ASSESSMENT OF CLINICAL PROFILE, TREATMENT OUTCOME, AND ASSOCIATED FACTORS AMONG ALUMINUM PHOSPHIDE POISONING PATIENTS AT ASELLA REFERRAL AND TEACHING HOSPITAL, ARSI UNIVERSITY, ETHIOPIA

BY: DR. FITSUM MOLA (MD, INTERNAL MEDICINE RESIDENT)

ARSI UNIVERSITY

COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF INTERNAL MEDICINE

JANUARY, 2026

ASELLA, ETHIOPIA

ASSESSMENT OF CLINICAL PROFILE, TREATMENT OUTCOME, AND ASSOCIATED FACTORS AMONG ALUMINUM PHOSPHIDE POISONING PATIENTS PRESENTED TO ADULT EMERGENCY DEPARTMENT OF ASELLA REFERRAL AND TEACHING HOSPITAL, ARSI UNIVERSITY, ASELLA, CENTRAL ETHIOPIA.

A THESIS SUBMITTED TO DEPARTMENT OF INTERNAL MEDICINE, COLLEGE OF HEALTH SCIENCE ARSI UNIVERSITY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE SPECIALITY CERTIFICATE IN INTERNAL MEDICINE.

BY: DR. FITSUM MOLA (MD, INTERNAL MEDICINE RESIDENT)

ADVISORS: DR GADISA DEJENE (MD, ASSISTANT PROFESSOR OF INTERNAL MEDICINE),

DR. HAILU FEKADU (PHD, ASSISTANT PROFESSOR OF PUBLIC HEALTH)

ARSI UNIVERSITY

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JANUARY, 2026

ASELLA, ETHIOPIA

Arsi University College of Health Sciences Department of Internal Medicine thesis Submission Form

Name of investigator	Dr. Fitsum Mola (MD, Internal Medicine Resident)
Name of advisors	Dr. Gadisa Dejene (MD, Internist, Assistant Professor) Dr. Hailu Fekadu (PhD, assistant professor of public health)
Title of the research project	Assessment of clinical profile, treatment outcome, and associated factors among aluminum phosphide poisoning patients at Asella referral and teaching hospital, Arsi university.
Duration of study	Dec, 2025
Study area	Arsi University, CoHS, Asella Referral & Teaching Hospital
Total estimated cost of the Study	30,080 ETB
Address of Investigator	Phone: +251913091016 Email: ewnetmola@gmail.com
Address of primary Advisors	Phone: +251913149005 Email: gadisa600@gmail.com
Address of Co-Advisor	Phone: + 251911717608 Email: hailufekadu18@yahoo.com

January, 2026

Asella, Ethiopia

ACKNOWLEDGEMENT

First of all I express special thanks to the almighty God for his help for my success in my postgraduate education and for preparation of this research thesis. And then, I would like to extend my appreciation and thanks to my advisors Dr. Gadisa Dejene and Dr. Hailu Fekadu for their continued supports, valuable advice, constructive comments & correction in the preparation of my research thesis. I would like to extend my heartfelt gratitude to Arsi University, College of Health Sciences, and Department of Internal Medicine for giving me this chance for preparation of research thesis.

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ACRONYMS/ABBREVIATIONS

AlP- Aluminum Phosphide

ARDS- acute respiratory distress syndrome

ARTH- Asella Referral and Teaching Hospital

AU- Arsi University

BP- Blood pressure

ED- Emergency Department

ECG- electrocardiography

GCS- Glasgow coma scale

IQR- interquartile range

LOS- length of stay of hospital

PH3- Phosphine Gas

ROS - Reactive Oxygen Species

SBP- systolic blood pressure

SRB- suicidal related behavior

WHO- World Health Organization

ABSTRACT

Background: Aluminum phosphide (AlP) is an economical, widely utilized rodenticide and solid fumigant associated with an exceptionally high case fatality rate. In Ethiopia, AlP poisoning has emerged as a significant public health issue, marked by elevated mortality and a lack of extensive local research. Because no specific antidote exists, identifying clinical predictors is essential for improving survival through optimized supportive care.

Objective: To assess the clinical profile, treatment outcomes, and associated factors among aluminum phosphide poisoning patients presented to the adult emergency department of Asella Referral and Teaching Hospital (ARTH), central Ethiopia.

Methods: An institution-based cross-sectional study was conducted analyzing 116 eligible cases presented between August 2020 and 2025. All eligible AlP poisoning cases were included to maximize statistical power. Data were extracted from medical registries using a structured tool and analyzed via SPSS version 26. Descriptive statistics will be conducted to characterize the study population. Bivariate and multivariable logistic regression models were employed to identify independent predictors of mortality, with statistical significance set at $p < 0.05$.

Results: Among the 116 cases, the majority were female (58.8%), rural residents (79.3%), and young adults with a mean age of 26 years. All instances (100%) were identified as intentional self-harm. The most common clinical manifestations were vomiting (100%), epigastric pain (93%), and initial hypotension (40.5%). Despite medical management, including the use of magnesium sulfate and calcium gluconate in nearly half of the cases, the overall mortality rate was 31%. Multivariable analysis identified two independent predictors of the mortality: initial hypotension (SBP ≤ 90 mmHg) (AOR = 264.946; 95% CI: 1.175, 5.9×10^4, $p = 0.044$), and a hospital stay of less than two days (AOR = 167.269; 95% CI: 4.282, 6534.394, $p = 0.006$).

Conclusion: Aluminum phosphide poisoning remains a highly lethal method of self-harm. Hemodynamic instability and a hospital stay of less than two days—serve as the primary determinant of mortality. These findings underscore the need for rapid hemodynamic support.

Keywords: Aluminum phosphide, Clinical profile, Mortality, Associated factors, Ethiopia.

1. INTRODUCTION

1.1. BACKGROUND

Aluminum phosphide (AlP) constitutes an economical and widely utilized rodenticide. Additionally, it serves as a potent solid fumigant that is regularly employed for the preservation of grain. AlP is commercially available in the form of dark grey tablets weighing 3 grams. Due to its unrestricted availability in the marketplace and the lack of regulatory controls in developing nations, it has emerged as one of the frequently utilized substances for self-poisoning across various regions of the developing world (1,2).

When AlP is consumed, phosphine gas (PH3) is liberated as a consequence of the interaction between AlP and hydrochloric acid along with water present in the gastric environment. This exceedingly hazardous PH3 subsequently permeates through the gastrointestinal system and is disseminated throughout the organism, culminating in systemic toxicity (2–4).

PH3 exerts inhibitory effects on cytochrome-c oxidase, resulting in a significant reduction of oxidative phosphorylation and cellular respiration by as much as 70%. The excessive generation of reactive oxygen species (ROS) coupled with subsequent cellular injury culminates in ultimate cellular demise (3–5).

Organs exhibiting elevated oxygen requirements, including the heart, lungs, kidneys, liver, and brain, demonstrate heightened susceptibility to damage induced by PH3, which is associated with the production of ROS (6). The most frequently seen clinical features of AlP poisoning include nausea, vomiting, abdominal pain and hemodynamic instability (7–9).

Other features may include restlessness, headache, diarrhea, fatigue, cough, dyspnea, cyanosis and central nervous system involvement resulting in seizure and varying degrees of altered level of consciousness (8,10).

