Analysis of Red Blood Cell Indices and Its Significance in Acute Decompensated Heart Failure

Arul Murugan C.[1], Moogaambiga S.[2], Ranga Bashyam S.R.[3]

[1]Department of General Medicine, Vinayaka Mission's Kirupananda Variyar Medical College and Hospitals, Salem, Tamilnadu, India. [2]Department of General Medicine, Vinayaka Mission's Kirupananda Variyar Medical College and Hospitals, Salem, Tamilnadu, India. [3]Department of General Medicine, Vinayaka Mission's Kirupananda Variyar Medical College and Hospitals, Salem, Tamilnadu, India.

ABSTRACT

BACKGROUND

Heart failure is one of important causes of significant morbidity and mortality in India. The role of red blood cell indices in the prognosis of heart failure is limited in literature. In spite of diagnostic and therapeutic advances, heart failure is associated with patient mortality. The identification and development of new therapeutic modalities of high-risk patients is important for treatment. We wanted to measure the red blood cell indices in patients with acute decompensated heart failure and evaluate its prognostic significance.

METHODS

This descriptive study was done in our hospital among patients suffering from acute decompensated heart failure aged less than 60 years. One hundred patients with acute decompensated heart failure have been examined. The automatic cell analyser has measured the Red Cell indices such as haematocrit (PCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Volume (MCV), Red Cell Distribution Width - SD (RDW), RBC count, and haemoglobin. LV dysfunction was determined by 2D echocardiogram and categorised as mild LV dysfunction, moderate LV dysfunction, and severe LV dysfunction. For statistical analysis, the unpaired two sample t-test, analysis of variance test and Pearson correlation coefficients were used.

RESULTS

The MCV range in the present study was in normal range in 36 %, high in 60 % and low in 14 % of participants. In 54 % participants, PCV was normal, 23 % had abnormal PCV. RDW `SD and RDW ` CV were increased in 68 % and 64 % in the study subjects respectively. 20 % of the participants had severe, 59 % had moderate and 21 % had mild LV dysfunction respectively (p value <0.001). Average RDW SD in patients with severe LV dysfunction were 62 femtoliters, 49 FL and 47 FL in moderate and mild LV dysfunction respectively.

CONCLUSIONS

Red blood cell indices such as haemoglobin, PCV, MCV, RDW play a significant role in predicting heart failure prognosis. Red Cell Distribution Width (RDW) levels and MCV were increased in heart failure. High RDW correlated with more severe LV dysfunction. Treatment of anaemia with subsequent decrease of RDW contribute to improved outcome. RDW is thus a cheap and easily accessible biomarker which can be used as an early indicator of a patient's heart failure.

KEYWORDS

Heart Failure, Red Blood Cell Indices, MCV, RDW

Corresponding Author:
Dr. Arul Murugan C.,
Flat F1, 1st Floor,
Green House Apartments,
Thiruvalluvar Street,
Subramaniya Nagar, Suramangalam,
Salem-636005, Tamilnadu, India.
E-mail: dr.arulc@gmail.com

DOI: 10.18410/jebmh/2020/461

How to Cite This Article:
Murugan AC, Moogaambiga S, Bashyam RSR. Analysis of red blood cell indices and its significance in acute decompensated heart failure. J Evid Based Med Healthc 2020; 7(40), 2223-2227. DOI: 10.18410/jebmh/2020/461

Submission 13-06-2020,
Peer Review 29-07-2020,
Acceptance 18-08-2020,
Published 05-10-2020.

