(89.5)	62(68.1)
	≥ 150	27(37.5)	2(37.5)	29(31.9)
EF	< 30	11(12.2)	9(30.0)	20(16.7)
	≥ 30	79(87.8)	21(70.0)	100(83.3)

patients in the case group). The mean ejection fraction in the controls group was 47.06% + 15.94 and for the cases it was 43.73 + 19.99 and 26.7% of controls and 40% of cases had EF less than 40% (Figure 3). Plain chest x-ray was done for study patients and it was found that pulmonary edema, pleural effusion, cardiomegaly and pneumonia were common findings in both cases and control groups (Figure 4).

In case of laboratory investigations, random blood sugar, baseline CBC, serum creatinine, liver enzyme and electrolytes (NA&K) were determined for all patients and their values are listed in Table 4. Sixty-five percent (65.1%) of control group had RBS of 70–140 mg/dl, and 39.6% of cases had RBS of greater or equal to 180 mg/dl. The mean

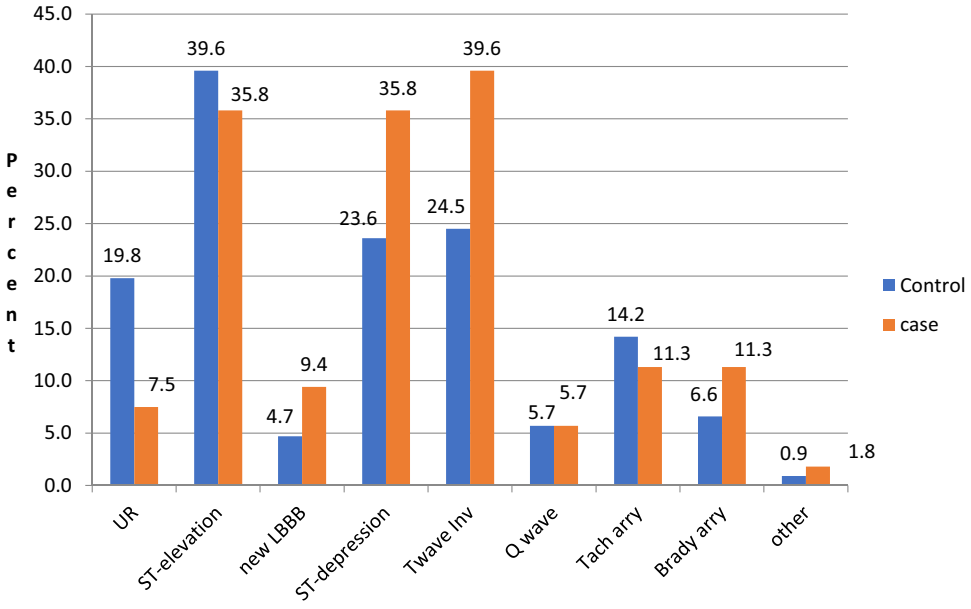

Figure 2 ECG findings of patients who presented with ACS at UOGCSH, Northwest Ethiopia, 2022 (N=169).

