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CASE REPORT

Hypersensitivity Reaction and Acute Respiratory Distress Syndrome in Pyrethroid Poisoning and Role of Steroid Therapy

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Abstract

Background: Pyrethroids are generally of low toxicity to humans, but in suicidal poisonings which are usually associated with ingestion of high doses, they lead to severe systemic effects.
Case Report: A 30-year old woman presented to emergency department with a history of intentional ingestion of about 15 mL of prallethrin around 3 days earlier. She complained of shortness of breath along with chest pain for the last 2 days. She reported no vomiting or stomach pain prior to presentation to hospital. On chest auscultation, breath sounds were mildly decreased in bilateral infrascapular areas with generalized crepitation. Arterial blood gas analysis revealed respiratory alkalosis. Chest X ray and computed tomography of thorax revealed widespread confluent areas of consolidation with interlobular septal thickening involving bilateral parahilar regions suggestive of acute respiratory distress syndrome (ARDS). The patient did not respond to broad spectrum antibiotic coverage, diuretics and oxygen inhalation. Intravenous methylprednisolone (2 mg/kg/day divided 6 hourly) was started and slowly tapered off during the next days. The patient discharged after 3 weeks in good health.
Discussion: As pyrethroids can affect sodium channels, the osmotic gradient of alveolar epithelium probably disrupts and therefore, alveolar infiltrations gradually spread over lungs. In addition, there is a possibility of hypersensitivity reactions to pyrethroids, which can cause progressive inflammation and involve respiratory tract in severe cases.
Conclusion: Pyrethroid poisoning can lead to ARDS. Steroid therapy may help such patients tide over the pulmonary crisis.

Keywords: Adult Respiratory Distress Syndrome; Hypersensitivity; Methylprednisolone; Poisoning, Pyrethrins

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INTRODUCTION

Pyrethroids have been widely used to control insects for decades, and currently they comprise the majority of household insecticides (1). However, poisoning with these compounds have still remained a rare phenomenon with only occasional case reports. Pyrethroids are generally of low toxicity to humans, but in suicidal poisonings which are usually associated with ingestion of high doses, they lead to severe systemic effects. Toxicity initially manifests with local symptoms involving the site of exposure to the poison (2). Pyrethroid ingestion results in sore throat, nausea, vomiting and abdominal pain. There may also be mouth ulceration, increased secretions, dysphagia, esophagitis or even gastric ulceration and hematemesis (2-4). Pulmonary complications including aspiration pneumonitis and pulmonary edema following pyrethroid poisoning are rarely reported, but if occur they are predictive of poor prognosis which mandates intensive management (2).

We hereby report a young woman who presented with intentional ingestion of prallethrin (a potent pyrethroid insecticide) and manifested with acute respiratory distress syndrome (ARDS) and pulmonary edema, who was successfully treated with steroid therapy.

CASE REPORT

A 30-year old woman presented to the emergency department of Safdarjang Hospital in New Delhi, India with a history of intentional ingestion of about 15 mL of prallethrin around 3 days earlier. She complained of shortness of breath along with chest pain for the last 2 days. She reported no vomiting or stomach pain prior to presentation to hospital.

On examination, she was conscious and oriented but tachypneic (respiratory rate: 38 breaths/min) and tachycardic (pulse rate: 110 beats/min). Her blood pressure was 110/80 mmHg and her oxygen saturation on room air was 94%. Oral cavity inspection revealed intact mucosa. On chest auscultation, breath sounds were mildly decreased in bilateral infrascapular areas with generalized crepitation. No abdominal tenderness was found. Other systemic examinations as long as we did were unremarkable.

Lab testing revealed hemoglobin of 9.8 g/dL, leucocyte count of 11,000 cells/mm^3, platelet count of 448,000 cell/mm^3 and erythrocyte sedimentation rate of 60 mm/1sthr. Serum creatinine, liver enzymes, coagulation profile and serum electrolytes were within normal limits. Arterial blood gas analysis revealed respiratory alkalosis as PaO2 was 52 mmHg, $PaCO_2$ was 32 mmHg, pH was 7.51 and FiO_2 was 0.4.

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Initial PaO_2/FiO_2 ratio was 130. Electrocardiogram showed sinus tachycardia.