BACKGROUND

One of the severe health hazards that are common in today's world is heart failure. The condition is identified by various signs and symptoms such as fatigue in the body, dyspnoea. These two symptoms destroy and hamper the normal exercise acceptance of the body along with retention of fluid. These two metabolic impairment results in the development of many chronic diseases such as splanchnic congestion, peripheral oedema, ankle swelling, raised jugular venous compression and pulmonary crackles.[1,2] The defective cardiac output is due to elevation of intracardiac pressure which develops a series of changes such both in functional and structural portion of the heart, which results in irregularities in function.[1] The sorting of the dissimilar categories of heart failure is established upon on left ventricle ejection fraction (LVEF). The types are Heart failure in patient who shows a preserved left ventricular ejection fraction (LVEF) or (HFpEF). These type of patients shows standard level of LVEF which is (≥ 50 %). The second category is recognised as minor dysfunction of LVEF where the patient shows LVEF 40 - 49 %, the next type is moderate dysfunction and the rate of LV dysfunction is LVEF 30 - 39 %. The last and fourth category is patient with severe left ventricular impairment and the rate of dysfunction was found to be LVEF < 30 %).[1,3] The primary cause of this heart failure varies from individual to individual especially in terms of pathologies both in non-cardiovascular and cardiovascular. Numerous patients will agonize dissimilar illnesses at the similar point of time period, which eventually activate the heart failure. The patient with heart failure is generally observed with different conditions and symptoms such as myocardial infarction or heart attack, revascularization and most importantly a past of ischemic heart disease.[1] Consequently, amongst the maximum significant reasons of demise in patients with heart failure are circulatory illnesses, chiefly unexpected expiry and deteriorating heart failure.[3,4] Atrial fibrillation or AF and a record of hypertension condition are commonly observed among patient with HFpEF and it most common occurs among women and elderly population. Studies suggested that myocardial infarction is usually uncommon among the patient suffering from HFpEF.[5]

Numerous extrapolative biomarkers of demise and hospitalization in survivor with heart failure is progressively recognised and studied[1]. Inopportunely, their medical usages leftovers incomplete owing to the defies in stratifying the jeopardy of heart failure survivors. Additionally, numerous prognostic danger markers have been established in heart failure, which is beneficial in identifying the death reason of these patients.[6,7,8] Conversely, they are fewer beneficial to forecast heart failure hospitalizations cases.[9,10] In detail, numerous investigations solitary described a reasonable correctness of these replicas to expect death, at the same time as they were not as much of precise for expecting hospitalization.

One of the most usual rates of death and reason for re-hospitalisation is was found to be due to heart failure. Notwithstanding improvements in identification and treatment, heart failure is statistically related with extraordinary patient death. Recognition of high-risk survivors is significant for management, and improvement of novel medical modalities. Numerous investigations have been available on expecting prediction of heart failure by means of hemogram considerations or parameters. Anaemia is recognized to be a robust and self-regulating prognosticator of death along with defective red cell distribution width (RDW) which is also connected with death, liberated of anaemia. Additional samples comprise of higher level of leukocyte and little comparative lymphocyte totals and total eosinophil also regarded as a predator of mortality among the patient with heart failure. A diversity of hematologic factors is known to be of extrapolative implication in survivor with heart collapse. The primary purpose of the study is to examine which these identified factors or parameters are beneficial in guessing diagnosis among patients or survivors with acute decompensated heart failure (ADHF).

METHODS

The is a descriptive study, which was conducted among patients who were admitted in Vinayaka Mission's Medical College & Hospitals, Salem, in patients with acute decompensated heart failure. The participants those were included in the study are basically of age less than 60 years of both sex and were hospitalized due to deterioration of heart failure. The inclusion criteria were that the patient must have EF < 50 % and has any of the indication of fluid retention in the body such as jugular venous distension, pedal oedema, dyspnoea and orthopnoea. Participants or patient who had hypercholesterolemia, diabetes, and hypertension was also encompassed in the research. The participants of age greater than 60 and suffering from impaired hepatic function, Renal failure, vaLVular heart disease, thyroid illnesses, haematological malignancy, hemoglobinopathies, megaloblastic anaemia, females on oral contraceptive medications, chronic inflammatory disorders, patients on chemotherapeutic drugs were not included in the research plan. On admittance, all patients must comprehensive a survey to find figures on routine and jeopardy influences. Hypertension is categorised by a level of systolic pressure greater than 140 mm Hg or the diastolic pressure greater than 90 mm Hg on at least binary discrete amounts or as preceding usage of antihypertensive drug. Diabetes mellitus in this case was distinct as an earlier analysis if a patient consumes anti-diabetic drug or that kind of food or uncertainty a beforehand unprocessed patient had an abstaining venous blood glucose level of 126 mg / dL on twofold junctures.

