

# Recovery Rate and Predictors Among Patients with Acute Coronary Syndrome in Addis Ababa, Ethiopia: A Retrospective Cohort Study

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**Background:** Coronary artery disease (CAD) is the leading cause of mortality and morbidity in the world, including Ethiopia. Over seven million people die annually due to acute coronary syndrome (ACS) secondary to CAD. Despite this fact, studies are scant in Ethiopia. **Objective:** To determine recovery rate and predictors of time to recovery among ACS patients in St. Peter's Specialized Hospital, Addis Ababa, Ethiopia from October 2017 to October 2019.

**Methodology:** A retrospective cohort study was conducted among ACS patients. Patient charts were reviewed using a structured checklist. The Kaplan–Meier survival curve was used to estimate the survival time. Log–log plots were used to check proportional hazard assumption among categorical predictors. Bivariable and multivariable Cox regression analyses were performed to identify predictors of time to recovery. In bivariable analysis, variables with  $P \leq 0.25$  were fitted for multivariable Cox regression. Factors with  $P < 0.05$  in the multivariable Cox regression were independent predictors of time to recovery.

**Results:** A total of 471 patient charts with a diagnosis of ACS were reviewed. The mean length of hospital stay was  $2.98 \pm 1.30$  days with a total follow-up time of 1397 person-days. The recovery rate was 61.8%. The incidence density rate of recovery was found to be 20.5 per 100 person-days. Percutaneous coronary intervention (PCI) (AHR = 2.08, 95% CI: 1.57, 2.74) and absence of major bleeding (AHR = 1.44, 95% CI: 1.11, 1.87) were predictors of time to recovery.

**Conclusion:** In the current study, a considerable number of patients recovered within the first few days of admission. Absence of major bleeding and PCI were found to enhance early recovery of patients. Hence, early implementation of PCI and treatment of major bleeding may be vital to augment early recovery of patients with ACS. This can be achieved through involving case managers who can enhance the quality of treatment.

**Keywords:** acute coronary syndrome, coronary artery disease, recovery, survival rate

## Background

Acute coronary syndrome (ACS) is a term used to describe a range of conditions (acute ischemia and/or infarction) associated with an abrupt reduction in coronary blood flow.<sup>1</sup> Acute coronary syndrome is the commonest cause of morbidity and mortality in patients with coronary heart disease (CAD), contributing to an estimated 7.4 million deaths annually<sup>2</sup>. It can be caused by a very tight stenosis and plaque rupture which is the most frequent cause of coronary thrombosis. Platelets usually aggregate on the site, thus limiting blood flow that

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increases rate of death in ACS patients.<sup>3</sup> Acute coronary syndrome encompasses ST-elevated myocardial infarction, non ST-elevated, myocardial infarction and unstable angina.<sup>4</sup> ST-elevated myocardial infarction (STEMI) is a clinical syndrome defined by characteristic symptoms of myocardial ischemia in association with persistent ST elevation and subsequent release of biomarkers of myocardial necrosis. It is caused by complete occlusion of the culprit artery and mostly diagnosed in the presence of ischemic chest pain.<sup>5</sup> Troponin (T or I), the biomarker of choice to diagnose myocardial necrosis, is often normal during the first few hours of STEMI, thus emergent percutaneous coronary intervention (PCI) can be helpful.<sup>6</sup> Whereas, unstable angina (UA) and non ST-elevation (NSTEMI) are caused by incomplete occlusion of the culprit artery in 60–90% of cases.<sup>7</sup>

According to the World Health Organization, cardiovascular diseases are the leading causes of morbidity and mortality in 2020 worldwide.<sup>5</sup> In 2012, an estimated 17.2 million people died of cardiovascular diseases worldwide.<sup>8</sup> Likewise, CAD contributed to an estimated 46,000 hospital admissions in England in 2014.<sup>9</sup> Mortality from cardiovascular disease is predicted to reach 23.4 million in 2030, and the developing countries are expected to be major contributors to this increase.<sup>10</sup> Africa is home to more than one billion people living with CVDs with an estimated 1 million deaths attributable to CVD in sub-Saharan Africa.<sup>11</sup> The issue is not different in Ethiopia. A study conducted in Ethiopia also showed that among cardiovascular-related deaths, 72.6% were diagnosed with STEMI and in-hospital mortality rate was 27.4%.<sup>12</sup>

Different factors were reported to have a strong correlation with the incidence of ACS and treatment outcomes. Some of the strongest predictors of ACS outcomes include a history of diabetes mellitus, hypertension, hyperlipidemia, family history of ACS, and smoking.<sup>5,13–17</sup> Similarly, the findings of an Ethiopian study also revealed that history of hypertension, being Killip class III and IV, and STEMI diagnosis were independent predictors of death.<sup>12</sup> The recovery rate of ACS patients was also determined by coronary revascularization, percutaneous coronary intervention, major bleeding, defibrillation, hospital stay, and age at admission.<sup>18–20</sup>

The death of ACS patients can be mitigated by about 25% by primary prevention, 29% by secondary prevention, and 43% by other therapeutic improvements (thrombolytics, aspirin, renin angiotensin inhibitors, and beta-

blockers). Early de-escalation of antiplatelet treatment is also considered as an alternative approach in patients with acute coronary syndrome managed with PCI.<sup>12,14,21–23</sup> However, there is a gap in applications of strategies to enhance recovery rate and its predicting factors among admitted patients with ACS. Therefore, this study aimed to determine recovery rate and predictors of time to recovery among patients treated for ACS in St. Peter's Specialized Hospital, Addis Ababa, Ethiopia.

