



SERUM CHOLINESTERASE LEVELS AND MORTALITY PREDICTION IN PESTICIDE POISONING

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ABSTRACT

Background: Acute pesticide poisoning is common medical Emergency in developing nations and has a huge morbidity and mortality. Timely intervention of high-risk patients should be done early and serum cholinesterase has been proposed as a convenient biochemical indication of severity of poisoning.

Objective: To determine the association between serum cholinesterase levels and in-hospital mortality in patients presenting with pesticide poisoning.

Methodology: This was observational study that involved 72 patients who came into the clinic with acute pesticide poisoning in the period from March 2024 to February 2025 at Sir Syed College of Medical Sciences (For Girls) & Khairpur Medical College, Khairpur Mir's Pakistan. At admission, demographic information, exposure, clinical observations and laboratory values such as cholinesterase levels in serum were taken. Follow up was done to patients until discharge or death. Appropriate statistical tests were used to compare survivors and non-survivors and receiver operating characteristic (ROC) analysis was done to determine the predictive value of serum cholinesterase as a predictor of mortality.

Results: The mortality rate was 27.8%. Non-survivors had significantly lower serum cholinesterase levels, poorer Glasgow Coma Scale scores, and a higher requirement for mechanical ventilation compared to survivors ($p < 0.001$). A serum cholinesterase cutoff value of ≤ 1500 U/L predicted mortality with high sensitivity and specificity, and ROC analysis demonstrated excellent discriminative ability.

Conclusion: Serum cholinesterase level is a strong predictor of mortality in pesticide poisoning. Early estimation can assist in risk stratification and guide prompt intensive management.

Keywords: Pesticide poisoning, organophosphate poisoning, serum cholinesterase, mortality prediction, prognostic marker

INTRODUCTION

Acute pesticide poisoning is a serious health issue across the globe especially in the agricultural and low-income areas where the toxic substances are readily available [1]. The most frequently implicated agents include the organophosphate and carbamate pesticides that cause a significant percentage of deliberate and unintentional poisonings. These compounds inhibit the activity of acetylcholinesterase which results in the excessive accumulation of acetylcholine at the synapses and they cause a cholinergic crisis, a respiratory distress, altered consciousness, and cardiovascular instability [2-4].

Pesticide poisoning has a very diverse clinical presentation with mild muscarinic symptoms to life-threatening respiratory failure. Severe poisoning should be identified early since timely administration of atropine, protection of airways, and close monitoring can greatly lower mortality rate. Nonetheless, clinical results alone might not be easy to apply in an emergency room setting because of overlapping of symptoms and difference in exposure history. Thus, a objective biochemical indicator, one that is associated with severity of poisoning, is very useful [5-7].

A readily available laboratory test that indicates the extent of enzyme inhibition after exposure to organophosphates is serum cholinesterase. Higher levels are associated with a higher level of toxicity and have been suggested as one of the predictors of the severity of poisoning . While various studies have indicated that low levels of enzymes are associated with respiratory failure, ventilation requirements, and poor outcomes, its predictive value in clinical practice is not fully applied in most practice environments [8-10].

Given the high burden of pesticide poisoning and the need for early prognostic indicators, this study was conducted to evaluate the relationship between serum cholinesterase levels and mortality in patients presenting with acute pesticide poisoning and to assess its usefulness as a predictor of clinical outcome. In Pakistan, pesticide ingestion remains one of the leading causes of poisoning presenting to emergency and forensic departments.

METHODOLOGY

The present study was an observational study, which was designed as a prospective study to assess the relationship between serum cholinesterase levels and patient death cases in patients who presented themselves with pesticide poisoning. The study was conducted at Sir Syed College of Medical Sciences (For Girls) & Khairpur Medical College, Khairpur Mir's Pakistan between March 2024 and February 2025. Ethical approval was obtained from the Institutional Ethical Review Committee.

Demographic information, exposure type, route, and intent, and interval between intake and presentation to the hospital were gathered at the arrival. Thorough clinical assessment of the patient involved Glasgow Coma Scale (GCS), vital signs, pupil size, respiratory suffering, and ventilatory support requirement. Blood samples were collected during admission prior to oximes administration where possible and serum cholinesterase levels were determined through standardized automated enzymatic assay procedures in hospital laboratory. Favorable laboratory tests such as renal functional tests and blood artery gases were also noted where possible. Every patient was treated according to regular protocols of treating poisoning such as the use of atropine, oximes, oxygen therapy, and mechanical ventilation in case of need, and monitored till discharge or death throughout the hospital stay.

Data were recorded and were analyzed through the use of SPSS version 26. Issues of mean and standard deviation were used to measure continuous variables, and frequencies and percentages were used to measure categorical variables. The comparison of the continuous variables between the survivor and non-survivor was performed with the help of the independent sample t-test; the categorical variables were compared with the help of the chi-square test. ROC curves analysis was done to ascertain both the predictive power of the serum cholinesterase level on mortality, and the optimal cutoff value. A p-value of 0.05 was found to be statistically significant.

