Section: General Medicine

Original Research Article

CLINICAL PROFILE OF PATIENTS OF HERBICIDE POISONING ADMITTED IN A TERTIARY CARE HOSPITAL

Susmit Shah[1], Dhondba P. Bhurke[2], Govind Lone[3], Bharti Rathod[4], Vicky Dudhe[5], Tanushree Chaudhari[6]

[1]*Senior Resident, Department of General Medicine, Rajarshi Chhatrapati Shahu Maharaj Government Medical College and Chhatrapati Pramilaraje Hospital, Kolhapur, India.*
[2]*Professor and Head, Department of General Medicine, Government Medical College Hingoli, India.*
[3]*Assistant Professor, Department of General Medicine, Dr Shankarrao Chavan Govt medical College Nanded, India.*
[4]*Assistant Professor, Dept of General Medicine, Dr Shankarrao Chavan Govt medical College Nanded, India.*
[5]*Senior Resident, Karmaveer Marotrao Shambshio Kannamwar Government Medical College, Chandrapur, India.*
[6]*Ex-Senior Resident, Department of General Medicine, Government Medical College and Maharashtra Post graduate Institute of Medical Education and Research (MPGIMER), Nashik, India.*

Received *: 01/01/2026*
Received in revised form *: 10/01/2026*
Accepted *: 19/01/2026*

Corresponding Author:
Dr. Susmit Shah
Senior Resident, Department of General Medicine, Rajarshee Chattrapati Shahu Maharaj Government Medical College and Chhatrapati Pramilaraje Hospital, Kolhapur, India.
Email: susmitshah04@gmail.com

DOI:10.70034/ijmedph.2026.1.600

Source of Support: Nil,
Conflict of Interest: Nonedeclared

Int J Med Pub Health
2026; 16 (1); 3501-3507

ABSTRACT

Background: Herbicide poisoning is a significant public health concern due to its high morbidity and mortality. This study aimed to study the demographic profile, clinical features, complications, and outcomes of patients with herbicide poisoning.

Material and Methods: A total of 180 adult patients (>18 years) with a history or clinical features suggestive of herbicide ingestion, whose patients or relatives provided informed consent, were enrolled in the study. Detailed clinical data were collected, including demographic information, type of herbicide, intent of poisoning, route, quantity, and time to hospital presentation. Baseline investigations included hemogram, renal and liver function tests, ECG, blood glucose, ABG, and chest X-ray, with additional tests as clinically indicated. Management followed standard poisoning protocols, including decontamination, airway protection, ventilatory support, hemodialysis, hemoperfusion, and specific interventions based on the ingested herbicide.

Results: The majority of patients were young adults aged 21–30 years (45.5%), predominantly male (65.5%), married (65%), and engaged in farming (32.2%). Suicidal ingestion was most common (87.8%). Paraquat (35%) and glyphosate (27.2%) were the leading agents. Vomiting (68%), throat discomfort (41%), and dysphagia (24%) were frequent symptoms; oral ulcers (42%), tachycardia (34%), proximal muscle weakness (29%), icterus (27%), and hypotension (25%) were common signs. Complications included acute kidney injury (60%), respiratory failure (57.7%), sepsis (41.6%), and acute hepatitis (32.7%). Mortality was 46.1%, highest with paraquat (71.4%), with respiratory failure being the leading cause of death (39.7%).

Conclusion: Herbicide poisoning predominantly affected young married males in agricultural occupations. Early recognition, prompt supportive care, and preventive strategies, including stricter regulation, are essential to reduce morbidity and mortality.

Keywords: Herbicide poisoning, Paraquat, Glyphosate, Acute kidney injury, Respiratory failure, Mortality.

