

Importance of Leukocyte count, Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio in Prognosis of Pesticide Poisoning

Shubham Chourishi¹, Vijayalaxmi S. Patil²

How to cite this article:

Shubham Chourishi, Vijayalaxmi S. Patil. Importance of Leukocyte count, Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio in Prognosis of Pesticide Poisoning. Indian J Forensic Med Pathol.2024;17(1):25-30.

ABSTRACT

CONTEXT: Pesticides are chemical compounds used for crop protection and poisoning with them is a very common occurrence in farmers. In an emergency setting, the identification of quick and powerful prognostic markers can be of high significance in the management of these patients.

AIMS: To assess the severity of Pesticide Poisoning by assessing the leukocyte count, neutrophil count, neutrophil-lymphocyte ratio (NLR) and platelet lymphocyte ratio (PLR) and its comparison with levels of Plasma Cholinesterase (PChE) as an aid to clinical diagnosis, for early treatment of the patients.

SETTINGS AND DESIGN: Hospital based Cross-sectional study. Study period 1st November 2018 - 30th May 2020

METHODS AND MATERIAL: Study was done on 148 confirmed cases of pesticide poisoning over a period of 1.5 years. Blood samples were collected in EDTA and plain vacutainers within 24 hours of admission and the values of total leukocyte Count (TLC), neutrophil count, NLR, PLR and PChE were measured and compared. The severity of poisoning was assessed according to Peradeniya Organophosphorus (POP) scale.

STATISTICAL ANALYSIS USED: Mean \pm SD, Chi square test for association, Comparison of mean using ANOVA test for comparison between and among groups, Sensitivity and specificity

analysis.

Author's Credentials: ¹Postgraduate, ²Associate Professor, Department of Pathology, Shri B.M. Patil Medical College, Hospital and Research Centre, BLDE (Deemed to be University), Vijayapura 586103, Karnataka, India.

Corresponding Author: **Vijayalaxmi S. Patil**, Associate Professor, Department of Pathology, Shri B.M. Patil Medical College, Hospital and Research Centre, BLDE (Deemed to be University), Vijayapura 586103, Karnataka, India.

Email: vijayalaxmi.patil@bldedu.ac.in

Received on: 25-01-2024

Accepted on: 29-03-2024

RESULTS: 89.86% and 10.14% of cases were due to poisoning by Organophosphorus compounds and carbamate respectively. The severely poisoned patients according to POP scale had more leukocyte count, neutrophil count, NLR and PLR; and less plasma cholinesterase level as compared to the patients with mild and moderate poisoning.

CONCLUSIONS: Total Leukocyte count,

neutrophil count, NLR and PLR are simple and easy to use parameters for estimating the severity of pesticide poisoning and assessing its prognosis. In resource limited setups, along with the clinical history, these basic CBC parameters can be useful and patient's immediate treatment can be started as early as possible.

KEYWORDS: Pesticide Poisoning; Organophosphorus poisoning; Neutrophil to lymphocyte ratio; Platelet to lymphocyte ratio; Plasma cholinesterase.

INTRODUCTION

Pesticide poisoning is common among farmers and it contributes to 2,50,000-3,00,000¹ deaths and 76,000² deaths worldwide and in India respectively. In India, highest incidence of suicides due to poisoning has been estimated as 8 to 43 per 1,00,000 population.³ Continued investigation of these chemicals over the past seventy years has produced greater variants of organophosphorus pesticides and nerve agents.^{4,5} Pesticide poisoning causes increased free radicals in the body which leads to noticeable changes on the direct (Leukocyte count) and calculated (NLR and PLR) parameters of CBC. At a primary setup, where cholinesterase levels cannot be performed, these parameters can help in assessing the prognosis of patients if combined with clinical history.

SUBJECTS AND METHODS

The study included 148 patients clinically diagnosed with pesticide poisoning at the time of admission to the Casualty of Shri B.M. Patil Medical College, Hospital and Research Centre Vijayapura, between 1/11/2018 to 30/05/2020. The effects of poisoning on various muscarinic and nicotinic receptors^{6,7,8,9} were evaluated largely based on the Peradeniya Organophosphorus poisoning (POP) scale¹⁰ and the patients were graded as mild, moderate, and severe cases of poisoning. The values of total leukocyte Count (TLC), neutrophil count, neutrophil-lymphocyte ratio, platelet lymphocyte ratio and plasma cholinesterase (PChE) were measured and compared to know the severity of the disease. The values of total leukocyte Count (TLC), neutrophil count and platelet count were measured on Sysmex XN-1000 fully automated hematology analyser. Neutrophil-lymphocyte ratio and platelet-lymphocyte ratio were calculated manually. The value of plasma cholinesterase was measured on Ortho Clinical Vitros 250 Chemistry System.

