



"ELECTROCARDIOGRAPHIC AND BIOMARKER ALTERATIONS IN POISONING CASES: CARDIAC OUTCOME EVALUATION"

Medicine

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ABSTRACT

Background: Poisoning remains a significant public health challenge, particularly in regions like India where toxins such as organophosphates, aluminum phosphide (Celphos), and rodenticides are commonly accessible. These substances can cause severe cardiac complications, including arrhythmias and myocardial injury, contributing to increased mortality. Early detection of cardiac involvement through electrocardiogram (ECG) changes and cardiac biomarkers like Troponin I and NT-Pro BNP is crucial for improving survival rates. **Aims & Objectives:** This study aimed to evaluate ECG changes and cardiac biomarkers in patients with various poisonings and to assess the outcomes associated with cardiac involvement. **Methods:** A cross-sectional observational study was conducted at BRD Medical College, Gorakhpur, over a one-year period, including 191 acute poisoning cases. ECG recordings and measurements of Troponin I and NT-Pro BNP were analyzed. Chi-square, T-test, and ANOVA were used to assess statistical significance. **Results:** Elevated cardiac biomarkers were significantly associated with poisoning cases involving cardiac complications. Celphos poisoning demonstrated the strongest correlation between elevated biomarkers and poor outcomes. While QTc prolongation was noted, it was not a significant predictor of mortality. Patients requiring inotropic support, particularly in the Celphos group, had a higher mortality rate. **Conclusions:** Cardiac involvement, identified through ECG changes and elevated biomarkers, is a significant predictor of mortality in poisoning cases. Early diagnosis and intervention are essential for improving patient outcomes.

KEYWORDS

Poisoning, Cardiac Biomarkers, ECG Changes, Troponin I, Mortality.

INTRODUCTION

Exposure to toxins is a frequent cause of medical emergencies, and its effects depend on the type and amount of toxin involved. Quick medical evaluation is crucial for effective treatment, which could include the use of antidotes and supportive care. In India, the widespread availability of agricultural chemicals like insecticides and pesticides has contributed to a rise in poisoning cases. Commonly encountered toxins include heavy metals, corrosives, and over-the-counter medications.

Toxins can have a range of effects, from mild symptoms to life-threatening conditions. For example, corrosive ingestion causes gastrointestinal damage, while toxins like celphos and paraquat can directly harm the heart. Organophosphate poisoning, in particular, can cause electrolyte imbalances, metabolic acidosis, and an increase in sympathetic and parasympathetic activity, all of which can affect cardiac function.

Cardiac toxicity is a major concern, manifesting as hypotension, arrhythmias, myocarditis, and even sudden death. The World Health Organization (WHO) reports that pesticides are among the most commonly encountered toxins worldwide¹. Organophosphates, aluminum phosphide, rodenticides, and herbicides are frequent causes of poisoning, making it a significant public health issue.

In a study by Sanjay Samaria et al. (2024)², organophosphates were identified as the leading cause of poisoning in central India, followed by prescription medications and rodenticides. The electrocardiogram (ECG), a quick and accessible tool, can help diagnose cardiac toxicity. Changes such as sinus tachycardia, bradycardia, and QTc prolongation are common, with QTc prolongation linked to an increased risk of arrhythmias and sudden death. Dr. Ritu Singh et al.³ observed higher mortality in aluminum phosphide poisoning cases with ECG abnormalities.

Cardiac biomarkers, including NT-proBNP and troponin I, also indicate myocardial injury. While traditionally used for heart failure and acute myocardial infarction, these biomarkers are now recognized in non-cardiac conditions caused by toxins that stress the heart.

This thesis aims to investigate the relationship between poisoning, ECG changes, and cardiac biomarkers to understand the cardiac complications of poisoning better and improve clinical outcomes.

Need For Study

The increasing incidence of poisoning cases, particularly in regions like India where agricultural chemicals are widely accessible, has highlighted the critical need for early detection of cardiac complications. Poisoning from substances like organophosphates and Celphos can lead to severe cardiovascular issues, including arrhythmias and myocardial injury, which are major contributors to morbidity and mortality. Current diagnostic methods, such as ECG changes and cardiac biomarkers like Troponin I and NT-Pro BNP, offer valuable insights into the extent of cardiac involvement. However, there is a need for comprehensive studies that combine these diagnostic tools to enhance early detection and improve clinical outcomes. This study seeks to fill this gap by evaluating the correlation between ECG changes, cardiac biomarkers, and outcomes in poisoning cases, providing crucial data for better patient management.

