DOI: 10.7860/JCDR/2016/19091.8106

Original Article

Internal Medicine Section

A Prospective Study on Prevalence and Causes of Anaemia in Patients with Acute Coronary Syndrome

PENTA BHAVANADHAR[1], VANGIPURAM RANGACHARYULU SRINIVASAN[2], SAI SATISH ORUGANTI[3], KRISHNA PRASAD ADIRAJU[4]

Introduction: Anaemia is a contributor for adverse prognosis in Acute Coronary Syndrome (ACS), but the epidemiology and causes of anaemia in such patients is not defined.

Aim: To study the prevalence and aetiology of anaemia in hospitalized patients with ACS.

Materials and Methods: All consecutive patients admitted with ACS from January to March, 2010 were included. Their clinical information was recorded.

Results: Of 130 (87 males) consecutive admissions for ACS, 47.7% had unstable angina, 10% had Non ST-Elevation Myocardial Infarction (NSTEMI) and 42.3% had ST-Elevation Myocardial Infarction (STEMI). Overall prevalence of anaemia (haemoglobin <130 g/l in men and <120 g/l in women) was 51.5% (n=67) and was more prevalent in women (n=30, 69.8%) than men (n=37, 42.5%). Moderate to severe anaemia was more in women (34.9%) compared to men (20.8%). Anaemia was more common in unstable angina patients (58.2%) than in NSTEMI (11.9%) or STEMI (29.9%) patients (p=0.013). Aspirin (p<0.01) and/or clopidogrel intake (p<0.01) and raised serum creatinine (p<0.01) were more often in anaemic patients. Heart failure (p<0.01) and triple vessel disease (p<0.05) were associated with anaemia. Multivariate predictors of duration of hospital stay were haemoglobin (p<0.05) at admission and revascularisation procedure (p=0.01) during hospital stay. The most common cause of anaemia was iron deficiency (29.9%).

Conclusion: Anaemia was common in our patients admitted with ACS. Female gender, antiplatelet drug intake and raised creatinine were associated with anaemia, which in turn was associated with adverse in-hospital outcomes. The impact of correcting anaemia on outcomes in ACS needs long term prospective study.

Keywords: Coronary artery disease, Haemoglobin, India

INTRODUCTION

Cardiovascular Disease (CVD) is the foremost cause of death globally, leading to 17.3 million deaths per year; this number is probable to be intensified to more than 23.6 million by 2030 [1]. Acute Coronary Syndrome (ACS) presented as unstable angina, ST-Elevation Myocardial Infarction (STEMI) and Non ST-Elevation Myocardial Infarction (NSTEMI), are the leading causes of morbidity and mortality among CVD [2-5]. The escalating contribution of developing countries towards global burden of CVD is not often perceived [6]. In developing nations like India where 55% females aged 15–49 years, and 24% males aged 15–49 years are anaemic, nutritional anaemia becomes a major contributor to cause of anaemia [7]. The presence of co-existing anaemia, often complicates ACS and increases significant cardiovascular morbidity and mortality [8,9].

Anaemia provokes a series of cardiovascular alterations which initially may be favourably adapted, however, later lead to cardiac structural changes, which could predispose to CVD over time [10,11]. It is well established in patients with known CVD that anaemia has adverse effects on myocardial oxygenation resulting in provocation or acceleration of angina, and may worsen Congestive Heart Failure (CHF) [12]. It is also a recognised predictor and risk factor for mortality and morbidity in patients undergoing percutaneous intervention and cardiac surgeries [13-15]. However, much of this information is based on retrospective analyses of selected cohorts [8,14,16-18].

Although the cardiovascular consequences of anaemia were well understood, many questions still remain unanswered like the prevalence of anaemia at the time of presentation to hospital in a contemporary ACS population. The aetiology of anaemia and requirement of transfusion in these patients is also not well defined.

AIM

Our aim was to define the prevalence and associates of anaemia in consecutive acute coronary syndrome admissions; to characterize the nature of anaemia in these patients; and tracking these patients during admission, to define the incidence of transfusion requirement and duration of hospital stay in these patients.

MATERIALS AND METHODS

Setting

This was an observational, prospective study conducted at an Indian tertiary care center from January to March, 2010. Consecutive patients admitted with diagnosis of ACS to Intensive Coronary Care Unit (ICCU) or Acute Medical Care Unit (AMCU) were included. Patients were excluded only if they refused to give informed consent.

An ACS was diagnosed by treating cardiologist on the basis of the history, electrocardiogram (ECG) and elevated cardiac biomarkers. Patients who had been admitted to ICCU or AMCU were then reassessed and diagnosis was further verified by investigator, who completed a protocol-driven case record form.