RESULTS

The researchers involved 72 patients who were victims of pesticide poisoning, out of which 52 patients survived and 20 died which presented a mortality rate of 27.8. The non-survivors were much older and it took a long time before they could get to the hospital as compared to the survivors. There was no significant gender or type of exposure relationship, but the majority of them comprised suicidal organophosphate ingestion.

Table 1. Baseline Characteristics of Patients

Variable	Survivors (n=52)	Non-Survivors (n=20)	p-value
Age (years), mean $\pm$ SD	28.9 $\pm$ 9.7	36.4 $\pm$ 11.2	0.01
Male gender, n (%)	29 (55.8%)	13 (65.0%)	0.48
Time to hospital (hours), mean $\pm$ SD	3.8 $\pm$ 2.1	7.2 $\pm$ 3.5	<0.001
Suicidal ingestion, n (%)	44 (84.6%)	19 (95.0%)	0.24
Organophosphate exposure, n (%)	41 (78.8%)	18 (90.0%)	0.31
Pre-hospital treatment received, n (%)	21 (40.4%)	4 (20.0%)	0.09

Expired patients were characterized by significantly reduced levels of serum cholinesterase in the body and worse neurological condition at admission. They also experienced a lot of bradycardia, hypotension, respiratory distress, and mechanical ventilation. These results suggest that the extreme cases of cholinesterase depression are strongly related with clinical severity and mortality.

Table 2. Clinical Severity and Serum Cholinesterase at Presentation

Parameter	Survivors (n=52)	Non-Survivors (n=20)	p-value
Serum cholinesterase (U/L), mean $\pm$ SD	3278 $\pm$ 1425	914 $\pm$ 530	<0.001
GCS score, mean $\pm$ SD	12.6 $\pm$ 2.4	7.1 $\pm$ 2.2	<0.001
Heart rate (beats/min)	88 $\pm$ 14	62 $\pm$ 16	<0.001
Systolic BP (mmHg)	109 $\pm$ 16	84 $\pm$ 18	<0.001
Respiratory distress, n (%)	18 (34.6%)	18 (90.0%)	<0.001
Need for mechanical ventilation, n (%)	9 (17.3%)	19 (95.0%)	<0.001

Receiver operating characteristic analysis showed excellent predictive ability of serum cholinesterase for mortality. A cut-off value of ≤ 1500 U/L demonstrated high sensitivity and specificity in identifying high-risk patients. The high negative predictive value suggests normal or moderately reduced levels reliably indicate survival.

Table 3. Predictive Value of Serum Cholinesterase for Mortality

Diagnostic Measure	Value
Sensitivity	90.0%
Specificity	82.7%
Positive Predictive Value (PPV)	66.7%
Negative Predictive Value (NPV)	95.5%
Accuracy	84.7%
Area Under ROC Curve (AUC)	0.91