Cardiovascular involvement results in tachycardia, palpitation, marked hypotension, and ultimately unresponsive shock. AlP poisoning may have complications such as hepatic failure, pancreatitis, pleural effusion, pulmonary edema, acute respiratory distress syndrome, congestive heart failure, arrhythmia, acute renal failure, and disseminated intravascular coagulation (9–11).

Several electrocardiogram changes ranging from ST segment elevation/depression, T wave changes, supraventricular tachycardia, atrial flutter/fibrillation, QRS interval prolongation, variable degrees of heart block, to life threatening ventricular tachycardia and ventricular fibrillation were observed in different studies (3,12).

Laboratory abnormalities associated with AlP poisoning include leucopenia, leukocytosis, hyperglycemia, increased creatinine and blood urea nitrogen, increased serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminase, metabolic acidosis and electrolyte abnormalities of serum potassium and magnesium (13–17).

Treatment of AlP poisoning is mainly supportive as there is no effective antidote. Many agents have been proposed and tried in experimental and clinical studies. Magnesium sulfate, as an antioxidant and cell membrane stabilizer, has been commonly used as therapeutic agent in AlP poisoning although contradictory results have been reported concerning its use. Some studies indicate that AlP poisoning causes hypomagnesemia supporting the mortality benefit of supplementing magnesium sulfate (9,15,17,18).

The lethality associated with AlP toxicity varies significantly, with mortality rates spanning from 37% to 100%. The lethal threshold for an adult individual is estimated to lie between 150mg and 500mg (10,13,16).

1.2. STATEMENT OF THE PROBLEM

Globally WHO estimates that, in 2016, unintentional poisoning caused 106,683 deaths and the loss of 6.3 million years of healthy life (disability-adjusted life years) (19). 385 million cases of unintentional (i.e. accidental or occupational) acute pesticide poisoning incidents have been estimated annually worldwide, 11,000 of which end in death (20). The majority of pesticide-related deaths globally are due to intentional ingestion of pesticides. An estimated 15–20% of suicides globally are due to intentional ingestion of acutely toxic pesticides, equivalent to up to 140,000 deaths each year (20,21).

Suicide accounts for nearly a million deaths annually, with chemicals, particularly pesticides, contributing significantly, causing about 370,000 deaths each year worldwide. Acute poisonings

lead to high morbidity, mortality, and healthcare costs, especially in adults where self-poisoning is often intentional (22–24). An estimate of a systematic review that identified information spanning 108 nations from 2010 to 2014 indicates that there were over 110,000 pesticide self-poisoning deaths every year, or 13.7% of all suicides worldwide (25). The majority of fatal and non-fatal self-poisoning cases occur in low- and middle income countries which often lack strong regulatory systems, technical capacity and resources for safe pesticide control (20,22).

AlP poisoning is associated with a very high case fatality rate. It is often used in suicides, particularly in agricultural communities where it is readily available (3,4,26). AlP poisoning usually follows suicidal or rarely unintentional ingestion (27).

There has been a notable increase in the number of studies and cases related to AlP, indicating a growing concern and incidence of such poisonings worldwide (18). AlP was found to be the most common suicidal poison, causing 68.4 % of total deaths due to poisoning between 1992 and 2002 in north west India (16,27). The common use and easy availability of AlP is causing acute and chronic health effects which have reached major proportions in Asian and Middle Eastern countries such as India, Bangladesh, Iran, Jordan, and Sri Lanka (28).

Poisoning was reported as the second most common means of attempted suicide in a district of Ethiopia. The study showed that the majority of the poisoning cases were women, and strong detergents and rodenticides were the most frequently used poisons (29).

Epidemiological data on acute poisonings in Ethiopia is extremely rare. It is very difficult to find the primary data of poisoning in the country because most of the screening and confirmatory tests are not done routinely in available set up. Additionally, the country doesn’t have well organized poison control center (30). Furthermore no satisfactory data on demographical and etiological characteristics of poisoning were provided by the annual performance reports and other published documents of ministry of health (31).

As advances in technological and social developments have led to ease accessibility of most drugs and chemical substances in the society, the actual number of incidences of poisoning can be higher, because most cases of poisoning actually go unreported (32).

Acute poisonings constitute a significant source of aggregate morbidity, mortality, and health care expenditure. Although there are few studies done on poisoning in Ethiopia, acute poisoning including AlP is an important problem (22).

1.3. SIGNIFICANCE OF THE STUDY

The global epidemiology of acute poisoning, particularly in Ethiopia, reveals significant public health challenges characterized by high mortality rates and varying etiological factors.

AlP poisoning is a commonly used rodenticide, and is a major cause of poisoning cases in Ethiopia, particularly as a means of suicide that can lead to severe organ damage and has a high mortality rate.

The investigation of AlP poisoning holds substantial importance, as it represents a widespread method of self-inflicted harm within the nation, frequently attributed to the accessibility of rodenticides. This phenomenon results in elevated mortality rates and necessitates dedicated research endeavors aimed at elucidating therapeutic approaches and preventive strategies to mitigate the public health crisis correlated with this specific type of poisoning.

AlP poisoning constitutes a considerable public health issue in Ethiopia, marked by elevated mortality rates and a dearth of extensive research. The incidence of AlP poisoning within Ethiopia remains inadequately documented; however, existing studies suggest a significant occurrence, especially in rural regions where AlP is employed as a fumigant and rodenticide. The insufficiency of comprehensive data accentuates the imperative for further investigation to elucidate the complete extent of this concern in Ethiopia.

2. LITERATURE REVIEW

2.1. CLINICAL PROFILES

In a seven-year retrospective analysis at Tehran's Loghman-Hakim Hospital, Shadnia et al. found that, patients exhibited a wide spectrum of symptoms, with cardiovascular manifestations being the most predominant (78.12%). Hypotension (96% of those with cardiovascular symptoms) and tachycardia were common. Gastrointestinal disturbances, especially epigastric pain and vomiting, were also frequent, and over a quarter of patients (28.13%) presented with some level of depressed consciousness. Laboratory findings on admission revealed significant metabolic acidosis, with a mean arterial pH of 7.23 and bicarbonate of 12.7 mEq/L. Electrocardiogram (ECG) abnormalities, primarily ST-segment depression and sinus tachycardia, were present in 65.6% of cases (33).

In a one-year retrospective study conducted at a tertiary care hospital in Sahiwal, Pakistan, Qureshi et al. (2018) showed that the clinical presentation of AlP poisoning was dominated by cardiovascular instability. Shock and tachycardia were the most frequent manifestations, observed in 29.1% of patients. Other common symptoms included drowsiness or a confusional state (20.9%), gastrointestinal disturbances such as salivation, nausea, and vomiting (17.2%), headache and vertigo (13.7%), pupillary changes or lacrimation (10%), and dyspepsia with loose motions (8.1%). The authors highlighted that hypotension, acidosis, and shock are cardinal signs of severe poisoning, which often progresses rapidly despite supportive care (34) .