## Methods

### Study Area

This study was conducted in St. Peter's Specialized Hospital, which was established in 1963 as a tuberculosis (TB) treatment center in the nation. The hospital has a total of 500 staff of whom 250 are health-care professionals. It is mainly involved in the management of TB and TB/HIV patients. In addition, internal medicine, dermatology, ophthalmology, pediatrics, maternal and child health, mental health, and dental medicine services are also functional. Currently, a Cardiac Catheterization Laboratory, Echocardiography, critical care unit of cardiac patients with emergency OPD, and cardiac ward are functioning in the hospital. The service is commenced in collaboration with St. Paul's Hospital Millennium Medical College, Ethiopia. More than 100 cardiac patients are seen per day in the hospital.

### Study Design

An institutional-based retrospective cohort study was conducted among ACS patients who were admitted to the hospital for the treatment of ACS and related complications from October 29, 2017 to October 20, 2019 at St. Peter's Specialized Hospital.

### Study Population

All ACS patients who were admitted to St. Peter's Specialized Hospital from October 29, 2017 to October 20, 2019 were the study population.

### Exclusion Criteria and Inclusion Criteria

#### Inclusion Criteria

All records of patients with ACS who were admitted during the study period were included in this study.

#### Exclusion Criteria

Patient records with undocumented disease diagnosis, unknown date of admission and discharge, and unknown treatment outcomes were excluded from the current study.

## Sample Size Determination and Sampling Technique

This study is the first of its type in Ethiopia and all patient records were included in it. Primarily, the sample size was calculated by a single population formula considering the following assumptions: the proportion of the problem ( $P = 0.5$ ), margin of error ( $d = 0.05$ ), level of significance ( $\alpha = 0.05$ ),  $Z_{\alpha/2}$  at 95% CI = 1.96 and 10% contingency rate. Thus, a total of 422 study subjects were estimated to be the final calculated sample size. However, the total study subjects in the study area were 500. Hence, all subjects were taken as a total sample size. This was done because the data were collected from a secondary data source, which is liable to a high non-response rate. Regarding the sampling technique, all patients were included in this study and patient records were primarily identified from the health management information system (HMIS) registers. Then, patient cards were retrieved from card rooms using the medical registration numbers (MRNs) of each of the patients.

## Data Collection Methods

A checklist was adopted from patient records and reviewed literatures.<sup>2,5</sup> It consisted of variables such as socio-demographic information, date of admission and discharge, comorbidities, treatments given, and complications. Patient records were reviewed after collecting them from the card room using cardiac cases registry and MRNs. Patients with STEMI, NSTEMI, and UA were followed from admission to discharge. Outcomes of the treatment were measured at discharge. In this study, three data collectors (nurses) and one supervisor participated. One day training was given about the tool. Then, the data collectors were deployed to the data collection after we agreed on the tool. The primary investigator of the study and the supervisor were following the data collection process critically to minimize data errors.

## Data Processing and Analysis

Data were coded and cleaned using Epi-info (version 7), exported to STATA version 15 for analysis. The presence of missing values and possible outliers was checked through exploratory analysis. Survival time was determined from date of treatment initiation to date of discharge. Days were used as the time scale to calculate survival time. Kaplan–Meier survival function was employed to determine cumulative survival probability

of study subjects after initiation of the treatment. To determine the possible predictors of time to recovery, the Cox proportional hazard model with hazard ratio of 95% CI was used. Both bivariable and multivariable regression analysis were done to determine predictors of time to recovery. In bivariable analysis, variables with a  $p \leq 0.25$  level were included in the multivariable Cox regression model. All statistical tests were considered significant at 95% confidence interval. The log–log plot was used to check Cox proportional hazard assumption for categorical variables. Finally, the Cox regression model for its fitness was checked using Schoenfeld residual tests. The result revealed that the assumption is met at  $p = 0.282$ .

## Data Quality Assurance

Data quality was assured by applying a properly designed and pre-tested data collection tool. The tool was pre-tested in ten randomly selected charts in St. Peter's Specialized Hospital one week before the actual data collection. This was done to increase its ability to elicit relevant information and to check completeness and consistency. Five percent of the sample size was used for the pre-test. Then, corrective measures were taken before the actual time of data collection. In addition, training was given for data collectors and the supervisor. Proper categorization, coding of the questions was made. Finally, data collectors were closely followed by the supervisor and the principal investigator.

## Operational Definitions

### Recovery Rate

The number of ACS patients who recovered during the follow-up period divided by total study participants.

### Censored Cases

ACS patients who were alive (non-recovered), died, and referred were categorized under censored cases.

### ST-Segment Elevation Myocardial Infarction (STEMI)

Patients presented with clinical symptoms of myocardial ischemia in association with persistent ECG ST elevation and subsequent release of biomarkers of myocardial necrosis.<sup>24</sup>

### Non-ST-STEMI (NSTEMI)

Patients with documented clinical features of myocardial necrosis, as reflected in abnormally elevated levels of biomarkers of cardiac necrosis.<sup>24</sup>

## Percutaneous Coronary Intervention (PCI)

A procedure that involves a cardiologist feeding a catheter with a deflated balloon via the femoral artery or radial artery to a narrowing or occlusion in the coronary vessels. At the narrowing, the balloon is inflated to open the artery, allowing blood to flow. A stent may be placed at the site of the blockage to permanently open the artery.

**Killip class:** Killip class of the patient at the time of hospital admission:

Class 1: Absence of rales over the lung fields and absence of S3.

Class 2: Rales over 50% or less of the lung fields or the presence of an S3.

Class 3: Rales over more than 50% of the lung fields.

Class 4: Shock.

## Major Bleeding

Documented clinical bleeding associated with a fall in hemoglobin of 3 to  $\leq 5$  g/dl or reduction of hematocrit by greater than 15%.<sup>25</sup>

## Non-Recovered

The patient admitted and discharged alive against medical advice, without PCI, only angiography (diagnostic part), without necessary procedure.