MATERIALS AND METHODS

This cross-sectional observational study was conducted in the Medicine Emergency Department at BRD Medical College, Gorakhpur, Uttar Pradesh, over a one-year period, from May 2023 to June 2024. The study aimed to evaluate electrocardiogram (ECG) changes and cardiac biomarkers, particularly Troponin I and NT-Pro BNP, in patients with acute poisoning. A total of 191 patients, out of 204 admissions, met the inclusion criteria and consented to participate in the study. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from all patients or their legal representatives.

Patients included in the study were those aged 18 years and above who presented with a history of poisoning and provided informed consent. Exclusion criteria involved non-consenting patients. Detailed clinical evaluations were conducted for each patient, including history taking, systemic examination, and investigation of vital signs. Particular attention was paid to cardiovascular and respiratory assessments. Poisoning cases included exposure to a variety of toxins, with a focus on types, time of ingestion, comorbidities, and any prior treatments received.

All study participants underwent a 12-lead ECG recording within 15 minutes of admission, prior to the administration of any treatment, particularly in cases of organophosphate poisoning. The ECG analysis focused on PR and QT intervals, rhythm abnormalities, conduction issues, and ST-T segment changes. QT interval was corrected using the Bazett formula. Concurrently, blood samples were collected and processed to measure Troponin I and NT-Pro BNP levels in the central pathology lab of BRD Medical College.

The study used predefined cut-off values for QTc prolongation (>430 milliseconds), Troponin I (>0.04 pg/ml), and NT-Pro BNP (>300 pg/ml) to evaluate cardiac involvement. Data analysis was conducted using IBM SPSS software, with chi-square tests used for categorical variables, T-tests for comparing two independent groups, and ANOVA for comparing more than two groups. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Distribution of study subjects according to Age, Gender & comorbidities

AGE (Years)	Frequency (N)	% of Total
15 - 25	99	51.80%
26 - 35	45	23.60%
36 - 45	30	15.70%
46 - 55	8	4.20%
>55	9	4.70%
Total	191	100.00%
GENDER		
Male	102	53.40%
Female	89	46.60%
Total	191	100.00%
COMORBIDITY		
None	175	91.62%
Psychiatric illness	5	2.62%
HTN	4	2.1%
Seizure disorder	4	2.1%
T2DM	2	1.04%
CAD	1	0.52%
Total	191	100.00%

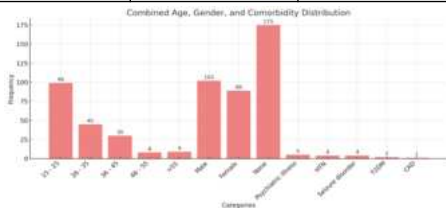


Figure 1: Distribution of study subjects according to Age, Gender & comorbidities

Table 2: Association of outcomes with ECG changes

ECG changes	IMPROVED	EXPIRED
Sinus rhythm	155	18
ST elevation	1	3
ST depression	2	6
LBBB	1	0
Ventricular ectopic	1	1
T Wave inversion	2	1

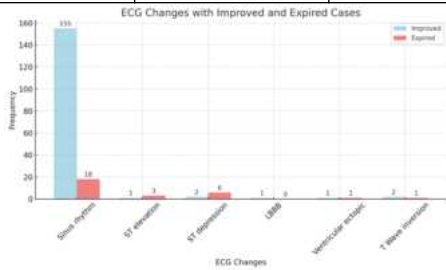


Figure 2: Association of outcomes with ECG changes

Table 3: E.C.G Changes observed in various poisoning

Poison	Sinus rhythm	ST elevation	ST depression	LBB	Ventricular ectopic	T Wave inversion
Insecticidal	66	0	1	1	1	0
Chlorpyrifos/cypermethrin	18	0	1	0	0	0
Celphos	30	0	0	0	0	0
Rodenticidal	38	4	6	1	0	3
Herbicidal	9	0	0	0	0	0
Others	20	0	0	0	0	0

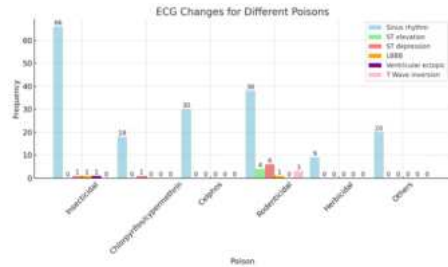


Figure 3: E.C.G Changes observed in various poisoning

Table 4: Association of different types of poison to QTc, Trop-I & NT-Pro BNP

Poison	Frequency		Qt c	TROP-I (Mean)		NT-Pro BNP(Mean)	
	Impr oved	Expire d	Media n	Impr oved	Expir ed	Impr oved	Expire d
Insecticidal	57	12	367	0.047	0.336	156	1710.1
Chlorpyrifos/cypermethrin	15	4	370	0.009	0.021	172.6	590.8
Celphos	41	9	367	0.052	0.523	142.2	388.9
Rodenticidal	29	1	366	0.007	0.01	62	50
Herbicidal	8	1	374	0.11	0.01	135.6	50
Others	14	0	367	0.01	-	57.5	-