INTRODUCTION

Poisoning remains a major global public health concern, contributing substantially to morbidity and mortality worldwide. The World Health Organization estimates nearly one million serious unintentional poisonings annually, with an additional two million hospitalizations due to suicide attempts involving toxic substances, particularly pesticides and herbicides.[1] Herbicides alone are responsible for approximately 150,000 deaths each year, with the burden disproportionately affecting low- and middle-income countries due to widespread agricultural use, easy access to toxic compounds, and limited regulatory control.[2,3] In India, extensive use of agricultural chemicals has made poisoning a significant health problem, with national data indicating that suicidal poisoning using household and agricultural agents is common.[4] According to the National Crime Records Bureau of India, suicide by consumption of pesticides and herbicides accounted for 19.4% and 19.7% of all suicidal poisoning cases in the years 2006 and 2007, respectively.[5] Herbicide poisoning thus represents not only a medical emergency but also a major social and public health challenge in the Indian context, where it is a frequently used method of attempted suicide.[6]

Herbicide poisoning is commonly encountered due to easy availability, unsafe storage, inadequate awareness regarding toxicity, and minimal regulatory control, particularly in developing countries. Among herbicides, paraquat and glyphosate are associated with high morbidity and mortality. Paraquat, a non-selective contact herbicide, is environmentally persistent and widely used despite its well-recognized toxicity, remaining one of the most commonly sold weed killers worldwide.[7-9] Clinically, paraquat poisoning initially presents with corrosive gastrointestinal symptoms, followed by delayed complications such as oral ulceration, acute kidney injury, hepatic dysfunction, progressive pulmonary damage, and multiorgan failure, which are the major causes of mortality.[10] Glyphosate poisoning typically causes gastrointestinal corrosive injury and dysphagia, while severe cases may progress to shock, arrhythmias, metabolic acidosis, pulmonary edema, and renal failure requiring hemodialysis. 2,4-Dichlorophenoxyacetic acid (2,4-D), a selective herbicide widely used in wheat-growing regions of India, is less frequently reported but often underdiagnosed due to its clinical resemblance to organophosphorus poisoning, leading to misclassification and underreporting.[11]

In many cases in India, patients are brought to hospitals in an unconscious state, and reliable information regarding the ingested poison is unavailable. In such situations, diagnosis relies heavily on clinical features and examination findings. Understanding the clinical profile of herbicide poisoning is therefore essential for early recognition, assessment of severity, prognostication, and timely intervention. Early identification of complications and aggressive management can be lifesaving and may significantly reduce mortality and morbidity. Hence, this prospective study was undertaken to study the clinical profile of patients of herbicide poisoning admitted in a tertiary care hospital to identify the early symptoms, know about the presenting and delayed complications early intervention and treatment which will help to prevent complications reduce mortality.

MATERIALS AND METHODS

This institution-based prospective observational study was conducted at a tertiary care teaching hospital over a period of 19 months, from June 2022 to January 2024. A total of 180 adult patients aged more than 18 years, with a history or clinical features suggestive of herbicide ingestion, who were admitted to the medical wards or intensive care units during the study period and whose patients or relatives provided informed consent, were enrolled. A complete enumeration sampling technique was adopted, wherein all eligible cases presenting during the data collection period were included. Patients were excluded if they had consumed mixed compounds or insecticides, had pre-existing chronic liver disease, chronic kidney disease, chronic lung disease including COPD or pulmonary fibrosis, were pregnant, or had received prior treatment at an outside hospital before presentation.

Detailed clinical data were collected using a predesigned proforma. Whenever feasible, attendants were requested to provide the container or package insert of the ingested poison to confirm the compound. A thorough history was obtained, including demographic details, marital status, type of agent consumed, intent (suicidal, accidental, or homicidal), route of exposure, estimated quantity ingested, and time interval between ingestion and hospital presentation. Detailed general and systemic examinations were performed. Measures to prevent further absorption of the toxin, such as gastric lavage and administration of activated charcoal, were initiated or continued depending on the type and timing of poisoning. Data were obtained manually from patients' medical records. Baseline investigations performed for all patients included complete hemogram, renal function tests, liver function tests, electrocardiography, random blood glucose, arterial blood gas analysis, and chest radiography. Additional investigations such as serum electrolytes, serum proteins, prothrombin time with INR, high-resolution computed tomography of the chest, and ultrasonography of the abdomen were performed when clinically indicated. All patients were managed according to standard protocols for poisoning. On admission, decontamination measures were undertaken,