## Recovered Cases

ACS patients who were discharged having recovered after treatment.

Incidence density rate of recovery rate: is computed by dividing the total numbers of recovered cases to the total person-day follow-up period.

## Ethical Considerations

Before data collection, ethical clearance was obtained from the outpatient directorate of St. Peter's Specialized Hospital and St. Paul's Hospital Millennium Medical College institutional review boards (IRBs). The informed consent was waived due to the anonymized data, and this study was conducted in accordance with the Declaration of Helsinki in which it is stated that in medical research using identifiable human material or data, physicians must normally seek consent for the collection, analysis, storage and/or reuse. There may be situations where consent would be impossible or impractical to obtain for such research or would pose a threat to the validity of the research. In such situations the research may be done only after consideration and approval of a research ethics committee.<sup>26</sup> The names of patients were replaced with

codes to avoid individual identifiers. Permission was obtained from the hospital officials before data collection. All the patient information was kept confidential and anonymous.

## Results

### Socio-Demographic Characteristics and Admission Details of Acute Coronary Syndrome Patients in St. Peter's Specialized Hospital

In this study, a total of 471 patient charts out of 500 with a diagnosis of ACS were reviewed giving a 96% response rate. The mean age of patients was  $56.30 \pm 10.04$  years with a range of 25–86 years. Of the total study subjects, 315 (71.1%) were males and the mean length of hospital stay was  $2.98 \pm 1.298$  days with a minimum of one day and the maximum 8 days. The urban residents were also found to be highly at risk for ACS, since more than three-quarters of ACS patients were from urban areas (Table 1).

### Clinical Presentation on Admission of Acute Coronary Syndrome Patients in St. Peter's Specialized Hospital

Regarding the clinical presentation of patients at admission, shortness of breath (67.6%), nausea and vomiting (56%), and abdominal pain (72%) were primarily seen among patients with UA. Likewise, arrhythmia was commonly seen among patients with STEMI. Besides, fever and dyspnea were equally distributed in each of the three types of ACS (Table 2).

### Initial Assessments

In the initial admission, the systolic and diastolic blood pressures were between 90–120 and 60–80 mmHg, respectively. Whereas, the average heart rates during admission was between 60–100 beats per minute. It was also documented that the survival of Killip class IV patients was low at about 4%, whereas the other classes had a better chance of survival, especially ACS patients in Killip class I, of which there were 110 (38%). Echocardiography was done for about 467 patients. Among patients with documented ejection fraction result, 56 (11.4%) had severe reduction in left ventricular ejection fraction (Table 3).

Creatine kinase muscle and brain (CK-MB) were measured for 66.6% of patients and 141 (29.9%) of patients were within normal range, while 173 (36.7%) were in abnormal

**Table 1** Socio-Demographic Characteristics and Admission Details of Acute Coronary Syndrome Patients in St. Peter's Specialized Hospital, 2017–2019 (N = 471)

Variable	STEMI Frequency (%)	NSTEMI Frequency (%)	Unstable Angina Frequency (%)
<b>Gender</b>			
Male	111 (71.6%)	100 (74.6%)	124 (68.1%)
Female	44 (28.4%)	34 (25.4%)	58 (31.9%)
<b>Age</b>			
≤55	64 (34.4%)	52 (38.8%)	64 (41.3%)
55–65	58 (32.7%)	60 (44.8%)	58 (37.4%)
>65	33 (37.5%)	22 (16.4%)	33 (21.3%)
<b>Educational Status</b>			
Unable to read	42 (27.1%)	20 (14.9%)	42 (23.1%)
Able to read	34 (21.9%)	33 (24.6%)	34 (18.7%)
Elementary school	17 (10.9%)	23 (17.1%)	26 (14.3%)
Secondary school	30 (19.3%)	36 (28.9%)	50 (27.5%)
College or University	32 (20.6%)	22 (16.3%)	30 (16.4%)
<b>Residence</b>			
Urban	128 (82.5%)	123 (91.8%)	145 (79.7%)
Rural	27 (17.5%)	11 (8.2%)	37 (20.3%)

range. Troponins were also done and it was documented for 125 (26.5%) of patients. The average low density lipoprotein (LDL >100 mg/dl) was recorded among 74 (15.7%) patients. Similarly, triglyceride (TG <150 mg/dl) was seen in 69 (14.9%) patients and triglyceride >150 mg/dl was recorded among 328 (69.6%) of patients. Besides, 9.7% of patients had HDL >40 mg/dl. The random blood sugar (RBS) measured was found to be between 70–120 mg/dl.

### Comorbidities and Classes of Diagnosis of Acute Coronary Syndrome Patients

Regarding the comorbidities, 98 (31.8%) of STEMI patients and 210 (68.2%) NSTEMI and UA had hypertension at admission. Likewise, 185 (68.1%) of patients with NSTEMI and UA as well as 87 (31.9%) patients with STEMI were found to have diabetes mellitus. Heart failure was diagnosed among 149 (70.6%) of NSTEMI and UA, and 62 (29.4%) of patients with STEMI.