Data Collection

We collected data on demographic and clinical information that was relevant to ACS and anaemia (e.g., past history of Coronary Artery Disease (CAD), previous revascularisation, hypothyroidism, hypertension, diabetes, chronic kidney disease, drug history and dietary habits). Chronic kidney disease was defined according to National Kidney Foundation Disease Outcomes Quality Initiative definition i.e., either kidney damage or a Glomerular Filtration Rate (GFR) of less than 60mL/min/1.73 m^2 of body surface area lasting for longer than 3 months [19]. A broad range of clinical attributes were included to describe the potential associations between these clinical attributes of ACS patients and anaemia.

Haematology and blood chemistry were obtained from the first admission blood sample, which was obtained in Emergency Medicine Ward, ICCU or AMCU.

Invasive Management and Duration of Hospital Stay

Patients identified by the cardiology team as having high-risk features, such as ongoing ischemia, were triaged for additional investigations, which usually involved Coronary Angiography (CAG). When required these patients had undergone Percutaneous Coronary Intervention (PCI) or Coronary Artery Bypass Graft surgery (CABG) and such details were also recorded including the number coronary vessels affected. The severity of CAD was assessed by number of abnormal epicardial coronaries demonstrated by CAG. Duration of hospital stay and in-hospital death was used as a surrogate measure of hospital outcome.

Laboratory Analysis and Definition of Anaemia

Anaemia was defined according to World Health Organization criteria as Haemoglobin (Hb) <120 g/l in women and <130 g/l in men [20,21]. Its severity was graded as mild when Hb was 100-129 g/l in men and 100-119 g/l in women, and either moderate or severe when Hb was 70-99 g/l and less than 70 g/l, respectively in women. In men, it was graded either moderate or severe when Hb was 80-109 g/l and less than 80 g/l, respectively [20,21]. Anaemic status, severity and its possible causes were identified from admission blood samples with haematinic parameters like serum ferritin, vitamin B12 and folate levels in most of the patients. In patients with normal haematinic parameters relevant additional tests were done to evaluate the aetiology. Anaemia was classified as normocytic if Mean Corpuscular Volume (MCV) was 83-101 fl [22]. Any value above this was considered as macrocytic and any value below this as microcytic.

Automated cell counter (Coulter LH-500, Beckman Coulter) was used to measure haemoglobin and red cell indices on admission.

Ethical Approval and Informed Consent

The Chairman of the Institutional Ethical Committee of the study centre approved this study. The study protocol conforms to the ethical guidelines of the Declaration of Helsinki as reflected in a priori approval by the institution's clinical research and education committee. The informed consent was taken in their local language from all patients.

STATISTICAL ANALYSIS

Continuous variables were presented as mean and standard deviation and categorical variables as counts and percentages. Significance was assessed at $p<0.05$ level of significance. Student's t-test (two tailed, independent) had been used to find the significance of study parameters on continuous scale (between two groups Inter group analysis). Chi-square/ Fisher-Exact test had been used to find the significance of study parameters on categorical scale between two or more groups. Levene's test was performed to assess the homogeneity of variance.

Haemoglobin values were categorized as anaemia or no anaemia and potential associations with haemoglobin levels were identified using descriptive analyses. Associations with admission duration were also studied. Variables significant ($p<0.05$) in a simple univariate regression analysis were entered into a forward step-wise regression model, with entry and removal criteria of $p < 0.2$ and $p < 0.4$, respectively. A multivariate association significant at $p <0.05$ was taken as predictor of duration of hospital stay. The STATA (StataCorp LP, Texas, USA) program, version 10.1 and Epi info (CDC, Georgia, USA) program, version 2.3 were used for the analysis of the data.

RESULTS

Of 130 (87 males) consecutive patients with ACS admitted during study period, 62 (47.7%) patients had unstable Angina, 13 (10%) had NSTEMI and 55 (42.3%) had STEMI. Overall prevalence of anaemia was 51.5% of the study population. Prevalence of anaemia was related to gender, it was more common in women (n=30, 69.8%) compared to men (n=37, 42.5%; $p<0.01$). Mean haemoglobin in the first admission blood sample was higher in men (132 ± 28 g/l) than in women (108 ± 23 g/l).

The characteristics of patients with anaemia and without anaemia were described in [Table/Fig-1]. Mean age of anaemic patients was higher than non anaemic (62.69±10.36 vs. 53.40±13.74 years; $p<0.01$). Occurrence of anaemia was higher in patients with chronic kidney disease (13.4%; $p<0.01$), hypothyroidism (13.4%; $p=0.04$), and diabetes (35.8%; $p=0.04$). The proportion of unstable angina (58.2%; $p=0.013$) was more in anaemic patients whereas the proportion of STEMI (29.9%; $p<0.01$) was more in non anaemic patients.