In a 16-year retrospective ICU-based study from Morocco, Louriz et al. (2009) found cardiovascular instability was prominent, with shock present in 42.6% of patients at admission. Glasgow Coma Scale (GCS) was relatively preserved (mean 14 ± 2), but altered consciousness was noted in a subset. Metabolic acidosis was significant, with a mean arterial pH of 7.1 ± 0.4 and bicarbonate of 16.3 ± 8.8 mmol/L. Electrocardiogram (ECG) abnormalities were common (57%), including sinus tachycardia, myocardial ischemia, atrial fibrillation, and ventricular arrhythmias (8).

In a five-year retrospective study from the East Delta region of Egypt, Deraz et al. (2022) reported that death was primarily due to progressive cardiogenic and hypotensive shock,

acute respiratory distress syndrome (ARDS), and late hepatorenal toxicity. Laboratory findings at admission revealed significant metabolic acidosis, along with elevated liver enzymes (ALT, AST) and serum creatinine in non-survivors. Notably, total leukocyte count (TLC), serum sodium, potassium, pH, bicarbonate, and base excess were significantly lower in patients who died. (35).

In a retrospective study from Felege Hiwot Referral Hospital in Northwest Ethiopia, Bogale et al. (2021) evaluated the most common presenting symptoms were gastrointestinal, with nausea and vomiting occurring in 74.4% of patients, followed by epigastric pain (33.6%). Cardiovascular involvement was prominent, with hypotension (SBP <90 mmHg) observed in 50.4% of cases. Laboratory abnormalities included leukocytosis, leukopenia, elevated liver enzymes (SGOT, SGPT), increased creatinine, and electrolyte disturbances. Electrocardiographic changes such as sinus tachycardia, ST-segment depression/elevation, T-wave changes, and conduction blocks were also documented, though not uniformly assessed in all patients (36) .

2.2. ASSOCIATED FACTORS

In a study conducted at Tehran, Shadnia et al. (2009) reported that patients with AlP poisoning were predominantly young, with a mean age of 27.1 years, and that 66% of cases occurred among individuals aged 20–40 years. Gender distribution was equal. Intentional self-harm accounted for 93% of cases, underscoring aluminum phosphide as a common means of suicide. The mean ingested dose was approximately 5.1 g, typically corresponding to one to three tablets; however, the number of tablets ingested did not demonstrate a significant association with survival. Most patients (65%) were residents of Tehran, and the incidence of poisoning peaked during the spring and winter seasons. Regarding prognostic factors, arterial blood pH emerged as a critical predictor of outcome. All patients with a pH below 7.2 died, whereas survival was universal among those with a pH of 7.35 or higher. Lower serum bicarbonate levels and the presence of electrocardiographic abnormalities were also significantly more frequent among non-survivors. In contrast, variables such as age, sex, immediate vomiting after ingestion, and time interval from ingestion to hospital arrival were not significantly associated with outcome. Overall, only three admission parameters—severe metabolic acidosis reflected by low arterial pH

and bicarbonate levels, and the presence of ECG abnormalities—were identified as statistically significant predictors of mortality (33).

In a forensic registry-based study from Pakistan, Malik et al. (2021) highlighted significant demographic and geographic associations. AlP poisoning accounted for 10.5% (99 cases) of all poisoning fatalities in the registry. There was a marked gender disparity, with females comprising 70.7% of cases compared to 29.3% males. The most affected age groups differed by sex: females were most commonly aged 11–20 years, while males were most frequently 21–30 years. Geographically, intoxication was more common in rural areas, with the highest number of cases reported from the Swat district. A seasonal peak was observed in December. The authors attributed the high prevalence in rural regions to the easy availability of AlP tablets (often called "wheat pills") in agricultural communities (37).

According to a study from Pakistan, Qureshi et al. (2018) demonstrated a pronounced demographic and intentional pattern in aluminum phosphide poisoning. The majority of patients (85.45%) were young, aged 12–30 years, with the highest incidence observed in the 21–30 year age group (43.63%). Females were disproportionately affected, comprising 59.1% of cases. In the youngest age group (12–20 years), females accounted for 27.27% of cases compared with 14.54% among males. Intentional self-poisoning was the predominant mode of exposure, reported in 79.1% of cases, while accidental ingestion accounted for the remainder. The authors attributed the high incidence among young individuals and females to psychosocial stressors, including impulsive behavior, relationship difficulties, family conflicts, and societal pressures. However, the study did not explicitly report statistical analyses or p-values assessing associations between these variables and patient outcomes (34).

In a study from Morocco, Louriz et al. (2009) reported that patients with AlP poisoning were predominantly young, with a mean age of 26 ± 11 years, and that females constituted 63.3% of cases. Ingestion was intentional in 96% of patients, with a mean ingested dose of 1.2 ± 0.7 g. The authors performed detailed statistical comparisons between survivors and non-survivors. On univariate analysis, several factors were significantly associated with mortality, including a higher APACHE II score, presence of shock, lower Glasgow Coma Scale (GCS) score, electrocardiographic abnormalities, acute renal failure reflected by elevated creatinine, low

prothrombin rate, hyperleukocytosis, and the need for vasoactive drug support or mechanical ventilation. Multivariate logistic regression identified only two independent predictors of mortality: shock (relative risk [RR] = 3.82, 95% CI: 1.12–13.38; p = 0.036) and altered level of consciousness as reflected by a lower GCS score (RR = 3.26, 95% CI: 1.18–8.99; p = 0.022). Notably, variables such as ingested dose, age, sex, and hyperglycemia were not significantly associated with mortality in this cohort (8).

Study from the East Delta region of Egypt by Deraz et al. (2022) reported that AlP poisoning predominantly affected young adults aged 18–45 years, who constituted 66% of cases, with a marked female predominance (62.5%) and a strong rural representation (79.3%). The authors also noted a rising incidence among urban residents and unemployed individuals in recent years, while suicidal intent accounted for the majority of cases (70.6%). Although the mean ingested dose was significantly higher among non-survivors, the time interval between ingestion and hospital presentation did not show a significant association with outcome, suggesting that clinical and biochemical severity—rather than demographic factors—were the primary determinants of mortality. Several laboratory parameters were strongly associated with mortality, including elevated alanine aminotransferase (ALT), aspartate aminotransferase (AST), and serum creatinine levels, as well as lower white blood cell count, serum sodium and potassium levels, arterial pH, bicarbonate, and base excess (35).

Matched-pair analysis by Zheng et al. (2023) reinforces that suicidal self-poisoning is strongly associated with a distinct clinical profile marked by youth, female sex, and, most critically, severe underlying psychiatric morbidity—specifically anxiety, depression, and a history of psychiatric disease. The study identifies both individual-level determinants (e.g., single marital status, smoking, sedentary lifestyle) and novel family-level risk factors, demonstrating that a family member's mental health status, education level, and introverted personality are significantly linked to the patient's suicide risk. Furthermore, the findings extend beyond somatic care, highlighting that the patient's post-attempt mental health trajectory is closely correlated with their family's psychological state, underscoring the need for family-integrated psychiatric assessment and intervention in the aftermath of a poisoning event. These elements of psychiatric profile, familial influence, and lifestyle are essential to consider when evaluating the

precipitating factors and holistic outcomes of acute poisoning cases, including those involving AlP (38).

