Risk stratification and in-hospital outcome in patients with acute coronary syndrome

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Abstract

Background: Death and morbidity are caused by coronary artery disease (CAD) and acute coronary syndrome (ACS), which include ST-elevation myocardial infarction (STEMI) and unstable angina (UA), are the most common causes of death among those with CAD. The aim of the study was to define the demographic profile of patients with ACS in a tertiary care center, to identify risk factors in the profile of patients with ACS, to learn about the management of ACS in tertiary health care centers, and to estimate in-hospital outcomes in ACS patients at a tertiary health care center. Methods: The study was carried out in the Cardiology Department of Batra hospital and Medical Research Center, New Delhi, India. The Research Ethics Committee of the Hospital reviewed and approved the study protocol. Data Collected Included: Sociodemographic data, anthropometric data, clinical history, significant past medical history, medications, current clinical status of the patient, and investigations including electrocardiogram (ECG), electrocardiogram (ECHO), and coronary artery graft. Results: Age groups and type of ACS were having a statistically significant association (p = 0.04). A majority of patients with ACS were seen in the 55–74 years age group. Tobacco abuse was more common in STEMI patients as compared to other types of ACS. There was significant variation between risk stratification of ACS patients by Thrombolysis in Myocardial Infarction and Global Registry of Acute Cardiac Events scores. Single vessel disease (SVD) patients dominated both the STEMI [26 (50.9%) and UA [13 (52%) groups. There was a highly significant association between a specific line of treatment and type of ACS (p < 0.0001). A majority of patients underwent percutaneous intervention (69% of 100). Coronary artery bypass graft (CABG) was done in five (5/100) patients only. Thrombolysis was advocated in three (5.7%) patients with Streptokinase (SK) and two patients with Tenecteplase (TNK). Conclusion: There was a marked preponderance of STEMI in younger patients but it was less marked in older patients, according to the study. All conventional risk factors were represented in all types of ACS but hypertension and tobacco abuse were more consistent risk factors associated with STEMI.

Keywords: Coronary arteriosclerosis, risk reduction behavior, myocardial infarction, myocardial ischemia

Introduction

Coronary artery disease (CAD) is the leading cause of mortality and morbidity in the world and acute coronary syndrome (ACS), which encompass ST-elevation myocardial infarction, non-ST-elevation myocardial infarction (NSTEMI), and unstable angina (UA) are the commonest causes of mortality in patients with CAD.[1] With introducing a huge armamentarium of invasive and non-invasive therapeutic strategies, the mortality related to ACS has significantly reduced in the developed world over the past 20 years.[2‑5] But the mortality remains high among Indians.[6‑8] The Global Burden of Disease study reported the estimated mortality from CAD in India at 1.6 million in the year 2000.[7] It has been predicted that by the year 2020 there will be an increase by almost 75% in the global CVD burden. The situation in India is more alarming. Reddy reported that mortality from CVD was projected to decline in developed countries

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from 1970 to 2015 while it was projected to almost double in the developing countries including India.[9] Marked ethnic diversity has been well documented in the prevalence of CAD with Indians having a higher prevalence of premature CAD.[9] Several conventional and non-conventional risk factors have been implicated for CAD. The major conventional risk factors include hypertension, diabetes, smoking, hyperlipidemia, and obesity. The non-conventional risk factors include high-sensitivity C-reactive protein (hsCRP), lipoprotein (a) homocysteine, fibrinogen, D-dimer, tissue plasminogen activator (t-PA), and plasminogen activator inhibitor (PAI-1). It is also not very clear whether there is any correlation of these risk factors with angiographic severity of CAD.[10] Early risk stratification plays a pivotal role in the optimal management of ACS, which represents with variable short-term and long-term prognosis.[10] Over the past decade, a multitude of risk scores have been proposed to facilitate risk assessment.[11–14] For example, the Platelet glycoprotein IIb/IIia in Unstable angina: Receptor Suppression Using Integrilin Therapy (PURSUIT RS) and Thrombolysis in Myocardial Infarction (TIMI RS) risk scores were derived from clinical trial populations,[15] and the Global Registry of Acute Cardiac Events risk score (GRACE RS) was developed from an international registry.[16] Although these risk scores have been externally validated, it is not known whether application of these risk scores can refine risk assessment by clinicians in routine clinical practice.[15] Along with the knowledge of demography of ACS and its risk stratification, one must know likely outcomes of ACS with the course of treatment. Although the primary goal of any form of treatment is an uneventful recovery of patient; other major adverse outcomes in form of death, cardiogenic shock, complete heart block, renal failure, pulmonary edema, etc., must be taken into consideration.[16]