Normocytic, microcytic or macrocytic anaemia at the time of admission was seen in 41 (61.2%), 19 (28.4%) and 7 (10.4%) patients, respectively. Microcytic anaemia was more commonly associated with female gender ($p<0.01$). In 46 (68.6%) patients, a single identifiable cause was found and in 5 (7.5%) patients multiple causes were seen whereas in 16 (23.9%) no cause could be identified. A low ferritin <20 µ/l) concentration was found in 20 patients (29.9%), low plasma vitamin B12 concentration (<190 ng/l) in 9 (13.5%), a low serum folate (<4 µg/l) concentration in 4 (6%) and an increased plasma Thyroid Stimulating Hormone (TSH) concentration (>5.5mU/l) in 3 (4.5%). The other causes were anaemia of chronic disease (3.0%), sickle cell trait (1.5%), chemotherapy induced bone marrow suppression (1.5%) and autoimmune haemolytic anaemia (1.5%).

The most common cause of anaemia was iron deficiency (29.9%). Out of 20 patients with iron deficiency, three patients had gastric erosions seen in upper gastrointestinal endoscopy. It was performed to evaluate the cause of upper GI bleed, one patient presented with haematemesis and other two patients had malena.

Five (7.5%) of the study patients had multiple cause of anaemia. Out of these five patients three (4.5%) had chronic kidney disease and vitamin B12 deficiency, one (1.5%) had combine Iron and vitamin B12 deficiency and other had folate deficiency and chronic kidney disease (1.5%).

Either aspirin or clopidogrel therapy were more often in anaemic patients than non anaemic patients at hospital presentation. Six (66.6%) out of nine patients with vitamin B12 deficiency were diabetics on metformin therapy.

Mean serum albumin were lower in patients with anaemia (36 ± 3 g/l) than non anaemic patients (39 ± 4 g/l) ($p<0.01$). Raised serum creatinine (mean) was seen in anaemic patients compared to non anaemic patients (143 vs. 99 µ mol/l; $p<0.01$).

Data of 94 (72.3%) patients who had undergone the CAG during the study was available. Single Vessel Disease (SVD) was more often found in non anaemic group than anaemic (39.3% vs. 26.3%; $p=0.102$). Triple Vessel Disease (TVD) was associated with anaemia ($p =0.03$).

Total 45 (34.6%) patients underwent revascularisation (PCI or CABG), 43 (95.6%) underwent PCI and 2 (4.4%) underwent CABG. Among 43 PCI patients, 18 (41.9%), 19 (44.2%) and 6 (14%) had SVD, Double Vessel Disease (DVD) and TVD, respectively. Two third of the patients with TVD had anaemia whereas only one third of patients with SVD and DVD had anaemia. CABG was done in two patients, one of them had TVD whereas other patient required intracardiac repair of septal rupture.

Clinical variables	Total (n=130)	Anaemia (n=67)	No anaemia (n=63)	p-value
Age (mean ± SD, y)	58 ± 13	62.69 ± 10.36	53.40 ± 13.74	<0.01*
Gender (male:female)	130	37:30	50:13	<0.01*
Haemoglobin (mean ± SD, g/l)	130	102 ±18.2	148.1±12.9	<0.01*
History of CAD, n (%)	42 (32.3%)	26 (38.8%)	16 (25.4%)	0.102
Previous revascularisation, n (%)	28 (21.5%)	17 (25.4%)	11 (17.5%)	0.201
Hypertension, n (%)	75 (57.7%)	42 (62.7%)	33 (52.4%)	0.235
CKD, n (%)	17 (32.3%)	9 (13.4%)	1 (1.6%)	<0.01*
Hypothyroidism, n (%)	11 (8.5%)	9 (13.4%)	2 (3.2%)	0.04*
Diabetes, n (%)	38 (29.2%)	24 (35.8%)	14 (22.2%)	0.04*
Vegetarian Diet, n (%)	6 (4.6%)	5 (7.5%)	1 (1.5%)	0.209
Aspirin Intake, n (%)	49 (37.7%)	34 (50.7%)	15 (23.8%)	<0.01*
Clopidogrel intake, n (%)	44 (33.8%)	31 (46.3%)	13 (20.6%)	<0.01*
Heart Failure, n (%)	37 (28.5%)	26 (38.8%)	11 (17.5%)	<0.01*
Duration of hospital stay (mean ± SD, days)	10.9 ± 9.5	12.56 ± 11.06	8.89±6.88	0.03*
Transfusion, n (%)	8 (6%)	7 (10.4%)	1 (1.6%)	0.04*
Present Revascularisation, n (%)	45 (34.6%)	18 (26.9%)	27 (42.9%)	0.02*
Serum creatinine (mean ± SD, µmol/l)	124 ± 80	143 ± 100	99 ± 48	<0.01*
Total proteins (mean ± SD, g/dl)	70 ± 7	67 ± 4.7	72 ± 7.5	<0.01*
Albumin (mean ± SD, g/l)	38 ± 4	36 ± 3.9	39 ± 3.3	<0.01*