including gastric lavage and activated charcoal administration where appropriate. Contaminated clothing was removed, and exposed skin was thoroughly washed with soap and water. Airway protection was ensured in unconscious patients, with endotracheal intubation and ventilatory support provided when required. Specific management strategies were employed based on the type of herbicide ingested. In suspected paraquat poisoning, early identification and airway management were prioritized. Gastric lavage was considered in conscious patients without active vomiting, along with administration of adsorbents, while supplemental oxygen was avoided unless absolutely indicated due to the risk of worsening pulmonary injury. Nutritional support via nasogastric tube was initiated early, and symptomatic treatment including antiemetics, analgesics, mucosal protective agents, and antibiotics for secondary infections was provided. Patients developing respiratory failure were managed according to standard acute respiratory distress syndrome (ARDS) protocols using lung-protective ventilation strategies. Renal function was closely monitored, and hemodialysis was initiated in patients with acute kidney injury. In cases of significant paraquat ingestion, hemoperfusion was considered as an early modality for toxin removal, ideally within four hours of ingestion. For 2,4-D compound poisoning, early alkaline diuresis was initiated to enhance drug elimination, aiming to maintain urine pH between 7.5 and 8.5, with careful differentiation from anticholinergic poisoning to avoid mismanagement. Additional supportive and specific treatments were provided based on the patient's clinical condition and complications.

Statistical Analysis

The data entry was done in Microsoft excel and were analyzed using SPSS version 20. Descriptive statistics were presented as mean ± standard deviation (SD) and percentage, where appropriate, to summarize the demographic characteristics, clinical features and outcomes of the cases. The variables were also compared between survivors and non-survivors. The t test was used to investigate the differences of quantitative variables. The relationships between categorical variables and the outcomes were evaluated using Chi square test where appropriate. In all cases, a confidence interval of 95% and a significance level of 5% ($P<0.05$) were considered significant.

RESULTS

Among the total 180 patients studied, maximum consisted of young adults, with 45.5% (n=82) of patients in the 21–30-year age group, followed by 23.8% (n=43) in aged 18–20 years. Males constituted 65.55% (n=118) of cases, and a majority were married (65%, n=117). Farmers formed the largest occupational group (32.2%, n=58), followed by students (25%, n=45). Regarding education, most patients had completed secondary or higher education (66.5%, n=120), while 11.1% (n=20) had no formal education, [Table 1]

Table 1: Socio-Demographic Profile of Patients with Herbicide Poisoning

Socio-Demographic Data		No of patients	Percentage
Age range (years)	18-20	43	23.8
	21-30	82	45.5
	31-40	13	7.2
	41-50	06	3.3
	51-60	18	10.0
	>60	18	10.0
Gender	Male	118	65.55
	Female	62	34.44
Marital status	Single	63	35.0
	Married	117	65.0
Occupation	Student	45	25.0
	Farmer	58	32.20
	Laborer	33	18.33
	Business	09	5.0
	Others	17	9.44
	Unemployed	18	10.0
Education status	No formal education	20	11.1
	Primary school	30	16.6
	Secondary/High school	70	38.8
	College/university	50	27.7
	Unknown	10	5.5

Suicidal exposure was the most common mode of poisoning, seen in 87.77% (n=158) of cases. Most patients presented early, with 46.11% (n=83) reaching the hospital within 6 hours and 35% (n=63) within 6–12 hours; only 2.77% (n=5) presented after 24 hours. Paraquat was the most frequently ingested herbicide (35%, n=63), followed by glyphosate (27.22%, n=49) and 2,4-D (ethyl ester) (16.11%, n=29) as shown in table 2.