Shokrzadeh et al. (2017) establishes a significant connection between deliberate self-poisoning and mental illness. It identifies mental disorder as the second most common precipitating factor for self-poisoning attempts, accounting for nearly 20% of all cases. Furthermore, the clinical profile of DSP patients reveals a high burden of psychiatric morbidity, with pharmaceuticals being the most frequently ingested agents and the rest is pesticides. This pattern underscores that underlying psychiatric conditions are not only a key motivator for the act of self-poisoning but also influence the method chosen, highlighting the critical need for integrated mental health assessment and intervention as a core component of both prevention and post-attempt care (39).

According van der Hoek (2005) acute pesticide poisoning in Sri Lanka is strongly linked to alcohol abuse, which significantly increases the risk of intentional self-poisoning. In this study, 36% of all pesticide poisoning patients were under the influence of alcohol at the time of admission. Alcohol dependence contributes to impulsivity, poor judgment, and lowered inhibition, making it easier for individuals in distress to act on suicidal thoughts using readily available pesticides (40).

Ethanol constitutes a significant risk factor for pesticide-induced toxicity and is frequently co-consumed during instances of self-poisoning involving pesticides. Clinical observations indicate that the concomitant ingestion of alcohol complicates the management of such cases (40,41). In retrospective study done in south Korea, Among the 7,320 patients of intentional pesticide intake, acute alcohol consumption showed a higher incidence of intentional poisoning (adjusted odds ratio: 2.43; 95% confidence interval: 2.11-2.80) (42).

Karakaya (2025) reported that the severity and outcome of AlP poisoning are influenced by a combination of demographic, exposure-related, and clinical factors. The ingested dose was identified as a critical determinant of outcome, with ingestion of ≥500 mg associated with mortality rates exceeding 70%. Delayed presentation to healthcare facilities, often beyond 2–4 hours after ingestion, was associated with a significantly poorer prognosis, largely due to the

rapid progression of cardiovascular collapse. Young adults from agricultural communities were disproportionately affected, frequently in the context of intentional self-harm, underscoring the influence of socioeconomic and mental health stressors. Several admission clinical parameters—including hypotension (systolic blood pressure <90 mmHg), severe metabolic acidosis (arterial pH <7.2), elevated shock index (>1.14), and altered mental status—were identified as strong predictors of poor outcome (43).

The northwest Ethiopia study by Bogale et al. (2021) identified several key factors linked to AlP poisoning. Demographically, patients were predominantly young (mean age 28.5 years), with 57.6% being female and 77.6% from rural areas. All cases were intentional (suicidal), often triggered by interpersonal conflicts. Exposure-related factors included an average ingestion of 1.2 tablets (≈3.6 g), and a mean time to presentation of 4.8 hours. Importantly, the amount ingested was significantly higher in non-survivors (1.6 vs. 1.0 tablet, p=0.006), whereas time to hospital arrival and average hospital stay of 2 days did not significantly affect outcome. Low systolic blood pressure (<90mmHg) at presentation, was identified as a significant predictor of mortality among patients with AlP poisoning. In addition, the amount of AlP ingested was strongly associated with outcome, with non-survivors ingesting a higher mean number of tablets compared to survivors (1.6 tablets versus 1.0 tablet) (36).

2.3. TREATMENT OUTCOMES

According to Shadnia et al. (2009), the overall case fatality rate of AlP poisoning was high at 31%, with all reported deaths occurring within the first 24 hours of hospitalization. Standard management included gastric decontamination using potassium permanganate and activated charcoal, along with supportive therapy such as intravenous calcium gluconate, magnesium sulfate, and sodium bicarbonate. A subset of patients who presented within one hour of ingestion also received coconut oil. Despite these interventions, mortality remained substantial, highlighting the extreme toxicity of aluminum phosphide. The study concluded that, even in the absence of advanced resources, mortality could be reduced through optimized medical management and stricter regulation of aluminum phosphide tablet availability. Furthermore, the strong association between admission pH and survival suggested that early and aggressive correction of metabolic acidosis may be a crucial component of treatment. The authors also

emphasized the need for a national standardized treatment protocol and the replacement of aluminum phosphide with safer alternatives to prevent such poisonings (33).

In a study from Pakistan, Qureshi et al. (2018) reported poor outcomes among patients with AlP poisoning. Despite aggressive resuscitative measures, the mortality rate was 56.36%, while only 43.64% of patients survived to hospital discharge. The authors highlighted the absence of a specific antidote for aluminum phosphide poisoning, with management remaining largely supportive and focused on airway stabilization, circulatory support, and correction of metabolic acidosis. Various therapeutic interventions—including gastric lavage with potassium permanganate, administration of coconut oil and magnesium sulfate, and the use of inotropic agents such as dopamine—were described; however, their effectiveness was considered controversial and inconclusive. The study also cited regional literature reporting even higher mortality rates, ranging from 70% to 90%, particularly in cases involving ingestion of doses exceeding 1.5 g, emphasizing the highly lethal nature of aluminum phosphide poisoning (34).

According to Louriz et al. (2009) of Morocco's study, a mortality rate of 49% among patients with AlP poisoning, with deaths occurring at a mean of 64 ± 47 hours after hospital admission. Management was primarily supportive and included gastric lavage, fluid resuscitation, vasopressor therapy, mechanical ventilation, and, in selected cases, administration of magnesium sulfate. No specific antidote was available. The authors concluded that hemodynamic failure was the principal cause of death, most commonly resulting from direct myocardial injury, as supported by electrocardiographic changes and postmortem findings of myocardial necrosis (8).

In a study from the East Delta region of Egypt, Deraz et al. (2022) reported a strikingly high overall mortality rate of 72.5% among patients with aluminum phosphide poisoning, with no significant variation observed across the five-year study period. Management was largely supportive, and the majority of patients required admission to the intensive care unit (35).

The study from northwest Ethiopia by Bogale et al. (2021) reported an overall mortality rate of 31.2% among patients with AlP poisoning. A protocol-driven management approach was employed, in which hypotensive patients were admitted to the intensive care unit and treated with dopamine, magnesium sulfate, hydrocortisone, and calcium gluconate, in addition to gastric

lavage and intravenous fluids. Non-hypotensive patients received gastric lavage and maintenance fluids only. Mortality among hypotensive patients was 61.9%, with a fatality rate of 55.6% even among those managed using the full treatment protocol. Importantly, all deaths occurred in the hypotensive group, while no fatalities were observed among normotensive patients. The study concluded that hypotension at presentation is a critical prognostic indicator and suggested that protocol-based management may help reduce mortality in resource-limited settings (36).

A recent systematic review and meta-analysis by Altaye et al. (2025) quantified the burden of metallophosphide (AlP and zinc phosphide) poisoning, reporting that these compounds account for approximately 38% of acute poisoning cases and are associated with a pooled mortality rate of 37% among patients with metallophosphide poisoning. These findings highlight AlP poisoning as one of the most prevalent and lethal toxicological challenges, particularly in agrarian communities where such compounds are readily accessible and commonly used as fumigants and rodenticides. (44).

