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## Original Article

# Outcome of patients supported by extracorporeal membrane oxygenation for aluminum phosphide poisoning: An observational study



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## ABSTRACT

**Introduction:** Aluminum phosphide (ALP) poisoning has a high mortality rate despite intensive care management, primarily because it causes severe myocardial depression and severe acute respiratory distress syndrome. The purpose of this study was to evaluate the impact of the novel use of extracorporeal membrane oxygenation (ECMO), a modified “heart-lung” machine, in a specific subset of ALP poisoning patients who had profound myocardial dysfunction along with either severe metabolic acidosis and/or refractory cardiogenic shock. **Methods:** Between January 2011 and September 2014, 83 patients with ALP poisoning were enrolled in this study; 45 patients were classified as high risk. The outcome of the patients who received ECMO ( $n = 15$ ) was compared with that of patients who received conventional treatment ( $n = 30$ ).

**Results:** In the high-risk group ( $n = 45$ ), the mortality rate was significantly ( $p < 0.001$ ) lower in patients who received ECMO (33.3%) compared to those who received conventional treatment (86.7%). Compared with the conventional group, the average hospital stay was longer in the ECMO group ( $p < 0.0001$ ). In the ECMO group, non-survivors had a significantly ( $p = 0.01$ ) lower baseline LV ejection fraction (EF) and a significantly longer delay in presentation ( $p = 0.01$ ).

**Conclusion:** Venous-arterial ECMO has been shown to improve the short-term survival of patients with ALP poisoning having severe LV myocardial dysfunction. A low baseline LVEF and longer delay in hospital presentation were found to be predictors of mortality even after ECMO usage. Large, adequately controlled and standardized trials with long-term follow-up must be performed to confirm these findings.

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## 1. Introduction

Pesticide poisoning is a worldwide health problem that can occur intentionally for suicidal or homicidal purpose and unintentionally as the result of accidental or occupational causes. Furthermore, self-poisoning accounts for one-third of suicides throughout the world.<sup>1</sup> Aluminum phosphide (ALP) is a solid fumigant that is used for the fumigation of agricultural compounds, in animal feed, and for pest control in agricultural fields. In North India, ALP poisoning has been found to be the most common cause of suicidal death.<sup>2</sup> In India, the considerable time gap between the ingestion of the poison and the initiation of proper treatment has been found to be the major reason for the high mortality rate of ALP poisoning. ALP poisoning mortality rates vary from 40% to 80%.<sup>3</sup> Once refractory myocardial depression sets in, which is not uncommon, the mortality rate further increases to 77% (37–100%).<sup>3,4</sup> Reports in the literature have shown that resistant hypotension and metabolic acidosis are robust predictors of a poor prognosis after ALP poisoning.<sup>5</sup> Extracorporeal membrane oxygenation (ECMO) is a well documented therapy for improving survival in patients with severe respiratory failure.<sup>6</sup> Venovenous ECMO is the preferred method in patients with isolated respiratory failure.<sup>6</sup> However, veno-arterial (VA) ECMO should be used in patients with combined cardio-vascular and respiratory failure.

In this study, we investigated the use of VA ECMO in a high-risk subgroup of ALP poisoning patients who were at a very risk of mortality with ALP poisoning. The high risk subgroup was identified by following two criteria: (1) severely reduced left ventricular ejection fraction (LVEF  $\leq$  35%) and (2) severe metabolic acidosis (pH  $\leq$  7.0) and/or refractory shock, i.e. systolic blood pressure  $<$ 80 mmHg despite conventional medical therapies.

## 2. Material methods

### 2.1. Study population

This was a tertiary care, single-center prospective study. We enrolled 83 patients admitted to our center with ALP poisoning between January 2011 and September 2014. All patients had ingestion of the tablet form of ALP with suicidal intention. Forty-five patients were classified as high-risk group of ALP poisoning. The patients of ALP poisoning were classified as a high risk if they met the following criteria:

1. Left ventricular myocardial dysfunction i.e. EF of  $\leq$ 35%
2. Severe metabolic acidosis (pH  $\leq$  7.0) and/or refractory shock i.e. systolic blood pressure  $<$ 80 mmHg despite conventional medical therapies.

All 45 patients were given the option for ECMO but 30 patients refused primarily due to economical issues. Thereby, 30 patients received the conventional mode of treatment (conventional group) while 15 patients received ECMO in addition to conventional treatment (ECMO group). The outcome of patients in the high-risk group that were

treated with ECMO and those of patients in the conventional treatment group was compared. Fig. 1 demonstrates the study design. Conventional treatment for ALP poisoning included gastric lavage with coconut oil, early resuscitation with fluid and vasoactive agent, intravenous magnesium sulfate, and intensive care management. Various vasoactive agents included dopamine, epinephrine, and nor-epinephrine. Intra-aortic balloon pumping was not used as a cardiac support in any of the patient. All patients in ECMO group and majority of the patients in conventional group received ventilator support at the time of admission or during the course of hospitalization.

### 2.2. ECMO indications and procedure

VA ECMO was considered for patients with ALP poisoning who were classified as high-risk group as mentioned above.

The cannulation site was determined based on patient status. The majority of patients underwent percutaneous cannulation through femoral vessels. The ECMO cannulation was done in intensive care unit. A venous cannula was placed in the inferior vena cava or right atrium for drainage infusion. The usual size of venous cannula ranges from 21 to 25 F. The return cannula is a short arterial cannula inserted via the common femoral artery. This cannula is fully inserted to the taper, with the tip lying in the common iliac artery or lower aorta. The usual size of arterial cannula ranges from 17 to 21 F. Additional distal perfusion 9 F return cannula ("backflow cannula") is inserted antegradely into the common femoral artery and directed into the superficial femoral artery.

The patients were maintained on a continuous heparin infusion to achieve an activated clotting time between 180 and 200 s. The goal for the activated clotting time was adjusted if there were issues with bleeding or coagulation. To maintain a hemoglobin level of  $\geq$ 10 g/dL and a platelet count of  $\geq$ 100,000  $\text{dL}^{-1}$ , patients received a transfusion during the ECMO treatment. The patients were continuously monitored in terms of hemodynamic improvement, reversal of metabolic acidosis, and adequate oxygenation. Once these parameters are satisfactory, the ECMO weaning protocols were initiated. The circuit flow was reduced to assess the native cardiac function in the setting of an increased venous return. Flow was reduced from 2.5 L/min in a series of 0.5 L/min increments while hemodynamic and echocardiographic evaluations were done. Decannulation was performed once the patient had improvement in LVEF to  $>$ 35%, maintaining systolic blood pressure of  $>$ 90 mmHg without any inotropic support and acidosis had recovered.

### 2.3. Statistical analysis

Continuous variables are presented as the mean  $\pm$  standard deviations. Categorical variables are expressed as percentages. Continuous variables were compared using Student's *t* test if the data followed a normal distribution and using the Wilcoxon test if the data were skewed. Categorical variables were compared using the chi-square test or Fisher's exact test as indicated. All probability values were 2-sided, and difference with *p* values of  $<$ 0.05 was considered statistically significant.

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