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Expert Opinion Article

Retrospective Study of Paraquat Poisoning in the Khandesh Region: Clinical Outcomes and Mortality Predictors

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Abstract

Introduction:
Paraquat is a widely used non-selective herbicide in India, especially in rural agricultural regions, and is associated with high morbidity and mortality due to the absence of a specific antidote and rapid progression to multi-organ failure [1]. In North Maharashtra, agricultural dependency, easy availability of paraquat, and limited awareness of its toxicity contribute to frequent accidental or intentional exposures. This study was conducted to evaluate the demographic, clinical, laboratory, and treatment profiles of paraquat poisoning patients, along with their outcomes, to generate evidence for improving prevention and management strategies.

Methodology:
A hospital-based observational study was conducted at a tertiary care center in North Maharashtra, including 34 confirmed cases of paraquat poisoning admitted during the study period. Data were collected from patient medical records and included demographic details, presenting clinical signs, postmortem findings where applicable, laboratory investigations, treatment modalities, and outcomes. Statistical analysis was performed to determine the frequency and percentage distribution of variables.

Results:
The majority of patients were males (64.7%) and farmers (61.8%), with the highest incidence in the 21–30 years (23.5%) and 31–40 years (20.6%) age groups. Oral ulcers/mucosal burns were observed in 41.7% of cases, lung congestion in 58.3%, and kidney congestion in 52.8%. Laboratory abnormalities included elevated AST/ALT in 38.2%, hyperbilirubinemia (>2 mg/dL) in 41.2%, elevated creatinine in 52.9%, and low hemoglobin in 44.1%. Steroids were administered to 58.8% of patients, cyclophosphamide to 17.6%, and dialysis to 8.8%, while hemoperfusion was rarely used (2.9%). The overall in-hospital mortality was 61.8%, with multiorgan failure (71.4% of deaths) as the leading cause, followed by acute kidney injury (23.8%) and acute lung injury (4.8%).

Conclusion:
Paraquat poisoning in North Maharashtra predominantly affects young male farmers and carries a high mortality rate despite medical intervention. The study highlights the need for stricter regulation of paraquat sales, farmer education on its hazards, and improved access to advanced therapeutic measures such as hemoperfusion to reduce mortality.

Keywords: Paraquat poisoning, North Maharashtra, multiorgan failure, agricultural toxicity, mortality, hemoperfusion, pesticide regulation.

Introduction

Paraquat is a highly toxic herbicide extensively used across India for weed control in crops such as cotton, rice, and potatoes. Despite being banned in over 70 countries due to its lethality, in India it remains easily accessible, often over-the-counter or online, especially in rural areas. The ease of availability contributes significantly to its use in intentional self-harm, particularly among farmers and low-income groups [1].

Clinically, paraquat ingestion leads to profound multisystem damage. The prominent organ systems

affected include the lungs, kidneys, and liver, with ensuing complications like pulmonary edema, acute kidney injury, hepatic dysfunction, and multiorgan failure—often fatal within days to weeks [2,3]. The early symptoms may appear deceptively mild or nonspecific, such as oral ulcerations and gastrointestinal irritation, delaying diagnosis and curative intervention [3].

The golden hour or early window post-ingestion is crucial; treatments such as early decontamination, antioxidants, immunosuppressive therapy, and hemoperfusion can influence outcomes, although no definitive antidote exists [4]. Mortality rates remain alarmingly high, often exceeding 50%, primarily due to respiratory failure and multiorgan dysfunction [5].

Given these realities, particularly within the Indian healthcare setting where paraquat continues to be sold and poisoning cases are frequent, the need for comprehensive research—integrating clinical, laboratory, and postmortem profiles—is urgent. This study aims to fill that gap by analyzing paraquat poisoning cases in a tertiary care setting, with a view toward improving early detection, management protocols, and public health interventions.

