

Study Of Red Cell Distribution Width [Rdw] & Red Cell Distribution Width To Platelet Ratio [Rpr] As Early Predictors Of Severity Of Acute Pancreatitis And Their Correlation With Bisap Scoring System

Monali Mathur¹, Ram Kishan Jat², Puneet Rijhwani³, *Vijendra Sharma⁴, Dharam P. Bansal⁵

1. Resident, Department of General Medicine, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
2. Associate Professor, Department of General Medicine, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
3. Professor, HOD and Unit Head, Department of General Medicine, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
4. Senior Resident, Department of General Medicine, JLN Medical College and Hospital, Ajmer, Rajasthan, India
5. Professor and Unit Head, Department of General Medicine, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India

***Corresponding author:**

Vijendra Sharma,

Senior Resident, Department of General Medicine, JLN Medical College and Hospital, Ajmer, Rajasthan, India

E mail ID: vijendra.gothwal@gmail.com

ABSTRACT

Aims and objectives: The present study was conducted to study red cell distribution width (RDW), and red cell distribution width to platelet ratio (RPR) as early predictors of severity in Acute Pancreatitis and their correlation with BISAP scoring system.

Materials and Methods: A hospital based prospective observational study was conducted in the Department of General Medicine, Mahatma Gandhi Medical College & Hospital, Jaipur. Total 117 Patients diagnosed with Acute Pancreatitis according to Revised Atlanta Criteria were included in the study.

Results: According to regression analysis, red cell distribution width to platelet ratio [RPR] was the only predictor of the severity of pancreatitis as compared to RDW and BISAP score.

Conclusion: From this study we confirmed that red cell distribution width to platelet ratio (RPR) is a good predictor of disease severity in patients with acute pancreatitis.

Keywords: acute pancreatitis, RDW, BISAP score

Introduction

Acute pancreatitis (AP) is an inflammatory disease of the pancreas gland that may cause local and systemic complications. Since the disease may cause severe organ damage and may have some fatal complications, assessment of disease severity is essential to determine their therapeutic strategies.¹

From Indian population no data is available regarding the actual incidence of the disease. Only some idea of incidence can be obtained from patients admitted in different tertiary care centres in India (in SP medical college Bikaner, Rajasthan 50 cases per year, Indira Gandhi

medical college Shimla, Himachal Pradesh 123 cases per year).^{2,3} The Incidence of the disease in USA is 49.2 cases/1,00,000 USA populations.⁴ In most of the cases the severity of the disease is mild with a favourable outcome (around 70%-85% cases). Although most of the Acute Pancreatitis cases are mild or moderate, Severe Acute Pancreatitis (SAP) develops in about 10-20% of patients and results in an intense inflammatory response that may cause severe local and systemic complications.⁵

Several single- and multi-parameter predictors have been described to evaluate the severity of the disease. Some scoring systems, such as Ranson, Glasgow and APACHE II, provide valuable clues to evaluate the severity and of Acute Pancreatitis. In several studies, certain biological markers, such as elevated C-reactive protein, elevated creatinine, high blood glucose and haemoconcentration on admission, have been used to predict mortality.⁶ However, most of these scoring systems are contain many parameters and aren't easy to perform in daily practice. Inexpensive, easily available and cost-effective markers that can be used in patient admission and follow-up are warranted in Acute Pancreatitis.⁷

The red blood cell distribution width (RDW) is a parameter evaluating the variability in the size of erythrocytes. It is a part of the complete blood count which is easily available in all over the world. Recently, Red cell distribution width has been associated with many inflammatory conditions. In current literature, although there are some previous studies about the role of red cell distribution width in diagnosis and follow-up of patients with Acute Pancreatitis, the association of this parameter with other commonly used severity criteria is still not clear.^{8,9}

The new revised Atlanta guidelines gave more stress on organ failure to predict outcome in acute pancreatitis patients rather than the local complications as was present in the 1992 Atlanta guidelines.¹⁰ So, systemic inflammatory response and the resulting organ failure predict superior outcomes in acute pancreatitis.¹¹ In systemic inflammatory response phase due to the effect of inflammatory cytokines, there occurs release of premature erythrocytes into the circulation and a resultant increase in Red Blood Cell distribution width.¹² It has been also found that when the systemic inflammatory response becomes more severe the total platelet count decreases. Although, the aetiology is not certain, this may be due to the inhibitory effect of inflammatory cytokines on bone marrow or may be due to the Disseminated Intravascular Coagulation (DIC) and the resultant consumption coagulopathy occurring at late stage of sepsis and systemic inflammatory response syndrome.¹³ So, ratio of Red cell distribution width to Total Platelet Count known as Red cell distribution width to platelet ratio (RPR) can be evaluated as a prognostic index to know the degree of severity of systemic inflammatory response and hence the outcome in acute pancreatitis.