[Table/Fig-1]: Characteristics of patients according to haemoglobin level at admission.
CAD – Coronary Artery Disease; CKD – Chronic Kidney Disease
*indicates significant statistical difference (p <0.05)

Variables	N	CV	p-value
Age (yrs)	130	0.009	0.904
Male	130	-1.608	0.362
CAD history	130	2.851	0.107
Previous Revascularisation (PCI or CABG)	130	2.096	0.312
Diagnosis	130	0.909	0.589
Hypertension	130	1.674	0.376
Chronic Kidney Disease	130	7.275	0.018*
Hypothyroidism	130	2.718	0.362
Diabetics	130	4.060	0.025*
Aspirin	130	2.344	0.170
Clopidogrel	130	2.696	0.123
Haemoglobin (g/dl)	130	-1.215	<0.01*
Leucocyte count (/µl)	130	0.005	0.787
ESR (/mm)	129	0.037	0.426
Creatinine (mg/dl)	130	2.590	<0.01*
Total Proteins (g/dl)	130	-0.620	0.610
Albumin (g/dl)	130	-4.254	0.049*
Heart Failure	130	2.039	0.267
Transfusion	130	9.154	<0.01*
Present Revascularisation (PCI or CABG)	130	3.694	0.03*

[Table/Fig-2]: Univariate regression for prediction of admission duration (Hospital stay in days).
CV – Coefficient of Variance; CAD – Coronary Artery Disease; PCI – Percutaneous Coronary Intervention; CABG – Coronary Artery Bypass Graft Surgery
*indicates significant statistical difference (p <0.05)

Of 130 study patients, 28.5% patients had congestive heart failure. Congestive heart failure was common in anaemic group compared to non anaemic group (p<0.01). Seven patients died (5.4%), five of whom had undergone non invasive management. Proportion (71.4%, n=5) of patients with anaemia was more in patients who died till discharge but it was not statistically significant (p=0.4).

Variables	CV	t-value	p-value
Transfusion	5.675	1.705	0.091
Present Revascularisation (PCI or CABG)	3.943	2.448	0.016*
Chronic Kidney Disease	-2.365	0.471	0.639
Diabetics	3.064	1.778	0.078
Haemoglobin (g/dl)	-0.732	2.293	0.024*
Creatinine (mg/dl)	2.611	1.782	0.077
Albumin (g/dl)	-0.854	0.383	0.702

[Table/Fig-3]: Multivariate regression for prediction of admission duration (Hospital stay in days).
CV – Coefficient of Variance; PCI – Percutaneous Coronary Intervention; CABG – Coronary Artery Bypass Graft Surgery *indicates significant statistical difference (p <0.05)

Eight (6%) acute coronary syndrome patients underwent blood transfusion, of whom 7 (87%) were anaemic on admission to hospital. Out of the 45 patients who had undergone interventional management, 3 (6.7%) and 1 (2.2%) patients were transfused pre and post catheterization, respectively. Compared to non anaemic patients, anaemic patients had a longer mean duration of hospital stay (12.7 vs. 9 days; p<0.01). Admission characteristics that were univariate and multivariate predictors of duration of hospital stay (days) are shown in [Table/Fig-2,3], respectively. Haemoglobin and coronary revascularisation after admission were multivariate predictors of admission duration (p = 0.02 and 0.016).

DISCUSSION

Anaemia presents as a cardiovascular risk factor not only in the general population, but also found to be associated with a considerably elevated rate of cardiovascular events in patients with ACS, heart failure, and in patients undergoing PCI and CABG [23]. Anaemia at hospital admission in patients presenting with ACS ranges between 15% and 43% according to some studies [24]. Prevalence of anaemia in previous studies by Bindra et al., in United Kingdom (UK), Arant et al., in United States (US), Anker et al., in Europe and Sulaiman et al., in Middle East was 18%, 21%, 28% and 28%, respectively [25-28]. All of them used same definition for anaemia as in our study. Anaemia was present in about half (51.53%) of the population of present study. The higher prevalence of anaemia in our study may be explained by the presence higher overall prevalence of anaemia (i.e., 24% in men and 55% in women) in our country where nutritional deficiency is common [7]. However, the previous studies mentioned were from developed nations like UK, US, Middle East and other European countries.

The gender wise difference in prevalence of anaemia and mean haemoglobin may be partly explained by the presence of significant difference in the overall prevalence of anaemia in both sexes. Moderate to severe anaemia was significant in women compared to men (34.9% vs. 20.8%). Mean haemoglobin level was also lower in women when compared to men (108 vs. 132 g/l) even in patients with normal haemoglobin likely due to hormonal influences [29].

