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Original Article:

Hematological and Biochemical Profile in Acute ST Elevation Myocardial Infarction and Correlation with Early Complications.

Dr.Jayaprakash.K[1], Dr.Raju George[2], Dr.V.L.Jayaprakash[3]

[(1)Additional Professor, Department of Cardiology, Government Medical College, Kottayam, Kerala- 686008. (2) Professor, Department of Cardiology, Mar Sleeva Medicity Hospital, Palai, Kottayam, Kerala-686584. (3) Professor, Department of Cardiology, Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, Kerala- 689101]

Corresponding Author: *Dr.Jayaprakash.K;*

Adress: "Sreelekshmi", Arattukadavu Road, Gandhinagar.P.O., Kottayam, Kerala, PIN- 686008

E mail: jayaprakashkpillai@gmail.com

Mobile: 9447418144

Abstract:

Background.

The world's biggest killer is ischemic heart disease, responsible for 16% of the world's total deaths. Transient alterations in the hematological and biochemical profile are known to occur of patients admitted with acute ST elevation myocardial infarction. Some of these parameters may help to identify high risk patients with increased likelihood of developing adverse cardiac events. Identifying such high-risk patients help the treating physician to plan more aggressive treatment strategies for these patients resulting in improved clinical outcome.

Objective.

To study the baseline hematological and biochemical laboratory parameters in patients admitted with acute ST elevation myocardial infarction and correlate with their in-hospital outcome.

Methodology.

554 consecutive patients admitted to the Intensive Coronary Care Unit, Government Medical College Hospital, Kottayam with first Acute ST Elevation Myocardial Infarction during a period of one year were included in the study. Blood samples were drawn at the time of admission for estimation of hemoglobin, total and differential WBC counts, blood sugar, blood urea, serum creatinine, serum electrolytes and lipid profile. Patients were treated according to the standard protocol and any adverse cardiac events during the hospitalization period was documented and correlated with the laboratory parameters.

Results.

There was statistically significant association between the following laboratory parameters and development of in-hospital complications: lower hemoglobin values (***p* =0.003**), higher total white blood corpuscle count (***p* =0.05**), higher Erythrocyte Sedimentation Rate (***p* =0.02**) and impaired renal function (***p* =0.0**).

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Conclusion.
In the present study, hematological and biochemical profile in 554 consecutive cases of first Acute ST Elevation Myocardial Infarction were analyzed and found to have significant correlation with major adverse cardiac events during the hospitalization period.
Key words: Myocardial infarction, Reperfusion therapy, Adverse cardiac events.

Introduction

Studies of the causation of ischemic heart disease have tended to concentrate on the role of cholesterol and lipids in relation to the atheromatous process. There is a growing body of evidence pointing to the importance of hematological factors as well as other disorders like renal dysfunction and electrolyte abnormalities in the causation as well as the outcome in acute myocardial infarction.

In the 1949 edition of his classic text, Dr Paul Dudley White[1] wrote that severe and sustained leukocytosis after myocardial infarction was associated with poor prognosis, and in 1954, Cole et al[2] reported that >32% of patients with an acute myocardial infarction and a white blood cell (WBC) count of >15 000/µL died within the first 2 months after the infarction, whereas <9% of patients with a WBC count <10 000/µL died within this same period.

Erythrocyte sedimentation rate (ESR) is a widely used laboratory test, and this is found to be elevated in many acute and chronic disease states characterized by tissue necrosis and inflammation. It has been noted that the inflammatory reaction within atherosclerotic plaques is of equal intensity to that found within the synovia of patients with acute rheumatoid arthritis. This evidence of inflammation has led to close scrutiny of various serum markers which might reflect evidence of underlying low-grade inflammation and prove helpful in predicting the likelihood of future acute coronary events.

Hyponatremia is the most common electrolyte disorder in hospitalized patients in diverse clinical settings. Hyponatremia commonly develops in the acute phase of ST-elevation myocardial infarction and is an independent predictor of 30-day mortality.