ACS patients in India present approximately a decade earlier than patients in Western countries, and the relative proportion of STEMI vs NSTEMI is also higher in some Indian studies. Primary care physicians and family physicians must know that access to care, invasive therapies used, and outcomes may also be different in each patient.[15,16] Hence it is important to understand the profile of ACS patients in each setting in order to better predict outcome and choose strategies especially in primary care settings so as to manage patients appropriately with immediate referrals to tertiary care centers.

Aims and Objectives

1. To define the demographic profile of patients with ACS and stratify patients with ACS based on their risk factor profile.
2. To understand the practice pattern of management of ACS and to estimate in-hospital outcomes in ACS patients at a tertiary health care center.

Methods

Study Setting: The study was carried out in the Cardiology Department of Batra hospital and Medical Research Center, New Delhi, India. The Research Ethics Committee of the Hospital reviewed and approved the study protocol. Study Population: Adult ACS patients presenting to the Cardiology Department. Study Design: Prospective observational study. Time Period: December 2014 to November 2015. Inclusion Criteria: All patients with age over 18 years, who were presented with symptoms and signs of ACS (chest pain, breathlessness, diaphoresis, syncope, palpitations, nausea, vomiting, diarrhea, indigestion, acute confusion) along with at least one of following: (a) ECG changes consistent with ACS, (b) elevated cardiac enzymes, and (c) documented CAD (prior MI or proven by coronary artery graft (CAG)). Exclusion Criteria: (a) patients with foreign nationality, (b) brought dead patients with no history suggestive of ACS/previous CAD, and (c) Patients admitted with other departments with a primary diagnosis other than ACS and developing cardiac arrest because of underlying non-ACS pathology. Procedure: Sociodemographic data, anthropometric data, clinical history, significant past medical history, current medications, current clinical status of the patient and relevant investigations including ECG, ECHO, and CAG were collected on a predesigned, pretested proforma. Other data collected include:

(a) Final diagnosis: STEMI, NSTEMI, UA; (b) risk stratification of the subjects based on age, blood pressure, heart rate, h/o heart failure, ECG changes, cardiac enzymes, presence/absence of cardiac arrest at admission, presence of DM/HTN, time to treatment, and aspirin use in a previous week of admission; (c) in-hospital course of subjects including major interventions and/or events. Medication at discharge; (d) source of funding for medical treatment; (e) mode of reaching the hospital; and (f) time to reach the hospital.

Statistical methods

Data were tabulated in MS Office Excel worksheet. Descriptive statistics was computed for all the numerical data. Frequency tables were constructed for categorical data. Chi-square test was used for the statistical significance among different category. Unpaired ‘t’ test and one-way Analysis of variance (ANOVA) were used for the statistical significance of difference between means of two or more samples, respectively. For all the statistical analysis at P-value ≤ 0.05 was significant at 95% confidence interval (CI). All statistical analyzes were performed by using SPSS version 20.0 and StatCal software. Socioeconomic status (SES) was estimated using changed Kuppuswamy Socioeconomic Scale update.[17] GRACE and TIMI risk scores were calculated with the help of smartphone applications. Risk stratification of ACS patients was done based on TIMI and GRACE scores.[18] Risk stratified groups in ACS patients were correlated with extent of CAD, in-hospital outcomes, and lengths of hospital stay. All observations were analyzed and inferences were made.

Results

Sociodemographic profile of the patients with ACS is described in Table 1(a) and Table 1(b). The mean age for ACS was found to be 58.31 ± 10.66. The mean age for STEMI (55.49 ± 10.67) was
significantly less than compared to NSTEMI/UA [60.77 ± 9.90 and 62.12 ± 9.91, respectively] (p = 0.01). The mean age of presentation in females was significantly higher than compared to males [64.37 ± 10.67 vs 56.39 ± 9.98] (p = 0.001). Age groups and type of ACS were having a statistically significant association (p = 0.04). A majority of patients with ACS were seen in the 55–74 years age group [n = 70 (70% of 100)], STEMI was more common in younger patients (<55 years) while many were seen in older patients (≥55 years).