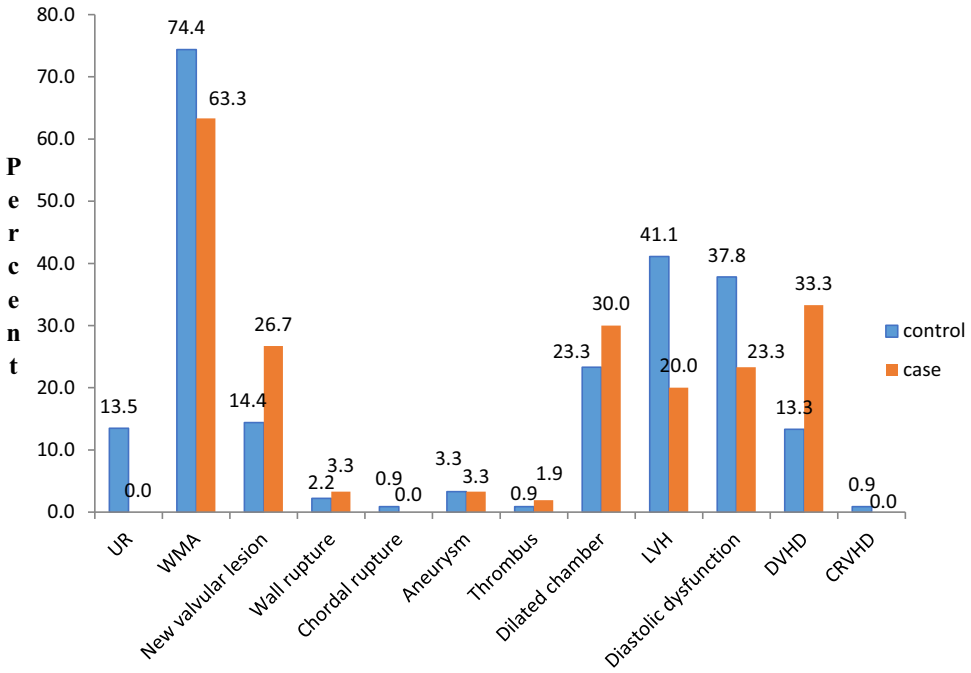

Figure 3 Echocardiographic findings of patients with ACS who presented to UOGCSH, Northwest Ethiopia, 2022 (N=169).

hemoglobin level was 14.16 g/dl + 2.23 for the controls and 12.81g/dl + 2.18 for cases. Low level of hemoglobin was recorded in 14.2% of the controls and 35.8% of the cases. Serum creatinine was raised in 32.1% of the controls and 43.4% of the cases and majority of patients had normal serum sodium and potassium level. Majority of the patients had elevation of their liver enzymes. Total cholesterol was 184.72±78.908 in controls and 164.30±59.95 in cases. 42.9% of cases and 50.9% of controls had low density lipoprotein greater than 100mg/dl (Table 7).

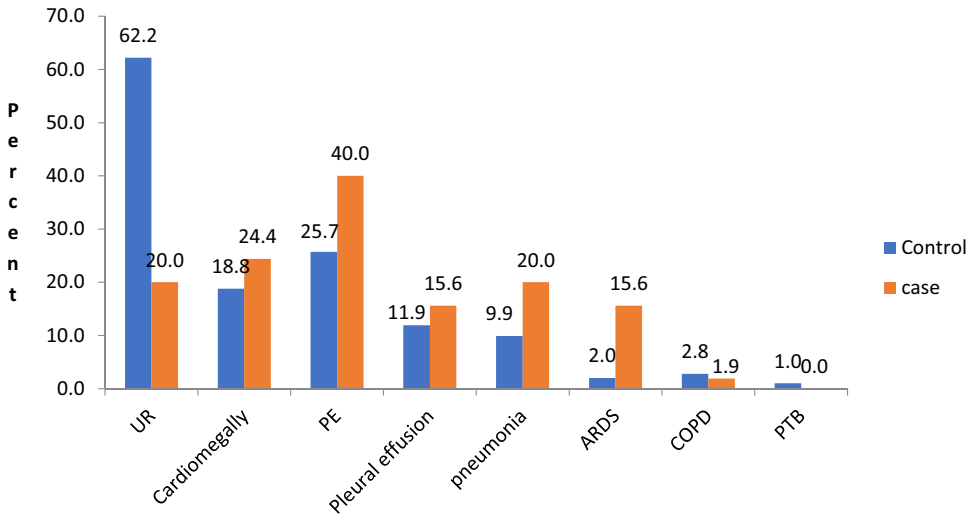

Figure 4 Plain chest X-ray findings of ACS patients at UOGCSH, Northwest Ethiopia, 2022 (N=169).

Determinants of In-hospital Mortality

In bivariate logistic regression, non-specific chest pain, B-blocker initiation and ACEIs initiation, KLIPP class, presence of cardiogenic shock and stroke as a complication, patients with concomitant illness, low oxygen saturation, presence of fever and low hemoglobin level were statistically significant with p value of <0.05 and entered into multivariate logistic analysis. In multivariate analysis, initiation of B-blockers, cardiogenic shock, stroke as a complication, low oxygen saturation and low hemoglobin were found to be significantly associated with in-hospital mortality.

Acute coronary syndrome patients who were not on beta blocker had 11.39 times (95% CI: 2.32–55.96) higher chance of in-hospital mortality than those patients on beta blocker. Patients with cardiogenic shock were 7.23 times (95% CI: 1.55–33.49) more at risk of in-hospital mortality as compared to those who did not have cardiogenic shock. Patients who had stroke as complication also had 7.61 times (95% CI: 1.81–31.92) higher risk of death before discharge than ACS patients without stroke as complication. Patients who had oxygen saturation <90% were 5.31 times (95% CI: 1.25–22.57) more likely to die in-hospital than those who had oxygen saturation > 90%. Patients who had hemoglobin level <12 g/dl were 3.43 times (95% CI: 1.13–10.35) more likely to die before discharge than those who had hemoglobin level ≥ 12 g/dl (Table 8).