The mean haemoglobin of patients with anaemia decreased as age increased from 4th decade to 8th decade. Even though such observation was not statistically significant (p=0.2) in our study, the similar trend was reported previously by Bindra et al., Mean age of the patients with anaemia was higher compared to patients without anaemia (62.7 vs. 53.4 years; p <0.01) [25]. The relationship of anaemia and age is not completely understood, it may be a feature of normal ageing process, or it may be pathological due to chronic conditions resulting anaemia of chronic disease, or chronic inflammation in elderly [30].

In present study, the type of ACS was also related to anaemia. Unstable angina (58.2%) was more common in anaemic patients and STEMI (55.6%) was more common in non anaemic patients (p=0.013 and <0.01, respectively). Melissa et al., proved that anaemia at presentation was independently associated with recurrent ischemia by using continuous ECG monitoring in non ST elevation ACS (i.e., unstable angina and NSTEMI) patients [29]. They suggested that mismatches in oxygen supply and demand and bleeding related complications are the potential mechanisms by which anaemia leads to recurrent ischemia. This may explain why unstable angina tended to be more common in anaemic patients of our study. In a previously reported study by Bindra et al., STEMI was more often observed in non anaemic patients similar to our study but the accurate mechanisms could not be explained [25].

In present study, anaemia was associated with chronic kidney disease and also the mean creatinine (143 vs. 99 µmol/L; p<0.01) was higher in anaemic patients. Anaemia has been a common associate of advanced renal disease but may also occur in lesser degrees of renal impairment. The reduced erythropoietin production and impaired haemopoietic response to this hormone are the probable reasons [31]. In studies by Reinecke et al., and Lee et al., renal dysfunction was found to be an adverse prognostic marker in ischemic heart disease patients particularly who were anaemic [17,18]. Morici N et al., also reported a weak relation of anaemia with renal dysfunction, age and body mass index [32]. Furthermore, the combination of anaemia and renal dysfunction resulted in poor prognosis in severe forms of ischemic heart disease with heart failure [33].

Diabetes was common in patients with anaemia compared to non anaemic patient and it was statistically significant. This association of anaemia and diabetics was explained due to presence subclinical renal dysfunction in them affecting the production and impaired haemopoietic response of erythropoietin [34,35]. In a large prospective study, David H Shu et al., showed that presence of both diabetes and anaemia in patients with myocardial infarction have a considerably raised mortality than those with either diabetes or anaemia alone [4].

In the study population, anaemia was strongly associated with antiplatelet drug intake, both aspirin (p<0.01) and clopidogrel (p<0.01). The presence of occult or overt blood loss with use of these anti platelet drugs is the possible explanation, similar observations were reported Bindra et al., Rao SV et al., and Berry C et al., [25,36,37]. Anaemia, particularly pre-procedural, has significant affect on the outcomes and mortality hence needs to be addressed but the antiplatelets can be continued, as a previous study by Pilgrim T et al., showed that there has been no increase in mortality or major bleeding rates even in moderate to severe anaemia patients with dual antiplatelet therapy (DAPT) [38]. Hence anti platelet deprivation is not recommended after ACS, rather another study by Wang H et al., reported increased stent thrombosis in severe anaemia which required anti platelet therapy [39].

Lower serum albumin was seen in anaemic than in non anaemic patients (36 vs. 39 g/l; p =0.02). Such observation was attributed to the impairment in both anabolic and haemopoietic functions in anaemic patients apart from nutritional deficiency [25].

Frequency of different types of anaemia according to mean corpuscular volume i.e., microcytic, normocytic or macrocytic were 28.4%, 61.2% and 10.4%, respectively. In the present study all women were postmenopausal and had significant microcytic anaemia compared to men which may be due to higher prevalence of malabsorption of iron in women leading to iron deficiency [40].

In study population, three patients with iron deficiency had evidence of gastric erosions and all of them had undergone PCI with stent placement. Bleeding following PCI or CABG is a known risk factor for causing anaemia as these patients were on multiple antiplatelet and anti fibrinolytic agents [14,15,18,36,37].

Other common causes identified were vitamin B12 deficiency (12%) and folate deficiency (6%). This may explained by the fact that daily intake of these micronutrients measured was less than Recommended Daily Allowance (RDA) in Indians, especially it was low in Andhra Pradesh state, where study was conducted, compared to other states in the country [41].

In patients who had undergone CAG, the SVD was common in non anaemic group than anaemic whereas multiple vessel disease was more in anaemic group. This finding was consistent with previous studies by Mc Kechnie et al., and Meneveau et al., but the appropriate explanation for such correlation cannot be adequately given with the current available knowledge [2,14]. Zeidman et al., had reported that patients with both CAD and anaemia tended to suffer from a more advanced degree of CAD compared to patients with CAD alone [5].