The condition of hypercholesterolemia is identified as the usage of cholesterol-lowering rehabilitation or the level of total cholesterol is 200 mg / dl. Burning of cigarettes or smoking was demarcated as the existing steady habit of cigarettes. The condition of anaemia is well-defined when the haemoglobin concentration lower than 14 mg / dl in men and that of 12 mg / dl in females. Venous blood was achieved from all the appointed patient in the study during the time of admission. The collected samples from all the

patients were examined in automated cell analyser which computes various parameters of blood such as Mean Corpuscular Volume (MCV), Haemoglobin, RBC count, Haematocrit, Mean Corpuscular Haemoglobin (MCH), Red cell Distribution Width (RDW).

Normal reference range - Hb - 12 to 16 gms %, RBC count - 3.5 million to 5.5 million / $cm.^3$, PCV - 36 to 45 %, MCV - 78 to 94 $\mu m.^3$, MCH - 27 to 33 pg, RDW SD - 40 to 50 FL, RDW CV – 11 – 15 %.

After 24 hours of admission in hospital the patients were examined with the help of 2D echocardiography. The LVEF were analyzed following the guidelines of American Society of Echocardiography with the help of modified Simpson method. Vivid statistics such as Mean and Standard Deviation (SD) for unremitting variables, and regularities and proportions for uncompromising variables were identified. The calculation and data analysis were done by SPSS software version 21.0 with the help of statistical techniques like analysis of variance test and unpaired independent samples "t" test.

RESULTS

RBC Count, Haemoglobin, MCH, MCV, PCV and RDW were tabulated as Mean ± SD; regularity and fraction for the detected values of the investigation factors are intended. 68 males and 32 females were included in the study. The percentage of patient present in the age group of 35 - 40 years is 25 % and that of 41 to 50 years is 34 %. The percentage of patient found in 51 to 60 years aged group was 41 %. The study also found that about among the participants 28 % of patient had hypertension and that of patient had diabetes mellitus was 46 %. The study also found that 54 % had haemoglobin within a usual range and that of 22 % patient had a lower level of haemoglobin.

Parameter	No.	Percentage	Range	Mean± SD
Hb (gms %)				
≤ 12	22	22	6.2 - 17.4	14.2 ± 2.6
12 – 16	54	54		
> 16	24	24		
RBC (Million / cc)				
≤ 3.5	20	20	2.8 - 6.78	4.8 ± 0.96
3.5 – 5.5	58	58		
> 5.5	22	22		
MCH in pg				
≤ 27	26	26	17.2 - 36.8	29.8 ± 3.4
27.6 – 33	56	56		
> 33	18	18		
PCV %				
≤ 36	23	23	12 - 56	42 ± 4.4
36 – 45	54	54		
> 45	23	23		
RDW - SD FL				
≤ 50	32	32	46 ± 1.4	P < 0.001
> 50	68	68	58 ± 1.2	
RDW - CV				
≤ 11	4	4	14.6 – 21.4	14 ± 1.2
11 – 15	32	32		
> 15	64	64		
MCV (μm^3)				
< 78	14	14	74 - 116	92 ± 1.4
78 - 94	36	36		
> 94	60	60		

Table 1. Haematological Parameters in the Participants N (100)

24 % of patient was found to be have higher level of haemoglobin. The study of RBC count found among the patients were 58 % normal, 20 % had lower level and 22 % had enhance range of RBC. The PCV range that were found among the patient are 54 % normal, 23 % had both lower level and higher level. The study of MCH range were found among patients are 56 % normal, 26 % had high, 18 % had low levels. The study of MCV Range were found to be 36 % normal, 60 % had high and 14 % had low range. The study also found that RDW - SD is increased among 68 % of study population and that of RDW - CV was found to be increased among 64 % of participants. The LV dysfunction that were identified from the study are 20 % had severe dysfunction, 59 % had moderate dysfunction and 21 % had mild dysfunction (Table 2).