**Table 2** Clinical Presentation on Admission of Acute Coronary Syndrome Patients in St. Peter's Specialized Hospital, 2017–2019 (N = 471)

Clinical Presentation	STEMI Frequency (%)	NSTEMI Frequency (%)	Unstable Angina Frequency (%)
<b>Shortness of Breath</b>			
Yes	108 (34.6%)	82 (61.2%)	123 (67.6%)
No	47 (29.7%)	52 (38.8%)	59 (32.4%)
<b>Nausea and Vomiting</b>			
Yes	81 (52.3%)	68 (50.7%)	102 (56.0%)
No	74 (47.7%)	66 (49.3%)	80 (44.0%)
<b>Arrhythmia</b>			
Yes	103 (66.5%)	84 (62.7%)	100 (54.9%)
No	52 (33.5%)	50 (37.3%)	82 (45.1%)
<b>Fever (Surface body T°&gt;38 °C)</b>			
Yes	77 (49.7%)	73 (54.5%)	91 (50%)
No	78 (50.3%)	61 (45.5%)	91 (50%)
<b>Abdominal Pain</b>			
Yes	106 (68.4%)	86 (64.2%)	131 (72%)
No	49 (31.6%)	48 (35.8%)	51 (28%)
<b>Dyspnea</b>			
Yes	88 (56.8%)	66 (49.3%)	96 (52.7%)
No	67 (43.2%)	68 (50.7%)	86 (47.3%)

Moreover, 122 (64.9%) of NSTEMI and UA patients, and 66 (35.1%) STEMI patients were found to have a smoking history.

Regarding the classes of diagnosis, 155 (32.98%), 133 (28.3%), and 183 (38.9%) were classified under STEMI, NSTEMI, and UA, respectively (Figure 1).

### Medications Given

With regard to medications given at admission, 442 (93.8%) of patients were given aspirin and 417 (88.5%) patients received clopidogrel. Anticoagulants were given for 408 (86.6%) patients. Likewise, 408 (86.6%) patients took ACE inhibitors. In addition, PCI was performed for 118 (48%) patients in St Peter's Specialized Hospital. Similarly, medications were given at discharge. Thus, aspirin was given for the majority (86.6%) and calcium channel blockers were given to 44.2% of patients only (Table 4).

**Table 3** Initial Assessment of Acute Coronary Syndrome Patients Admitted in St. Peter's Specialized Hospital, Addis Ababa, Ethiopia, 2017–2019 (N = 471)

Blood Pressure (mmhg)		
Variables	Frequency	Percent
<90/60	115	24.6%
90/60–119/79	126	26.8%
119/80–139/99	137	29.1%
140/100–159/109	93	19.7%
Heart rate (Beats/Minute)		
<60	27	5.7%
60–100	398	84.5%
>100	46	9.8%
Killip Class		
I	166	35.4%
II	146	31.1%
III	138	29.4%
IV	19	4.1%
Ejection Fraction (EF)		
<30%	57	11.4%
30–40%	134	28.4%
40–60%	255	54%
>60%	24	5.1%

## Treatment Outcomes and In-Hospital Complications

Of total patients, 245 (52%) developed atrial fibrillation and 264 (56%) of patients experienced thrombocytopenia

(platelet  $<150 \times 10^3$ ). Shock was the major complication seen in 317 (67.3%) patients (Table 5).

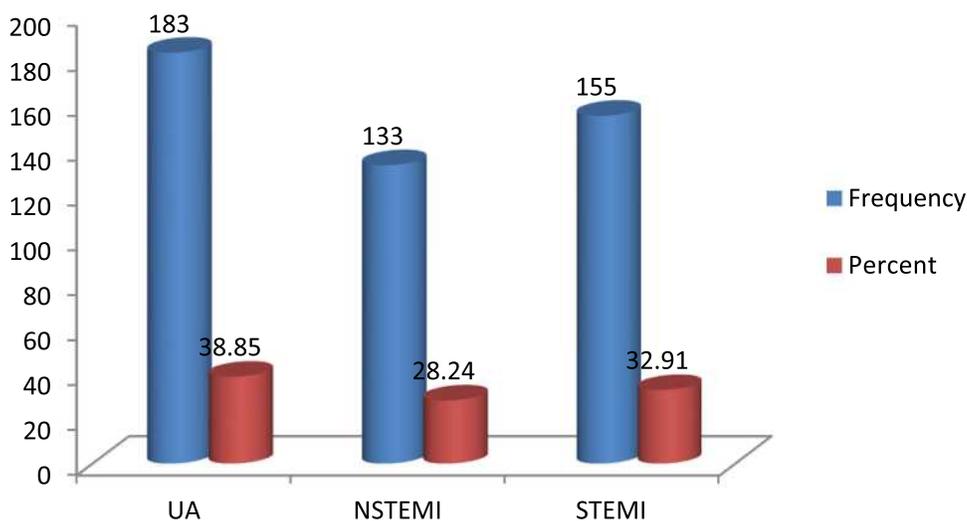
From the total of 471 patients who were admitted during the two-year period, 4 (0.9%) patients died. Others were discharged as non-recovered (58, 12.3%), referred (118, 25%), and recovered (291, 61.8%) cases (Figure 2).

## Survival Estimates for Time to Recovery

In this study a total of 286 ACS patients recovered at the end of the follow-up. The study subjects were followed for 1397 person-days. The incidence density rate of recovery was found to be 20.8 per 100 person-days (95% CI: 18.22, 22.90). Most of the patients recovered in the first three days with an incidence density rate of recovery of 30.1 per 100 person-days (95% CI: 24.2, 38.8). The median time of recovery was found to be three days (95% CI: 3, 4) and the mean time of recovery was four days (95% CI: 3.77, 4.25). The Kaplan–Meier survival curve depicts that the recovery rate of patients decreases as the duration of stay of patients increases (Figure 3).

## Multivariable Analysis of Factors Associated with Recovery Rate of ACS Patients

Among ACS patients, STEMI patients had the longest duration stay in the hospital. In the bivariable Cox regression analysis, sex, residence, educational status, and symptoms during admission, medications given during admission did not show any significant association with the outcome



**Figure 1** Class of diagnosis for Acute Coronary Syndrome patients in St. Peter's Specialized Hospital, Ethiopia, 2017–2019.