Methodology

This retrospective observational study was conducted in the North Maharashtra region at a tertiary care teaching hospital over a defined study period. All cases of paraquat poisoning, both fatal and non-fatal, presenting to the emergency department, medical wards, or brought for medicolegal autopsy during the study period were included. Inclusion criteria were: a history of paraquat ingestion or exposure confirmed by reliable history from the patient or attendants, clinical features consistent with paraquat toxicity, and/or supportive laboratory or postmortem findings. Patients with mixed poisonings or incomplete records were excluded. Demographic details (age, gender, occupation), exposure characteristics (route, estimated quantity, and time interval to hospital presentation), clinical signs and symptoms, vital parameters, and laboratory investigations (liver function tests, renal function tests, hemogram) were obtained from hospital records. Management details, including use of steroids, cyclophosphamide, hemoperfusion, dialysis, and other supportive measures, were noted. Outcomes were recorded as survived, died, or discharged against medical advice, with cause of death documented where applicable.

In cases undergoing medicolegal autopsy, gross postmortem findings were systematically recorded for each organ system (external examination, respiratory, gastrointestinal, liver, kidney, heart, spleen, brain), with special attention to lesions attributable to paraquat toxicity such as oral ulcers, pulmonary edema, and multiorgan congestion. Findings were grouped for analysis to identify common pathological patterns. All data were entered into a structured proforma and compiled in Microsoft Excel. Descriptive statistics were calculated, with frequencies and percentages used for categorical variables. Graphical representations such as bar charts and pie charts were prepared to illustrate the distribution of key parameters. Ethical clearance was obtained from the institutional ethics committee prior to commencement of the study, and confidentiality of patient information was maintained throughout.

Results

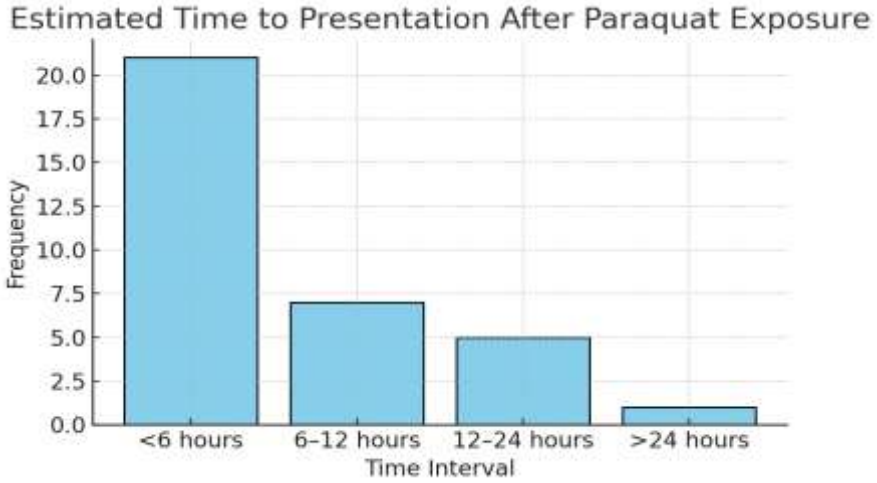
Table 1: Demographic Characteristics of the Study Population (n = 34)

Variable	Category	Frequency	Percent (%)
Age Group	11–20	6	17.6
	21–30	8	23.5
	31–40	7	20.6
	41–50	7	20.6
	51–60	3	8.8
	61–70	2	5.9
	71–80	1	2.9
Gender	Male	22	64.7
	Female	11	32.4
	Transgender	1	2.9
Occupation	Farmer	21	61.8
	Labourer	8	23.5
	Student	3	8.8

Variable	Category	Frequency	Percent (%)
	Housewife	2	5.9

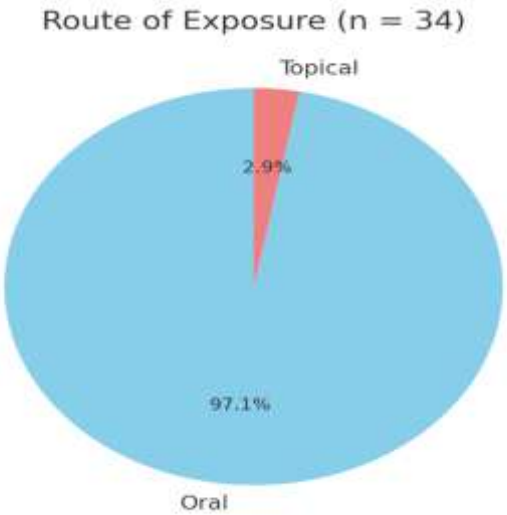
In the present study of 34 participants, the largest proportion belonged to the 21–30 years age group (23.5%), followed closely by the 31–40 years and 41–50 years groups, each contributing 20.6% of the sample. The youngest participants were in the 11–20 years category (17.6%), while those aged 51–60 years formed 8.8%, and a small proportion were aged 61–70 years (5.9%) or 71–80 years (2.9%). Males constituted the majority (64.7%), while females accounted for 32.4% and transgender individuals 2.9%. Occupationally, more than half of the participants were farmers (61.8%), followed by labourers (23.5%), students (8.8%), and housewives (5.9%). This indicates that the study predominantly involved young to middle-aged male farmers.