2.4. CONCEPTUAL FRAME WORK

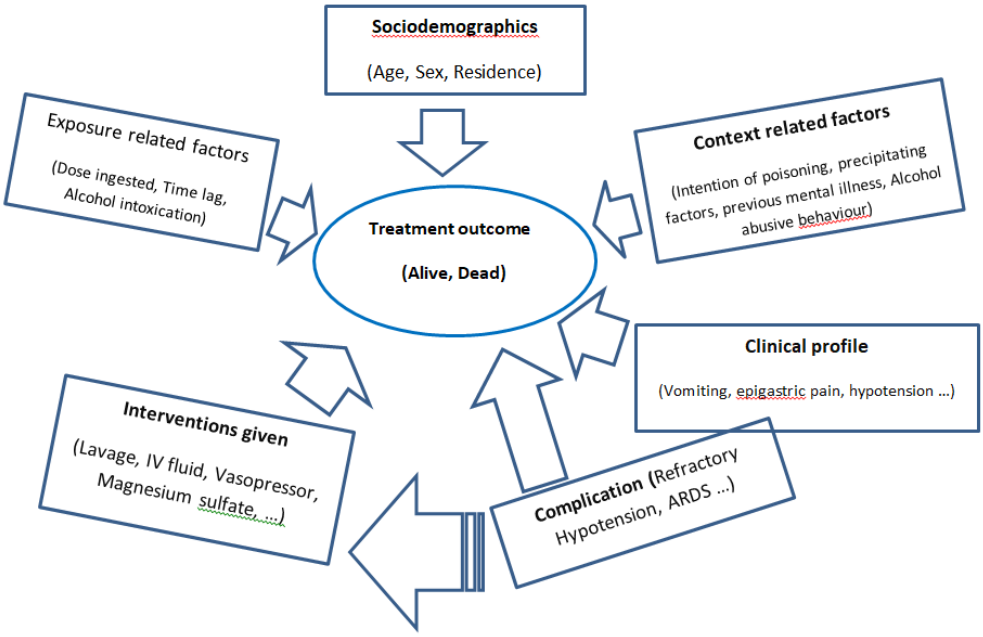

Figure 1: Conceptual framework for assessment of clinical profile, treatment outcome and associated factors among aluminum phosphide poisoning patients presenting to Asella referral and teaching hospital, December 2025. Adapted from litratures (36,45,46).

3. OBJECTIVES OF THE STUDY

3.1. GENERAL OBJECTIVE

- To assess clinical profile, treatment outcome, and associated factors among aluminum phosphide poisoning patients presented to the adult emergency department of Asella referral and teaching hospital, Dec, 2025.

3.2. SPECIFIC OBJECTIVES

- To assess treatment outcome among aluminum phosphide poisoning patients presented to the adult emergency department of Asella teaching and referral hospital, Dec, 2025.
- To assess clinical profile among aluminum phosphide poisoning patients presented to the adult emergency department of Asella teaching and referral hospital, Dec, 2025.
- To assess associated factors among aluminum phosphide poisoning patients presented to the adult emergency department of Asella teaching and referral hospital, Dec, 2025.

4. METHOD AND MATERIALS

4.1. STUDY AREA

The study conducted at Arsi University (AU), College of health science, Asella referral teaching hospital (ARTH) which is Located in the town of Asella. Asella is a town in central Ethiopia which is located in the Arsi zone of the oromia Region about 156 kilometers from Addis Ababa, the capital city of the country (47). Since 1964 ARTH was serving populations in Arsi and the nearby zones with current population of 3.8 million. The hospital has 321 beds with more than 6 departments (Internal Medicine, Surgery, Pediatrics, Gynecology and Obstetrics, Orthopedics and Oncology). The hospital is involved in training undergraduate and postgraduates in different specialties in 04 major departments (Internal Medicine, Surgery, Pediatrics and Child Health and Gynecology and Obstetrics). The hospital has been improving its health service delivery, currently has modern investigation modalities like digital X-rays, portable X-ray, different types of ultrasound, echocardiography, computerized tomography scan and culture service. The emergency unit is one of the departments serving patients frontly. The department is staffed with one emergency medicine senior, 18 nurses, and additionally attaching Residents and Interns from different department. It serves an average of around 1,150 patients on monthly basis of which an averages of 30 patients are present with acute poisoning (48).

4.2. STUDY DESIGN AND PERIOD

Institution based cross-sectional study design was conducted and data was collected from December 1 to 15, 2025.

4.3. SOURCE AND STUDY POPULATION

4.3.1. Source population

All AlP poisoning patient presented to Asella referral and teaching hospital.

4.3.2. Study population

All AlP poisoning patients who presented to Asella referral and teaching hospital from September 2020 to August 2025 and whose medical records fulfilled the inclusion criteria.

4.4. ELIGIBILITY CRITERIA

4.4.1 Inclusion criteria

- All clinically confirmed acute aluminum phosphide poisoning patients.
- Age of 15 years or more admitted to adult ED based on ARTH age policy.

4.4.2 Exclusion Criteria

- Patients with missing or incomplete medical records.
- Patients with unclear poisoning agent or duplicate records.
- Patients with chronic AlP poisoning cases.
- Patients discharge against medical advice

4.5. SAMPLE SIZE AND SAMPLING PROCEDURES

4.5.1. Sample size determination

The sample size for the study will be determined using single population formula considering the following assumption.

According to Hospital-based prospective study done at university of Gondar comprehensive specialized hospital magnitude of AlP was 20% (49).

$$n = \frac{Z_{\frac{\alpha}{2}}^{2} P(1-P)}{d^{2}}$$ $= (1.96)^2*0.20(1-0.20)/ (0.05)^2 =246$

Since source population is <10,000

$$n = \frac{n_o}{\left(1 + \frac{n_o}{N}\right)}$$

N=116

n=246/1+246/116

n= 79 for treatment outcome. Taking 10% nonresponse rate, final sample size will be **87**. Rather than sampling, all eligible aluminum phosphide poisoning cases were included to maximize statistical power.

4.5.2. Sampling procedure

"Participants were selected via a lottery method, a form of simple random sampling. All 116 population members were assigned a number; numbers were drawn at random without replacement until the target sample size of 87 was reached. Rather than sampling, all eligible aluminum phosphide poisoning cases were included to maximize statistical power.

4.6. STUDY VARIABLES

4.6.1. Dependent variable

- Treatment outcome of aluminum phosphide poisoning

4.6.2. Independent variables

- Socio-demographic factors (Age, Sex, Residence)
- Exposure related factors (number AlP tablets, reason for ingestion, precipitating factors, time lag from ingestion to hospital arrival, mental illness and alcohol abuse)
- Clinical profiles factors (presenting symptoms, SBP, laboratory abnormalities, treatment received, complications, ICU admission, and length of hospital stay).

4.7. OPERATIONAL DEFINITIONS

- **Acute AlP poisoning** is defined by rapid onset of severe systemic toxicity following a single high-dose exposure, typically via ingestion (suicidal/accidental) or inhalation of phosphine gas (within 10–15 minutes of exposure). It is highly toxic, especially when consumed from a freshly opened container and diagnosis is clinically and by confirming from label of poison (43,50).
- **Chronic AlP poisoning** refers to the cumulative health effects resulting from prolonged or repeated exposure to sub-lethal levels of AlP or its byproduct, phosphine gas typically over months or years, leading to gradual development of symptoms and potential long-term damage. Primarily seen in occupational settings, such as grain fumigation workers or pesticide applicators (13,43).
- **Alcohol misuse** is when an individual drink regularly drinks more than 14 units per week.
    - A unit of alcohol is 8g or 10ml of pure alcohol, which is about:
        - Half a pint of lower to normal-strength lager/beer/cider (Alcohol by Volume (ABV) 3.6%)
        - A single small shot measure (25ml) of spirits (25ml, ABV 40%)
        - A small glass (125ml, ABV 12%) of wine contains about 1.5 units of alcohol (51).