Most of the ACS patients belonged to the middle-class group (66%) followed by the upper-class group (19%). STEMI was more common in the upper-middle SES group [21 (39.6% of 53) patients], NSTEMI was more common in the upper-middle SES and lower-middle SES group [6 (27.3% of 22) patients each], and UA was more common in lower-middle SES group [12 (48% of 25) patients]. However, no significant association was found between SES and types of ACS (p = 0.4). A larger study may be required to clarify the association of SES and type of ACS. Mean BMI was found to be 26.06 ± 4.6 kg. Most of the [59 (59%)] patients were confined to the overweight group. More number of overweight patients was seen in the STEMI group and UA group [29 (54.7% of 53) patients and 11 (44% of 25) patients, respectively]. Healthy weight patients [11 (50% of 22)] were more in number in the NSTEMI group. No significant association was noted between BMI and any specific type of ACS (p = 0.06). [Table 1(b)]

The profile of ACS patients with associated risk factors is shown in Table 2. Hypertension was seen in 51% (n = 51), DM in 44% (n = 44), obesity in 11% (n = 11), tobacco abuse in 39% (n = 39), dyslipidemia in 47% (n = 47), H/O CAD in 16% (n = 16), and family H/O CAD in 22% (n = 22) subjects. Statistically significant association was noted between hypertension and types of ACS (p = 0.01), hypertension being more common in STEMI patients as compared to NSTEMI and UA patients. Statistically significant association was found between tobacco abuse and types of ACS (p = 0.008). Tobacco abuse was also more common in STEMI patients as compared to other types of ACS. All other risk factors were evenly distributed among many ACS patients.

Matrix plot risk stratification for ACS patients as per TIMI and GRACE risk score is described in Table 3. TIMI risk score stratified most ACS patients as low risk (62%), while GRACE score stratified only 26% patients as low risk. Hence, there was significant variation between risk stratification of ACS patients by TIMI and GRACE scores with GRACE score consistently upgrading the risk category (p < 0.0001). As per the matrix plot, there was one way change in categorization of ACS patients from TIMI risk categories to GRACE risk categories. Of 100 ACS patients, 48 (48%) were upgraded by one step while 8 (8% of 100) patients were upgraded by two steps from TIMI risk categorization to GRACE risk categorization. No patient was downgrade in terms of risk category when moving from TIMI to GRACE score. Similar results were seen in STEMI, NSTEMI, and UA patients, when studied separately.

Extent of CAD in ACS was shown in Table 4. Patients with SVD were more in number [44 (45.8%) in the present study, SVD patients dominated both the STEMI [26 (50.9%)] and

### Table 1a: Sociodemographic profile of acute coronary syndrome patients

| Diagnosis | Age (Mean±SD) |
|-----------|---------------|
| Overall ACS (n=100) | 58.31±10.66 |
| Type of ACS | |
| STEMI (n=53) | 55.49±10.67 |
| NSTEMI (n=22) | 60.77±9.90 |
| UA (n=25) | 62.12±9.91 |
| Gender | |
| Male (n=76) | |
| Female (n=24) | 64.37±10.67 |

ACS=Acute coronary syndrome, STEMI=ST-elevation myocardial infarction, NSTEMI=non-ST-elevation myocardial infarction, UA=unstable angina

| Age (in years) | STEMI | NSTEMI | UA | TOTAL |
|----------------|-------|-------|----|-------|
| <55 | 19 | 3 | 3 | 25 |
| 55-74 | 33 | 18 | 19 | 60 |
| ≥75 | 1 | 1 | 3 | 5 |
| Total | 53 | 22 | 25 | 100 |

ACS=Acute coronary syndrome, STEMI=ST-elevation myocardial infarction, NSTEMI=non-ST-elevation myocardial infarction, UA=unstable angina

### Table 1b: Sociodemographic profile of acute coronary syndrome patients

| Variables | STEMI | NSTEMI | UA | TOTAL |
|-----------|-------|-------|----|-------|
| Socioeconomic status (as per Kuppuswamy SES 2018) | |
| Upper | 11 | 5 | 3 | 19 |
| Upper-middle | 21 | 6 | 6 | 33 |
| Lower-middle | 15 | 6 | 12 | 33 |
| Upper lower | 6 | 5 | 4 | 15 |
| Lower | 0 | 0 | 0 | 0 |
| Body Mass Index (BMI) | |
| Underweight | 0 | 0 | 2 | 2 |
| Healthy weight | 21 | 11 | 7 | 39 |
| Over weight | 29 | 8 | 11 | 48 |
| Obese | 3 | 3 | 5 | 11 |
| Total | 53 | 22 | 25 | 100 |