Fig 1: Estimated Time to Presentation After Paraquat Exposure (n = 34)



The graph shows that the majority of patients with paraquat exposure (over 60%) presented to the hospital within 6 hours of ingestion, indicating rapid healthcare-seeking behavior in most cases. A smaller proportion arrived between 6–12 hours (about one-fifth) or 12–24 hours (around 15%), while very few patients presented after 24 hours. This pattern suggests that early presentation is common, which may be crucial for better clinical outcomes.

Fig 2: Route of Exposure (n = 34)



The pie chart shows that the vast majority of paraquat poisoning cases in this study occurred via the oral route (97.1%), while only a small fraction (2.9%) were due to topical exposure. This indicates

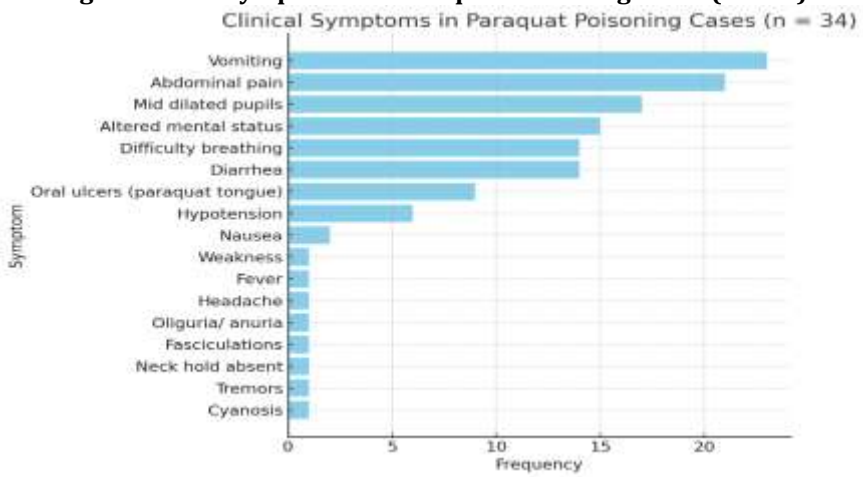
ingestion as the predominant mode of exposure among the patients.

Table 2 : Distribution of Blood Pressure and Respiratory Rate Categories (n = 34)

Parameter	Category	Frequency	Percent (%)
Blood Pressure	Normal BP	28	82.4
	Low BP	5	14.7
	High BP	1	2.9
Respiratory Rate	Normal (12–20)	17	50.0
	High (21–24)	11	32.4
	Very High (>24)	5	14.7
	Low (<12)	1	2.9

In this study, most patients (82.4%) had normal blood pressure at presentation, while 14.7% were hypotensive and only 2.9% were hypertensive. Regarding respiratory rate, half of the patients (50.0%) had normal values (12–20 breaths per minute), 32.4% showed mild tachypnea (21–24 breaths/min), 14.7% had marked tachypnea (>24 breaths/min), and 2.9% presented with bradypnea (<12 breaths/min). This indicates that abnormal respiratory rates, particularly elevated values, were relatively common compared to abnormal blood pressure findings.