**Table 4** In- Hospitalization Medications for Acute Coronary Syndrome Patients in St. Peter's Specialized Hospital, Addis Ababa, Ethiopia, 2017–2019 (N = 471)

Drugs	Diagnosis			
	Unstable Angina	NSTEMI	STEMI	Total
Admission medications				
Aspirin	173 (39.1%)	126 (28.5%)	143 (32.5%)	442 (93.8%)
Clopidogrel	168 (40.3%)	116 (24.3%)	133 (28.3%)	417 (88.5%)
Anticoagulant	156 (38.2%)	114 (27.9%)	138 (33.8%)	408 (86.6%)
Anti-pain	139 (38.7%)	104 (29%)	116 (32.3%)	359 (76.2%)
Statins	145 (38.7%)	107 (28.5%)	123 (32.8%)	375 (79.2%)
Discharge medications				
Aspirin	154(37.7%)	124(30.4%)	130(31.9%)	408(86.6%)
Clopidogrel	133(38.3)	106(30.6%)	108(31.1%)	347(73.7%)
ACEI	158(39.4%)	112(27.9%)	181(45.1%)	401(85.1%)
Calcium Channel blockers	77(37%)	56(26.9%)	75(36%)	208(44.2%)
Statins	145(F38.7%)	107(28.5%)	123(32.8%)	375(79.2%)

variable. Finally, age, tobacco use, hypertension at admission, diabetes mellitus, peripheral arterial disease, pallor, arrhythmia, use of statins, psychiatric disorders, reperfusion or vascularization were eligible for multivariable Cox regression analysis. In the multivariable Cox regression analysis, only two variables were found to be independent predictors (PCI and absence of major bleeding) of recovery rate of patients (Table 6). Thus, patients who were given PCI as intervention were two times more likely to recover early than those who were not given PCI treatment (AHR = 2.08, 95% CI: 1.57, 2.71). The time to recovery was also determined using Kaplan–Meier survival estimate and the fulfillment of the hazard assumptions was confirmed using the log–log plot (Figure 4). Similarly, absence of major bleeding was found to increase recovery rate by 1.44 times (AHR = 1.44, 95% CI: 1.11, 1.87). Similarly, the time to recovery was also determined using Kaplan–Meier survival estimate and the fulfillment of the hazard assumptions was confirmed using the log–log plot (Figure 5).

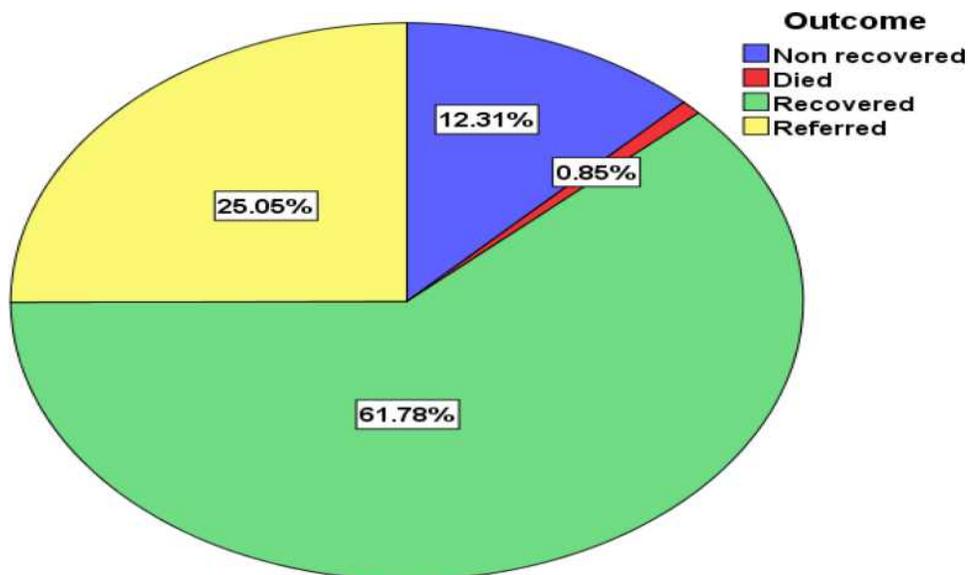
Finally, the hazard assumption was checked using a Schoenfeld residual test (the global test). Thus, the assumption was met and the p-value of a Schoenfeld residual test (global test) was 0.282.

## Discussion

The study determined the incidence density rate of recovery and predictors of time to recovery among patients admitted with acute coronary syndrome. A total of 471 patient charts were reviewed and the study subjects were followed for 1397 person-days of observation. Hence, the incidence density rate of recovery was found to be 20.5 per 100 person-days. The age distribution of ACS patients in St. Peter's Specialized Hospital was 56.3±10.4 years, which is in line with the age of patients in a study conducted at Addis Cardiac Hospital, Addis Ababa, where the mean age was 56 years. However, the mean age of patients in the current study is relatively lower than the age of patients in Kenya (59.7±3.8 years) and India (60.1±11.2).<sup>5,27</sup>

**Table 5** Major In-Hospital Complications in Acute Coronary Syndrome Patients Admitted at St. Peter's Specialized Hospital