Table 8 Determinants of in-Hospital Mortality Among Admitted ACS Patients at UOGCSH, Northwest Ethiopia, 2022 (N=169)

Variable	Controls N (%)	Cases N (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
Age in years						
< 55 55–64 ≥ 65	32(30.2) 31(29.2) 43(40.6)	14(26.4) 13(24.5) 26(49.1)	1 0.959(0.389–2.363) 1.382(0.624–3.060)	 0.927 0.425	1 0.478(0.122–1.876) 1.118(0.345–3.624)	 0.290 0.852
Non-specific chest pain						
Yes No	23(21.7) 83(78.3)	21(39.6) 32(60.4)	2.368 (1.154 −4.858) 1	0.019	1.223(0.416–3.597) 1	0.715
KILLIP class						
Class 1 and 2 Class 3 and 4	76 (71.7) 30(28.3)	23 (43.4) 30 (56.6)	1 3.304(1.660–6.576	 0.001	 0.269(0.054–1.332)	 0.108

(*Continued*)

Table 8 (Continued).

Variable	Controls N (%)	Cases N (%)	COR (95% CI)	P-value	AOR (95% CI)	P-value
B-blocker initiation						
Yes No	101(95.3) 5(4.7)	30(56.6) 23(43.4)	1 15.49(5.422–44.232)	0.000	1 11.39(2.320–55.961)	0.003
ACEIs initiation						
Yes No	81(76.4) 25(23.6)	18(34.0) 35(66.0)	1 6.300(3.054–12.996)	0.000	1 1.877(0.651–5.412)	0.244
Cardiogenic shock						
Yes No	5(4.7) 101(95.3)	25(47.2) 28(52.8)	11.29 (3.915–32.55) 1	0.000	7.219(1.556–33.488) 1	0.012
Stroke						
Yes No	6(5.7) 100(94.3)	13(24.5) 40(75.5)	5.417(1.925–15.241) 1	0.001	7.608(1.814–31.918) 1	0.006
Concomitant illness						
Yes No	25(23.6) 81(76.4)	32(60.4) 21(39.6)	4.937(2.427–10.042) 1	0.000	0.803(0.243–2.653) 1	0.719
Oxygen saturation						
<90% ≥ 90	24(22.6) 82(77.4)	35(66.0) 18(34.0)	6.644(3.208–13.759) 1	0.000	5.305(1.247–22.571) 1	0.024
Temperature						
<37.5 ≥ 37.5	103(97.2) 3(2.8)	42(79.2) 11(20.8)	1 8.992(2.388–33.866)	0.001	1 2.903(0.434–19.419)	0.272
Hemoglobin level						
<12 ≥ 12	15(14.2) 91(85.8)	19(35.8) 34(64.2)	3.390(1.549–7.420) 1	0.002	3.425(1.134–10.345) 1	0.029

Discussion

In this case control study, factors that determine in-hospital mortality among acute coronary syndrome patients at the University of Gondar Comprehensive Specialized Hospital Diabetes Clinic. In this study, patients who were not on beta-blockers, development of complication like cardiogenic shock and stroke, low saturation, and presence of anemia were found to be independent determinants of in-hospital mortality.

In this study, ACS patients who were not on beta-blockers had 11.39 times (95% CI: 2.32–55.96) higher risk of in-hospital mortality. The possible reason might be due to increased arrhythmia, re-infarction, and post-MI heart failure complication.[23] The finding of this study was in line with a cross-sectional study done at Ayder specialized hospital[24] where they found that acute coronary syndrome patients who had not been initiated on beta-blocker were at high risk of in-hospital mortality.

Acute coronary syndrome patients who developed cardiogenic shock were 7.219 times (95% CI: 1.556–33.488) more likely to die before discharge. This finding was similar to findings at Ayder specialized hospital and OPERA registry.[10,24] This is possibly due to comptonization of cardiac output which puts them at high risk of multi-organ failure due to low perfusion.[25]

Patients who had stroke as a complication were 7.61 times (95% CI: 1.81–31.92) more likely to have in-hospital mortality than those who did not develop stroke. In line with this study, a prospective ACUITY trial,[26] and PROMETHEUS registry[27] showed that development of stroke was an independent determinant of death at 30 days and one year. The possible reason might be due to increased multi-organ failure.