Fig 3: Clinical Symptoms in Paraquat Poisoning Cases (n = 34)



The bar chart shows that vomiting (n=23) and abdominal pain (n=22) were the most common clinical symptoms among paraquat poisoning cases, followed closely by mid-dilated pupils (n=17) and altered mental status (n=15). Difficulty breathing (n=14) and diarrhea (n=14) were also frequent. Less common findings included oral ulcers (n=9), hypotension (n=6), nausea (n=3), and various symptoms such as weakness, fever, headache, oliguria/anuria, fasciculations, absent neck hold, tremors, and cyanosis, each reported in only one case. This indicates that gastrointestinal and neurological symptoms predominated in presentation, with multi-system involvement in severe cases.

Table 3- Frequency Distribution of Key Laboratory Parameters in the Study Population

Parameter	Category	Frequency
Elevated AST/ALT	No	21
	Yes	13
Bilirubin > 2 mg/dL	No	20
	Yes	14
Creatinine Status	Elevated	18
	Normal	16
Haemoglobin Status	Normal	19
	Low	15

The bar chart shows that vomiting (n=23) and abdominal pain (n=22) were the most common clinical symptoms among paraquat poisoning cases, followed closely by mid-dilated pupils (n=17) and altered mental status (n=15). Difficulty breathing (n=14) and diarrhea (n=14) were also frequent. Less common findings included oral ulcers (n=9), hypotension (n=6), nausea (n=3), and various symptoms such as weakness, fever, headache, oliguria/anuria, fasciculations, absent neck hold, tremors, and cyanosis, each reported in only one case. This indicates that gastrointestinal and neurological symptoms predominated in presentation, with multi-system involvement in severe cases.

Table 4 - The frequency distribution table for the main treatment modalities received by paraquat poisoning patients:

Treatment	Yes (n)	No (n)
Steroids Administered	20	17
Cyclophosphamide Administered	6	31
Hemoperfusion	1	36
Dialysis	3	34

Table 4 shows that among the 34 paraquat poisoning patients, 20 received steroid therapy while 17 did not. Cyclophosphamide was administered in only 6 cases, with the majority (31 patients) not receiving it. Hemoperfusion was rarely performed, with just 1 patient undergoing the procedure. Dialysis was initiated in 3 patients, whereas 34 did not require it. This indicates that steroid therapy was the most commonly used treatment modality, while advanced interventions like hemoperfusion and dialysis were infrequently employed.

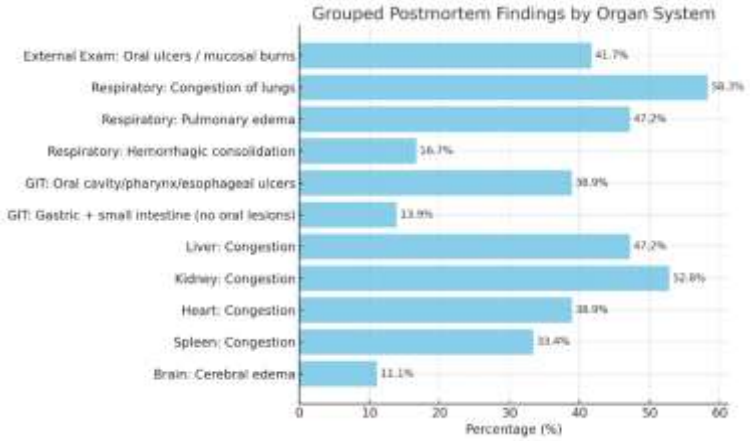
Table 5- Frequency distribution table with both in-hospital outcomes and causes of death:

Outcome	Frequency (n)	Cause of Death (if applicable)	Frequency (n)
Survived	9	–	–
Died	21	Multiorgan Failure	15
		Acute Kidney Injury	5
		Acute Lung Injury	1
Discharged Against Medical Advice	5	–	–

Table 5 summarizes both the overall in-hospital outcomes and the specific causes of death among paraquat poisoning patients. Out of 34 patients, 9 survived and 5 left the hospital against medical advice (DAMA). Death occurred in 21 patients, with the majority (15 cases) attributed to multiorgan failure. Acute kidney injury was identified as the cause of death in 5 cases, and acute lung injury in 1

case. This highlights that mortality was high in this cohort, with multiorgan failure being the predominant fatal outcome.