LVEF %	No. of Cases	RDW SD (FL)	Hospital Stay (Days)	Death
< 30	20	62 ± 1.6	14 ± 2	8
30 - 39	59	48 ± 1.8	8 ± 3	1
40 - 49	21	46 ± 1.6	3 ± 1	0

Table 2. Severity of LV Dysfunction and Prognosis with RDW

The mean RDW SD found from the study are very high in severe LV dysfunction 62 FL, moderate 49 FL and that of mild LV dysfunction is 47 fL. The period of hospital stay in different cases of LV dysfunction or impairment were 15 days in case of severe condition, in case of moderate is 8 days and in case of mild dysfunction is of 4 days. The death count found in the study was 8 in case of severe dysfunction and that of restrained is one in case of moderate dysfunction, no mortality observed in mild LV dysfunction group.

DISCUSSION

Augmented as well as diminished levels of haemoglobin are freely related with adverse prognosis in heart failure.[11] The study found that almost 58 % of the study participants falls within the standard range of RBC count, the rate of increased count was 22 % and that of decreased was 20 %. Thrombus formation develops due to defective RBC count. Medical interpretations propose that a multiplicity of haemorrhage complaints can be cured by raising the RBC amounts, unfaltering the platelet levels.[12] Increase in blood viscosity results in thrombosis which cause obstruction, this is caused due to elevation of RBC count. RBC plays an important role in maintaining the haemostasis mechanism along with many factors named as degranulation of ADP and ATP, stimulating platelet aggregation under reduced level of PO2 & acidic pH. This happens in reaction to mechanical deformation.[13] the level of PCV that is found in the study were 23 % of lower level and that of 23 % higher level. Haematocrit also known as PCV is defined as the percentage of blood volume that is filled by erythrocytes which helps in calculating the oxygen transport capability of the blood.

The residence time of circulating platelet is enhanced by higher level of haematocrit; it also elevates the factors responsible for coagulation. This occurs near the activated

endothelium since it facilities the transport of platelets towards the walls of the vessels which in turn results in collisions with vasculature. The volume of erythrocyte is measured by mean corpuscular volume (MCV) and the volume of haemoglobin present in erythrocytes is measured by MCH. The patient with this MCH and MCV is generally high amongst the patient with LV dysfunction. A new indicator of estimates in acute decompensated heart failure is high MCV.[14] CAD development occurs due to the combination effect of morphology of erythrocytes and volume of haemoglobin present in the erythrocytes. Automated blood cell counters of present days are used in measuring the Red cell Distribution Width. It is well - defined as measure of standard eccentricity of mean volume and red cell volume and generally conveyed as proportion in 2 means: RDW - SD and RDW - CV. It is a quantity of red cell mass dissimilarity and is a catalogue of erythrocytes heterogeneity. The value is grounded upon volume distribution curve of RBC. The study found that RDW - CV among the study population was 64 % and that of RDW - SD is 68 %.

The result of Echo found in the study was that EF value lower than 30 % was found among 20 candidates, within the range of 30 % to 39 % was found among 59 candidates and that of 40 % to 49 % was found among 21 candidates. Two groups with different values of RDW were compared. The study also found that the value of mean RDW was highest among the group 62 FL consisting of EF value less than 30 % after the appraisal with modest LV dysfunction with values of 49 FL and 47 FL respectively. The p value was found to be less than 0.01, which is regarded as statistically significant, and the value of correlation coefficient was also found to be significant. This identified results clearly states that there is a correlation amongst the LV ejection fraction and RDW. The hospital stay of the patient will severe LV dysfunction and also for longer period and also had higher RDW SD. The study and its observations clearly indicate that RDW can be regarded as a biomarker for heart failure which is also cheaper and easily available. There is an independent relation between cardiovascular disease, death with level of RDW.[15] Few studies also states that there is a strong association between duration of hospital stay and level of RDW which also increases the death rate among patients who are distress from myocardial infarction.[16] RDW is correlated with poor prognosis in patients with acute heart failure. Even though the action relic's hypothetical, high intensities is found to be related with augmented oxidative stresses and hemodynamic. RDW is influenced by hypertension and diabetes.[17]