Table 2: Pattern of Exposure, Time to Hospitalization, and Type of Herbicidal Compound Ingested

Parameters		No of patients	Percentage
Exposure	Suicidal	158	87.77
	Accidental	16	8.88
	Homicidal	06	3.33
Time from consumption of poison to hospitalization (hours)	<6	83	46.11
	6-12	63	35.0
	12-18	16	8.88
	18-24	13	7.22
	>24	05	2.77
Herbicidal compound present	Paraquat	63	35.0
	Glyphosate	49	27.22
	2,4-D (Ethyl ester)	29	16.11
	Pendimethalin	13	7.22
	Atrazine	06	3.33
	Pyrazon	04	2.22
	Others	16	8.88

Vomiting was the most common presenting symptom, reported in 67.7% (n=122) of patients, followed by throat discomfort in 40.55% (n=73). On clinical examination, oral ulcers were the most frequent finding (42.2%, n=76), followed by tachycardia (34.44%, n=62), proximal muscle weakness (28.99%, n=52), icterus (27%, n=48), hypotension (25%, n=45), and miosis (13.88%, n=25), as depicted in figure 1.

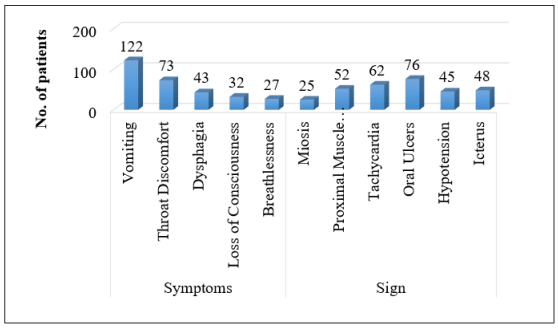

Figure 1: Clinical Presentation – Symptoms and Signs among Patients with Herbicide Poisoning

Acute kidney injury was observed in 108 patients (60%), respiratory failure in 104 patients (57.7%), sepsis in 75 patients (41.6%), and acute hepatitis in 59 patients (32.7%), [Figure 2]

Among the 180 patients, 53.8% (n=97) recovered, while 46.1% (n=83) died, (Figure 3). Of the 83 deaths, the most common cause was respiratory failure (39.7%, n=33), followed by acute kidney injury (21.6%, n=18), hepatic encephalopathy (16.8%, n=14), sepsis (10.8%, n=9), and refractory shock (8.4%, n=7). [Figure 3]

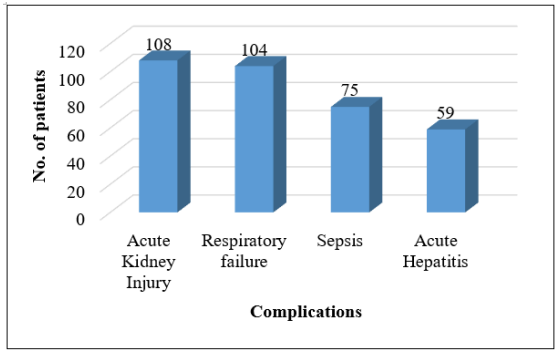

Figure 2: Complications of Herbicide Poisoning

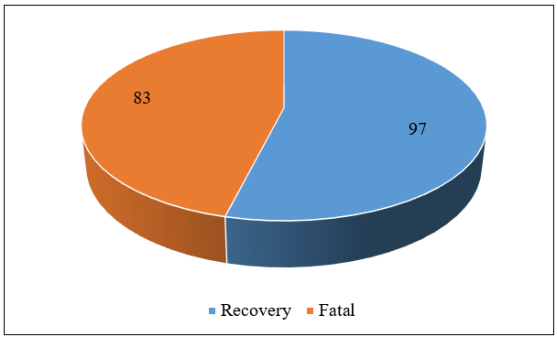

Figure 3: Patient outcomes

Mortality was highest with paraquat poisoning, with 45 deaths out of 63 patients (71.4%), and lowest with pyrazon, which had no deaths (0/4). Pendimethalin caused 6 deaths among 13 patients (46.1%). Glyphosate accounted for 18 deaths (36.7%), and 2,4-D (ethyl ester) for 9 deaths (31%). Atrazine and other compounds caused 1 (16.6%) and 4 (25%) deaths, respectively, [Table 3]