The risk of subsequent cardiovascular events is higher among patients with chronic kidney disease than among persons with normal renal function. The two-year mortality rate after myocardial infarction among patients with end-stage renal disease is approximately 50 percent- twice the mortality rate after myocardial infarction in the general population.

Aim of Study

Prospective observational study involving patients admitted with first Acute ST Elevation Myocardial Infarction in the Intensive Coronary Care Unit at Government Medical College Hospital, Kottayam during a period of one year. The objective was to study the correlation between the in-hospital outcome in these patients with their baseline hematological and biochemical laboratory parameters including hemoglobin,

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white blood cell count, erythrocyte sedimentation rate, blood sugar, blood urea, serum creatinine, serum electrolytes and lipid profile.

Materials and Methods

554 consecutive patients admitted to the Intensive Coronary Care Unit, Government Medical College Hospital, Kottayam with first Acute ST Elevation Myocardial Infarction during a period of one year were included in the study.

Initial clinical evaluation including relevant clinical history and physical examination were done and the appropriate therapy was initiated. Blood samples were drawn at the time of admission for estimation of hemoglobin, total and differential WBC counts, blood sugar, blood urea, serum creatinine, serum electrolytes and lipid profile. Patients were treated according to the usual protocol for management of Acute Myocardial Infarction including reperfusion therapy, antiplatelet agents, and other drugs as per standard guidelines.

The patients were followed up during the period of hospital stay and the clinical course of the disease and occurrence of various in-hospital complications like cardiac failure, arrhythmias, post infarction angina or death were recorded. The patients were categorized into two groups based on the presence or absence of complications occurring during the hospitalization period: **Group I** had an uneventful recovery without any complications during the hospital stay whereas **Group II** developed one or more of the complications during the hospitalization period.

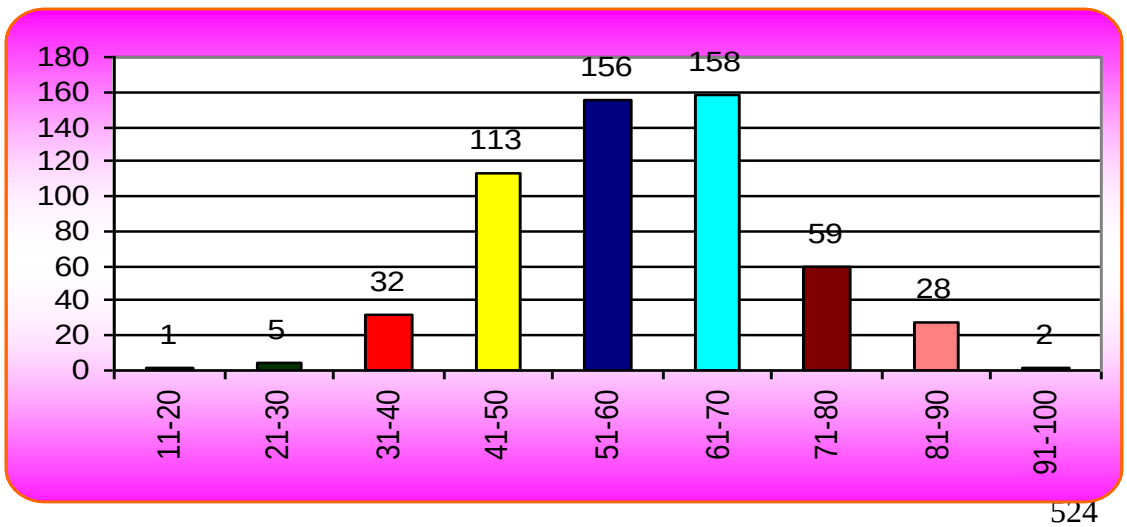
The data was analyzed to find any correlation between occurrence of the acute coronary event and development of in-hospital complications with any alterations in the hematological and biochemical parameters measured at the time of admission.