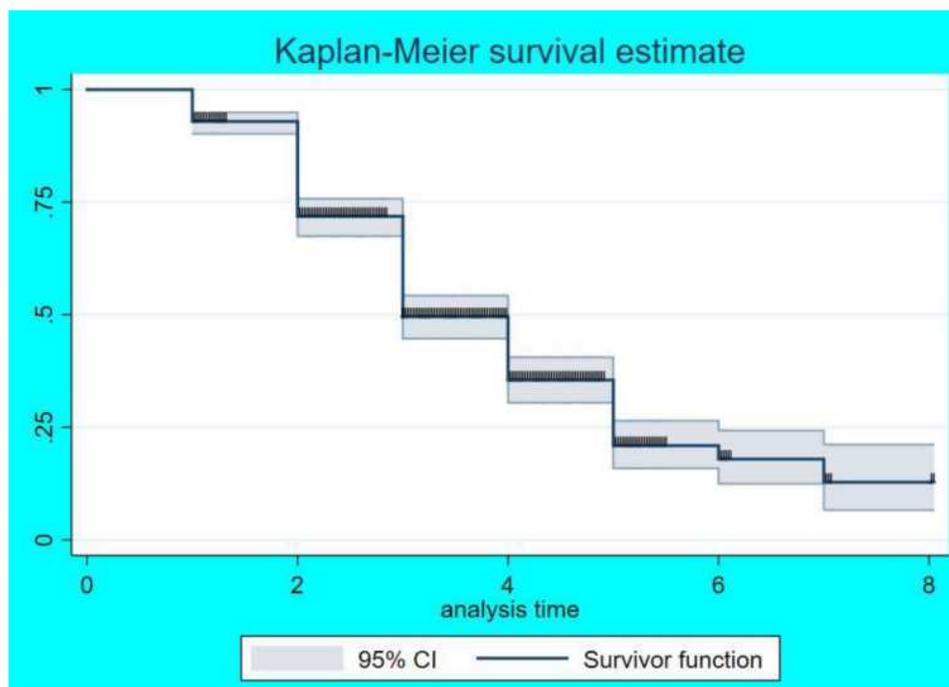
Variables	Diagnosis			
	Unstable Angina	NSTEMI	STEMI	Total
Atrial Fibrillation	96	70	79	245 (52%)
Thrombocytopenia	93	87	84	264 (56%)
Super Ventricular Tachycardia	74	33	65	172 (36.5)
Shock	114	103	100	317(67.3%)



**Figure 2** Treatment outcomes of Acute Coronary patients in St. Peter's Specialized Hospital, Ethiopia, 2017–2019.

Regarding the length of hospital stay, the mean length of hospital stay was found to be  $2.98 \pm 1.30$  days. The current finding is lower than the mean hospital stays in TASH and Kenya where the mean lengths were  $9.77 \pm 6.42$  days and  $5.3 \pm 1$  days, respectively.<sup>12</sup> The discrepancy may be accounted by absence of services such as PCI and thrombolytics in TASH as well as socio-demographic differences of study subjects. The clinical status or the presence of comorbidities

may have an effect on duration of hospital stay of patients. Patients with longer length of stay have more comorbidities and in-hospital complications, and are less often treated with evidence-based medications and are less likely to receive PCI.<sup>28</sup> The length of hospital stay of ACS patients can substantially decrease with the improvement of therapies, implementation of evidence-based therapies and advanced technologies such as PCI.<sup>29</sup>



**Figure 3** Kaplan–Meier survival curve of clients admitted with Acute Coronary Syndrome at St. Peter's Specialized Hospital from 2017 to 2019.

**Table 6** Multivariable Analysis of Covariates Associated with the Predicted Recovery Rate of ACS Patients at St. Peter's Specialized Hospital, Addis Ababa, Ethiopia, 2017–2019

Variables	Categories	Outcome		CHR (95% Confidence Interval)	AHR (95% Confidence Interval)
		Censored	Recovered		
PCI	Yes	61	188	2.56 (2.00–3.56) 	2.08(1.57–2.74)* 
	No	119	103		
Major bleeding	Yes	57	175	 1.99 (1.50–2.40)	 1.44(1.11–1.87)*
	No	123	116		
Reperfusion / Vascularization	Yes	89	175	1.33(1.05–1.68) 	1.30(1.00–1.69) 
	No	91	116		
Pallor	Yes	112	200	1.3(1.02–1.65) 	1.26(0.98–1.62) 
	No	68	91		
Peripheral Arterial Disease	Yes	50	108	0.71(0.52–0.96) 	1.25(0.98–1.6) 
	No	130	183		
Thrombocytopenia	Yes	93	171	0.82(0.65–1.03) 	1.13(0.80–1.59) 
	No	87	120		
Arrhythmia	Yes	121	166	1.31(0.99–1.73) 	0.86(0.68–1.09) 
	No	59	125		
In-hospital Morphine	Yes	131	228	0.99(0.98–0.99) 	1.18(0.88–1.58) 
	No	49	63		
Age	–	–	–	1.2(1.02–1.65)	0.99(0.98–1.00)
Psychiatric disorder	Yes	112	192	1.03(0.72–1.47) 	1.13(0.87–1.47) 
	No	68	99		
Discharged Clopidogrel	Yes	125	122	1.25(0.98–1.65) 	1.14(0.85–1.50) 
	No	55	69		
Statins	Yes	119	209	1.06(0.30–1.39) 	0.99(0.98–1.00) 
	No	61	82		
Tobacco use	Current smoker	16	27	1.03 (0.68, 1.57)	0.91(0.59, 1.41)
	X smoker	14	28	1.45(0.95–2.2)	0.99(0.59–1.41)
	Stop	50	81	1.25 (0.94–1.63)	1.08(0.8–1.44)
	Average Smoker	25	41	1.03(0.72–1.47)	0.95(0.66–1.37)
	No	75	114		