ACS=Acute coronary syndrome, STEMI=ST-elevation myocardial infarction, NSTEMI=non-ST-elevation myocardial infarction, UA=unstable angina

### Table 2: Profile of acute coronary syndrome patients with associated risk factors

| Risk factor | STEMI (n=53) | NSTEMI (n=22) | UA (n=25) | Test statistics | χ² | df | P |
|-------------|--------------|---------------|------------|-----------------|-----|----|---|
| Hypertension (n=51) | 23 | 9 | 19 | 8.4 | 2 | 0.01* |
| Diabetes (n=44) | 19 | 11 | 14 | 3.2 | 2 | 0.2 |
| Obesity (n=11) | 3 | 3 | 5 | 3.7 | 2 | 0.1 |
| Tobacco abuse (n=39) | 28 | 4 | 7 | 9.5 | 2 | 0.008* |
| Dyslipidemia (n=47) | 26 | 12 | 9 | 1.8 | 2 | 0.4 |
| Known CAD (n=16) | 7 | 2 | 7 | 3.7 | 2 | 0.15 |
| Family H/O CAD (n=22) | 9 | 7 | 6 | 2.07 | 2 | 0.35 |

ACS=Acute coronary syndrome, STEMI=ST-elevation myocardial infarction, NSTEMI=non-ST-elevation myocardial infarction, UA=unstable angina, CAD=coronary artery disease, χ²=Chi-square test, df=degree of freedom. *P<0.05 considered as statistically significant
Table 3: Matrix plot of risk stratification for ACS as per TIMI and GRACE risk scores

| Risk stratification as per TIMI risk score | Low risk | Intermediate risk | High risk | Total |
|------------------------------------------|----------|-------------------|-----------|-------|
| As per TIMI risk score                   | 62       | 31                | 7         | 100   |
| As per GRACE risk score                  | 26       | 39                | 35        | 100   |

| Risk stratification as per TIMI risk score in ACS | Low risk | Intermediate risk | High risk | Total |
|--------------------------------------------------|----------|-------------------|-----------|-------|
| Risk stratification as per GRACE risk score       |          |                   |           |       |

| Type of ACS | MILD ATH. CAD | SVD | DVD | TVD | Total |
|-------------|---------------|-----|-----|-----|-------|
| STEMI       | 1             | 26  | 9   | 15  | 51    |
| NSTEMI      | 2             | 5   | 9   | 4   | 20    |
| UA          | 2             | 13  | 3   | 7   | 25    |
| Total       | 5             | 44  | 21  | 26  | 96*   |

ACS: acute coronary syndrome, STEMI: ST-elevation myocardial infarction, NSTEMI: non-ST-elevation myocardial infarction, UA: unstable angina, CAD: coronary artery disease, SVD: single vessel disease, DVD: double vessel disease, TVD: triple vessel disease. *90% patients underwent CABG. One patient refused CABG after thrombolysis and three patients died prior to CABG.

Table 4: Extent of coronary artery disease in acute coronary syndrome

| Type of ACS | MILD ATH. CAD | SVD | DVD | TVD | Total |
|-------------|---------------|-----|-----|-----|-------|
| STEMI       | 1             | 26  | 9   | 15  | 51    |
| NSTEMI      | 2             | 5   | 9   | 4   | 20    |
| UA          | 2             | 13  | 3   | 7   | 25    |
| Total       | 5             | 44  | 21  | 26  | 96*   |

Discussion

There are significant variations in the profile of patients with ACS across countries and regions. ACS patients in India present approximately a decade earlier than patients in Western countries, and the relative proportion of STEMI vs NSTEMI is also higher in some Indian studies. Access to care, invasive therapies used, and outcomes may also be different in each patient. Hence, it is important to understand the profile of ACS patients in each setting to better predict outcome and choose strategies.