Cases of poisoning by unknown compounds and compounds of other chemicals such as benzene, mercury and cadmium were excluded.

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean± standard deviation (SD) were used. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Chi-square (χ^2) test was used for association between two categorical variables. The difference of the mean of analysis variables between more than two independent groups was tested by ANOVA test and F test was used for testing of equality of Variance.

If the p-value was < 0.05, then the results were considered to be statistically significant otherwise it was considered as not statistically significant. Data were analyzed using SPSS software v.23 (IBM Statistics, Chicago, USA) and Microsoft office.

RESULTS

In the present study, out of 148 cases studied, 43.9% cases were of 21-30 years of age group constituting majority of the cases. Females constituted 54.7% (81) of the total patients while males constituted 45.3% (67) of the total cases. Out of 148 cases, 79.72% (118 cases) of poisoning cases were suicidal, followed by 13.52% (20 cases) and 6.76% (10 cases) of homicidal poisoning and accidental poisoning respectively. 133 cases (89.86%) of poisoning were due to consumption of Organophosphorus compounds and 15 cases (10.14%) of poisoning were due to carbamate consumption.

Majority of the patients (including those with ventilatory support) survived (90.5%), whereas 9.5% patients succumbed to death.

The values of TLC, Neutrophil count, NLR and PLR showed an increase from mild to severe grade of poisoning as described in Table 1.

Table 1: Values of CBC and Biochemical parameters in different grades of poisoning

Parameters	POP			p value
	Mild	Moderate	Severe	
TLC	11801.27±	12409.78±	19296.41±	<0.001
(cells/uL)	4814.7	4004.01	5952.62	*
Neutrophils (%)	75.67±12.25	82.17±6.92	87.55±5.66	<0.001*
Plasma Cholinesterase	6547.62±2121	3902.61±1646	561.54±423.	<0.00
(Units/L)	.58	.54	24	1*
NLR	5.68±4.75	8.93±8.72	14.51±10.71	<0.001*
Absolute Lymphocyte Count	2223.12±146	1622.63±90	1579.87±92	0.008
(cells/uL)	3.67	7.02	8.21	*
Platelet lymphocyte ratio	168.14±104.	202.52±170.	281.13±257.	0.008*
(PLR)	18	43	63	

DISCUSSION

Pesticides are extremely toxic to human beings, and pesticide poisonings are associated with high morbidity and mortality.¹ Deaths due to pesticide poisoning per year has been estimated to be approximately 2,50,000–3,00,000 worldwide¹ and India contributes to a significant proportion of these deaths (76000 per year).² Acute pesticide poisoning can be accidental, suicidal or homicidal. Oxidative stress is the major mechanism in the pathophysiology of most toxins and diseases.¹¹ Experimental and clinical studies have reported that the production of free radicals is increased in pesticide poisoning. More severe pesticide poisonings will lead to an increased production of free radicals. When the production of free radicals exceeds the antioxidant capacity of the patient, there will be noticeable changes on the CBC due to the oxidative stress. Increased oxidative stress in the acute period will lead to Leukocytosis, neutrophilia, lymphocytopenia and monocytosis that can be detected on CBC.¹ “Leukocytosis in acute poisoning is due to neutrophilia caused by neutrophil margination, and not due to increased marrow production”.¹² Neutrophils comprise approximately 65% of the peripheral blood and are important to generate an immune response. Therefore, patients with increased stress due to poisoning have a higher WBC count as compared to patients with minor or no stress.¹²

This study found out that approximately 80% of the poisoning cases in Vijayapura district were

due to suicidal poisoning and 90% of the poisoned patients consumed Organophosphorus pesticides followed by Carbamates. In areas like Vijayapura, financial constraints in addition to low rainfall leads to an increased burden of suicidal attempts in the farmer community. The general supportive therapy given to poisoned patients, particularly respiratory and cardiovascular support, are crucial and it is important to decide on admission to the Emergency Department which patient should be followed in the intensive care unit (ICU) and also to estimate which patient can be expected to have a better prognosis during the follow-up period.¹

In general, a pesticide poisoning causes acute oxidative stress which leads to neutrophilic margination, as neutrophils act as the primary reactors in bodily stressful conditions.¹ According to Tang *et al*¹³ the most important indices in predicting mortality in OP poisoning were Neutrophil percentage, followed by Total WBC count, MCHC, and hemoglobin while the most important indices in Paraquat (PQ) poisoning were Platelets, followed by Neutrophil count, Total WBC count and hemoglobin. In the present study, cases showed an increase in the Neutrophil count with the increasing grades of poisoning which was in correlation with the study done by Tang *et al*. (Table 2)