Results

554 cases of first Acute ST Elevation Myocardial Infarction were admitted to the CCU during the study period of 12 months. Out of this, 230 patients (78%) were males whereas 124 cases (22%) were females.

Age Distribution:

Patients were of age ranging from 20years to 95years.Peak incidence of myocardial infarction occurred in the 6th and 7th decades, together constituting 57% of total number of cases.



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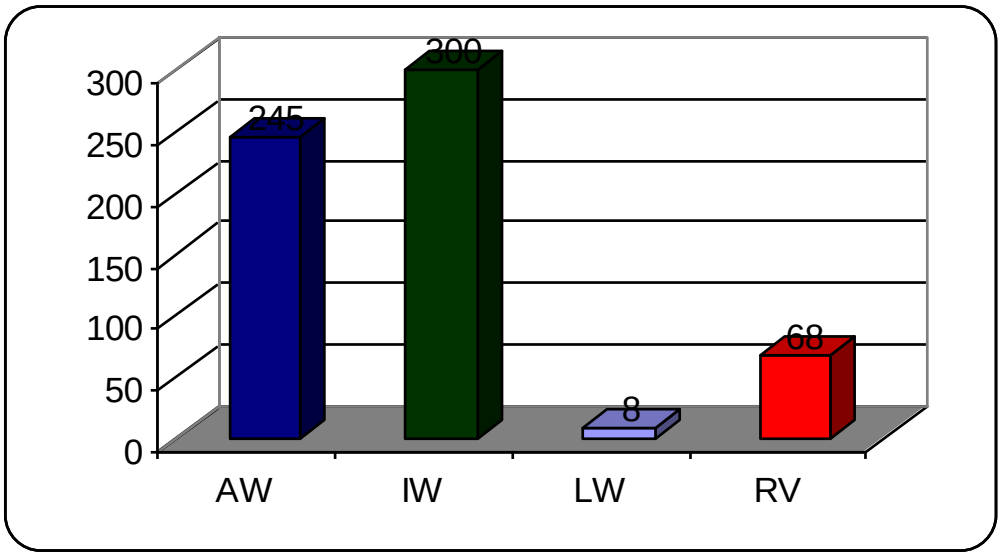
Smoking:

49% of the patients (n=271) were **smokers** and all of them were males. History of alcohol consumption was obtained in 21% of cases.

Territory of Myocardial Infarction:

54% patients had inferior wall MI whereas 44% had anterior wall MI. Right ventricular infarction occurred in 12% cases.



Hemoglobin:

Hemoglobin values were available in 499 patients. The values were ranging from 7.9gm to 15.8gm/dl. Most patients (n=360) had hemoglobin in the normal range of 12-15gm/dl whereas 133 patients had values below 12gm/dl and 6 patients had hemoglobin >15gm/dl.

Relation between Hemoglobin value and In-hospital complications:

	Hb-Group I	**Hb-Group II+**
Mean	12.63	12.23
SD	1.14	1.20
Count	373	126
Z value	-3.36	
P value	0.003	

The mean value of hemoglobin in patients who had uneventful course in the hospital (Group I) was 12.63 gm/dl compared to 12.23 gm/dl in those who developed in-hospital complications (Group II). The difference was statistically significant (***p*=0.003**)

Total White Blood Cell Count:

Total WBC count was ranging from 5000-18600 cells/µL.432 patients had WBC count in the range of 5000-11000/µL while 67 patients had count more than 11000/µL.

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Total WBC count and occurrence of complications:

The mean white blood cell count on admission was 9353.88 cells/µL in those patients who had no complications (Group I) compared with 9735.71 cells/µL in those who developed complications during the hospital stay (Group II). The difference between the two groups was statistically significant (***p*=0.05)**.

	WBC-Group I	**WBC-Group II**
Mean	9353.88	9735.71
SD	1640.82	2113.59
Count	374	126
Z value	2.09	
P value	0.05	

Polymorphonuclear Leukocyte count in Acute STEMI:

The mean polymorphonuclear leukocyte count was 73.75cells/µL. There was no significant difference between patients without complications and those with in-hospital complications (***p*= NS)**.