4.8. DATA COLLECTION PROCEDURES

Data extraction tool was adapted from WHO Pesticide exposure record material and from other published article in English version. Case records of acute AlP were retrieved with their record numbers. Data was collected by trained nurses and medical interns and supervised by medical residents from the patient charts. Information about sociodemographic variables, number of poison taken, suicidal intent, precipitating factors, time lag from ingestion to hospital arrival, mental illness, alcohol abuse, and precipitating factors was be collected.

4.9. DATA QUALITY CONTROL

The data was collected by nurses and medical interns from patients' chart documented by the clinicians using data extraction tool. The principal investigator trained and coordinated the process of data collection and supervision. Pretest was done on 5% of the sample before the actual data collection started. The data collection format was checked for its completeness and any gap identified was corrected immediately. The diagnosis of senior physician was taken from patient chart to identify the right diagnosis.

4.10. DATA PROCESSING AND ANALYSIS

Data was entered using kobotoolbox, subsequently cleaned, edited, and then exported to SPSS version 26 for analysis. Descriptive statistics was carried out and categorical variables were reported as frequencies and percentages whereas; mean was be used for continuous variables. Binary logistic regression analysis was applied to identify factors associated with AlP poisoning. P value < 0.2 in the bivariate logistic regression was fitted into the multivariable logistic regression analysis. The strength of association measured by using adjusted odds ratio with 95% CI and P-value < 0.05 was considered as statistically significant.

4.11. ETHICAL CONSIDERATIONS

Ethical clearance was obtained from Asella College of Health Sciences research committee. Then, official letter was delivered to data manager. Moreover, after getting permission, patient's charts that fulfill the criteria were selected. Confidentiality of data collected was kept and names of the patients were not included during data collection and information gained was not exposed to third party.

5. RESULT

5.1. SOCIO-DEMOGRAPHIC CHARACTERISTICS

The study included a total of 116 case records after excluding cases with incomplete documentation or multi-agent poisoning (total record found was 150). The patient population was predominantly female 68 (58.6%), resulting in a female-to-male ratio of 1.4. The age of the participants ranged from 15 to 60 years, with a median age of 24 years (interquartile range [IQR]: 20-27). Notably, the largest age group affected was those between 21–30 years 53(45.7%), followed by those ≤ 20 years (34.5%). A significant majority of the patients 92(79.3%) resided in rural areas (table 1).

Table 1: Distribution of socio-demographic characteristics among Aluminium phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

Variables	Category	Frequency (n)	Percentage (%)
Age (years)	≤ 20	40	34.5
	21–30	53	45.7
	31–40	12	10.3
	> 40	11	9.5
Sex	Female	68	58.8
	Male	48	41.4
Residence	Rural	92	79.3
	Urban	24	20.7

5.2. ASSOCIATED FACTORS

In the present study, all ingestions (116, 100%) were intentional and suicidal in nature. The most frequently reported precipitating factor was interpersonal conflict or quarrel, accounting for 53 cases (45.6%). However, a substantial proportion of patients 57 (49.0%) did not report a specific precipitating trigger. Other reported precipitating factors included health-related distress or disability, substance abuse, and unwanted pregnancy (Figure 2).

Regarding the quantity of toxin ingested, the minimum and maximum amounts were 0.25 and 7 tablets, respectively. The median number of tablets consumed was 1 (IQR: 1–2). The majority of patients 71 (61.2%) ingested one tablet or less (Table 2).

The time interval between AlP ingestion and presentation to the ED ranged from 0.5 to 17 hours, with a median time of 2 hours (IQR: 2–4). Most patients 72 (62.1%) presented to the hospital within two hours of ingestion (Table 2).

The length of hospital stay (LOS) ranged from 0.08 to 15 days, with a median duration of 1.8 days (IQR: 1–3). Hospital stay was evenly distributed, with 58 patients (50%) hospitalized for less than two days and an equal proportion remaining hospitalized for two days or longer (Table 2).

Table 2: Distribution of exposure associated characteristics and length of hospital stay among Aluminium phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

Variables	Category	Frequency (n)	Percentage (%)
Time lag from ingestion to hospital arrival (in hours)	≤ 2	72	62.1
	>2	44	37.9
Number of tablets ingested	≤1	71	61.2
	>1	45	38.8
Length of stay in days	<2	58	50
	≥2	58	50

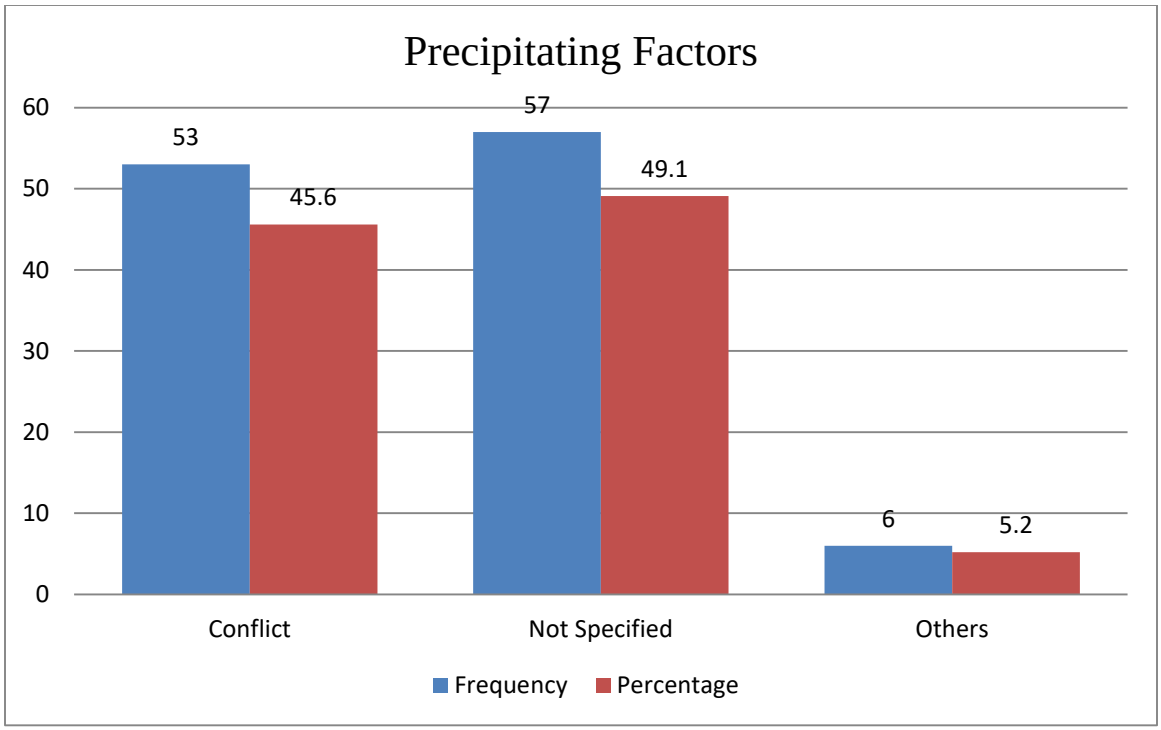

Figure 2: Distribution of precipitating factors among intentional Aluminum phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

5.3. CLINICAL PROFILE

Upon admission, the most common clinical symptoms were vomiting 116 (100%) and epigastric pain 108 (93%). In terms of hemodynamic status, 47 patients (40.5%) were hypotensive at the time of initial assessment (Table 3).