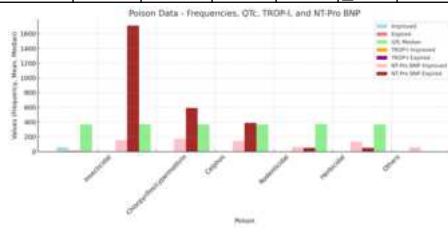


Figure 4: Association of different types of poison to QTc, Trop-I & NT-Pro BNP

Table 5: Distribution of biomarker levels in normal & abnormal ECG

E.C.G	Normal biomarker	Elevated biomarkers	P value
Normal E.C.G	159/173	14/173	<0.001
Abnormal E.C.G	5/18	13/18	

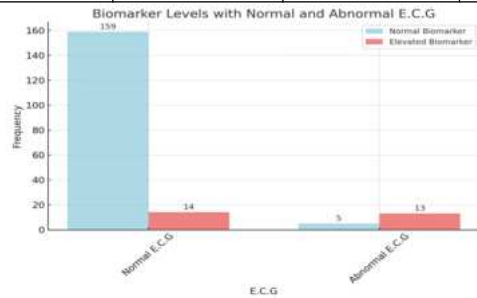


Table 6: Distribution of outcomes based on normal & elevated Trop-I & NT Pro BNP

POISON	Outcome		P- value	Normal NT-Pro BNP	Elevated NT-Pro BNP	P-value
	Normal TROP-I (Death/ Total)	Elevated TROP-I (Death/ Total)		(Death/ Total)	(Death/ Total)	
Insecticidal	8/59	4/10	0.066	8/57	4/12	0.066
Chlorpyrifos/cypermethrin	4/18	0	-	1/14	3/5	0.0005
Celphos	1/36	8/14	<0.0001	1/39	8/11	0.0001
Rodenticidal	1/30	0	-	1/29	-	-
Herbicidal	1/7	0	-	-	-	-
Others	0	0	-	-	-	-

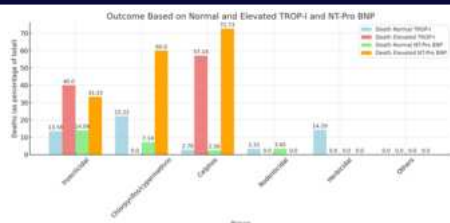


Figure 6: Distribution of outcomes based on normal & elevated Trop-I & NT Pro BNP

DISCUSSION

The current study, conducted on 191 patients at Baba Raghav Das Medical College, Gorakhpur, aimed to evaluate electrocardiographic (ECG) changes and cardiac biomarkers in poisoning cases over a one-year period.

The present study found that the majority of the study participants were between the ages of 15-25 years, accounting for 51.80% of the total subjects. The next most common age group was 26-35 years, comprising 23.60%, followed by 36-45 years at 15.70%. Only a small percentage (4.20%) of participants were between 46-55 years, and an even smaller group (4.70%) were over 55 years. In terms of gender distribution, there were slightly more males (53.40%) than females (46.60%). Regarding comorbidities, 91.62% of the subjects had no prior medical conditions. Psychiatric illness (2.62%) was the most prevalent comorbidity, followed by hypertension (2.1%), seizure disorders (2.1%), type 2 diabetes mellitus (1.04%), and coronary artery disease (0.52%). **Maharani B. et al.**⁴ (2013) conducted a study in Tamil Nadu, India, and involved 150 cases of poisoning. It was found that 47 out of these 150 cases (31.3%) were from the 20-25 age group. The study highlighted the high incidence of poisoning in younger individuals, particularly between the ages of 20-25 years that aligned with the findings of present study. **Asawari et al.**⁵ conducted a study in Pune, Maharashtra, the male-to-female ratio was reported as 1.2:1, with males accounting for 568 cases (56.24%) and females for 442 cases (43.76%). These findings align closely with our study, where a slightly higher proportion of males (53.40%) was observed compared to females.