	DC-Poly Group I	**DC-Poly Group II**
Mean	73.64	74.08
SD	11.77	11.18
Count	374	126
Z value	0.37	
P value	NS	

Erythrocyte Sedimentation Rate:

ESR was ranging from 1 to 135mm/hour. ESR was normal (<20 mm/hour) in 302 patients (55%), between 20-50 mm/hr in 23%, between 50-100 mm/hr in 8% and above 100 mm/hr in 2% of the patients.

Mean value of ESR was 20.5 mm/hour in the entire population. There was significant difference between those who had an uneventful hospital course compared with those patients who developed in-hospital complications (19.20 vs 24.52 mm/hour, ***p*=0.02**).

	ESR-Group I	**ESR-Group II**
Mean	19.20	24.52
SD	22.63	27.96
Count	363	117
Z value	2.48	
P value	0.02	

Random blood sugar was ranging from 39-500mg/dL. Majority (n=291) had blood sugar in the range of 100-200mg/dL.

The mean value of random blood sugar was 161.1mg/dl in Group I compared with 172.60mg/dl in Group II. The difference between the two groups was not statistically significant (***p*=NS***)*.

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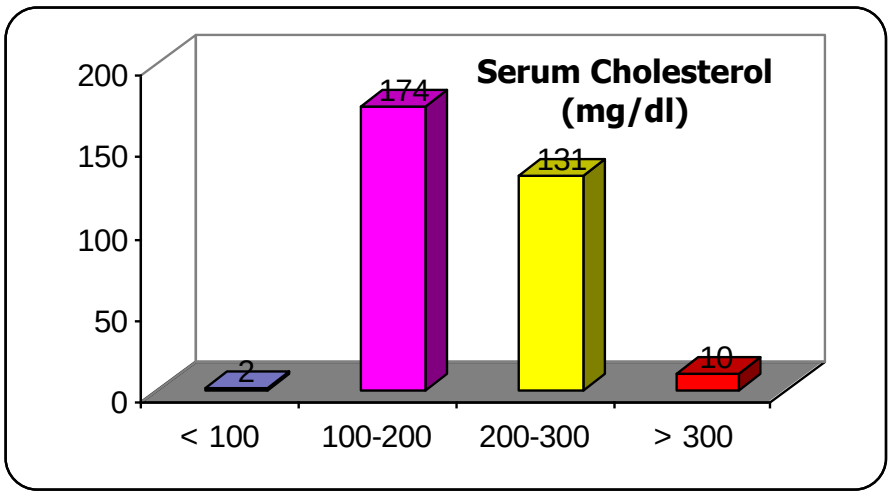
Renal function parameters: Blood urea was in the range of 12mg/dl to 170mg/dl.72 patients had values above 40mg/dl while the rest had values below 40mg/dl. Serum creatinine values ranged from 0.7 to 4mg/dl. The value was below 1.5 mg/dl in 36 patients and was above 1.5mg/dl in the remaining 29 patients in whom the report was available.

	Blood Urea-Group I	**Blood Urea -Group II**
Mean	29.54	37.16
SD	13.43	23.61
Count	370	136
Z value	4.53	
P value	0	

Lipid Profile:

Fasting lipid profile values were available in 143 patients. Serum total cholesterol, LDL and HDL cholesterol and serum triglycerides were estimated.

Serum total cholesterol values ranged from 71mg/dl to 384mg/dl. The value was below 100mg/dl in 2cases while it was between 100-200mg/dl in 174 patients, 200-300mg/dl in 131 patients and above 300 in 10 cases.



The difference between the mean total cholesterol values in Group I and Group II (202.20mg/dl *vs.* 193.71mg/dl) was not statistically significant (***p*=NS)**.

