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LETTER TO THE EDITOR

Fatal inhalational paraquat poisoning: Need for awareness among Indian Farmers

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Dear Editor,

Paraquat (1-methyl-4-(1-methylpyridin-1-ium-4-yl)pyridin-1-ium) is a non-selective herbicide extensively used in agricultural activities in India. Unfortunately, it is also a means of self-harm due to its high acute toxicity and the absence of an effective antidote [1]. Recently, paraquat has also been used in criminal poisonings [2-4]. While the suicidal and homicidal abuse of paraquat in India has received attention from the scientific community, accidental exposure among pesticide applicators and farmers remains a significant concern that needs to be addressed. The morbidity and mortality associated with accidental poisonings are high in vulnerable groups such as children and the elderly [5]. Here, we present a case of fatal acute inhalational paraquat poisoning.

A 55-year-old male farmer presented with fever and altered sensorium following occupational exposure to a pesticide during agricultural activity without appropriate personal protective equipment. Notwithstanding supportive medical intervention, his condition deteriorated, and he succumbed after 48 hours while undergoing treatment at a healthcare facility. During police investigation and subsequent verification of medical records, the herbicide inhaled turned out to be paraquat dichloride. Clinically, the deceased presented with breathlessness and abdominal pain. Laboratory investigation revealed elevated liver enzymes, urea and creatinine levels, indicating multiorgan organ involvement. Homogenous diffuse fluffy infiltrates were noted on chest X ray. All the above-mentioned findings were consistent with paraquat poisoning noticed in general medical practice.

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At autopsy, the deceased was lean-built, and the body showed a generalized yellowish hue, suggestive of liver failure. On internal examination, the brain was oedematous with a mild yellowish discoloration (Figure 1) and weighed 1150 grams. The lungs were markedly congested, haemorrhagic, and indurated in the upper lobes, with the right lung adherent to the thoracic cavity (Figure 2). The right lung weighed 774 grams, while the left lung weighed 738 grams. On histopathological examination, pulmonary oedema and interstitial haemorrhages were noted amidst hemosiderin-laden macrophages, and foci of congested blood vessels (Figure 3). The liver was enlarged, weighed 1274 grams, and exhibited a yellowish discoloration (Figure 4). On histopathological examination fatty changes with peripheral cellular infiltrates were present (Figure 5). The right kidney weighed 131 grams, and the left kidney weighed 130 grams, both showing yellowish discoloration (Figure 6). Histopathological examination demonstrated mild interstitial infiltrates and interstitial haemorrhages (Figure 7). The stomach contained approximately 100 mL of green fluid with no suspicious odour, and the gastric mucosa was normal. Chemical analysis of routine viscera, including the liver, kidneys, gastric contents, and blood, did not detect paraquat. Although preserving lungs would have yielded a positive result with respect to detection of paraquat we did not preserve lungs assuming good systemic distribution of paraquat in this case.

A common reason for the non-detection of paraquat in biological matrices is its rapid elimination from the body, particularly when there is a prolonged survival period following ingestion or exposure. Additionally, paraquat concentrations may fall below the analytical limit of detection, or the compound may undergo degradation prior to analysis. Furthermore, a significant time lapse between exposure and death can also contribute to undetectable levels in post-mortem samples. However, taking into account the history of exposure, a review of medical records from the time of initial treatment, and relevant toxic pathological findings showing characteristic *paraquat lung* with *hepatorenal* involvement, the cause of death was determined to be paraquat poisoning. The police investigation concluded the manner of death was accidental.

Since the exposure occurred in an informal setting and an open area, calculating the actual levels of paraquat in ambient air was difficult. However, the general levels at which paraquat becomes fatal are mentioned here. Time Weighted Average (TWA) for paraquat dichloride is 0.1 mg/m^3 as respirable dust [6]. The Time Weighted Average (TWA) refers to the average exposure to a hazardous substance over a standard period, usually around 8 hours which is used in occupational health regulation [7]. The Threshold Limit Value (TLV) is the level of chemical concentration to which a worker can be exposed on a daily basis without experiencing adverse health effects [7]. Sadly, no such values are available for farming activities in our country since there is no corporate farming as well as large swathes of land are held by small and marginal farmers.