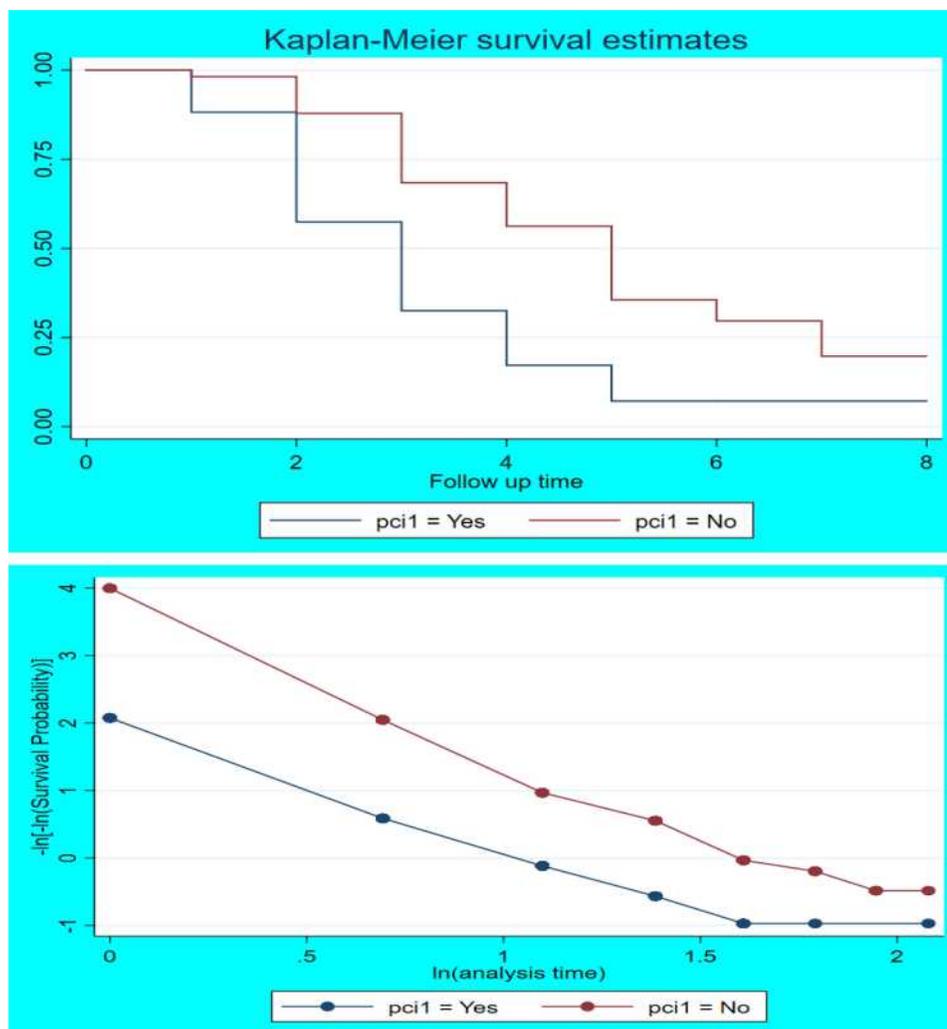
**Notes:** \*Statistically significant predictors at  $P < 0.05$ .

**Abbreviations:** AHR, Adjusted Hazard Ratio; CHR, Crude Hazard Ratio.

Regarding the incidence density rate of recovery, it was found that around 21 patients with ACS recovered in 100 person-days observation. However, studies are scant to compare our results and discuss accordingly. The median and the mean times of recovery of ACS patients are three and four days, respectively. The current findings are a little bit different from duration of recovery date in the study done by the European Society of Cardiology in which ACS patients recovered within 2–3 days of

treatment. This could be due to early rehabilitation, adequate follow up and early screening of at-risk patients in Europe. But, in Ethiopia the screening process of ACS patients is relatively poor.<sup>30</sup> The other possible justification may be presence of high level procedures in the developed world.<sup>31</sup>

Regarding the factors, the absence of major bleeding and PCI were found to be the independent predictors of time to recovery of patients with ACS. The absence of