This study highlights the outcomes of patients based on different ECG changes, where sinus rhythm was associated with the highest improvement rate—155 out of 173 cases improved, while only 18 resulted in death. In contrast, more severe ECG abnormalities like ST elevation and ST depression were linked to worse outcomes, with 3 out of 4 ST elevation cases and 6 out of 8 ST depression cases leading to death. Ventricular ectopic beats and T wave inversion also had a high mortality risk, with over 50% of these cases ending in death. These findings suggest that more pronounced ECG changes correlate with poor prognoses in poisoning cases. Similarly, **Joshi et al. (2013)**⁶ investigated acute myocardial infarction as a complication of organophosphate poisoning. They found that ST segment changes, particularly ST elevation, were present in 6.7% of cases, with a mortality rate of 60%. This closely mirrors the present study's finding of 75% mortality in patients with ST elevation. Joshi et al. also noted that T wave inversion occurred in 8% of cases, which is higher than the 1.7% observed in the current study, though both studies show that this ECG abnormality is associated with poorer outcomes. In a study by **Mittal et al. (2021)**⁷, the toxicology of poisoning in India from 2010 to 2020 was reviewed, focusing on poisoning cases involving pesticides and other toxins. ECG changes like sinus tachycardia and ST depression were highlighted as significant markers for clinical prognosis. ST depression, seen in 4.5% of the present study, was associated with higher mortality in Mittal's study, where 65% of patients with this finding did not survive, closely matching the current study's result of 75% mortality.

The present study found varying ECG changes across different types of poisonings. Insecticidal poisoning, with 66 cases of sinus rhythm, showed minimal abnormalities, with only 1 case each of ST depression, LBBB, and ventricular ectopic, and no ST elevation or T wave inversion. Chlormethrin/cypermethrin poisoning was similar, with 18 cases of sinus rhythm and 1 case of ST depression. Celphos poisoning had 30 cases of sinus rhythm and no major ECG changes. Rodenticidal poisoning had the most pronounced abnormalities, with 38 cases of sinus rhythm, 4 cases of ST elevation, 6 of ST depression,

and 1 case each of LBBB and T wave inversion. Herbicidal poisoning had 9 cases of sinus rhythm and no abnormalities. In Tripathy et al. (2018),⁸ sinus tachycardia was the most common ECG abnormality in organophosphate poisoning, which aligns with the present study where sinus rhythm predominated, especially in insecticidal (94.3%) and rodenticidal (77.6%) poisonings. Tripathy's study also reported ST depression in 18% of cases, slightly higher than the 12.2% ST depression observed in rodenticidal poisoning in the current study. In contrast, Joshi et al. (2013)⁶ found that ST elevation was present in 6.7% of organophosphate poisoning cases, which is comparable to the 8.2% of rodenticidal poisoning cases with ST elevation in the present study. Both studies highlight the significance of ST segment changes as a marker for severe cardiac toxicity. Joshi's study further reported that T wave inversion was noted in 8% of patients, which is consistent with the 6.1% observed in rodenticidal poisoning in the current study.

The present study found distinct patterns of QTc prolongation, Troponin-I, and NT-Pro BNP levels across various poison types. In **insecticidal poisoning**, 57 patients improved, and 12 expired, with a median QTc of 367 ms. Troponin-I levels were higher in expired cases (0.336 vs. 0.047), and NT-Pro BNP levels were significantly elevated in expired patients (1710.1 vs. 156 pg/ml). In **chlormethrin/cypermethrin poisoning**, 15 patients improved, and 4 expired, with a median QTc of 370 ms and higher NT-Pro BNP in expired patients (590.8 vs. 172.6 pg/ml). **Celphos poisoning** had 41 improved and 9 expired, with a median QTc of 367 ms and elevated Troponin-I (0.523 vs. 0.052) and NT-Pro BNP (388.9 vs. 142.2) in expired cases. **Rodenticidal poisoning** showed minimal changes, with 29 improved and 1 expired, and a median QTc of 366 ms. **Herbicidal poisoning** had 8 improved and 1 expired, with a median QTc of 374 ms, elevated Troponin-I in improved cases (0.11), and comparable NT-Pro BNP levels. **Aghabiklooei et al. (2013)**⁹, conducted a study on the cardiac effects of organophosphate poisoning and found a median QTc interval of 370 ms in severe cases, which aligns with the QTc intervals in the present study, particularly in chlormethrin/cypermethrin poisoning (370 ms) and herbicidal poisoning (374 ms). The study also highlighted that QTc prolongation was a significant predictor of mortality, as was observed in the current study where prolonged QTc intervals were seen across cases with poor outcomes. **Unnikrishnan et al. (2005)**¹⁰, focusing on poisoning trends in Karnataka, elevated NT-Pro BNP levels were identified as a significant marker for cardiac stress in poisoning cases. They found NT-Pro BNP levels ranging from 200-500 pg/mL in patients with moderate to severe poisoning, similar to the findings in the present study, especially in chlormethrin/cypermethrin poisoning cases where NT-Pro BNP levels were 590.8 pg/mL in expired patients. The high NT-Pro BNP levels in insecticidal poisoning cases (1710.1 pg/mL) in the present study further underscore the cardiac stress caused by poisoning, correlating with Unnikrishnan et al.'s findings.