Complete blood count (CBC) is one of the most common and inexpensive laboratory tests in the hospital. Derived from Complete Blood Count, RDW (Red cell distribution width) is a parameter that reflects the heterogeneity of red blood cell (RBC) volume, and classifies anaemia. Elevated Red cell distribution width is considered to be an inflammatory marker and predicts poor outcomes of several diseases including heart failure,¹⁴ acute kidney injury,¹⁵ sepsis,¹⁶ and cancers.¹⁷ Platelets play a major role in regulating inflammation and innate immunity. Platelets adhere to endothelium and mediate neutrophil chemotaxis, infiltration, and secretion of proinflammatory chemokines in the progress of acute inflammation.¹⁸ Platelet count decreases in severe diseases and is a predictor for mortality.¹⁹ Red blood cell distribution width to platelet count ratio (RPR) is a novel and simple indicator of inflammation. Studies have reported the value of RPR in detecting hepatic fibrosis²⁰ and predicting poor prognosis of severe burn injury.²¹

In addition, haemostatic disorders ranging from hypercoagulopathy to disseminated intravascular coagulation (DIC) appear in Acute Pancreatitis and are related to disease severity.²² In a recent study to predict hepatic fibrosis stages in patients with chronic

Hepatitis B, Chen et al used the red cell distribution width to platelet ratio (RPR).²³ Using these two parameters, which are easily calculated, the necessity for liver biopsy for these patients will be reduced. The Red cell distribution width to platelet ratio (RPR) reflects inflammation severity; therefore, we aimed to evaluate the severity of patients with Acute Pancreatitis using red cell distribution width [Red cell distribution width] & red cell distribution width to platelet ratio [RPR] as early predictors of severity of acute pancreatitis and their correlation with Bedside Index of Severity in Acute Pancreatitis (BISAP) Scoring System.

Materials and methods

Type of Study: A hospital based prospective observational study

Period of Study: March 2021 to September 2022

Place of Study: Department of General Medicine, Mahatma Gandhi Medical College & Hospital, Jaipur

Institute Ethics Committee approval to be obtained before start of study.

Written and informed consent of the patients was obtained from all participants before enrolment into the study.

All the participants were informed about aims, objectives and methods of study.

Selection Of Cases:

117 patients of Acute Pancreatitis in In Patient Department (IPD).

SAMPLE SIZE:

Considering the prevalence of acute pancreatitis to be 7.9%²⁴ and absolute error of 5%, the sample size comes out to be 117. Patients diagnosed with Acute Pancreatitis according to Revised Atlanta Criteria.

Inclusion criteria:

- All patients diagnosed as Acute Pancreatitis by Revised Atlanta criteria.
- Age more than 18 years.
- Patients who are willing to give consent.

Exclusion criteria:

- Age less than 18 years.
- Traumatic/Autoimmune pancreatitis.
- Known case of Chronic Kidney Disease.
- Known case of Chronic Liver Disease.
- Hepatocellular carcinoma.
- Expecting (pregnant) women
- The patients receiving radiotherapy-chemotherapy
- Those with anaemia (including those receiving B12, iron therapy)
- Immunodeficiency patients
- Patients unwilling to give consent.

Statistical analysis

The data was coded and entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of percentages, means and standard deviations. The data were checked for normality before statistical analysis using Kolmogorov Simonov test. The unpaired t test (for quantitative data to compare two independent observations) was applied. The chi square test was used for quantitative data comparison of all clinical indicators. Level of significance was set at $P \leq 0.05$.

Observation and results

Mean age was 50.13 years in mild acute pancreatitis group, 51.07 years in moderate acute pancreatitis group and 53.44 year in severe acute pancreatitis group. Comparison of age and severity of acute pancreatitis showed statistically non-significant results.

