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PREDICTORS OF POOR OUTCOME IN PARAPHENYLENE DIAMINE ('BLACK STONE') POISONING: A RETROSPECTIVE COHORT FROM NAWABSHAH, PAKISTAN

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Abstract

Background: Paraphenylene diamine, commonly known as "black stone", is a readily available hair-dye chemical widely used for intentional self-poisoning in South Asia. Despite its high fatality rate, evidence on predictors of poor outcomes remains limited. This study aimed to identify demographic, clinical, and laboratory factors associated with adverse outcomes in patients presenting with black stone poisoning.

Study design: Retrospective cohort study

Place of study: This study was conducted at People's University of Medical & Heath Sciences for women Nawabshah

Duration: June 2023 to December 2023

Methods: Medical records of 240 patients were reviewed for demographics, intent of ingestion, clinical presentation, laboratory findings, and outcomes. Outcomes were defined as discharge, leaving against medical advice, or death. Data were analyzed using descriptive statistics, bivariate comparisons, and regression analysis, with significance set at $p<0.05$.

Results: The cohort comprised 240 patients, predominantly young adults (mean age 24 years) with a female majority (75%). Most cases followed suicidal ingestion (nearly 90%). The average time from ingestion to hospital arrival was under six hours. Laboratory findings showed mean hemoglobin of 12.7 g/dL, total leukocyte count around 10.5 $\times 10^3/\mu L$, and serum glucose of 259 mg/dL. Neurological and cardiovascular manifestations were strongly associated with adverse outcomes, whereas other laboratory variables showed limited predictive value. Mortality was most evident in patients who had ingested larger amounts or presented with severe systemic involvement.

Conclusions: Black stone poisoning continues to affect young women disproportionately in our setting, largely due to suicidal intent. Neurological and cardiovascular complications emerged as early red flags for poor prognosis. Prompt recognition and aggressive management of these features are essential to improve survival. Preventive strategies, including community awareness and restrictions on the availability of paraphenylene diamine, are urgently needed.

Keywords: Paraphenylene diamine, black stone, hair dye poisoning, predictors, outcomes, Pakistan

Introduction

Black stone poisoning, most often caused by ingestion of paraphenylene diamine (PPD) commonly found in hair dye, is an emerging public health concern in South Asia and other low- and middle-income regions [1]. Traditionally used in cultural and cosmetic practices, PPD has become easily accessible and is therefore frequently misused for suicidal attempts, especially among young adults and women [2]. The chemical is highly toxic, leading to multisystem involvement ranging from oropharyngeal edema and respiratory distress to acute renal failure, myocarditis, and sudden death [3,4].

Epidemiological data suggest that the burden of black stone poisoning is substantial but underreported due to diagnostic challenges, lack of awareness among healthcare providers, and cultural stigma [5,6]. Regional hotspots, including Pakistan, India, and parts of North Africa, have reported increasing cases, with mortality rates varying between 20% and 40% depending on dose ingested and timeliness of treatment [7,8]. The young demographic most affected by this poisoning highlights its impact not only as a toxicological problem but also as a psychosocial and economic burden [9].

Clinically, patients often present with nonspecific but rapidly progressive symptoms. These include gastrointestinal distress, stridor, dysphagia, facial and tongue swelling, cardiovascular instability, rhabdomyolysis, acute renal injury, and neurological complications [10,11]. Such diverse manifestations make early recognition difficult, often delaying intervention. Moreover, there is no specific antidote for PPD poisoning; management relies largely on supportive measures, airway protection, and timely dialysis in cases of renal involvement [12].

Several case reports and small cohort studies have emphasized the unpredictable and often fatal nature of black stone ingestion [13–15]. Mortality is frequently attributed to airway compromise and cardiotoxicity [7]. Predictors of poor outcome, such as neurological and cardiovascular manifestations, renal involvement, and delayed hospital presentation, have been described in limited studies, but systematic data remain scarce [12,16].

Understanding these predictors is crucial for improving triage, guiding clinical decision-making, and tailoring intensive monitoring for high-risk patients [15,17]. From a public health perspective, such research also supports preventive strategies, including regulating sales of toxic hair dyes, raising awareness, and integrating mental health services for at-risk populations [18].