LDL cholesterol values ranged from 28-268mg/dl. It was below 100mg/dl in 21 patients, 100-160mg/dl in 80 patients and >160mg/dl in 41 cases.

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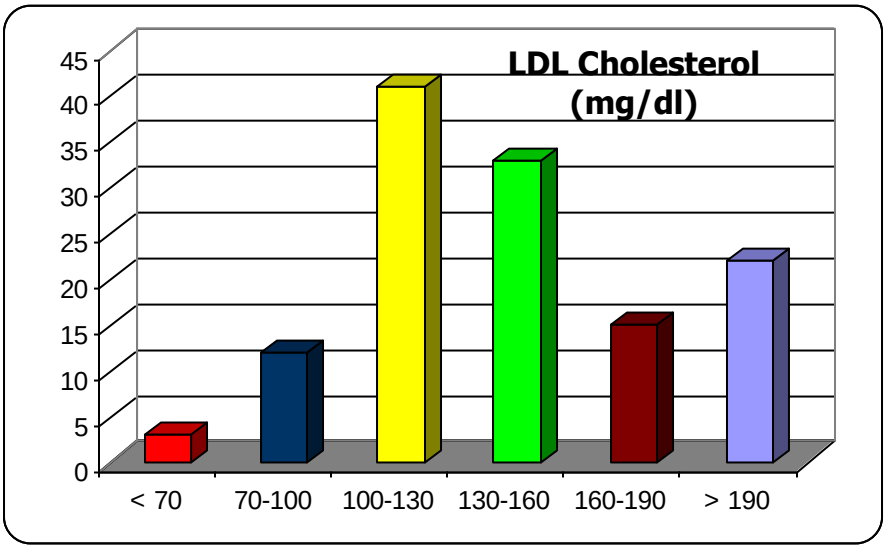

LDL cholesterol values were significantly lower in Group I compared with Group II patients (145.74mg/dl *vs.* 128.59mg/dl, ***p*=0.04**)

	LDL-Group I	**LDL- Group II**
Mean	145.74	128.59
SD	42.04	50.10
Count	103	39
Z value	-2.05	
P value	0.04	

Triglyceride values were in the range of 24-526mg/dl.135 patients had values below 150mg/dl whereas 40 patients had values above 150mg/dl.

HDL cholesterol values ranged from 20-93 mg/dl.98 patients had values below 40mg/dl whereas 60 patients had values between 40-60mg/dl and 2 patients had values above 60mg/dl.

Serum Electrolytes in Acute Myocardial Infarction:

Serum sodium levels were ranging from 118-147meq/l. Most patients (n=311) had value between 135-145meq/l while in 184 patients it was between 120-135meq/l and below 120meq/l in 2 patients.

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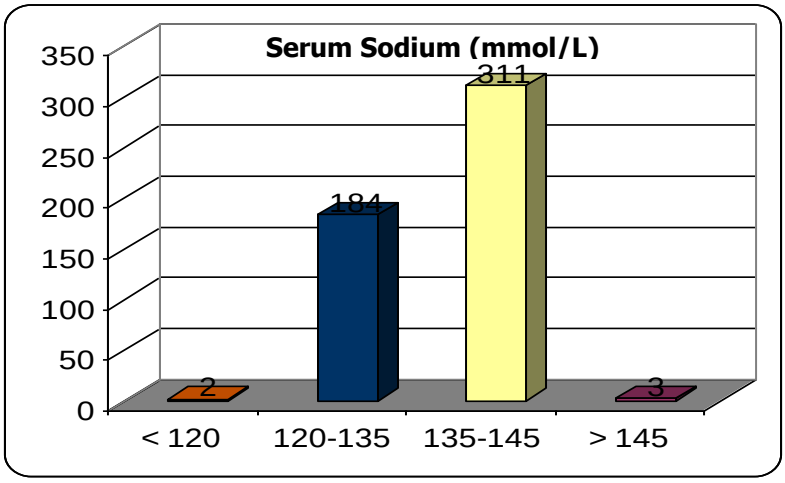