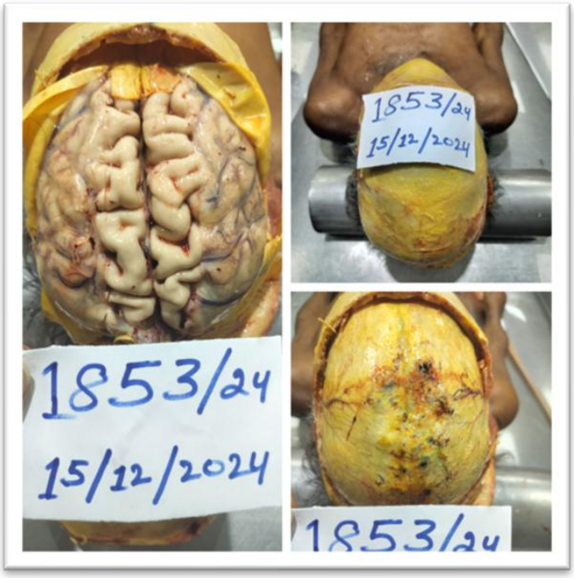

Figure 1. Icteric scalp, dura and oedematous brain

Figure 2. Haemorrhagic, heavily congested lungs

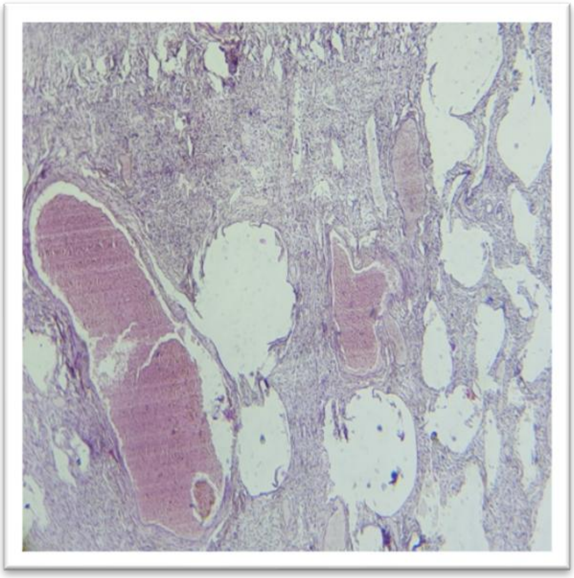

Figure 3. Histopathology lung (H & E, 400X), Pulmonary oedema and interstitial haemorrhages

Figure 4. Yellowish liver

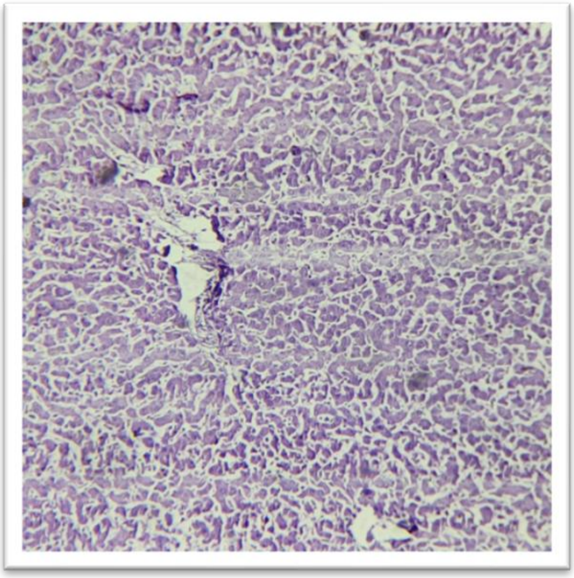

Figure 5. Histopathology liver (Haematoxylin and Eosin staining, 400X), Fatty changes with peripheral cell infiltration

Figure 6. Yellowish discolouration of kidneys

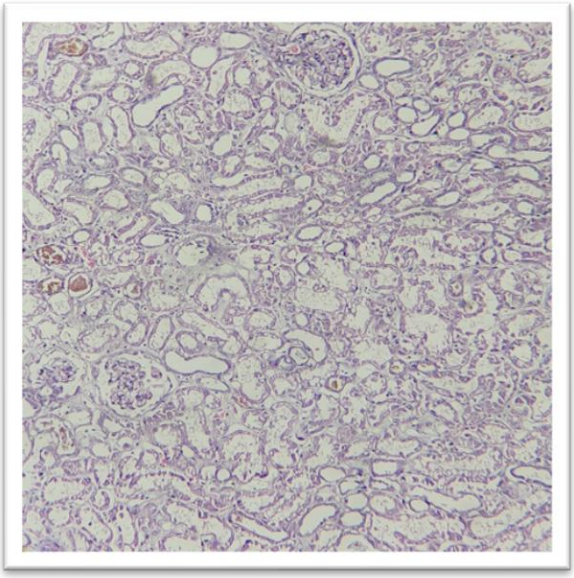

Figure 7. Histopathology Kidney (Haematoxylin and Eosin staining, 100X), Interstitial haemorrhages and infiltrates.