Congestive heart failure was common in anaemic group compared to non anaemic group and anaemia was associated with heart failure (p<0.01). Various prospective [3-5] and retrospective studies [8,16] published on relationship of anaemia and ACS had reported a higher prevalence of congestive heart failure. It has been stated in a recent study that haemoglobin level is an independent determinant of heart failure in ACS patients [42]. Presence of congestive heart failure is a predictor of in-hospital outcome following PCI or acute coronary events [14,18]. Proportion of anaemic patients were higher in patients who died than those survived till discharge although this was not statistically significant in our study, this may be due to small sample size and cross sectional nature of study, but it is a well proven fact that anaemia is an independent predictor of in-hospital and long term mortality [8,12,17,25,43].

In our study duration of hospital stay was used as a surrogate marker for hospital outcome. Mean duration was found to be longer in anaemic patients compared to non anaemic (12.7 vs. 9 days; p=0.03). Univariate and multivariate analyses were done to predict duration of hospital stay. Haemoglobin, diabetes, chronic kidney disease, serum creatinine, serum albumin, transfusion and coronary revascularisation (PCI or CABG) were found to be univariate predictors. But in multivariate analysis, lower haemoglobin was found to be an independent predictor of duration of hospital. The other parameter which was found as an independent predictor was coronary revascularisation during hospital stay. These findings were supported by earlier studies done by Wu et al., Bindra et al., Sabatine et al., Reincke et al., and Lee et al. They also reported that anaemic patients had longer duration of hospital stay and anaemia was independent predictor of in-hospital and 1-year mortality [8,16-18,25].

LIMITATION

Main limitation of the study was duration of study which was short (3 months). With the present study, prognostic information could not be provided due to the limited sample size and lack of follow-up data after discharge. As our hospital is a multi specialty tertiary care centre receiving more severe and complicated cases, there may be referral bias due to which the study may not reflect the true prevalence. Aetiology of anaemia could not be assessed completely due to patient factors and limitation in the tests available.

CONCLUSION

Overall prevalence of anaemia was high in the study population. The most common cause of anaemia was nutritional deficiency followed by chronic kidney disease and blood loss due to antiplatelet agents. The presence of anaemia is a risk factor for increased morbidity and in-hospital mortality in these patients. As anaemia is a relatively frequent condition which remains often under-diagnosed and untreated, its prevention and earlier detection may lead to improved outcomes. Hence further research is needed to examine the role of correction of anaemia in reducing long-term morbidity and mortality in these patients.

ACKNOWLEDGEMENTS

We thank the Director of the study centre for allowing us to conduct this study and all the residents and the nurses of ICCU and AMCU for their ongoing support. We thank Dr. IR Vara Prasad for editing this manuscript.