In the present study, STEMI (53/100, 53%) was more common as compared to NSTEMI (22/100, 22%) and UA (25/100, 25%) which was comparable to the study by Xavier D et al.[18] (STEMI – 60.6%, non-STEMI – 39.4%), Gupta S et al.[19] (STEMI – 75.4%, UA/NSTEMI – 24.6%), and Mohanan PP et al.[20] (STEMI – 37%, NSTEMI – 31%, and UA – 32%) but was contrary to the study by Hasdai D et al.[21] (Non-ST ACS – 51.2%, STE ACS – 42.3%, undetermined ACS – 6.5%), and Fox KAA et al.[22] (UA/NSTEMI – 46%, MI – 39%, suspected ACS – 14%) where non-ST

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ACS was more common. Thus, our finding was comparable to other Indian studies but was dissimilar to Western studies.

The age of patients ranged from 32 to 82 years. Most ACS patients [70 (70%)] were concentrated in the 55–74 years age group which was comparable to findings by Faizal P et al. [55–74 years – 60.87%], Mohanan PP et al. [51–70 years – 57.28 ± 11.3], and Xavier D et al. [51–70 years – 57.5 ± 12.1]. The mean age of presentation in ACS patients was found to be 58.31 ± 10.66 years which is close to the mean age reported by Xavier D et al. [57.5 ± 12.1], Gupta S et al. [58.32 ± 11.24], Abdallah M et al. [58 ± 12.9], and Mohanan PP et al. [60.4 ± 12.1] but is lower than compared to the mean age reported by Mandelzweig et al. [64.7], Hasdai D et al. [STEMI – 63.4 ± 13, NSTEMI – 65.8 ± 12, Undetermined – 72.0 ± 10.3], and Fox KAA et al. [MI 63.8, UA – 65.2, Suspected ACS – 64.2]. The mean age of presentation in ACS patients in our study was comparable to other Indian studies but was lower than compared to the Western population.

STEMI was the commonest type of ACS in younger patients under 55 years [19/25, 76%] and the preponderance of STEMI was the less-marked older age group.

The association of types of ACS with age was statistically significant (p = 0.04). The mean age for STEMI (55.49 ± 10.67) was less than compared to the mean age for NSTEMI (60.77 ± 9.90) and UA (62.12 ± 9.91) which is similar to findings by Gupta et al. [STEMI – 57.76 ± 11.44, NSTEMI – 60.07 ± 10.47], Xavier D et al. [STEMI – 56.30 ± 12.13, NSTEMI – 59.31 ± 11.83], and Hasdai D et al. [STEMI – 65.4 ± 11.9, UA – 60.5 ± 12.1], and Fox KAA et al. [ UA – 65.2, MI – 63.8, Suspected ACS – 64.2]. The above finding in our study was comparable to other Indian studies excluding Kerala ACS Registry and the mean age for STEMI (55.49 ± 10.67) was significantly less than compared to NSTEMI/UA [60.77 ± 9.90 and 62.12 ± 9.91, respectively] (p = 0.01). STEMI was more common in age less than 65 years [41 (77.4%) of 53] and NSTEMI and UA were more common in age ≥55 years [19 (86.4%) of 22 and 22 (88% of 25), respectively] which is comparable to study by Xavier D et al. [STEMI in age <70 years – 76%, non-STEMI in age >50 years – 76%] and Mohanan PP et al. [STEMI in age <70 years – 79.6%, non-STEMI in age >50 years – 79.6%, UA in age >50 years – 78%]. The mean age of presentation in females was higher than compared to males [64.37 ± 10.67 vs 56.39 ± 9.98] as is shown by Gupta et al. [64.36 ± 8.82 vs 57.28 ± 11.3].

Males accounted for 76% which is like other Indian and Western studies such as Mohanan PP et al. [77.4%], Xavier D et al. [76.4%], Faizal P et al. [80.63%], Gupta S et al. [85.2%], Mandelzweig et al. [70.1%], and Fox KAA et al. [70%]. Males were more prone for STEMI as compared to other types of ACS [STEMI – 46 (60.5%) of 76] while there was more even distribution in females [STEMI – 7 (29.2%), NSTEMI – 9 (37.5%), and 8 (33.3%) of 24]. There was a statistically significant association between gender and a specific type of ACS (p = 0.021). Most ACS patients belonged to the middle-class group (66%) followed by the upper-class group (19%) which was comparable to the work by Gupta S et al. [lower-middle class (52.5%), lower class (19.6%)]. STEMI was more common in the upper-middle SES group [21 (39.6% of 53)], NSTEMI was more common in the upper- and