Female were 36.7% in mild acute pancreatitis group, 43.3% in moderate acute pancreatitis group and 29.6% in severe acute pancreatitis group. Male were 63.3% in mild acute pancreatitis group, 56.7% in moderate acute pancreatitis group and 70.4% in severe acute pancreatitis group. Comparison of gender and severity of acute pancreatitis showed statistically non-significant results.

Mean BMI was 25.21 kg/m² in mild acute pancreatitis group, 21.81 kg/m² in moderate acute pancreatitis group and 24.64 kg/m² in severe acute pancreatitis group. Comparison of BMI and severity of acute pancreatitis showed statistically non-significant results.

Mean Haemoglobin was 9.47 g/dl in mild acute pancreatitis group, 9.55 g/dL in moderate acute pancreatitis group and 10.003 g/dl in severe acute pancreatitis group. Comparison of Haemoglobin and severity of acute pancreatitis showed statistically significant results.

Mean platelets was 98516.67 per unit in mild acute pancreatitis group, 102300 per unit in moderate acute pancreatitis group and 111666.67 per unit in severe acute pancreatitis groups. Comparison of platelets and severity of acute pancreatitis showed statistically significant results.

Mean Triglyceride was 180.40 mg/dL in mild acute pancreatitis group, 218.03 mg/dL in moderate acute pancreatitis group and 178.11 mg/dL in severe acute pancreatitis groups. Comparison of Triglyceride and severity of acute pancreatitis showed statistically significant results.

Mean HDL was 37.92 mg/dL in mild acute pancreatitis group, 38.77 mg/dL in moderate acute pancreatitis group and 44.70 mg/dL in severe acute pancreatitis groups. Comparison of HDL and severity of acute pancreatitis showed statistically significant results.

Table 1: Comparison of RDW and Severity of Acute Pancreatitis

	N	Mean	Std. Deviation	P value
Mild acute pancreatitis	60	14.808	1.42	0.69
Moderate acute pancreatitis	30	14.16	1.405	
Severe acute pancreatitis	27	14.88	1.66	
Total	117	14.66	1.49	

Mean RDW was 14.808 in mild acute pancreatitis group, 14.16 in moderate acute pancreatitis group and 14.88 in severe acute pancreatitis groups. Comparison of RDW and severity of acute pancreatitis showed statistically non-significant results.

Table 2: Comparison of RPR and Severity of Acute Pancreatitis

	N	Mean	Std. Deviation	P value
Mild acute pancreatitis	60	.0168	.001	0.001 (S)
Moderate acute pancreatitis	30	.0157	.008	
Severe acute pancreatitis	27	.0133	.004	
Total	117	.0157	.009	

Mean RPR ratio was 0.0168 in mild acute pancreatitis group, 0.0157 in moderate acute pancreatitis group and 0.0133 in severe acute pancreatitis groups. Comparison of RPR ratio and severity of acute pancreatitis showed statistically significant results.

Table 3: Comparison of BISAP and Severity of Acute Pancreatitis

BISAP	mild acute pancreatitis	Moderate acute pancreatitis	severe acute pancreatitis	Total
0	7 (11.7%)	2 (6.7%)	4 (14.8%)	13 (11.1%)
1	25 (41.7%)	16 (53.3%)	11 (40.7%)	52 (44.4%)
2	22 (36.7%)	8 (26.7%)	9 (33.3%)	39 (33.3%)
3	6 (10%)	4 (13.3%)	3 (11.1%)	13 (11.1%)
Total	60 (100%)	30 (100%)	27 (100%)	117 (100%)

P VALUE=0.001 (S)

BISAP score 1 was 41.7% in mild acute pancreatitis group, 53.3% in moderate acute pancreatitis group and 40.7% in severe acute pancreatitis groups. BISAP score 2 was 36.7% in mild acute pancreatitis group, 26.7% in moderate acute pancreatitis group and 33.3% in severe acute pancreatitis groups. BISAP score 3 was 10% in mild acute pancreatitis group, 13.3% in moderate acute pancreatitis group and 11.1% in severe acute pancreatitis groups. Comparison of BISAP and severity of acute pancreatitis was shown statistically significant results.

Table 4: Regression analysis for predictor of the study

	Unstandardized Coefficients		P value	95.0% Confidence Interval	
	Odd ratio	Std. Error		Lower Bound	Upper Bound
RDW	.014	.053	.795	-.092	.120
RPR	1.711	.762	.02 (S)	.202	3.220
BISAP	-.003	.092	.974	-.185	.179

Depended variable: severity of pancreatitis

According to regression analysis, red cell distribution width to platelet ratio [RPR] was the only predictor of the severity of pancreatitis as compared to RDW and BISAP score.