Hyponatremia in Acute Myocardial Infarction:

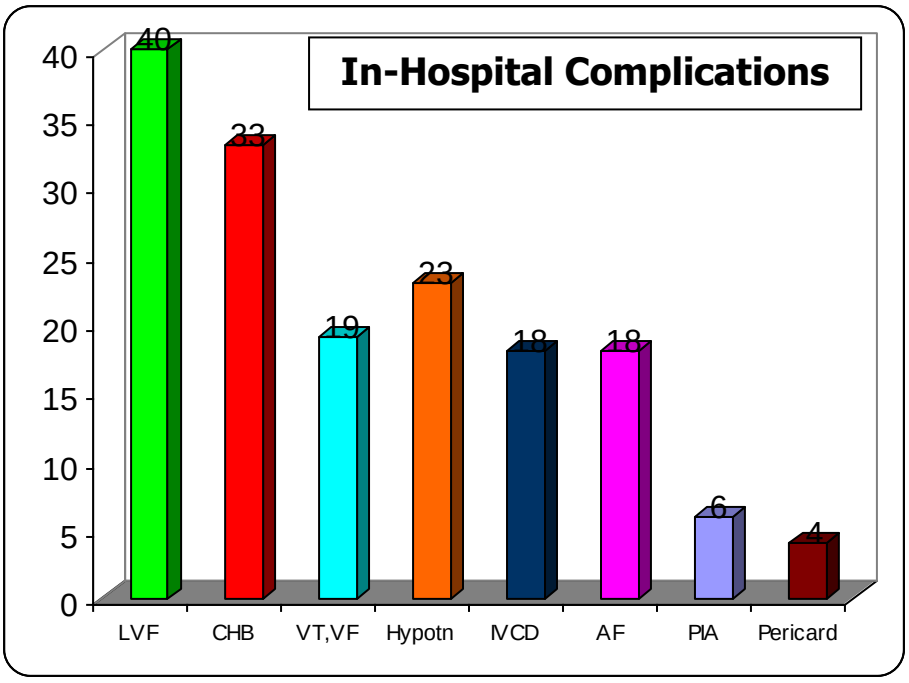
The mean serum sodium level in Group I was 134.98meq/L *vs.* 135.10meq/l in Group II and the difference was not statistically significant.

Serum potassium was ranging from 2.1- 6.8 meq/l. The value was between 3.5-5 meq/l in 397 patients while 67 patients had value less than 3.5meq/l and 38 had levels above 5 meq/l.

The difference in serum potassium values between patients with (Group I) and without complications (Group II) was not statistically significant (4.21meq/l *vs* 4.04meq/l, ***p*=NS)**.

Thrombolytic therapy: 73% of the patients (n=406) had undergone thrombolysis while 6% (n=33) had thrombolysis with half dose streptokinase (0.75 million units). 21% of patients (n=114) were not thrombolysed, mainly because of delayed presentation.

In-hospital complications: 166 patients (30%) developed complications related to STEMI during the hospital stay.



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This included left ventricular failure (7%, n=40), CHB (6%, n=33), ventricular tachycardia or fibrillation (3.4%, n=19), hypotension (4.2%, n=23), intra ventricular conduction defects (3.2%, n=18), atrial fibrillation (3.2%, n=18), post infarction angina (1.1%, n=6), pericarditis (0.7%, n=4) and death (9.6%, n=53).

Discussion

In the present study, total WBC count was ranging from 5000-18600 cells/μL with a mean value of 9450 cells/μL. The mean WBC count in patients who had an uneventful course after the index acute coronary event was 9354 cells/μL compared 9736 cells/μL in those who developed complications (Group II) and the difference was statistically significant (***p*=0.05**). However, no significant difference was observed between the two groups in the polymorphonuclear leukocyte count.