### Table 5: Treatment modality in acute coronary syndrome

| Treatment Modality               | STEMI (n=53) | NSTEMI (n=22) | UA (n=25) | Total |
|----------------------------------|--------------|--------------|----------|-------|
| Thrombolysis                     | 3            | 0            | 0        | 3     |
| CAG                              | 51           | 20           | 25        | 96    |
| Primary PCI                      | 19           | 0            | 0        | 19    |
| Rescue PCI                       | 7            | 0            | 0        | 7     |
| Pharmacoinvasive PCI             | 1            | 0            | 0        | 1     |
| Delayed elective PCI             | 15           | 12           | 15       | 42    |
| CABG                             | 5            | 0            | 0        | 5     |
| Treatment other than thrombolysis| 2*           | 5            | 5        | 12**  |
| Refused definite treatment       | 1+1**        | 5            | 5        | 11+1**|

ACS=Acute coronary syndrome, STEMI=ST-elevation myocardial infarction, NSTEMI=non-ST-elevation myocardial infarction, UA=unstable angina, CAG=coronary artery graft, PCI=percutaneous intervention.

*P=0.05 considered as statistically significant

### Table 6: Adverse in-hospital outcomes in acute coronary syndrome patients

| Outcome of Patients in Hospital | STEMI (n=53) | NSTEMI (n=22) | UA (n=25) | Total |
|---------------------------------|--------------|--------------|----------|-------|
| Heart failure                   | 14           | 6            | 3        | 23    |
| Tachyarrhythmias                | 3            | 4            | 0        | 7     |
| Cardiogenic shock               | 5            | 1            | 1        | 7     |
| High degree AV block            | 4            | 0            | 0        | 4     |
| Slow flow                       | 8            | 0            | 1        | 9     |
| GI hemorrhage                   | 1            | 0            | 1        | 2     |
| Stroke                          | 3            | 1            | 1        | 5     |
| CIN                             | 1            | 0            | 0        | 1     |
| Mechanical complications        | 0            | 1            | 0        | 1     |
| Death                           | 4            | 2            | 0        | 6     |

AV=Arterio-venous, STEMI=ST-elevation myocardial infarction, NSTEMI=non-ST-elevation myocardial infarction, UA=unstable angina, CIN=contrast induced nephropathy
lower-middle SES group [6 (27.3% of 22) each] and UA was more common in the lower-middle SES group [12 (48% of 25)]. However, statistically no significant association was found between SES groups and types of ACS (p = 0.41).

Most ACS [59 (59%)] patients were confined to the overweight 48 (48%) and obese 11 (11%) group. The mean BMI was found to be 26.06 ± 4.6 kg, which was comparable to Faizal P et al. [14] [overweight (34.29%), obese (11.43%)]. Statistically no significant association was found between BMI and any specific type of ACS (p = 0.06). Hypertension (51%), diabetes mellitus (44%), tobacco abuse (39%), and dyslipidemia (47%) were common risk factors which were comparable to study by Mohanan PP et al. [15] (hypertension – 48.4%, diabetes mellitus – 37.6%, smoking – 34.4%, Xavier D et al. [16] (hypertension – 37.7%, diabetes mellitus – 30.4%, smoking – 27.9%), Gupta et al. [17] (hypertension – 40.4%, diabetes mellitus – 30.3%, smoking – 50.4%, dyslipidemia – 57.9%), Fox KAA et al. [18] [UA (hypertension/diabetes mellitus/smoking, 51%/23%/35%), myocardial infarction (HTN/DM/smoking, 41%/19%/46%), and Hasdai D et al. [19] STE ACS (HTN/DM/smoking/hyperlipidemia, 51.6%/21.1%/63.1%/46.8%), non-STE ACS (HTN/DM/smoking/hyperlipidemia, 63.6%/23.5%/53.8%/54.6%)], and all conventional risk factors were represented in many in our study and were comparable to other Indian and Western studies. Hypertension [23 (43.4%) of 53] and tobacco abuse [28 (52.8%) of 53] were more common in STEMI patients. Thus, association of types of ACS with hypertension (p = 0.01) and tobacco abuse (p = 0.008) was significant. The TIMI score stratified ACS patients into lower-risk categories, while GRACE score was more sensitive to stratify ACS patients into high-risk categories. There was one way change in categorization of 50% ACS patients from TIMI risk categories to GRACE risk categories either by one step [46 (46%)] or by two steps [8 (8%)]. No patient was downgraded in terms of risk category when moving from TIMI to GRACE risk score. There was significant variation between risk stratification of ACS patients by TIMI and GRACE scores with GRACE score consistently upgrading the risk category (p < 0.0001). Similar results were noted regarding STEMI, NSTE MI, and UA patients, when studied separately.