This study was conducted in Nawabshah, Sindh, Pakistan, where black stone poisoning has been increasingly reported as a major cause of toxicological emergencies. The objective was to identify demographic, clinical, and laboratory predictors of poor outcome in patients presenting with PPD poisoning, thereby contributing to improved management protocols and preventive policies in the region.

Methodology

A sample of 240 patients was calculated using the OpenEpi calculator, with 95% confidence, 90% power, and an expected mortality rate of 36%. Consecutive sampling was applied, and all eligible patients admitted during the study period were included until the required sample size was reached.

All patients aged 18 years and above, of either gender, with a history of black stone (paraphenylene diamine, PPD) ingestion and admitted for management were included. Patients with incomplete medical records, uncertain diagnosis, or poisoning due to substances other than PPD were excluded.

Data were retrieved from hospital records and recorded on a structured proforma. Information included demographic characteristics (age, gender, marital status, residence), exposure details (intent, estimated amount ingested, and time from ingestion to hospital arrival), clinical presentation (gastrointestinal, neurological, cardiovascular, respiratory, and renal manifestations), investigations (hemoglobin, total leukocyte count, random blood glucose, serum alkaline phosphatase, renal function tests, and ECG findings), and outcomes (discharge, left against medical advice, or death).
All data were analyzed using SPSS version 26.0. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Group comparisons were performed using chi-square tests, independent t-tests, and one-way ANOVA where appropriate. Logistic regression analysis was applied to identify independent predictors of poor outcome, with a p-value of less than 0.05 considered statistically significant.
Ethical approval was obtained from the Institutional Review Board of Peoples University of Medical and Health Sciences. As the study was retrospective, patient identifiers were not collected and all data were anonymized before analysis.

Results

A total of 240 patients with black stone (paraphenylene diamine) poisoning were included in the study. The mean age of the patients was 24.1 years with a standard deviation of 4.3, and the majority of cases fell within the age range of 18 to 32 years. Females were predominantly affected, making up 75 percent of the cohort. Most ingestions were intentional, with nearly 90 percent of patients presenting after a suicidal attempt, while a smaller proportion involved accidental exposure. The majority of patients reached the hospital within six hours of ingestion, although the time ranged from one to twenty-four hours.
Laboratory evaluation showed an average hemoglobin of 12.7 g/dL, a mean total leukocyte count of approximately $10.5 \times 10^3/\mu L$, a mean serum alkaline phosphatase of 129.1 U/L, and a mean random blood glucose level of 258.8 mg/dL. Electrocardiographic abnormalities were observed in several patients and were more frequent among those with severe systemic involvement.
When clinical features were compared with patient outcomes, neurological and cardiovascular manifestations were strongly associated with poor prognosis. These included altered consciousness, seizures, hypotension, arrhythmias, and cardiac arrest, which were more commonly observed among patients who died during admission. The estimated amount of substance ingested also influenced prognosis, with larger ingestions linked to higher mortality.
Statistical analysis demonstrated that differences in total leukocyte count across outcome groups were significant, while most other laboratory parameters showed limited predictive value. Logistic regression identified neurological and cardiovascular complications as independent predictors of poor outcome.
Regarding hospital outcomes, the majority of patients recovered and were discharged after receiving supportive management. A notable number left against medical advice, while mortality was observed in those with severe systemic manifestations, particularly involving the cardiovascular and neurological systems.

Table 1. Demographic characteristics of patients with black stone poisoning (n = 240)

Variable	Value
Age (years)	Mean 24.1 ± 4.3 (Range 18–32)
Female gender	177 (75%)
Male gender	59 (25%)
Intentional ingestion	212 (89.8%)
Accidental ingestion	24 (10.2%)

Table 2. Laboratory findings of patients with black stone poisoning

Parameter	Mean ± SD
Hemoglobin (g/dL)	12.7 ± 1.4
Total leukocyte count (×10³/μL)	10.5 ± 3.2
Serum alkaline phosphatase (U/L)	129.1 ± 45.6
Random blood glucose (mg/dL)	258.8 ± 72.5

Table 3. Clinical outcomes of patients with black stone poisoning

Outcome	Frequency (%)
Discharged	~180 (75%)
Left against medical advice	~36 (15%)
Death	~24 (10%)

Discussion

This study highlights the clinical profile and predictors of outcome in patients with paraphenylene diamine ("black stone") poisoning admitted to a tertiary hospital. Our findings reinforce the fact that the majority of cases occur among young women with suicidal intent, and that neurological and cardiovascular complications are the strongest predictors of poor prognosis.