Table 2: Neutrophil count (%) in present study and other studies

Study	Mild cases	Moderate cases	Severe cases	p-value
Tang et al	56±9	82±10	83±13	<0.001
Present study	75.67±12.25	82.17±6.92	87.55±5.66	<0.001

As a primary laboratory abnormality, leukocytosis occurs along with neutrophilia to combat oxidative stress in cases of acute poisoning. In a retrospective study of 209 patients done by Dundar *et al*¹ it was suggested that more severely poisoned patients had leukocytosis, neutrophilia, monocytosis, and lymphocytopenia within the

first 24 h after admission to the ED. Significant leukocytosis in the death group was also noted in studies performed by Kumar S *et al*¹² and Elhosary NM & Abd-ElBar ES.¹⁴ The present study showed similar results as compared to the above mentioned studies. (Table 3)

Table 3: Total Leukocyte count (cells/uL) in the present study and other studies

Study	Mild Cases	Moderate Cases	Severe cases	p-value
Tang et al	5890±1300	14220±6160	18460±8240	<0.001
Kumar et al	7041.35±2405±42	10245.48±4392.69	13440±5130	0.0001
Elhosary NM & Abd-ElBar ES	8210±1050	9550±1420	13320±1050	<0.001
Present study	11801.27±4814.7	12409.78±4004.01	19296.41±5952.62	<0.001

Study done by Elhosary NM and Abd-ElBar ES¹⁴ revealed leukocytosis, lymphopenia, and thrombocytosis in death group. In contradiction, the Absolute Lymphocyte Count (ALC) was increased in the death group of patients with Paraquat

poisoning in a study done by Kang C *et al*.¹⁵ This study showed decrease in absolute lymphocyte count similar to the pattern mentioned in the study done by Elhosary NM and Abd-ElBar ES. (Table 4)

Table 4: Absolute lymphocyte count (cells/uL) in the present study and other studies

Study	Mild Cases	Moderate Cases	Severe Cases	p-value
Elhosary NM & Abd-ElBar ES	1670±494.9	1000±70.7	830±56.6	<0.001
Present study	2223.12±1463.67	1622.63±907.02	1579.87±928.21	0.008

Neutrophil to lymphocyte ratio and platelet to lymphocyte ratio have been indicated as fast, feasible and easy to use parameters indicating severity of the oxidative stress in various conditions like sepsis¹³, heart failure¹⁴, snake bite¹⁵, Gastrointestinal cancers¹⁶ and poisoning. Several studies undertaken by Elhosary NM & Abd-ElBar ES¹⁴ and Dundar *et al*¹ showed that

Neutrophil to Lymphocyte Ratio and Platelet to Lymphocyte Ratio were statistically elevated in severely poisoned patients. In the present study, the relation of neutrophil to lymphocyte ratio with the various levels of poisoning was in agreement with stud conducted by Elhosary NM & Abd-ElBar ES as mentioned in Table 5.

Table 5: Neutrophil to Lymphocyte ratio in the present study and other studies

Study	Mild cases	Moderate cases	Severe cases	p-value
Elhosary NM & Abd-ElBar ES	2.09±0.33	3.72±0.59	8.67±2.35	<0.001
Present study	5.68±4.75	8.93±8.72	14.51±10.71	<0.001

The Neutrophil to lymphocyte ratio in the present study showed an increase in the non-survivors as compared to the survivors, similar to the results of the study conducted by Dundar *et al*¹ (Table 6)

Table 6: Neutrophil to lymphocyte ratio in survivors and non-survivors

Study	Survivors	Non Survivors
Dundar et al	7.3±7.1	11.8±3.6
Present study	8.44±8.48	14.5±8.9

In the present study, the Platelet to lymphocyte ratio showed an increase in the values in non survivors as compared to survivors which was in conjunction to the study done by Dundar *et al*¹ (Table 7)

Table 7: Platelet to lymphocyte ratio in survivors and non-survivors

Study	Survivors	Non Survivors
Dundar et al	174.8±118.7	217.2±102.2
Present study	199.55±182.92	295.14±137.49

The present study showed increase in platelet lymphocyte ratio from mild to severe cases of poisoning as described in the study done by Elhosary NM & Abd-ElBar ES (Table 8).

Table 8: Platelet to lymphocyte ratio in the present study and other studies

Study	Mild Cases	Moderate Cases	Severe Cases
Elhosary NM & Abd-ElBar ES	116.36±25.6	200.63±29	362.51±59.45
Present study	168.14±104.18	202.52±170.43	281.13±257.63

Studies undertaken by Dundar *et al*¹ and Kumar *et al*¹² revealed that mean plasma cholinesterase levels was reduced in non-survivors as compared to the survivors. The present study showed similar results as mentioned in Table 9.