Of the total cases, laboratory investigations were performed in 96 patients (82.8%), of which 52 (44.8%) showed abnormal results. The most frequently observed hematological and biochemical abnormalities were leukocytosis (14.6%) and hyperkalemia (18.9%), respectively. Other laboratory abnormalities, including hypernatremia, hyperglycemia, and hypoglycemia, were categorized as “other” (Figure 3).

Table 3: Distribution of clinical symptoms and hemodynamic status upon hospital arrival among Aluminum phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

Category	Variables	Frequency (n)	Percentage (%)
Symptoms at presentation	Vomiting	116	100
	Epigastric Pain	108	93.1
	Nausea	38	32.8
	Altered Consciousness	20	17.2
	Headache	16	13.8
Hemodynamic Status (SBP) presentation	Normotensive	69	59.5
	Hypotensive	47	40.5

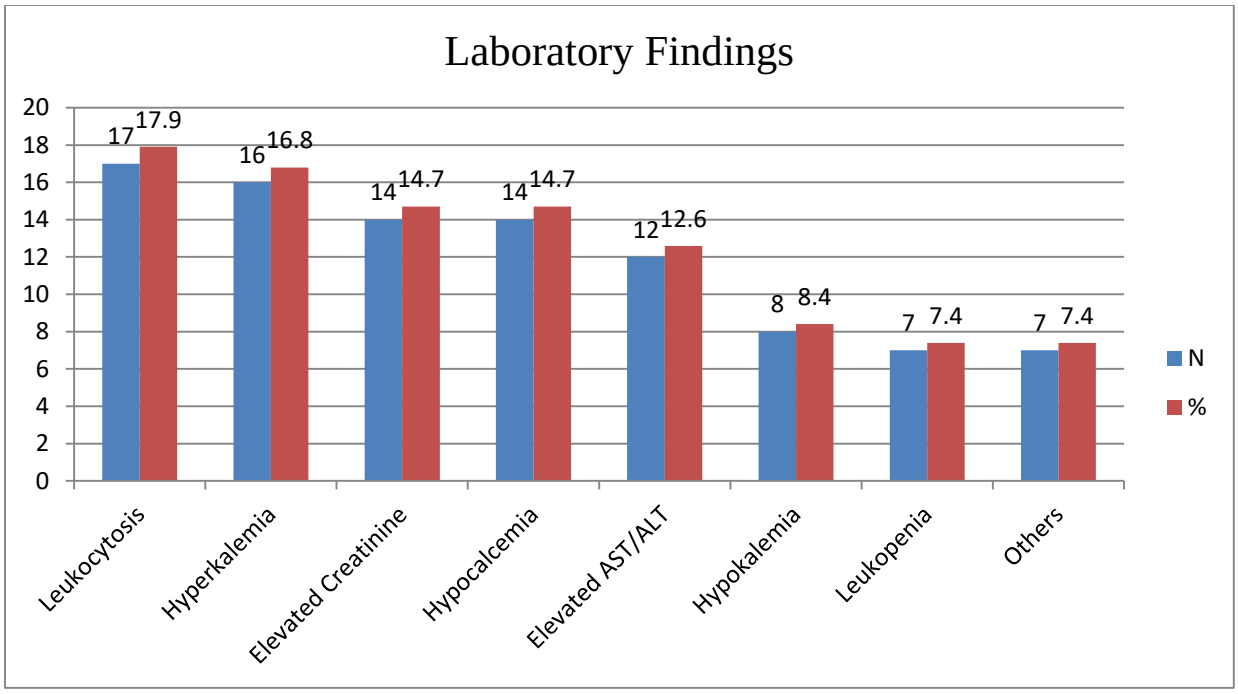

Figure 3: Distribution of laboratory findings among Aluminum phosphide poisoning patients (n=95) presenting to Asella referral and teaching hospital, December 2025.

All patients 116 (100%) received intravenous fluids, and nearly all 115 (99.1%) were administered either omeprazole or cimetidine. Other commonly used treatments included magnesium sulfate (48.3%), calcium gluconate (48.3%), and vasopressors (47.4%). Additional treatments, such as 40% dextrose, regular insulin, potassium chloride, and mechanical ventilation, were categorized as “other” (Table 4).

Complications occurred in 60 patients (51.7%). The most prevalent complication was refractory hypotension (46.5%), followed by electrolyte abnormalities (22.4%). Other complications, including metabolic acidosis, glycemic abnormalities, liver transaminitis, and aspiration pneumonia, were categorized as “other” (Figure 4).

Table 4: Distribution of treatments received among Aluminium phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

Category	Variables	Frequency (n)	Percentage (%)
Treatments	IV Fluids (Maintenance)	116	100
	Omeprazole/Cimetidine	115	99.1
	Magnesium Sulfate	56	48.3
	Calcium Gluconate	56	48.3
	Vasopressors	55	47.4
	Hydrocortisone	55	47.4
	Digoxin	30	5.6
	Gastric lavage	28	5.2
	ICU admission	6	1.1
	Others	17	3.2

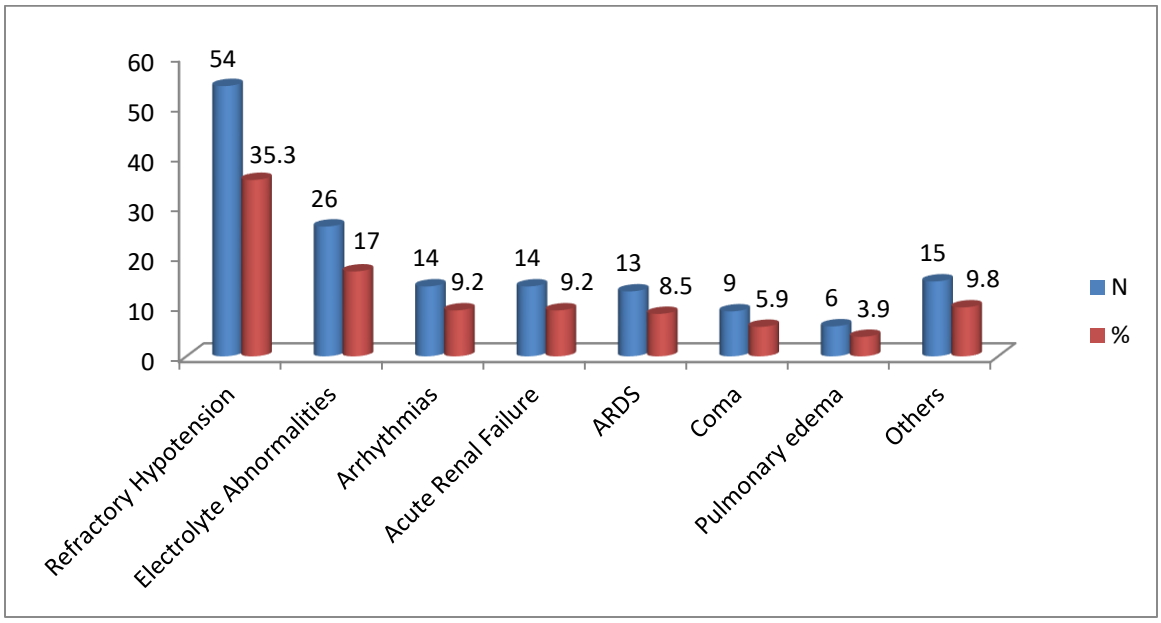

Figure 4: Distribution of complications among Aluminium phosphide poisoning patients (n=153) presenting to Asella referral and teaching hospital, December 2025