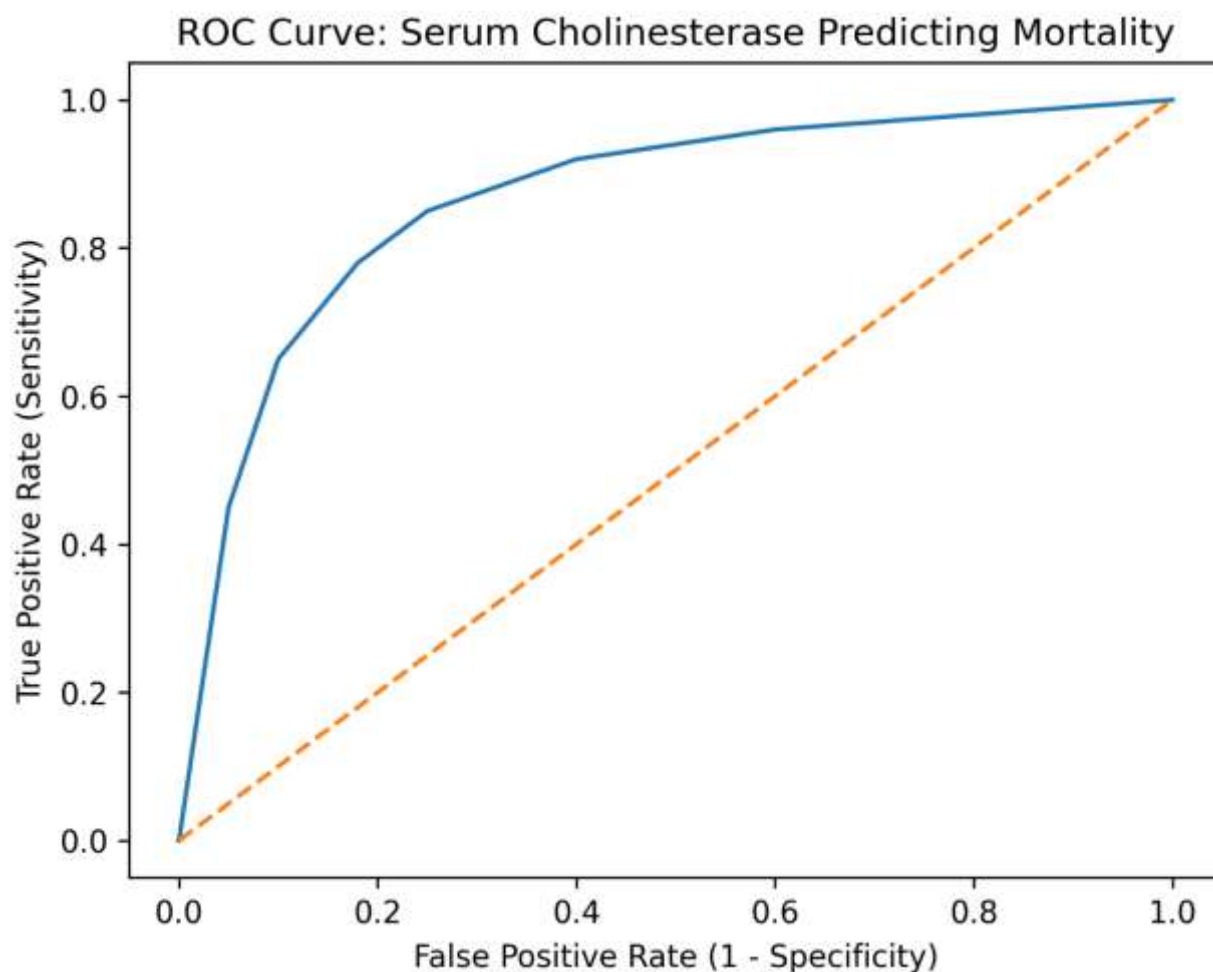


Figure 1: Receiver operating characteristic (ROC) curve demonstrating the ability of serum cholinesterase level to predict mortality. The curve shows high diagnostic performance with an area under the curve (AUC) of approximately 0.91, indicating excellent discrimination between survivors and non-survivors.

DISCUSSION

The burden is particularly high in South Asian countries including Pakistan due to easy availability of agricultural pesticides [11, 12]. Acute pesticide poisoning continues to be a significant health issue among the general population in developing nations in the cases of easy access to organophosphate pesticides and their tendency to abuse it in self-harm. The mortality rate was 27.8 in the current study that indicates both the severe clinical burden in terms of late hospital admission and severe cholinergic toxicity. Expired patients arrived at the hospital much later than the survivors thus confirming the already developed idea that early resuscitation and atropinization have significant positive effect in cases of poisoning [13-15].

An important conclusion of this research was that the serum cholinesterase level was significantly lower in non-survivors as compared to survivors. The inhibition of serum cholinesterase occurs following the exposure to organophosphates, and its level of inhibition is inversely proportional to the level of acetylcholinesterase inhibition in neuromuscular junctions. The current findings indicated that the worse the enzyme levels were the worse the neurological status was and the worse the mortality was, and thus biochemical severity is similar to the clinical severity [16-18].

Severely poisoned patients were also less likely to get GCS scores, hypotension, bradycardia as well as a much greater requirement of mechanical ventilation. These symptoms signify developed cholinergic crisis with respiratory failure and cardiovascular crumbles, which are acknowledged as strong predictors of mortality in organophosphate intoxication. This paper has found that the

connection between ventilatory need and mortality is strong, and therefore the need to protect the airways early and use aggressive supportive management is critical [19-21].

Receiver operating characteristics analysis proved that serum cholinesterase is a good predictor of mortality, and its properties are good sensitivity and specificity across the chosen cutoff [22]. The negative predictive value is very high implying that patients whose enzyme activity remains relatively intact are unlikely to deteriorate thus this test is clinically helpful in the case of triage and risk stratification of patients in the emergency. Therefore, the serum cholinesterase is not only a diagnostic biomarker but also a prognostic biomarker [23, 24].

On the whole, the research shows that the clinical assessment with serum cholinesterase estimation can enhance early detection of the high-risk patients. This low cost laboratory test can be used in decision-making about ICU admission, monitoring intensity, and early ventilatory support in environmentally restricted environments where the use of advanced scoring systems may not be easily accessible.

CONCLUSION

Serum cholinesterase level is a strong and reliable predictor of mortality in acute pesticide poisoning. Severely depressed enzyme levels correlate with poor neurological status, need for mechanical ventilation, and increased risk of death. Early measurement of serum cholinesterase can assist clinicians in rapid risk stratification and timely management, ultimately improving patient outcomes.

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