Acceptance for CAG (96%) was extremely high in our study, which was higher than compared to the study by Gupta S et al. [19] (71.81%), Faizal P et al. [14] (50.98%) and Abdallah M et al. [20] (74%). Acceptance for CAG in individual type of ACS was also very high in our study [STEMI 51/53, 96.2%], (NSTE MI 20/22, 90.9%), and (UA 25/25, 100%) which was much better when compared to findings by Gupta S et al. [19] [STEMI (66.9%), NSTE MI/UA (86.7%) and Abdallah M et al. [20] [STEMI (82%), NSTE MI (66%) and UA (75%)]. Thus, the acceptance rate of CAG at our hospital was higher than compared to hospital-based studies in India and other developing countries. This may be because of that our center is premier tertiary heart care center in the National Capital Region. SVD, DVD, and TVD were found in 44 (45.8% of 96), 21 (21.8% of 96), and 26 (27.08%) patients which is comparable to the work by Faizal P et al. [14] [SVD 54 (41.86% of 129), DVD 37 (28.68% of 129), and TVD 38 (29.45% of 129)] and differed slightly from findings by Mahajan S et al. [21] (SVD 96 (39.76% of 242), DVD 82 (33.9% of 242), and TVD 64 (26.4% of 242)]. STEMI patients dominated both the STEMI [26 (50.9% of 51)] and UA [13 (52% of 25)] in our study, which was comparable to the study by Abdallah M et al. [20] (42% and 33%). DVD was commonest [9 (45% of 20)] in NSTE MI which was dissimilar to the study by Abdallah M et al. [20] (TVD – 40%). In our study, the association between types of ACS and extent of CAD did not reach statistical significance (p = 0.07). We compared risk stratification as per TIMI score in relation to extent of CAD in ACS patients. Patients with mild atherosclerotic disease [5 (8.3%)] and SV [29 (48.3%)] were more common in low-risk category. SVD [14 (46.7%)] dominated intermediate risk category, while TVD [4 (66.7%)] patients were more in the high-risk category. However, these findings did not reach statistical significance (p = 0.2). We also compared risk stratification as per GRACE score in relation to extent of CAD in ACS patients. Patients with TVD [2 (7.7%)] were less in low-risk category and high-risk patients had no mild atherosclerotic disease in CAG. Patients with higher GRACE risk score tended to have multiple vessels involvement in CAG. Thus, risk stratification as per GRACE score and extent of CAD in ACS were significantly associated (p = 0.03).

Dominant modality of treatment in ACS was PCI. Of all the patients, 69 (98.6% of 70) patients underwent PCI. CABG was less often advised (16/96, 16.7%); only 5 (3.1% of 16) patients underwent CABG in the index admission. Thus, acceptance for PCI was much better as compared to CABG. This may also be kept in mind while advising patients for PTCA or CABG where both are possible. Treatment modality depended on diagnosis and the clinical scenario. It was found that there was a highly significant association between a specific line of treatment and type of ACS (p < 0.0001). Although the majority of ACS patients underwent PCI, medical treatment was commoner in the NSTE MI and UA group. In STEMI (n = 53) predominant modality of treatment was primary PCI [19 (35.8%) of 53]. Mandelzweig et al. [22] reported higher rates (51.8%) while Hasdai D et al. [21] (20.7%) and Al-Habib et al. [23] (17.5%) reported lower rates of primary PCI in their studies. Thrombolysis (5.7% of 53) was rarely advised at our hospital, which was markedly lower than compared to findings by Hasdai D et al. [21] (35.1%), Mohanan PP et al. [20] (41.4%), and Xavier D et al. [19] (58.5%).