Table 3: Compound-Specific Mortality

Compounds	Total No. of Patients	Deaths
Paraquat	63	45
Glyphosate	49	18
2,4-D (Ethyl ester)	29	09
Pendimethalin	13	06
Atrazine	06	01
Pyrazon	04	00
Others	16	04

Mechanical ventilation was the most frequently required supportive intervention (43.30%), followed by hemodialysis (36.66%), indicating a high burden of respiratory and renal complications among the

study population. Inotropic support (21.11%) and lactulose (15.555) were used in a smaller proportion of patients, as shown in table 4.

Table 4: Treatment of Complications

Treatment Modality	Total Patients	Percentage (%)
Mechanical ventilation	78	43.30
Inotropic support	38	21.11
Lactulose	28	15.55
Hemodialysis	66	36.66

Non-survivors showed a significantly higher prevalence of sepsis, loss of consciousness, shock, acute kidney injury, respiratory failure, and acute hepatitis compared to survivors. All these clinical variables demonstrated statistically significant associations with mortality, ($p<0.05$), highlighting their importance as predictors of poor outcome in the study population, [Table 5]

Table 5: Clinical Characteristics and Outcomes Between Survivors and Non-Survivors

Characteristics		Survivor (n)	Non-survivor (n)	P value
Sepsis	Yes	12	63	<0.001
	No	85	20	
Loss of consciousness	Yes	00	32	0.017
	No	97	51	
Shock	Yes	2	63	0.011
	No	95	20	
Acute Kidney Injury	Yes	35	73	0.001
	No	62	10	
Respiratory failure	Yes	34	70	0.017
	No	63	13	
Acute hepatitis	Yes	04	55	<0.001
	No	93	28	

DISCUSSION

In the present study of 180 patients with herbicide poisoning, the majority were young adults aged 21–30 years (45.5%), with a median age of 25 years, consistent with findings from Kim et al,[12] and Sarkar TS et al,[13] who reported most cases in the 26–40-year age group. Males predominated (65.55%), with a male-to-female ratio of 1.91, similar to ratios reported by Kim et al.[12] and Ramamoorthi K et al,[14] indicating a consistent male predominance in herbicide poisoning. Consistent with previous studies,[14-16] young males who were married, engaged in agricultural occupations, have lower education levels, and reside in rural areas appear to be at higher risk, likely due to occupational stress, familial responsibilities, peer pressure, and limited employment opportunities. In current study, farmers constituted the largest occupational group (32.2%, n=58), followed by students (25%, n=45) and laborers (18.33%, n=33), reflecting both exposure risk and socio-economic factors, aligning with findings from Cherukuri et al,[15] and Pratyusha Thummalagunta et al.[16]

The majority of herbicide exposures (87.7%) were intentional, reflecting deliberate self-harm, which is consistent with findings from Amiri et al,[17] in Iran, where 76.9% of poisonings were suicidal, and Sabzghabaee et al,[18] who reported that all 29 paraquat poisonings were intentional. Most patients (46.11%, n=83) reached the hospital within six hours of ingestion, while 35% (n=63) arrived within 6–12 hours, highlighting the importance of timely medical intervention. Previous studies by Kim et al,[12] and Hong et al,[19] similarly emphasized that shorter pre-hospitalization times are associated with improved survival. Paraquat was the most commonly ingested herbicide (35%, n=63), followed by glyphosate (27.22%, n=49) and 2,4-D (ethyl ester) (16.11%, n=29), with smaller proportions for pendimethalin, atrazine, pyrazon, and other compounds. These patterns align with prior studies, including Sarkar TS et al,[13] and Pratyusha Thummalagunta,[16] which also reported paraquat as the most frequent agent, and Cherukuri et al,[15] where 78% of cases involved paraquat, confirming its predominance and high toxicity in self-poisoning incidents.