Fig 4 - Postmortem Findings



The postmortem findings graph shows that the respiratory system was most frequently affected, with congestion of the lungs observed in 58.3% of cases and pulmonary edema in 47.2%. Kidney congestion was also common (52.8%), followed by liver congestion (47.2%) and external oral ulcers/mucosal burns (41.7%). Gastrointestinal tract lesions such as oral cavity/pharynx/esophageal ulcers were present in 38.9%, while heart congestion was noted in a similar proportion (38.9%). Spleen congestion occurred in 33.4% of cases, hemorrhagic consolidation in the lungs in 16.7%, and cerebral edema in 11.1%. These findings highlight multi-organ involvement, with respiratory and renal systems being most commonly affected in paraquat poisoning cases.

Discussion

The present study from the North Maharashtra region highlights the epidemiological profile, clinical spectrum, management, and outcomes of paraquat poisoning cases, along with characteristic postmortem findings. Paraquat, a bipyridyl herbicide, is known for its high acute toxicity and lack of a specific antidote, making its ingestion a medical emergency with high mortality rates [6].

In our study, the majority of patients were young to middle-aged adults, with a predominance of males and farmers by occupation. This aligns with existing Indian literature where paraquat exposure is more common in agricultural communities, reflecting occupational access and the rural–agrarian socio-economic context [7]. Most exposures occurred via the oral route, which is consistent with the intentional ingestion patterns reported in previous studies [8].

The time to presentation was <6 hours in the majority of cases, which is critical as early decontamination may influence survival. However, even with early presentation, the mortality in our series remained high, reflecting the severity of systemic toxicity and limited efficacy of available treatments [9].

The most common presenting symptoms—vomiting, abdominal pain, mid-dilated pupils, altered mental status, and respiratory distress—are consistent with gastrointestinal irritation, neurotoxicity, and evolving pulmonary injury seen in paraquat poisoning [10]. Oral ulcerations ("paraquat tongue") were a notable finding, indicative of caustic mucosal injury [11].

A substantial proportion of patients showed elevated liver enzymes, hyperbilirubinemia, and deranged renal parameters, indicating early multiorgan involvement. Elevated creatinine was observed in more than half the cases, highlighting the nephrotoxic potential of paraquat, which is also reported in prior Indian studies [12].

Postmortem analysis revealed frequent congestion and edema in the lungs, kidneys, and liver. Pulmonary edema and hemorrhagic consolidation were common respiratory findings, consistent with paraquat's well-documented propensity to cause progressive pulmonary fibrosis and acute lung injury [13]. Cerebral edema was less frequent but noted in fatal cases, suggesting secondary hypoxic or metabolic insult.

Supportive measures, including steroids and cyclophosphamide, were administered in several cases, though their clinical benefit remains debated in literature [14]. Hemoperfusion, which can be beneficial if initiated very early, was rarely performed, likely due to limited availability in the region. The overall survival rate was poor, with multiorgan failure as the leading cause of death, followed by isolated acute kidney or lung injury. This mirrors the grim prognosis described in other Indian and Southeast Asian cohorts [15].

The study underscores the urgent need for preventive strategies, including stricter regulation of paraquat sales, safer packaging, and public awareness campaigns to reduce accidental and intentional ingestion [16]. In rural North Maharashtra, integrating poison control services with primary healthcare could aid in rapid referral and initiation of early decontamination.

Conclusion

In this study of 34 patients with paraquat poisoning from the North Maharashtra region, the majority were males (64.7%) and farmers (61.8%), with the most affected age groups being 21–30 years (23.5%) and 31–40 years (20.6%). Clinically, oral ulcers/mucosal burns were seen in 41.7% of cases, lung congestion in 58.3%, and kidney congestion in 52.8%. Laboratory abnormalities included elevated AST/ALT in 38.2%, bilirubin >2 mg/dL in 41.2%, elevated creatinine in 52.9%, and low haemoglobin in 44.1%. Steroids were administered to 58.8% of patients, while hemoperfusion and dialysis were rarely used. Despite early presentation in many cases, the in-hospital mortality was high at 61.8%, with multiorgan failure (71.4% of deaths) being the leading cause, followed by acute kidney injury (23.8%) and acute lung injury (4.8%). These findings emphasize the severe prognosis of paraquat poisoning in this setting and highlight the urgent need for preventive measures, early diagnosis, and wider availability of advanced treatment modalities to improve outcomes.

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