The demographic trend observed in this study, with a mean age of 24 years and female predominance, is consistent with reports from Southern Punjab, where Khan et al. described an epidemic of black stone poisoning among young women with a similar age distribution [16]. Likewise, a Tunisian study by Amira et al. reported that most cases involved females in their second and third decades of life, reflecting both easy availability of the substance and psychosocial vulnerability of this population [17].

In our cohort, nearly 90 percent of cases followed suicidal ingestion, which mirrors findings from Perumal et al. in India, where suicidal intent accounted for the vast majority of presentations [18]. The strong predominance of intentional self-harm underscores the urgent need for psychosocial interventions and regulation of PPD-containing products.

The clinical spectrum in our patients was wide, but neurological and cardiovascular involvement emerged as the strongest predictors of mortality. Similar observations have been made in other cohorts. Tiwari et al. demonstrated that electrocardiographic abnormalities such as arrhythmias and conduction blocks were common and significantly associated with fatal outcomes [19]. Jedidi et al. further documented fatal myocarditis due to PPD, emphasizing the direct cardiotoxic potential of this compound [20].

Renal complications, although present in some of our patients, did not appear as strong independent predictors of death in this dataset. However, other studies have highlighted renal involvement as a major determinant of outcome. Naqvi et al. described acute kidney injury as a frequent and severe complication requiring dialysis, with substantial mortality risk [21]. This difference may reflect variations in dose ingested, delays in presentation, or differences in supportive care practices across centers.

Our mortality rate of approximately 10 percent was lower than the 20–40 percent reported in earlier studies from Pakistan and North Africa [22,23]. One possible explanation is the relatively short time-to-hospital observed in our patients, as most arrived within six hours of ingestion. Early presentation likely allowed timely airway management and supportive therapy, reducing mortality compared to cohorts with longer delays.

The laboratory variables in our analysis, such as hemoglobin, leukocyte count, glucose, and alkaline phosphatase, did not show strong or consistent associations with outcome, except for total leukocyte count, which showed significant differences across outcome groups. Similar limitations of laboratory predictors have been noted by Sakuntala et al., who found that clinical presentation was more reliable than biochemical markers in anticipating prognosis [24].

Overall, this study strengthens the evidence that airway compromise, neurological deterioration, and cardiovascular instability should be regarded as early red flags for poor outcome in PPD poisoning. Our findings align with the broader body of literature but also suggest that with early hospital presentation and prompt supportive management, mortality may be reduced compared to historical reports.

Nevertheless, the study has limitations, including its retrospective design, reliance on hospital records, and the possibility of underestimation of delayed complications such as renal failure. Prospective multicenter studies with standardized protocols are needed to validate these predictors and refine triage criteria.

Conclusion

This study demonstrates that black stone (paraphenylene diamine) poisoning in our region predominantly affects young women, usually through intentional ingestion. Although a wide spectrum of clinical and laboratory features was observed, neurological and cardiovascular complications consistently emerged as the strongest predictors of poor outcome. Early hospital presentation and supportive management appeared to improve survival compared with previously reported mortality rates.

The findings emphasize the importance of rapid recognition of red-flag features such as airway compromise, arrhythmias, and altered consciousness, which should prompt aggressive monitoring and intervention. From a public health perspective, the data highlight the urgent need for preventive measures, including stricter regulation of paraphenylene diamine sales, community education about its lethality, and provision of psychosocial support for individuals at risk of self-harm.

Future prospective, multicenter studies are recommended to validate these predictors and develop standardized management guidelines, which may ultimately reduce the morbidity and mortality associated with this preventable form of poisoning.

Source of Funding

None

Permission

Ethical approval obtained

Conflict of Interest

None

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