Discussion:

Acute pancreatitis (AP) is an inflammatory process of the pancreas that often leads to local and systemic complications. It is also the most common pancreatic disease worldwide. According to the 2012 revised Atlanta classification for Acute pancreatitis, Severe Acute pancreatitis (SAP) has been redefined as Acute pancreatitis with persistent organ failure (organ failure lasting for more than 48 hours), whose mortality rate is between 20%-50%. There are two phases during Acute pancreatitis; systemic inflammatory response syndrome and the resultant organ failure dominate the early phase. There are currently no effective drugs available to treat Acute pancreatitis, and thus most care is supportive. Thus, rapid assessment of disease severity and the evaluation of prognosis are pivotal to determine therapeutic strategies as effective treatment could significantly decrease mortality in patients with Severe Acute pancreatitis.^{25, 26, 27}

The red blood cell distribution width (RDW) is a part of the routine complete blood count and can easily be obtained by clinicians. red blood cell distribution width (RDW) is a means of evaluating the variability in the size of erythrocytes and has been used widely in the differential diagnosis of anaemia. Recently, red blood cell distribution width (RDW) was shown to be associated with inflammatory reactions and has been used as a prognostic biomarker in hypertension, coronary disease, stroke, pulmonary hypertension, and acute kidney injury. However, it is not yet clear whether red blood cell distribution width (RDW) is associated with the prognosis of Severe Acute pancreatitis (SAP) patients or whether it can be used as a prognostic indicator for Severe Acute pancreatitis (SAP) patients.^{28, 29, 30}

Mean age was 50.13 years in mild acute pancreatitis group, 51.07 years in moderate acute pancreatitis group and 53.44 year in severe acute pancreatitis group. Similarly, in a study by Cetinkaya et al,⁵⁶ the mean age of the patients with severe acute pancreatitis was 52 years.³¹ Similarly in a study by Zhang F X et al, mean age of the patients with severe acute pancreatitis was 47 years.

Acute Pancreatitis is an inflammatory event of the pancreas. Excessive and uncontrolled systemic inflammatory reactions are key to the pathogenesis of Severe Acute pancreatitis (SAP) and related multiple organ dysfunction during the course of Severe Acute pancreatitis (SAP). Therefore, as an inflammatory indicator, the level of Red cell Distribution Width (RDW) should theoretically increase in Severe Acute pancreatitis (SAP) and should have predictive value for both disease severity and mortality in Severe Acute Pancreatitis patients. Zhang et al³² confirmed that Red cell Distribution Width (RDW) was positively associated with Acute Pancreatitis severity and was a useful predictive parameter for Acute Pancreatitis severity at the early admission stage. Wang et al³³ demonstrated that for each 1% increase in the RDW level, the mortality rate of elderly septic patients increased by 18%. The study by Zhang et al⁹ further confirmed that Red cell Distribution Width (RDW) was greater in the non-surviving Severe Acute pancreatitis (SAP) patients than in the surviving patients, and had better prognostic value for Severe Acute pancreatitis (SAP) patients than either the APACHE II score or the SOFA score. Therefore, clinicians could rapidly recognize those Severe Acute pancreatitis (SAP) patients with a higher risk for mortality when their Red cell Distribution Width (RDW) level was increased. More active therapy could then be promptly given in order to save their lives.

Inflammatory mediators have a pivotal role in the pathogenesis of Acute Pancreatitis, and also influence haemostasis, leading to coagulation abnormalities. These range from intravascular thrombosis to disseminated intravascular coagulation. Platelet activating factor is an inflammatory mediator and plays a role in the early stages, where it activates platelets, neutrophils, mast cells and amplifies the production of other cytokines. Another important factor in the coagulation cascade, known as tissue factor, induces coagulopathy and leads to reduced platelet count, fibrinogen and Anti Thrombin III levels.³⁴ In a study by Lasson A et al³⁵ of 27 patients with acute pancreatitis, platelet counts, prothrombin levels were decreased. In another study, plasma pre-kallikrein, Anti Thrombin III and platelet count were reduced during the first week after admission.³⁶