REFERENCES

[1] Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, et al. Heart disease and stroke statistics-2015 update: a report from the american heart association. *Circulation*. 2015;131(4):e29.
[2] Meneveau N, Schiele F, Seronde M-F, Descotes-Genon V, Oettinger J, Chopard R, et al. Anaemia for risk assessment of patients with acute coronary syndromes. *The American Journal of Cardiology*. 2009;103(4):442-47.
[3] Cavusoglu E, Chopra V, Gupta A, Clark LT, Eng C, Marmur JD. Usefulness of anaemia in men as an independent predictor of two-year cardiovascular outcome in patients presenting with acute coronary syndrome. *The American Journal of Cardiology*. 2006;98(5):580-84.
[4] Shu DH, Ransom T, O'Connell CM, Cox JL, Kaiser SM, Gee SA, et al. Anaemia is an independent risk for mortality after acute myocardial infarction in patients with and without diabetes. *Cardiovasc Diabetol*. 2006;5(8):b14.
[5] Zeidman A, Fradin Z, Blecher A, Oster HS, Avrahami Y, Mittelman M. Anaemia as a risk factor for ischemic heart disease. *Imaj-Ramat Gan-*. 2004;6(1):16-18.
[6] Noor L, Adnan Y, Khan SB, ur Rehman H, Ahmad F, Hafizullah M. Changing trend of presentation of acute coronary syndrome in Peshawar over the last sixteen years. *J Ayub Med Coll Abbottabad*. 2011;23(2).
[7] Alvarez-Uria G, Naik PK, Midde M, Yalla PS, Pakam R. Prevalence and severity of anaemia stratified by age and gender in rural India. *Anaemia*. 2014;2014.
[8] Sabatine MS, Morrow DA, Giugliano RP, Burton PB, Murphy SA, McCabe CH, et al. Association of haemoglobin levels with clinical outcomes in acute coronary syndromes. *Circulation*. 2005;111(16):2042-49.
[9] Bassand J-P. Impact of anaemia, bleeding, and transfusions in acute coronary syndromes: a shift in the paradigm. *European Heart Journal*. 2007.
[10] Levin A, Thompson CR, Ethier J, Carlisle EJ, Tobe S, Mendelssohn D, et al. Left ventricular mass index increase in early renal disease: impact of decline in haemoglobin. *American Journal of Kidney Diseases*. 1999;34(1):125-34.
[11] Foley RN, Parfrey PS. Cardiovascular disease and mortality in ESRD. *Journal of Nephrology*. 1997;11(5):239-45.
[12] Lee G, Foerster J, Lukens J. Wintrobe's clinical haematology. 12th ed: Lippincott Williams & Wilkins; 2009.
[13] van Straten AH, Hamad MAS, van Zundert AJ, Martens EJ, Schönberger JP, de Wolf AM. Preoperative haemoglobin level as a predictor of survival after coronary artery bypass grafting A comparison with the matched general population. *Circulation*. 2009;120(2):118-25.
[14] McKechnie RS, Smith D, Montoye C, Kline-Rogers E, O'Donnell MJ, DeFranco AC, et al. Prognostic implication of anaemia on in-hospital outcomes after percutaneous coronary intervention. *Circulation*. 2004;110(3):271-77.
[15] Kulier A, Levin J, Moser R, Rumpold-Seitlinger G, Tudor IC, Snyder-Ramos SA, et al. Impact of preoperative anaemia on outcome in patients undergoing coronary artery bypass graft surgery. *Circulation*. 2007;116(5):471-79.
[16] Wu W-C, Rathore SS, Wang Y, Radford MJ, Krumholz HM. Blood transfusion in elderly patients with acute myocardial infarction. *New England Journal of Medicine*. 2001;345(17):1230-36.
[17] Reinecke H, Trey T, Wellmann J, Heidrich J, Fobker M, Wichter T, et al. Haemoglobin-related mortality in patients undergoing percutaneous coronary interventions. *European Heart Journal*. 2003;24(23):2142-50.
[18] Lee PC, Kini AS, Ahsan C, Fisher E, Sharma SK. Anaemia is an independent predictor of mortality after percutaneous coronary intervention. *Journal of the American College of Cardiology*. 2004;44(3):541-46.
[19] Levey A, Coresh J, Balk E, Kausz A, Levin A, Steffes M. National kidney foundation disease outcomes quality initiative clinic practice guidelines for chronic kidney disease: evaluation, classification and stratification. *Ann Intern Med*. 2003;139:137-47.
[20] WHO, UNICEF, UNU. Iron deficiency anaemia: assessment, prevention and control, a guide for programme managers. Geneva: World Health Organization. 2001.
[21] FAO, WHO. World declaration and plan of action for nutrition: Food and Agriculture Organization of the United Nations; 1992.
[22] Osei-Bimpong A, McLean R, Bhonda E, Lewis S. The use of the white cell count and haemoglobin in combination as an effective screen to predict the normality of the full blood count. *International Journal of Laboratory Haematology*. 2012;34(1):91-97.
[23] Hong YJ, Jeong MH, Choi YH, Song JA, Kim DH, Lee KH, et al. Relation between anaemia and vulnerable coronary plaque components in patients with acute coronary syndrome: virtual histology-intravascular ultrasound analysis. *Journal of Korean Medical Science*. 2012;27(4):370-76.
[24] Meroño O, Cladellas M, Recasens L, Garcia-Garcia C, Ribas N, Bazan V, et al. In-hospital acquired anaemia in acute coronary syndrome. Predictors, in-hospital prognosis and one-year mortality. *Revista Española de Cardiología (English Edition)*. 2012;65(8):742-48.