Studies of the relationship between leukocytosis and coronary artery disease conducted from 1974 to 1996 were summarized by Danesh et al[3] in a meta-analysis of 19 prospective studies involving 7229 patients with a weighted mean follow-up of 8 years. Comparison of individuals with WBC counts in the highest third with those in the lowest third yielded a coronary heart disease risk ratio of 1.5 (95% CI, 1.4 to 1.6) even though the majority of these studies made adjustments for smoking and other known risk factors.

Data from the Studies of Left Ventricular Dysfunction (SOLVD) trial[4], which enrolled stable patients with left ventricular dysfunction are of interest because the strong association of WBC count with cardiovascular mortality observed in the whole group, even after multivariate analysis ($P<0.001$), was found to be confined exclusively to the group in which ischemic vascular disease was responsible for the ventricular dysfunction. This observation supports a selective contribution of leukocytosis to the chronic vascular changes or the acute thrombotic phenomena that contribute to ischemic vascular disease.

Barron et al[5] evaluated data from 975 patients in the Thrombolysis in Myocardial Infarction (TIMI) 10A and 10B trials and found that Elevation in WBC count was associated with reduced epicardial blood flow and myocardial perfusion, thromboresistance (arteries open later and have a greater thrombus burden), and a higher incidence of new congestive heart failure and death.

A J-shaped relationship between mortality and leukocyte count was observed in the large registry study by Grzybowski et al[6] and in 2 other registry studies, wherein patients with the lowest leukocyte counts appeared to be a subgroup with higher mortality than the next highest WBC count group, and the remaining patients demonstrated a nearly linear relationship between leukocyte count and mortality.

In the present study, there was a negative correlation between the occurrence of complications following acute MI and the hemoglobin values. The mean hemoglobin was significantly lower in those who developed in-hospital complications compared to those who had an uneventful recovery (12.63 *vs.* 12.23 gm/dL, ***p*=0.003**).

Data from the Diet and Reinfarction Trial (DART) were examined by Burr et al[7] to check the prognostic effects of plasma fibrinogen, plasma viscosity, white blood cell count, haemoglobin and mean platelet volume in 92 deaths among 1755

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men who had recently recovered from acute myocardial infarction. All these variables were significantly associated with all-cause mortality over the following 18 months (haemoglobin negatively, the others positively). Haematological variables have an important prognostic significance after myocardial infarction.

The erythrocyte sedimentation rate (ESR) is a cheap and widely applicable test and has possible predictive value in CAD.

In the present study, the erythrocyte sedimentation rate showed wide variation in the study population, ranging from 1 to 135 mm/hour. The value was less than 20mm/hr in majority of the patients (55% of the population). ESR was between 20-50 mm/hr in 23% of patients, between 50-100 mm/hr in 8% and above 100 mm/hr in 2% of the patients.

The mean ESR value in patients who developed complications during hospital stay (Group II) was significantly higher than those who had an uneventful recovery (Group I) -19.2mm/hour ***vs.*** 24.52mm/hour (***p*=0.02**).

Correlation between inflammatory markers like ESR and the outcome after acute myocardial infarction has been studied in many previous trials. The study by Erikssen et al[8] provides erythrocyte sedimentation rate information on 243 coronary heart disease deaths and 240 non-fatal myocardial infarction cases among 2014 apparently healthy men aged 40–60 years followed for 23 years. It presents the longest follow-up period of any prior study. Of particular interest was a re-examination of the cohort 7 years later. The erythrocyte sedimentation rate was a strong predictor of subsequent coronary heart disease mortality among the 403 men who had developed angina pectoris and/or had a positive exercise ECG test by the time of the second survey.

In post hoc analysis of the original Zwolle trial, a prospective randomized trial in which primary percutaneous coronary intervention (PCI) was compared with streptokinase (SK) for treatment of STEMI in 346 patients, Timmer et al[9] observed that elevated ESR and admission glucose are independent predictors of mortality in STEMI patients treated with reperfusion therapy. Patients with ESR in the upper quartile (>14 mm/hour) were compared to patients with a normal ESR. Both elevated ESR and hyperglycemia were associated with a worse prognosis and increased mortality. Elevated ESR was particularly associated with an increased risk of sudden death (OR: 3.3, 17% vs. 6%, P < 0.01).