CONCLUSIONS

There are various factors that are helpful in predicting heart failure. The factors are RDW, haemoglobin and MCV. The levels of Red Cell Distribution Width (RDW) - SD, RDW - CV and MCV were found to be increased in case of heart failure. RDW was found to be increased among subjects with severe dysfunction of LV in comparison with mild and moderate heart failure. It is not only a strong marker for heart failure but also an indicator of death due to heart failure. If patients with elevated levels of RDW and anemia are treated in time, improved results can be obtained.

Financial and Competing Interests - None

REFERENCES

[1] Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J 2016;37(27):2129-2200.

[2] Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/ AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/ American Heart Association Task Force on practice guidelines. Circulation 2013;128:e240-e327.

[3] Maggioni AP, Dahlström U, Filippatos G, et al. Heart Failure Association of the European Society of Cardiology (HFA) EURObservational Research Programme: regional differences and 1 - year follow-up results of the Heart Failure Pilot Survey (ESC-HF Pilot). Eur J Heart Fail 2013;15(7):808-817.

[4] Pocock SJ, Ariti CA, McMurray JJV, et al. Predicting survival in heart failure: a risk score based on 39 372 patients from 30 studies. Eur Heart J 2013;34(19):1404-1413.

[5] Meta-analysis Global Group in Chronic Heart Failure (MAGGIC). The survival of patients with heart failure with preserved or reduced left ventricular ejection fraction: an individual patient data meta-analysis. Eur Heart J 2012;33(14):1750-1757.

[6] Mosterd A, Hoes AW. Clinical epidemiology of heart failure. Heart 2007;93(9):1137-1146.

[7] Djoussé L, Driver JA, Gaziano JM. Relation between modifiable lifestyle factors and lifetime risk of heart failure. JAMA 2009;302(4):394-400.

[8] Go AS, Mozaffarian D, Roger VL, et al. Heart disease and stroke statistics--2013 update: a report from the American Heart Association. Circulation 2013;127(1):143-152.

[9] Bleumink GS, Knetsch AM, Sturkenboom MCJM, et al. Quantifying the heart failure epidemic: prevalence, incidence rate, lifetime risk and prognosis of heart failure The Rotterdam Study. Eur Heart J 2004;25(18):1614-1619.

[10] Ouwerkerk W, Voors AA, Zwinderman AH. Factors influencing the predictive power of models for predicting mortality and/ or heart failure hospitalization in patients with heart failure. JACC Heart Fail 2014;2(5):429-436.

[11] Chonchol M, Neilson C. Hemoglobin levels and coronary artery disease. Am Heart J 2008;155(3):494-498.

[12] Wohner N. Role of cellular elements in thrombus formation and dissolution. Cardiovac Hematol Agents Med Chem 2008;6(3):224-228.
[13] Weiss HJ, Lages B, Hoffmann T, et al. Correction of platelet adhesion defect in delta storage pool deficiency at elevated hematocrit, possible role of adenosine di phosphate. Blood 1996;87(10):4214-4222.
[14] Tomoya U, Rika K, Manabu H, et al. High mean corpuscular volume is a new indicator of prognosis in acute decompensated heart failure. Circulation Journal: official journal of the Japanese Circulation Society. 2013;77(11):2766-2771.
[15] Felker GM, Allen LA, Pocock SJ, et al. CHARM Investigators. Red cell distribution width as a novel prognostic marker in heart failure. Data from the CHARM program and the Duke Databank. J Am Coll Cardiol 2007;50(1):40-47.
[16] Sangoi MB, Guarda NDS, Rodel APP, et al. Prognostic value of red cell distribution width in prediction of in hospital mortality in patients with acute myocardial infarction. Clin Lab 2014;60(8):1351-1356.
[17] Tanindi A, Topal FE, Topal F, et al. Red cell distribution width in patients with prehypertension and hypertension. Blood Press 2012;21(3):177-181.