The red cell distribution width (RDW), an index of variability of erythrocyte size, has been reported as a predictor of mortality in some conditions, such as cardiac disease, strokes, infections and peripheral artery disease. Hu et al³⁷ evaluated the RDW in various liver diseases. The red cell distribution width (RDW), was increased in patients and was positively correlated with bilirubin, creatinine levels, prothrombin time, and negatively correlated with platelet count and albumin level. The half life of red blood cells is higher than bilirubin and albumin; therefore, the red cell distribution width (RDW), represented a more stable index. Proinflammatory cytokines of sepsis affect the survival of erythrocytes in circulation, damage

the membranes, suppress maturation and lead to larger and newer reticulocytes to enter circulation and increase the red cell distribution width (RDW). In addition, high oxidative stress can also reduce erythrocyte survival and increase the release of large premature erythrocytes into the circulation. Sadaka et al³⁸ demonstrated that an RDW on the first day of septic shock was very strongly associated with mortality and morbidity.

As mentioned above, the red cell distribution width (RDW) was increased in some pathological conditions, including acute pancreatitis. Some of the inflammatory cytokines that play a role in the aetiology of pancreatitis affect haemostasis and lead to coagulation abnormalities. In a recent study, Chen et al³⁹ evaluated the red cell distribution width to platelet ratio (RPR) to predict hepatic fibrosis stages in patients with chronic hepatitis B. Using these two indices, they stated that with such a simple and non-invasive method, the necessity for liver biopsy would be reduced because they found that this ratio provided the greatest value of liver fibrosis. In a study from our clinic, Şenol et al⁴⁰ demonstrated that an increased red cell distribution width (RDW) level was an independent predictor of mortality in Acute Pancreatitis patients. Based on this study, we asked whether red cell distribution width to platelet ratio (RPR) could be useful to assess the mortality of patients with Acute Pancreatitis. We then evaluated these parameters for our patients on hospital admission.

Early recognition of disease severity and early treatment interventions are very important to reduce the rates of morbidity and mortality. Severe Acute Pancreatitis needs urgent management, admission to an intensive care unit, optimization of oxygen delivery and maintenance of tissue perfusion. Improved outcome is associated with early restoration of blood volume circulation;⁴¹ therefore, careful monitoring of patients with Acute Pancreatitis improves survival. Consistent with the correlations mentioned above, we found that the red cell distribution width to platelet ratio (RPR) could predict mortality in patients with Acute Pancreatitis.

According to regression analysis, red cell distribution width to platelet ratio [RPR] was the only predictor of the severity of pancreatitis as compared to red cell distribution width (RDW) and Bedside index for severity of acute pancreatitis (BISAP) score. Cetinkaya E et al., studied Red cell distribution width to platelet ratio (RPR) in 102 patients and found it as a promising prognostic factor in acute pancreatitis.⁵⁶ They found both red cell distribution width (RDW) and red cell distribution width to platelet ratio (RPR) as independent and significant variables on admission to predict mortality. Badar JK et al also concluded that red cell distribution width to platelet ratio (RPR) was a useful marker of disease severity in acute pancreatitis, especially in early stage.⁵⁹

Conclusion

As complete blood count is a routine investigation done in all indoor admission patients, so if a variable from complete blood count like red cell distribution width to platelet ratio (RPR) can predict the disease severity in acute pancreatitis early, then it will be definitely helpful for us to decide in which patients more detailed investigations or extra care is required and we can use our resources accordingly. From this study we confirmed that red cell distribution width to platelet ratio (RPR) is a good predictor of disease severity in patients with acute pancreatitis.