Danesh et al[10] published an analysis of pooled data of 1703 patients from previously published prospective studies on the association of the erythrocyte sedimentation rate and the subsequent development of coronary heart disease. Comparing erythrocyte sedimentation rates in individuals in the top third with those in the bottom third at baseline revealed a risk ratio of 1·33 (95% Cl 1·15 to 1·54, $P \leq$ 0·0001).

Hyponatremia, a marker of neurohormonal activation, is a common electrolyte disorder among patients with acute ST-elevation myocardial infarction. The long-term prognostic value of hyponatremia during the acute phase of infarction is not known.

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In the present study, hyponatremia (serum sodium <135meq/L) was observed in 186 patients. There was no significant difference between the mean serum sodium values in patients with and without complications during hospital stay (***p*=NS**).

Goldberg et al[11] studied 978 patients with acute ST elevation myocardial infarction and without a history of heart failure who survived the index event. During the hospital stay, sodium levels were obtained on admission and at 24, 48, and 72 hours. The median duration of follow-up after hospital discharge was 31 months (range, 9-61 months).

Hyponatremia, defined as a mean serum sodium level less than 135mEq/L, was present during admission in 108 patients (11.0%). In a multivariable Cox proportional hazards model adjusting for other potential clinical predictors of mortality and for left ventricular ejection fraction, hyponatremia during admission remained an independent predictor of post discharge death (hazard ratio [HR], 2.0; 95% confidence interval [CI], 1.3-3.2; *P*=.002).

In the present study, value of blood urea was available in 507 patients (92% of total study group) and serum creatinine values available in 65 (12%) cases. Blood urea was >40 mg/dl in 13% of cases (n=72). Mean blood urea value was significantly higher in patients with complications (Group II) compared to those without complications during hospital stay (29.54 mg/dl *vs*. 37.16 mg/dl, ***p*=0**).

In a study by Anavekar et al[12], as part of the Valsartan in Acute Myocardial Infarction Trial (VALIANT), data from 14,527 patients with acute myocardial infarction complicated by clinical or radiologic signs of heart failure, left ventricular dysfunction, or both, and a documented serum creatinine measurement, was analyzed. The risk of death or the composite end point of death from cardiovascular causes, reinfarction, congestive heart failure, stroke, or resuscitation after cardiac arrest increased with declining estimated GFRs. Even mild renal disease, as assessed by the estimated GFR, should be considered a major risk factor for cardiovascular complications after a myocardial infarction.

Conclusions:

In the present study, hematological and biochemical Profile in 554 consecutive cases of first Acute ST Elevation Myocardial Infarction were analyzed for finding any correlation with early complications**.**

The following observations were made:

Males constituted 78% of the total number of cases. Smoking was a major risk factor observed in 63% of cases, all being males.57% of the total number of cases were constituted by patients in the 6^{th} and 7^{th} decade. Territory of Myocardial Infarction was Inferior wall in 54% cases, Anterior wall in 44% and Lateral/Posterior wall in the remaining 2% of patients. 12% patients had Right ventricular Myocardial Infarction and all patients had associated Inferior Wall Myocardial Infarction. Incidence of Right ventricular myocardial infarction with Inferior wall MI was 23%. 30% of the patients developed complications during the mean period of five days of hospitalization. This included left ventricular failure (7%), complete heart block (6%),

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hypotension (4.2%), intraventricular conduction defects (3.2%), atrial fibrillation (3.2%) and post infarction angina (1.1%).

There was statistically significant association between the following laboratory parameters and development of in-hospital complications: lower hemoglobin values (***p* =0.003**), higher total white blood corpuscle count (***p* =0.05**), higher Erythrocyte Sedimentation Rate (***p* =0.02**) and impaired renal function (***p* =0.0**).

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