The most common clinical features included vomiting (67.7%), throat discomfort (40.5%), dysphagia (23.8%), breathlessness (15%), and loss of consciousness (17.7%), reflecting both gastrointestinal and central nervous system involvement. These findings are comparable with Pratyusha Thummalagunta,[16] who reported vomiting (60%), abdominal pain (50%), throat discomfort (42%), and breathlessness (52%), and Cherukuri et al,[15] showing vomiting (68.3%), throat discomfort (26.7%), abdominal pain (23.3%), dysphagia (16.7%), and breathlessness (10%). Oral ulcers (42.2%) and tachycardia (34.44%) were the most frequent examination findings in our study, indicating mucosal and cardiovascular effects, while proximal muscle weakness (28.99%) and icterus (27%) highlighted neuromuscular and hepatic involvement. Hypotension (25%) and miosis

(13.88%) further reflect circulatory and toxicological effects. These patterns are consistent with prior studies, including Pratyusha Thummalagunta (oral ulcers 48%),[16] and Sarkar TS et al. (oral ulcers 24%),[13] underscoring the importance of thorough clinical evaluation to identify early gastrointestinal, neuromuscular, and systemic manifestations, which may progress to respiratory compromise due to muscle involvement in prolonged cases.

In the present study, acute complications were common among patients with herbicide poisoning, with acute kidney injury observed in 60%, respiratory failure in 57.7%, sepsis in 41.6%, and acute hepatitis in 32.7%, highlighting severe multi-organ involvement. Respiratory failure, affecting 104 patients (58%), was often related to central nervous system depression or respiratory muscle weakness, necessitating mechanical ventilation in several cases. These findings are consistent with Ramamoorthi K et al,[14], where 55.4% of paraquat-poisoned patients developed respiratory failure and 50.9% required ventilatory support, with 43.6% exhibiting hypotension requiring inotropes. Similarly, Cherukuri et al.[15] reported acute renal failure in 28% of patients, some requiring hemodialysis or hemoperfusion. Sarkar TS et al,[13] also found 58% of patients had acute kidney injury, 64% had deranged liver enzymes, and 30% experienced alveolar damage causing respiratory failure. Laboratory investigations in our study demonstrated elevated blood urea, serum creatinine, AST, and ALT in patients who died or were discharged against medical advice compared to survivors, emphasizing the prognostic value of early laboratory assessment in predicting outcomes.

The overall case fatality rate was 46.4%, which is lower than the very high fatality rates of 50%–90% reported in other studies. Cherukuri et al,[15] reported a fatality of 61.7% with 38.3% survivors, while Sarkar TS et al.[13] observed 38% mortality and 62% recovery, with compound-specific fatality rates of 56.2% for paraquat, 12.5% for glyphosate, and 0% for pretilachlor. Similarly, Pratyusha Thummalagunta,[16] reported 46% deaths and 56% patients discharged after recovery. These findings indicate that, although fatality remains substantial, timely supportive care and early intervention can reduce mortality in herbicide poisoning cases.

The study is limited by the lack of data on socioeconomic, mental health, and environmental factors, absence of long-term follow-up, and potential underreporting or misclassification of exposures. Only a limited range of herbicides was studied without toxicological confirmation, and variations in treatment protocols were not accounted for. Additionally, the sample size was substantial, it may not fully represent the broader population, limiting the generalizability of the findings.

CONCLUSION

Herbicide poisoning in the present study predominantly affected young adult males, particularly those who were married, engaged in agricultural occupations, and had lower educational levels. Suicidal ingestion was most common, with paraquat being the leading agent. Frequent symptoms included vomiting, throat discomfort, and dysphagia while oral ulcers, tachycardia, proximal muscle weakness, icterus, and hypotension were common examination findings. The complications like acute kidney injury, respiratory failure, and sepsis contributed to a case fatality rate of 46.1%, highest with paraquat poisoning. Early recognition and timely supportive management were key to improving outcomes, highlighting the importance of preventive measures and stricter herbicide regulation.