There was progressive clinical deterioration of clinical status of the patient with hypoxemia and drop in oxygen saturation as was evident from the analysis of arterial blood gas. Chest X ray and computed tomography of thorax revealed widespread confluent areas of consolidation with interlobular septal thickening involving bilateral parahilar regions suggestive of ARDS (Figure 1A and B). Two-dimensional (2D) echocardiography revealed an ejection fraction of 54% with dilated right atrium and right ventricle with mild tricuspid regurgitation. Anti-neutrophil cytoplasmic antibodies (both cytoplasmic and perinuclear patterns) and anti-nuclear antibody, done to rule out any pre-existing lung pathology following systemic vasculitis, were negative.

The patient was treated symptomatically with broad spectrum antibiotic coverage, diuretics and oxygen inhalation. However, she did not show any improvement, and in view of suspected underlying inflammatory reaction, intravenous methylprednisolone (2 mg/kg/day divided 6 hourly) was started and continued for the 5 following days. As the patient responded favorably, methyl prednisolone was tapered off in next 7 days and changed to oral prednisolone (2 mg/kg/day once daily). The patient discharged after 3 weeks in good health. On the first follow-up, 1 month after discharge, the patient was greatly improved with normal PaO2 and oxygen saturation on room air. Her chest radiography was normal and 2D echocardiogram showed normal chambers and valves with ejection fraction of 64%. Oral steroids were further tapered to a lower dose (tapered by 5 mg every week) and stopped gradually in 2 months.

DISCUSSION

To the best of our knowledge, this is the first article that shows the effective role of steroid therapy in systemic pyrethroid poisoning. Prallethrin ($C_{19}H_{24}O_3$) is a structural derivative of naturally occurring pyrethrins derived from the flower *Chrysanthemum cinerariifolium* (2,5). It is marketed as a mosquito repellent by Godrej as "Good Knight Silver Power" and SC Johnson as "All Out" in India (5). It is also used for killing wasps and hornets, including their nests. Its mechanism of action involves sodium and chloride channels. Pyrethroids can delay the closure of voltage-sensitive sodium channels that consequently reduces the action potential threshold and causes repetitive firing, which may be the mechanism of paresthesia in humans (2,5). At relatively high concentrations, pyrethroids can also act on GABA-gated chloride channels, which may be responsible for the seizures (2,5).

Incidence of acute human poisonings from exposure to pyrethroids is difficult to determine, as it being an uncommon phenomenon due to its low inherent toxicity in mammals with very limited literature on its mortality (2,6). In most reported cases, type II pyrethroids (fenvalerate, deltamethrin or cypermethrin) were responsible for poisoning and systemic features occurred 4 to 48 hours after spraying (2,4). The majority of pyrethroid poisoning events occur secondary to inappropriate occupational handling such as use of highly concentrated solutions, prolonged exposure to the poison, spraying against the window, dermal contact when spraying with unprotected hands or mouth.

Signs and symptoms of pyrethroid poisoning are very similar to those of organophosphate poisoning; and therefore,