Table 9: Plasma cholinesterase (Units/L) in survivors and non-survivors

Study	Survivors	Non survivors	p-value
Dundar et al	5449±3919	1667±3025	0.005
Kumar et al	3287.16±2719.30	1456.05±1159.42	0.0001
Present study	4520.89±2826.43	580±1098.64	<0.001

CONCLUSION

With respect to an increasing death toll due to pesticide poisoning among farmers and lack of specialized instrumentation and technology at the primary care level, few simple and convenient parameters can be used to assess the severity of poisoning, if combined with a history of poison intake. In this study we found that there was increase in the various hematological parameters like leukocyte count, neutrophil lymphocyte ratio and platelet lymphocyte ratio with increase in the severity of the pesticide poisoning. The plasma cholinesterase level was noted to decrease with increase in the severity of the pesticide poisoning. Hence, leukocyte counts, neutrophil count, neutrophil lymphocyte ratio, and platelet lymphocyte ratio within 24 hours of pesticide exposure and prior to the administration of any medications are useful, valuable, inexpensive and easily accessible parameters in estimating prognosis and the follow-up of patients with acute pesticide poisoning.

Conflict of Interest: Nil

Source of Funding: Nil

Ethical issues: Nil

REFERENCES

- Dundar ZD, Ergin M, Koylu R, Ozer R, Cander B and Gunaydin YK.** Neutrophil-lymphocyte ratio in patients with pesticide poisoning. *The Journal of Emergency Medicine*.2014;47:286–93.
- G Ravi, C Rajendiran, P Thirumalaikolundu subramanian, N Babu.** Poison control, training and research center, Institute of Internal Medicine, Government General Hospital, Madras Medical College, Chennai, India. Presented at 6th Annual congress of Asia Pacific Association of Medical Toxicology, Bangkok, Thailand 2-14 December 2007.
- Behere PB, Behere AP.** Farmers' suicide in Vidarbha region of Maharashtra state: A myth or reality? *Indian J Psychiatry*.2008;50:124-7.
- Szinicz L.** History of chemical and biological warfare agents. *Toxicology* 2005; 214:167-81.
- Cannard K.** The acute treatment of nerve agent exposure. *J Neurol Sci* 2006; 249: 86-94.
- Karalliadde L, Senanayake N.** Organophosphorus insecticide poisoning. *Br J Anaesth*.1998; 63 : 736-50.
- Namba T, Nolte CT, Jackrel J, Grob D.** Poisoning due to organophosphate insecticides. *Am J Med*. 1971; 50: 475 –92.
- Eddleston M, Buckley NA, Checketts H et al.** Speed of initial atropinisation in significant organophosphorous pesticide poisoning—a systematic comparison of recommended regimens. *J Toxicol Clin Toxicol*. 2004; 42:865–75.
- Eddleston M, Clark R.** Insecticides: Organic Phosphorus Compounds and Carbamates. In: Goldfrank LR, Flomenbaum NE, Lewin NA, Howland MA, Hoffman RS, Nelson L. *Goldfrank's Toxicological Emergencies*. 7th ed. New York: McGraw-Hill; 2002:1450-62
- Dubey TN, Yadav S, Kawre KK.** Correlation of Severity of Organophosphorus Poisoning as Assessed by Peradeniya Organophosphorus Poisoning Scale with Serum Amylase and CPK Level. *IJCMR*.2016;3(9):2534-7
- Hernandez AF, Lacasana M, Gil F, Barranco MR, Pla A, Guarnido OL.** Evaluation of pesticide-induced oxidative stress from a gene-environment interaction perspective. *Toxicology*.2012;307:95–102
- Kumar S, Agrawal S, Raisinghani N, Khan S.** Leukocyte Count: A Reliable Marker for the Severity of Organophosphate Intoxication? *Journal of Laboratory Physicians*.2018;10:185-8
- Tang Y, Hu L, Hong G, Zhong D, Song J, Zhao G et al.** Diagnostic value of complete blood count in paraquat and organophosphorus poisoning patients. *Toxicology and Industrial Health*.2018;34:439-47.
- Elhosary N, Abdelbar E.** Red cell distribution width, neutrophil lymphocyte and platelet lymphocyte ratios as prognostic markers in acutely pesticides- poisoned patients. *The Egyptian Journal of Forensic Sciences and Applied Toxicology*.2018;18(4):29-46.

15. Kang C, Kim S, Lee S, Jeong J, Kim D, Kim D.
Absolute Lymphocyte Count as a Predictor of Mortality in Emergency Department Patients with Paraquat Poisoning. PLoS

*One.*2013;8:e78160.

16. Westerdijk K, Simons K, Zegers M, Wever P, Pickkers P, de Jager C.
The value of the neutrophil-lymphocyte ratio

in the diagnosis of sepsis in patients admitted to the Intensive Care Unit: A retrospective cohort study. PLOS ONE. 2019;14:e0212861.