References

- ¹ Joshua A. Greenberg MD, Jonathan Hsu, et al. Clinical practice guideline: management of acute pancreatitis *Can J Surg* 2016;59:128-140.
- ² Negi N, Mokta J, Sharma B, Sharma R, Jhobta A, Bodh V, et al. Clinical profile and outcome of acute pancreatitis: A hospital based prospective observational study in sub Himalayan State. *JAcute PancreatitisI*. 2018;66:22-24
- ³ Sharma S, Salim M, Gothwal SR. A study on acute pancreatitis-incidence, prevalence, morbidity and mortality, in Western Rajasthan. *IJBAMR*. 2017;6(3):545-48.
- ⁴ Yang AL, Vadhavkar S, Singh G, Omary MB. Epidemiology of alcohol-related liver and pancreatic disease in the United States. *Arch Intern Med*. 2008;168:649-56
- ⁵ Forsmark ChE, Vege SS, Wilcox CM. Acute Pancreatitis. *N Engl J Med* 2017;376:598-9
- ⁶ Pitchumoni CS, Patel NM, Shah P. Factors influencing mortality in acute pancreatitis: can we alter them? *J Clin Gastroenterol* 2005; 39: 798-814
- ⁷ Ganji A, Esmaeilzadeh A, Ghanaei O, et al. Predictive value of red blood cell distribution width for mortality in patients with acute pancreatitis: A systematic review and meta-analysis. *Med J Islam Repub Iran* 2017;31:124
- ⁸ Solak Y, Yilmaz MI, Saglam M, et al. Red cell distribution width is independently related to endothelial dysfunction in patients with chronic kidney disease. *Am J Med Sci* 2014;347:118-24.
- ⁹ Senol K, Saylam B, Kocaay F, et al. Red cell distribution width as a predictor of mortality in acute pancreatitis. *Am J Emerg Med* 2013;31:687-9.
- ¹⁰ Bradley EL III. A clinically based classification system for acute pancreatitis. Summary of the International Symposium on Acute Pancreatitis, Atlanta, Ga, September 11 through 13, 1992. *Arch Surg*. 1993;128:586-90

- ¹¹ Kwong WT, Ondrejková A, Vege SS. Predictors and outcomes of moderately severe acute pancreatitis. Evidence to Reclassify. *Pancreatology*. 2016;16(6):940-945
- ¹² Seth HS, Mishra P, Khandekar JV, Raut C, Mohan AK, Ammannaya GK, et al. Relationship between high red cell distribution width and systemic inflammatory response syndrome after extracorporeal circulation. *Braz J Cardiovasc Surg*. 2017;32(4):288-94
- ¹³ Dewitte A, Lepreux S, Villeneuve J, Rigother C, Combe C, Ouattara A, et al. [13] Blood platelets and sepsis pathophysiology: A new therapeutic prospect in critical ill patients. *Ann Intensive Care*. 2017;7(1):115
- ¹⁴ Xanthopoulos A, Papanicolaou M, Zajichek A, et al. In-hospital red blood cell distribution width change in patients with heart failure. *Eur J Heart Fail*. 2019;21(12):1659–1661
- ¹⁵ Wang B, Lu H, Gong Y, et al. The association between red blood cell distribution width and mortality in critically ill patients with acute kidney injury. *Biomed Res Int*. 2018;2018:9658216
- ¹⁶ Kim CH, Park JT, Kim EJ, et al. An increase in red blood cell distribution width from baseline predicts mortality in patients with severe sepsis or septic shock. *Crit Care*. 2013;17(6):R282.
- ¹⁷ Han F, Liu Y, Cheng S, et al. Diagnosis and survival values of neutrophil-lymphocyte ratio (NLR) and red blood cell distribution width (Red cell distribution width) in esophageal cancer. *Clin Chim Acta*. 2019;488:150–158.
- ¹⁸ Herter JM, Rossaint J, Zarbock A. Platelets in inflammation and immunity. *J Thromb Haemost*. 2014;12(11):1764–1775

- ¹⁹ Fawzy A, Anderson JA, Cowans NJ, et al. Association of platelet count with all-cause mortality and risk of cardiovascular and respiratory morbidity in stable COPD. *Respir Res.* 2019;20(1):86
- ²⁰ Lee HW, Kang W, Kim BK, et al. Red cell volume distribution width-to-platelet ratio in assessment of liver fibrosis in patients with chronic hepatitis B. *Liver Int.* 2016;36(1):24–30
- ²¹ Qiu L, Chen C, Li SJ, et al. Prognostic values of red blood cell distribution width, platelet count, and red cell distribution width-to-platelet ratio for severe burn injury. *Sci Rep.* 2017;7(1):13720
- ²² Kakafika A, PAcute Pancreatitisadopoulos V, Mimidis K, Mikhailidis DP. Coagulation, platelets, and acute pancreatitis. *Pancreas* 2007; 34:15-20
- ²³ Chen B, Ye B, Zhang J, Ying L, Chen Y. Red cell distribution width to platelet ratio: a novel noninvasive index for predicting hepatic fibrosis and cirrhosis in chronic hepatitis B. *PLoS One* 2013; 8: e68780
- ²⁴ Harrison DA, D'Amico G, Singer M. The Pancreatitis Outcome Prediction (POP) Score: a new prognostic index for patients with severe acute pancreatitis. *Critical care medicine* 2007;35(7):1703-1708
- ²⁵ Vege SS, DiMagno MJ, Forsmark CE, Martel M, Barkun AN. Initial Medical Treatment of Acute Pancreatitis: American Gastroenterological Association Institute Technical Review. *Gastroenterology.* 2018;154:1103–1139
- ²⁶ Peng T, Peng X, Huang M, Cui J, Zhang Y, Wu H, Wang C. Serum calcium as an indicator of persistent organ failure in acute pancreatitis. *Am J Emerg Med.* 2017;35:978–982.
- ²⁷ Banks PA, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG, Tsiotos GG, Vege SS Acute Pancreatitis Classification Working Group. Classification of acute pancreatitis--2012: Revision of the Atlanta classification and definitions by international consensus. *Gut.* 2013;62:102–111