The present study found a significant correlation between ECG changes and cardiac biomarkers in poisoning cases. Among those with normal ECGs, 159 out of 173 had normal biomarkers, while 13 out of 18 patients with abnormal ECGs had elevated biomarkers ($p < 0.001$), suggesting that abnormal ECGs are predictive of myocardial injury. **Sharma et al. (2002)**¹¹ also emphasized the importance of ECG changes in predicting cardiac involvement in poisoning cases. In their research, 70% of patients with abnormal ECGs had elevated cardiac biomarkers, which aligns with the present study's findings. Sharma et al. concluded that ECG, along with biomarkers like Troponin I, is crucial for early detection of myocardial injury in poisoning cases, a conclusion that is mirrored in the present study.

The present study found that elevated Troponin-I (TROP-I) and NT-Pro BNP levels were strongly associated with higher mortality across different types of poisoning. In insecticidal poisoning, 4 out of 10 patients with elevated TROP-I died compared to 8 out of 59 with normal TROP-I ($p = 0.066$), while 4 out of 12 with elevated NT-Pro BNP died compared to 8 out of 57 with normal levels ($p = 0.066$). In chlormethrin/cypermethrin poisoning, no deaths occurred among those with elevated TROP-I, but 3 out of 5 with elevated NT-Pro BNP died ($p = 0.0005$). In Celphos poisoning, elevated TROP-I was a strong predictor of mortality, with 8 out of 14 deaths in the elevated group compared to 1 out of 36 in the normal group ($p < 0.0001$), and 8 out of 11 deaths in patients with elevated NT-Pro BNP ($p = 0.0001$). For rodenticidal and herbicidal poisoning, deaths were minimal, with no significant associations due to smaller sample sizes. **Joshi et al. (2013)**⁶ examined myocardial infarction as a complication of pesticide

poisoning and found a significant correlation between elevated TROP-I levels and mortality. Joshi et al. reported that elevated TROP-I was associated with a 60% mortality rate in pesticide poisoning, closely resembling the 57% mortality in the present study's celphos poisoning group. Both studies confirm that elevated TROP-I is a crucial marker of cardiac injury and a predictor of poor outcomes. **Hasan et al.**¹² conducted a study analyzing cardiac markers in organophosphorus (OP) poisoning, focusing on the levels of NT-pro BNP, CK-MB, and Troponin I. The study found a significant elevation in NT-pro BNP levels in both OP poisoned groups (with and without cardiac signs). Specifically, 60.5% of cases without cardiac signs had elevated NT-pro BNP levels, and among these, 15.8% were at high risk for developing heart failure. In cases with cardiac signs, 100% showed elevated NT-pro BNP, with 26% being at high risk for heart failure. However, Troponin I levels did not show significant differences between groups with or without cardiac signs, reflecting minimal myocardial injury in OP poisoning based on Trop-I markers. This is relevant to our study where elevated NT-Pro BNP levels in chlorpyrifos/cypermethrin and Celphos poisoning were also strongly associated with worse outcomes.

CONCLUSION

The study highlights significant electrocardiographic and biomarker alterations in poisoning cases, providing crucial insights into cardiac outcomes. Most patients (51.80%) were in the 15-25 age group, with a nearly equal gender distribution. ECG changes varied across different poison types, with sinus rhythm being the most common finding. ST elevation, depression, and ventricular ectopic were noted in severe cases like Celphos and rodenticidal poisonings. Biomarker analysis revealed that elevated Troponin-I and NT-Pro BNP levels were associated with higher mortality, particularly in Celphos poisoning, where significant differences between improved and expired patients were observed. The association between normal ECG findings and lower biomarker levels indicates a better prognosis, while abnormal ECGs with elevated biomarkers showed poor outcomes. Notably, elevated NT-Pro BNP levels in chlorpyrifos and Celphos cases had the highest correlation with mortality, underscoring the importance of these biomarkers in predicting cardiac involvement in poisoning. Overall, early detection of ECG changes and biomarker levels plays a critical role in improving patient management and predicting outcomes in poisoning cases.

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