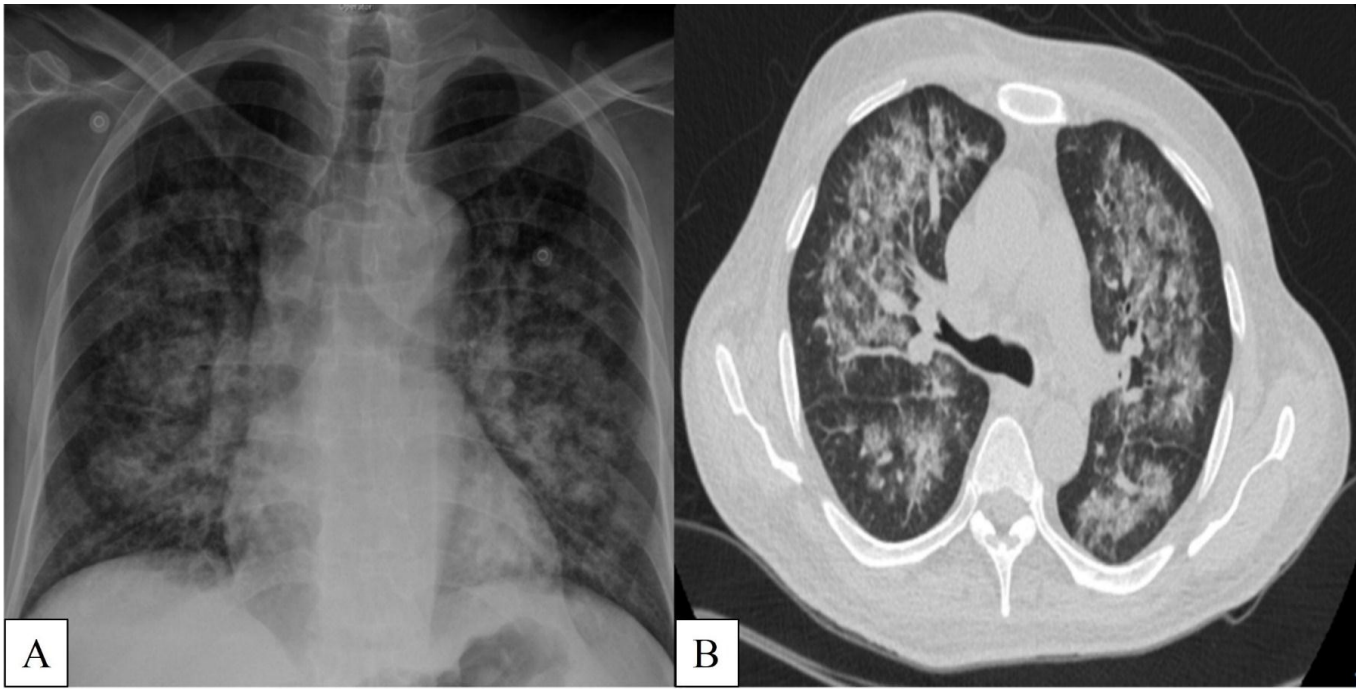

Figure 1. Pulmonary imaging (A: Chest X ray, B: Computed Tomography Scan) of the patient with pyrethroid poisoning

a diagnostic challenge happens if the patient has impaired consciousness, the source of poisoning is unavailable and the medical setting lacks specific laboratory facilities to measure the poison in the patients' blood (a phenomenon that is not uncommon in developing countries). Dermal exposure results in paresthesia which recovers spontaneously in a few hours (2). Ingestion of pyrethroids causes nausea, vomiting, abdominal pain, dizziness, headache, fatigue, palpitation, chest tightness and visual blurring. Coma, convulsions and pulmonary edema are uncommon but may occur in severe poisonings (2,4,7). In a large review of acute poisonings due to pyrethrin and pyrethroid insecticides over a 5-year period in the Unites States, a total of 407 cases were evaluated. Most cases had mild illness and the most common effects were respiratory manifestations (52%) followed by neurologic manifestations (40%) (8). The most common respiratory manifestations were cough (28%), upper airway irritation (24%) and dyspnea (22%) (8). These signs and symptoms are likely to be due to aspiration pneumonitis or poison-induced pulmonary edema, and are partly attributable to organic solvents in the poison formulation (2,3,8).

ARDS or non-cardiogenic pulmonary edema, irrespective of etiology, still carries a high mortality despite significant advancements in critical care management over the recent decades (9). Fluid balance in healthy alveoli is regulated to maintain a meniscus of epithelial fluid or lining layer. Liquid moves across the alveolar epithelium at the junctions between cells (paracellular) because of the osmotic gradient generated by active inward trans- epithelial sodium transport through apical epithelial sodium channels that are present in both type I and type II pneumocytes (10). As pyrethroids can affect sodium channels (2,5), the osmotic gradient probably disrupts and therefore, alveolar infiltrations gradually spread over lungs. In addition, there is a possibility of hypersensitivity reactions to pyrethroids, which can cause progressive inflammation and involve respiratory tract in severe cases (2).

For ARDS to resolve, we should help alveolar epithelium to clear the edema. Diuretics can be helpful in this regard as they can maintain a negative fluid balance (11). However, our patient did not respond well to this treatment. Later, pulse therapy with methyl prednisolone resulted in significant improvement. This further strengthens the hypothesis of pyrethroid-induced hypersensitivity reaction. Steroids can reverse the inflammatory process; although their effectiveness for ARDS management is under question (12).

CONCLUSION

Pyrethroid poisoning can lead to ARDS. Steroid therapy may help such patients tide over the pulmonary crisis, and thus is better to be considered as an effective measure in such situations along with intensive care. This observation needs further validation in prospective studies.

Conflict of interest: None to be declared.

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