-
- ²⁸ Sangoi MB, Da Silva SH, da Silva JE, Moresco RN. Relation between red blood cell distribution width and mortality after acute myocardial infarction. *Int J Cardiol.* 2011;146:278–280.
- ²⁹ Bilal A, Farooq JH, Kiani I, Assad S, Ghazanfar H, Ahmed I. Importance of Mean Red Cell Distribution Width in Hypertensive Patients. *Cureus.* 2016;8:e902
- ³⁰ Oh HJ, Park JT, Kim JK, Yoo DE, Kim SJ, Han SH, Kang SW, Choi KH, Yoo TH. Red blood cell distribution width is an independent predictor of mortality in acute kidney injury patients treated with continuous renal replacement therapy. *Nephrol Dial Transplant.* 2012;27:589–594.
- ³¹ Zhang FX, Li ZL, Zhang ZD, Ma XC. Prognostic value of red blood cell distribution width for severe acute pancreatitis. *World J Gastroenterol.* 2019;25(32):4739-4748
- ³² Zhang T, Liu H, Wang D, Zong P, Guo C, Wang F, Wu D, Tang M, Zhou J, Zhao Y. Predicting the Severity of Acute Pancreatitis With Red Cell Distribution Width at Early Admission Stage. *Shock.* 2018;49:551–555.
- ³³ Wang AY, Ma HP, Kao WF, Tsai SH, Chang CK. Red blood cell distribution width is associated with mortality in elderly patients with sepsis. *Am J Emerg Med.* 2018;36:949–953.
- ³⁴ Kakafika A, Papadopoulos V, Mimidis K, Mikhailidis DP. Coagulation, platelets, and acute pancreatitis. *Pancreas.* 2007;34:15–20
- ³⁵ Lassin A, Ohlsson K. Consumptive coagulopathy, fibrinolysis and protease-antiprotease interactions during acute human pancreatitis. *Thromb Res.* 1986;41:167–183
- ³⁶ Lee WS, Huang JF, Chuang WL. Outcome assessment in acute pancreatitis patients. *Kaohsiung J Med Sci.* 2013;29:469–477.

- ³⁷ Hu Z, Sun Y, Wang Q, Han Z, Huang Y, Liu X, Ding C, Hu C, Qin Q, Deng A. Red blood cell distribution width is a potential prognostic index for liver disease. *Clin Chem Lab Med.* 2013;51:1403–1408
- ³⁸ Sadaka F, O'Brien J, Prakash S. Red cell distribution width and outcome in patients with septic shock. *J Intensive Care Med.* 2013;28:307–313.
- ³⁹ Chen B, Ye B, Zhang J, Ying L, Chen Y. RDW to platelet ratio: a novel noninvasive index for predicting hepatic fibrosis and cirrhosis in chronic hepatitis B. *PLoS One.* 2013;8:e68780
- ⁴⁰ Şenol K, Saylam B, Kocaay F, Tez M. Red cell distribution width as a predictor of mortality in acute pancreatitis. *Am J Emerg Med.* 2013;31:687–689.
- ⁴¹ Gardner TB, Vege SS, Chari ST, Petersen BT, Topazian MD, Clain JE, Pearson RK, Levy MJ, Sarr MG. Faster rate of initial fluid resuscitation in severe acute pancreatitis diminishes in-hospital mortality. *Pancreatology.* 2009;9:770–776.