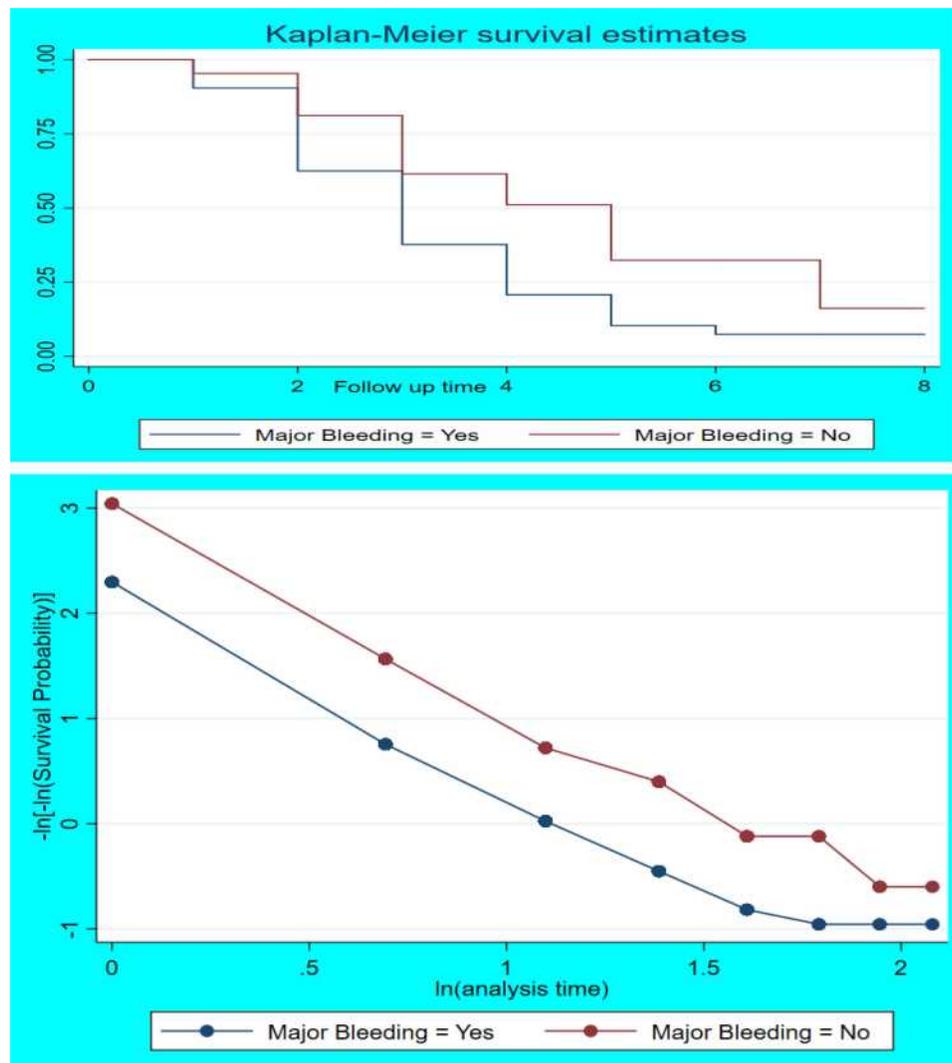


**Figure 4** Survival probability of ACS patients given PCI with log-log plot.

major bleeding is found to enhance the time of recovery by 1.44 times. The possible explanation for this may be that the presence of bleeding negatively impacts the survival of patients. This increases the demand for the intensity and duration of dual antiplatelet therapy. Thus, predicting bleeding complications and prompt management may help early recovery of ACS patients.<sup>32</sup> Besides, ACS patients suffering from bleeding should be on strict follow up. This is because bleeding may result in low ejection fraction, hypotension and decreased coronary blood flow that may lead to heart block and myocardial infarction. This may result in prolonged time of recovery of patients with ACS.<sup>19</sup> Likewise, administration of PCI for ACS patients is found to shorten the time of recovery of patients from ACS in that the likelihood of time of recovery was increased by two times. In the current study, more than

65% of patients recovered after administration of PCI. In general, when evidence-based medicine, such as PCI, transradial approach, selection of drug-eluting stents, aspiration thrombectomy, and the use of aggressive antithrombotic regimens is applied, the clinical outcome of ACS patients can improve significantly.<sup>33</sup> In addition, another finding also revealed that the mortality rate of patients with ACS can reduce with advanced procedures such as PCI.<sup>29</sup> PCI treatment was also reported to increase the overall survival of ACS elderly patients.<sup>34</sup>

In this study, hypertension, diabetes mellitus and heart failure were the commonest comorbidities of study subjects. The current findings are line with study results in Kenya where type 2 diabetes and hypertension were the main comorbidities associated with ACS.<sup>17</sup> Likewise, chest pain, shortness of breath, nausea and vomiting,



**Figure 5** Survival probability of ACS patients with the absence of major bleeding and log-log plot.

arrhythmia, fever and dyspnea were the common clinical presentations of patients at admission. Hence, patients with comorbidities and elders with serious clinical presentations need special care to enhance their survival. This is supported by study findings which revealed that elderly patients and patients with comorbidities should get much more attention to increase their survival.<sup>30</sup> Timely reperfusion in STEMI patients was also found to significantly improve the rate of survival of ACS patients.<sup>35</sup>

## Strengths and Limitations of the Study

To the authors' knowledge, this study is the first of its type in determining the incidence density rate of recovery and predictors of ACS in the study area. This could

help as a benchmark to conduct longitudinal studies in the future. All efforts were made to explore important data about comorbidities such as diabetes mellitus, hypertension, heart failure and important factors related to ACS in two years. However, this study is a single-centered study and it may be difficult to generalize to the general population, which is the main limitation of the study. Besides, some important variables might not be identified due to the retrospective nature of the data. This could affect the true estimates of some important outcome measures such that recovery rate could be over- or under-estimated. Moreover, only two independent predictors of time to recovery were found which could be associated with absence or incompleteness of some important variables.

## Conclusion

This study shows that ACS patients were treated in line with the recommendations of international guidelines in St. Peter's Specialized Hospital and a considerable number of patients recovered in the due date. Treatment of major bleeding and PCI were independent predictors enhancing the time of recovery of patients. Therefore, follow up should be implemented strictly during treatment of patients with ACS. Prompt treatment of major bleeding and early implementation of PCI for all patients with ACS may decrease the burden of ACS-related complications. Finally, we recommend the active involvement of care managers (trained nurses) to improve the quality of the program. This is because care managers can help ACS patients to make lifestyle changes; can monitor their conditions; and can provide information and advice to promote patient empowerment that can improve self-management skills.<sup>36</sup>

## Abbreviations

ACE, Angiotensin Converting Enzyme Inhibitors; ACS, Acute Coronary Syndrome; AHR, Adjusted Hazard Ratio; AIDS, Acquired Immunodeficiency Syndrome; AHA, American Heart Association; CAD, Coronary Artery Disease; CABG, Coronary Artery Bypass Graft; CHD, Coronary Heart Disease; CI, Confidence Interval; CHR, Crude Hazard Ratio; CKMB, Creatinine Kinase MB; CVD, Cardiovascular Disease; GRACE, Global Registry of Acute Coronary Events; HDL, High Density Lipoprotein; HR, Hazard Ratio; HIV, Human Immunodeficiency Virus; LDL, Low Density Lipoprotein; ICU, Intensive Care Unit; NSTEMI, Non ST Segment Elevated Myocardial Infarction; PCI, Percutaneous Coronary Intervention; SPSS, Statistical Package for Social Sciences; STEMI, ST Segment Elevated Myocardial Infarction; TASH, Tikur Anbessa Specialized Hospital; TB, Tuberculosis; TIMI, Thrombolytic in Myocardial Infarction; UA, Unstable Angina; VCT, Voluntary Counseling and Testing; WHO, World Health Organization.

## Data Sharing Statement

The datasets generated and analyzed during the present study are available from the corresponding author on reasonable request.

## Consent for Publication

All authors agree that this paper is publishable.

## Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

## Disclosure

The authors declare that they have no competing interests in this work.

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