REFERENCES

1. Gunnell D, Eddleston M, Phillips MR, Konradsen F. The global distribution of fatal pesticide self-poisoning: Systematic review. BMC Public Health 2007; 7:357
2. World Health Organization. Guidelines for establishing a poison center. Geneva: WHO; 2020.
3. Karunarathne A, Gunnell D, Konradsen F, Eddleston M. How many premature deaths from pesticide suicide have occurred since the agricultural green revolution? Clin Toxicol. 2020;58(4):227–32.
4. Srivastava A, Peshin SS. An epidemiological study of poisoning cases reported to the National Poisons Information center, All India Institute of Medical Sciences, New Delhi. Hum Exp Toxicol 2005; 24:279-85.
5. Gunnell D, Eddleston M, Phillips MR, Konradsen F. The global distribution of fatal pesticide self-poisoning: Systematic review. BMC Public Health 2007; 7:357
6. Shopova VL, Dancheva VY, Salovsky PT, Stoyanova AM, Lukano TH. Protective effect of U 74389G on paraquat induced pneumotoxicity in rats. Environ Toxicol Pharmacol 2002;24:167 73.
7. Chen HW, Tseng TK and Ding LW. Intravenous paraquat poisoning. J Chin Med Assoc 2009; 72: 547-550.
8. Vale JA, Meredith TJ, Buckley BM. Paraquat poisoning: Clinical features and immediate general management. Hum Toxicol 1987;6:41-7.
9. Kolilekas L, Ghizopoulou E, Retsou S, Kourelea S and Hadjistavrou C. Severe paraquat poisoning. A long-term survivor. Respiratory Medicine Extra 2006; 2: 67-70.
10. Pavan M. Acute kidney injury following Paraquat poisoning in India. Iran J Kidney Dis 2013; 7: 64-66.
11. Chandrasiri N. The first ever report of homicidal poisoning by intramuscular injection of gramoxone (paraquat). Ceylon Med J 1999; 44: 36-39.
12. Kim SJ, Gil HW, Yang JO, Lee EY, Hong SY. The clinical features of acute kidney injury in patients with acute paraquat intoxication. Nephrol Dial Transplant 2009;24:1226-32.
13. Sarkar TS, Santra G. A clinico-epidemiological Study of acute Self-poisoning by different Types of herbicidal Substances used in agricultural Fields: A Study from Patients admitted in a Tertiary Care Hospital in West Bengal. J Assoc Physicians India 2022;70(8):23–26.
14. Ramamoorthi K, Acharya V, Lewis M. Paraquat – boon or bane? A retrospective study of paraquat poisoning and outcomes in a tertiary care centre in South India. Medical Journal of Dr DY Patil Vidyapeeth. 2022;0(0):0.
15. Cherukuri H, Pramoda K, Rohini D, Thunga G, Vijaynarayana K, Sreedharan N, et al. Demographics, clinical characteristics and management of herbicide

poisoning in tertiary care hospital. Toxicol Int 2014; 21:209-13.
16. Pratyusha Thummalgunta, Mahesh Vemuri: Clinical, laboratory and epidemiological study of acute suicidal ingestion of different types of herbicides in patients admitted in health care hospital November 2022; DOI:10.30574/ijsra.2022.7.2.0229.
17. Amiri AH, Delfan B and Jaferian S. Paraquat Poisoning Cases Treated at Shohada Ashayer Hospital of Khorramabad in 2001-2006. Research Journal of Biological Sciences 2008; 3: 525-529.
18. Sabzghabaee AM, Eizadi-Mood N, Montazeri K, Yaraghi A and Golabi M. Fatality in paraquat poisoning. Singapore Med J 2010; 51: 496- 500.
19. Hong SY, Yang DH, Hwang KY. Associations between laboratory parameters and outcome of paraquat poisoning. Toxicol Lett 2000; 118:53-9.