The lowest relevant inhalation no-observed-effect concentration (NOEC) for paraquat is 0.01 mg/m³, based on a 21-day whole-body exposure study in rats according to a recent risk assessment report [8]. With the lungs being one of the primary target organs for toxicity in paraquat poisoning [9], inhalational exposure—both in acute and chronic settings—can be fatal. It is common for Indian farmers to work without gloves or masks (unsafe pesticide use), leading to unintended exposure through both inhalation and dermal contact [10]. There have been instances of skin corrosion and burns due to occupational dermal exposure to paraquat [11]. However, this case emphasises the often-overlooked inhalational paraquat poisoning. From the Bhopal gas tragedy to the Yavatmal pesticide poisonings, there have been instances of mass casualties due to inhalational chemical exposures in India [12].

The history provided by the police and the relatives of the deceased was vague and lacked important details, making it unlikely quantify the inhalational paraquat exposure. There is limitation in measuring the paraquat concentration in air/body in these circumstances. The accurate estimation requires samples to be collected from the filtration system of the sprayers which are generally not used. In rural India, owing to poor financial support, knapsack/back pack sprayers are commonly used in agricultural activities. These sprayers are minimally motorized and does not have any air filters. Thus, it is impossible to sample and analyse airborne paraquat quantities.

In our country, farmers are exposed to a range of pesticides, including insecticides, herbicides, fungicides, and rodenticides. The extent of exposure and their adverse effects vary depending on the chemical composition of the pesticide and the target organ affected. This exposure can lead to a several health issues, including respiratory diseases, cardiovascular problems, gastrointestinal disturbances, and neurological conditions. Chemical pesticides, which include water-insoluble chemicals such as nitrogen dioxide and phosgene, may cause toxic pulmonary damage and some pesticides may can cause skin corrosion [13].

A national survey in the United States identified farming as one of the most hazardous occupations, with pesticide use being a major contributing factor. Waggoner et al. analysed 338 injury-related fatalities over 727,543 person-years (1993–2008), noting an increasing trend in pesticide-related deaths. Pesticide dispersion and runoff pose risks to the environment and nearby individuals exposed during spraying. Five herbicides—2,4,5-T, paraquat, alachlor, metribuzin, and butylate—have been linked to a higher risk of fatal injuries [14]. Dermal absorption of organophosphates can cause severe neurological symptoms or death, while pesticides may also trigger anaphylaxis or contact dermatitis [15].

Although no protective gear or application technique can fully eliminate pesticide exposure, many farmers hesitate to use recommended protective equipment, increasing their risk. Pesticide-related risks can be minimized by taking precautions during transportation, storage, handling, application, and disposal. Formulations with a pH below 5 or above 8 can cause eye irritation and corneal opacity, especially in granular and dust forms. Oral exposure may result from poor hygiene practices, such as using the mouth to clear clogged nozzles, drinking from contaminated hoses, or handling food with pesticide-contaminated hands. Farmers can reduce exposure by using washable PPE, including goggles to prevent ocular exposure, respirator masks for inhalational protection, and rubber-lined clothing to prevent dermal contact. Clothes made of denim fabric have some protective effect [15]. In summary:

1. Try to avoid skin contact, wash hands thoroughly with water and soap after use.
2. Label the containers, use proper spraying equipment, check for any leaks and wear and tear changes in the spraying equipment.
3. Store the agrochemicals in a cool, dry and well-ventilated room, avoid spraying in windy conditions to prevent drift and inhalation.
4. Wash contaminated clothing and body parts and provide awareness to the farmers and the general public.

It is necessary to create awareness among Indian farmers about the hazards of unsafe pesticide handling as it can impact their health in multiple ways. Comprehensive intervention measures including awareness campaigns and safety training programs are a need of the hour [16]. Nevertheless, it is important to design novel risk communication strategies to inculcate a safety culture among the rural population.

We cannot always blame the farmer or pesticide applicator for this precarious situation. In fact, they are not in a financial position to purchase safety gear. The pesticide companies also have a responsibility to ensure the safe use of hazardous substances manufactured by them. It is time to think of designing agrochemicals that are effective but do not pose an occupational hazard. It would be great if the pesticide companies consider distributing washable personal protective equipment (PPE) free of cost during each crop season and actively promote their use as a corporate social responsibility in selected areas of the country where there is rampant use of pesticides in agriculture.

The local health care workers should work in collaboration with agriculture extension officers to spread the word on safe handling of pesticides. Practical demonstrations on wearing gloves and masks should be carried out before the crop season begins.

Limitations

Paraquat was not detected in biological matrices in this case due to lapse of time. Lungs were not preserved for chemical analysis. Quantitative analysis of viscera was not carried out due to lack of resources.

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Conflicts of interest

The authors declare that they do not have conflict of interest.

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Ethics committee approval

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