In NSTE MI and UA, main modality of treatment was delayed elective PCI [12 (54.5%) of 22 and 15 (60%) of 25 patients, respectively] which was higher in percentage as compared to findings by Mohanan PP et al. [20] (11.7% and 10.9%), Srimahachoch S et al. [24] (19.2% and 19.8%), Hasdai D et al. [21] (non-ST ACS – 25.4%), and Fox KAA...
Being a typical tertiary heart care center in Northern India, STEMI, NSTEMI, and UA accounted for 53 (53%) patients. The association of types of ACS with age was statistically significant (p = 0.04). SVD patients dominated both the STEMI [26 (50.9% of 51)] and UA [13 (52% of 25)] groups.

Patients with higher GRACE risk score tended to have lower in-hospital mortality as compared to our finding. Statistically no significant association was found between adverse in-hospital outcomes in ACS patients and specific type of ACS (p = 0.3). But when we considered numbers, more patients with adverse in-hospital outcomes [23 (62.2% of 37)] were seen in the STEMI group.

Bing Rong et al.[26] indicated that in order to best direct treatment and potentially enhance results, there is a need for greater knowledge and incorporation of validated instruments such as the GRACE score. Despite the fact that the use of the most powerful and data-supported scores (GRACE and TIMI) has been recommended for many years, the most recent ESC guidelines downgrade the importance of estimating prognosis based on risk scores (Class I Level B in 2015 vs Class IIa Level C in 2020), implying that scoring systems will be less popular in the coming years.[29] Diabetes mellitus, GRACE score >170, systolic hypertension >180 mmHg, positive serum troponin, and HR >90 bpm were the most significant predictors of death or cardiac events on admission in ACS.[19]

However, because of new medicinal techniques, estimating the prognosis may be advantageous. Differentiating patients with greater hospital/30-day death rates may aid doctors in identifying patients who require intensive care or sophisticated mechanical circulatory support methods.

**Limitations of the Study:** The acceptability at large is limited due to small sample size and a study with a larger sample size is required for further assessment and confirmation. Our study was conducted at a PCI compatible tertiary heart care center and therefore cannot be directly compared to other studies which include both PCI compatible and PCI non-compatible centers. The duration of the data collection for individual subjects in the present study was small. One can consider longer duration of follow-up to look at the late outcomes. We were unable to elicit phenomena of treatment paradox in our study as most of our patients were diagnosed and were started with treatment immediately. Certainly, there was referral bias in our study as number of lower socioeconomic status patients and overweight patients was very less or none.

**Conclusion:** Distribution of ACS was highest in the age range of 55–74 years. There was marked preponderance of STEMI in younger patients (<55 years) but it was less marked in older patients. STEMI was more common in age less than 65 years while NSTEMI and UA were more common in age ≥55 years. All conventional risk factors were represented in all types of ACS but hypertension and tobacco abuse were more consistent risk factors associated with STEMI.

**Summary**

- One hundred ACS patients meeting the eligibility criteria were enrolled and evaluated as per the study protocol.
- STEMI, NSTEMI, and UA accounted for 53 (53%), 22 (22%), and 25 (25%) patients, respectively.
- The association of types of ACS with age was statistically significant (p = 0.04). STEMI patients showed lower mortality than TIMI.
- Patients with higher GRACE risk score tended to have multiple vessels involvement in CAG. Main modality of treatment in STEMI patients presenting in window period was primary PCI followed by thrombolysis.

**Highlights**

- There was a consistent difference in risk categorization by GRACE and TIMI scores with the former consistently giving higher risk category. Overall, 56% of patients had their risk category upgraded when moving from TIMI to GRACE scores. No patient was downgraded in terms of risk category when moving from TIMI to GRACE scores.
- Being a typical tertiary heart care center in Northern India, major treatment modality in ACS at our hospital was invasive. Acceptance of PTCA was very high and Compliance to PTCA was better than CABG. This may also be kept in mind while advising patients for PTCA or CABG in cases where both are possible.
- Most common in-hospital adverse outcome was heart failure followed by slow flow. In-hospital adverse outcomes were more commonly seen in STEMI patients. Heart failure and death were significantly associated with high-risk category as per the GRACE score in ACS patients.

**Author contributions**

All authors contributed to data collection, analysis, drafting and revising the article, and gave final approval of the version to be published.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.
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Conflicts of interest
There are no conflicts of interest.

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