[25] Bindra K, Berry C, Rogers J, Stewart N, Watts M, Christie J, et al. Abnormal haemoglobin levels in acute coronary syndromes. *QJM*. 2006;99(12):851-62.
[26] Arant CB, Wessel TR, Olson MB, Merz CNB, Sopko G, Rogers WJ, et al. Haemoglobin level is an independent predictor for adverse cardiovascular outcomes in women undergoing evaluation for chest pain: results from the National Heart, Lung, and Blood Institute Women's Ischemia Syndrome Evaluation Study. *Journal of the American College of Cardiology*. 2004;43(11):2009-14.
[27] Anker SD, Voors A, Okonko D, Clark AL, James MK, von Haehling S, et al. Prevalence, incidence, and prognostic value of anaemia in patients after an acute myocardial infarction: data from the OPTIMAAL trial. *European Heart Journal*. 2009;30(11):1331-39.
[28] Sulaiman K, Prashanth P, Al-Zakwani I, Al-Mahmeed W, Al-Motarreb A, Al Suwaidi J, et al. Impact of anaemia on in-hospital, one-month and one-year mortality in patients with acute coronary syndrome from the Middle East. *Clinical Medicine & Research*. 2012;10(2):65-71.
[29] Rousseau M, Yan RT, Tan M, Lefkowitz CJ, Casanova A, Fitchett D, et al. Relation between haemoglobin level and recurrent myocardial ischemia in acute coronary syndromes detected by continuous electrocardiographic monitoring. *The American journal of cardiology*. 2010;106(10):1417-22.
[30] Gaskell H, Derry S, Moore RA, McQuay HJ. Prevalence of anaemia in older persons: systematic review. *BMC Geriatrics*. 2008;8(1):1.
[31] Eckardt K-U. Cardiovascular consequences of renal anaemia and erythropoietin therapy. *Nephrology Dialysis Transplantation*. 1999;14(5):1317-23.
[32] Morici N, Cantoni S, Antonicelli R, Murena E, Cavallini C, Petronio AS, et al. Anaemia in octogenarians with non-ST elevation acute coronary syndrome: Aging or disease? *Int J Cardiol*. 2014;176:1147-49.
[33] Berry C, Norrie J, Hogg K, Brett M, Stevenson K, McMurray JJ. The prevalence, nature, and importance of haematologic abnormalities in heart failure. *American Heart Journal*. 2006;151(6):1313-21.
[34] Thomas MC, Cooper ME, Tsalamandris C, MacIsaac R, Jerums G. Anaemia with impaired erythropoietin response in diabetic patients. *Archives of Internal Medicine*. 2005;165(4):466-69.
[35] Ferreira M, António N, Gonçalves F, Monteiro P, Gonçalves L, Freitas M, et al. Haemoglobin: simply a laboratory value or a powerful predictor of risk in patients with acute coronary syndrome? *Revista Portuguesa de Cardiologia (English Edition)*. 2012;31(2):121-31.
[36] Rao SV, O'Grady K, Pieper KS, Granger CB, Newby LK, Van de Werf F, et al. Impact of bleeding severity on clinical outcomes among patients with acute coronary syndromes. *The American Journal of Cardiology*. 2005;96(9):1200-06.
[37] Berry C, Kelly J, Cobbe SM, Eteiba H. Comparison of femoral bleeding complications after coronary angiography versus percutaneous coronary intervention. *The American Journal of Cardiology*. 2004;94(3):361-63.
[38] Pilgrim T, Vetterli F, Kalesan B, Stefanini GG, Räber L, Stortecky S, et al. The impact of anaemia on long-term clinical outcome in patients undergoing revascularization with the unrestricted use of drug-eluting stents. *Circulation: Cardiovascular Interventions*. 2012;5(2):202-10.
[39] Wang H, Yang Y, Ma L, Wang X, Zhang J, Fu J, et al. Impact of Anaemia and Dual Antiplatelet Therapy on Mortality in Patients Undergoing Percutaneous Coronary Intervention with Drug-Eluting Stents. *Scientific reports*. 2015;5.
[40] Pasricha S-R, Flecknoe-Brown SC, Allen KJ, Gibson PR, McMahon LP, Olynyk JK, et al. Diagnosis and management of iron deficiency anaemia: a clinical update. *Med J Aust*. 2010;193(9):525-32.
[41] Laxmaiah A, Rao M, Kumar RH, Arlappa N, Venkaiah K, Brahmam G. Diet and nutritional status of tribal population in ITDA project areas of Khammam district, Andhra Pradesh. *J Hum Ecol*. 2007;21(2):79-86.
[42] Mozos I. Mechanisms linking red blood cell disorders and cardiovascular diseases. *BioMed Research International*. 2015;2015.
[43] Moura B. Anaemia and prognosis in acute coronary syndromes. *Revista Portuguesa de Cardiologia (English Edition)*. 2012;31(2):133-34.

PARTICULARS OF CONTRIBUTORS:
1. Senior Resident, Department of Cardiology, Gandhi Medical College, Secunderabad, Telangana, India.
2. Former Professor and Head, Department of General Medicine, Nizam's Institute of Medical Sciences, Hyderabad, Telangana, India.
3. Professor and Head (Unit 1), Department of Cardiology, Nizam's Institute of Medical Sciences, Hyderabad, Telangana, India.
4. Professor, Department of General Medicine, Nizam's Institute of Medical Sciences, Hyderabad, Telangana, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Penta Bhavanadhar,
Senior Resident, Department of Cardiology, Gandhi Medical College, Secunderabad,
Telangana-500003, India.
E-mail: bhavanadhar@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jan 26, 2016**
Date of Peer Review: **Mar 18, 2016**
Date of Acceptance: **Apr 06, 2016**
Date of Publishing: **Jul 01, 2016**