Supplemental oxygen (2 to 4 L/min) by nasal cannula for those who had SaO2 level less than 90% is associated with decreased morbidity and mortality by increasing the amount of oxygen delivered to the myocardium, which decreases the pain associated with myocardial ischemia.[11] In this study, ACS patients with low oxygen saturation (<90%) were at high risk of in-hospital mortality with AOR of 5.31 (95% CI 1.25–22.57), which is in line with a prospective study done in western Sweden in which patients with oxygen saturation <90% were more at risk of in-hospital mortality than patients with higher oxygen saturation (greater than 90%).[12]

Anemia was found to be a risk factor for adverse outcome of admitted acute coronary syndrome patients, which occurs in 25.9% to 45.4% of ACS patients.[28–30] In this study, patients with hemoglobin level less than 12g/dl had higher mortality than patients with hemoglobin level of greater than 12 g/dl (AOR=3.43 (95% CI: 1.13–10.35)). Similarly, studies done in Spain,[28] Italy,[30] Netherlands[31] and other multicenter studies[29,32] showed that ACS patients with hemoglobin level less than 12 g/dl had higher mortality rate than those who had hemoglobin level of greater than 12 g/dl. The possible reason might be due to increase in left ventricular wall tension, and left ventricle dysfunction.[30]

Strengths and Limitations of the Study

Strength of the Study

Since this study was a case-control study, it is better in identifying the determinants of in-hospital mortality than cross-sectional study done in Ethiopia previously. This study might be a corner stone for other studies and will help in improving our practice in treating acute coronary syndrome and will direct our focus towards treatable and achievable determinants of in-hospital mortality.

Limitation of the Study

As this study used a retrospective method, it might have missed some clinical, laboratory and radiological data.

Conclusions

Not receiving beta-blockers and developing complications like cardiogenic shock, stroke, low oxygen levels, and anemia were found to be greater risk factors for in-hospital mortality among myocardial infarction patients. This finding is relevant for patients undergoing similar treatment in settings with limited resources. It highlights the necessity for increased focus, including well-coordinated emergency and intensive care unit interventions, to reduce in-hospital mortality among patients experiencing these complications.

Abbreviations

ACEIs, Angiotensin Converting Enzyme Inhibitors; ACSl, Acute coronary syndrome; AHA, American Heart Association; AMI, Acute Myocardial Infarction; AOR, Adjusted Odds Ratio; ARBs, Angiotensin Receptor Blockers; BBs, B-Blockers; BPM, Beats per minute; CABG, Coronary Artery Bypass Graft; CAD, Coronary Artery Disease; CCB, Calcium channel blocker; CHD, Coronary Heart Disease; CI, Confidence Interval; CVD, Cardiovascular diseases; DM, Diabetes Mellitus; ED, Emergency Department; ECG, Electrocardiogram; EF, Ejection fraction; EMS, Emergency Medical Services; GCS, Glasgow Coma Scale; GRACE, Global Registry of Acute Coronary Events; HDL, High density lipoprotein; HAART, Highly active antiretroviral therapy; HIV/AIDS, Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome; ICU, Intensive Care Unit; IHD, Ischemic heart disease; K, Potassium; LBBB, Left bundle branch block; LDL, Low density lipoprotein; LMICs, low- and middle-income countries; LVEF, Left ventricular ejection fraction; MI, Myocardial Infarction; NA, Sodium; NSTEMI, Non-ST Elevation Myocardial Infarction; PCI, Percutaneous Coronary Intervention; PHT, Pre-hospital time; PHC, Primary Healthcare; RBS, Random Blood Sugar;

SGOT, Serum glutamic oxaloacetic transferase; SGPT, Serum glutamic pyruvic transferase; STEMI, ST Elevation Myocardial Infarction; SSA, Sub Saharan Africa; TASH, Tikur Anbessa specialized hospital; TC, Total cholesterol; TG, Triglyceride; UA, Unstable angina; UOG, University of Gondar; UOGCSH, University of Gondar Comprehensive specialized Hospital; UK, United Kingdom; WMA, Wall Motion Abnormality; WHO, World Health Organization.

Data Sharing Statement

The data-set is available from corresponding authors and can be obtained upon reasonable request.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors have declared that there are no conflicts of interest regarding the content of this work.

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