5.4. TREATMENT OUTCOMES

The overall mortality rate was 31.9% (95% confidence interval [CI]: 23.6–41.2%), while 68.1% of patients survived and were discharged (Figure 5).

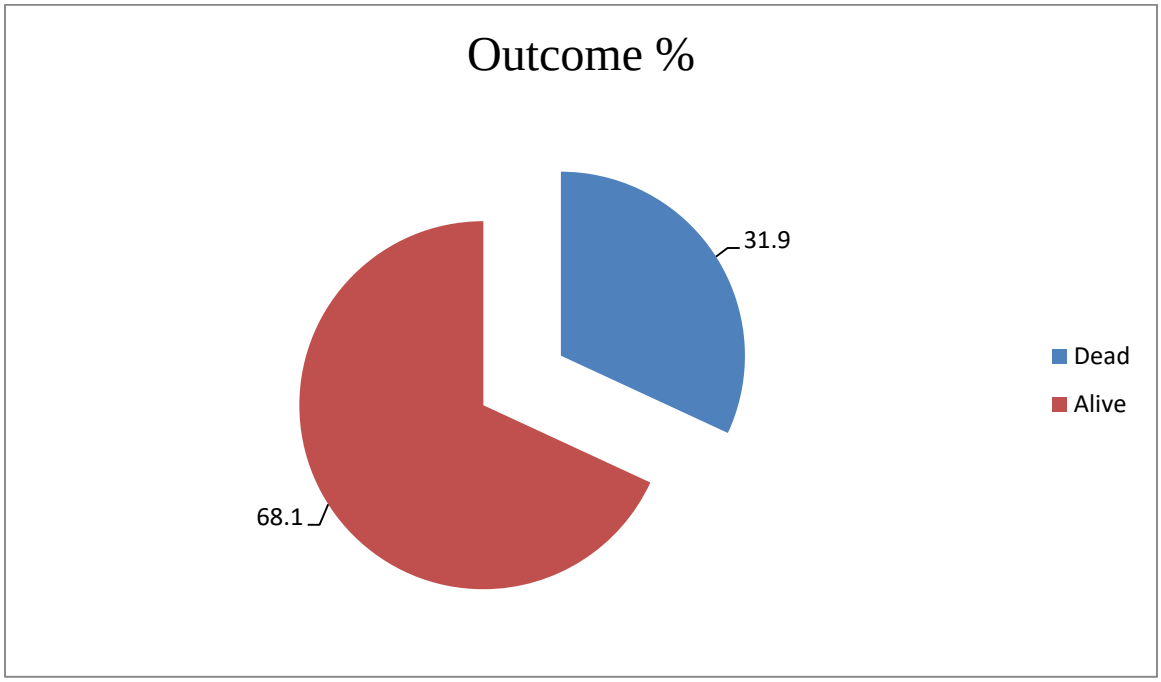

Figure 5: Treatment outcome among Aluminum phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

In the multivariable logistic regression model, two variables were identified as statistically significant independent predictors of in-hospital mortality ($p < 0.05$): initial systolic blood pressure (SBP) at presentation and length of hospital stay (LOS).

Hemodynamic status at admission, reflected by initial SBP, was the most critical determinant of outcome. Patients presenting with hypotension (SBP < 90 mmHg) had markedly higher odds of death compared with normotensive patients (AOR = 264.946; 95% [CI]: 1.175–5.9 × 10^4; p = 0.044). This finding underscores the dominant role of early cardiovascular compromise in AlP poisoning.

Length of hospital stay was also independently associated with mortality. A hospital stay of less than two days (< 2 days) was strongly linked to death (AOR = 167.269; 95% [CI]: 4.282–6534.394; p = 0.006). This reflects the observed clinical pattern in which all deaths occurred within the first 24 hours of admission, whereas patients who survived beyond 48 hours had a substantially higher likelihood of eventual discharge.

In contrast, socio-demographic variables and pre-hospital time factors did not independently predict mortality after adjustment for clinical severity. Although the typical patient profile consisted of young females, neither sex (p = 0.435) nor age group (including ≤20 years and 21–30 years) demonstrated statistical significance in the multivariable model. Similarly, place of residence (rural versus urban) did not influence survival odds (p = 0.437), suggesting that outcomes were determined by physiological status at presentation rather than geographic factors.

The time lag between ingestion and ED presentation was also not a significant predictor of outcome (p = 0.958). This finding supports prior evidence indicating that clinical severity on arrival outweighs elapsed time in determining prognosis.

Several clinical variables that were significant in the bivariate analysis showed attenuation toward borderline significance in the multivariable model. Ingesting more than one tablet (>1) demonstrated a strong crude association with mortality (COR = 4.256) but did not retain independent significance after adjustment (p = 0.065). Likewise, altered level of consciousness was associated with a very high adjusted odds ratio (AOR = 1057.7) but narrowly missed statistical significance (p = 0.055), suggesting substantial collinearity with other markers of severe toxicity, particularly hypotension.

Laboratory abnormalities and the presence of clinical complications were significantly associated with mortality in crude analysis but did not remain independent predictors in the multivariable model. This indicates that these variables are closely linked to the patient's initial hemodynamic and neurological status and do not provide additional prognostic value once these primary factors are accounted for.

As summarized in Table 5, multivariable logistic regression identified initial hypotension and short length of hospital stay as the principal independent predictors of mortality. While factors

such as tablet quantity ingested, altered mental status, laboratory abnormalities, and complications showed strong associations in unadjusted analyses, their effects were attenuated after adjustment for hemodynamic stability. These findings indicate that early cardiovascular collapse represents the final common pathway leading to death in AlP poisoning within this cohort.

Table 5: Multi-variable logistic regression analysis of variables among Aluminium phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

Variables	**Category**	**Treatment outcome**		**COR**	**AOR**	**P**
		Alive	**Dead**			
Sex	Male	31	17	1	1	
	Female	48	20	0.760 (0.345, 1.672)	0.324 (0.019, 5.477)	0.435
Age	≤20	30	9	0.800 (0.175, 3.664)	10.047 (0.016, 6330.754)	0.483
	21-30	34	20	1.569 (0. 373 , 6.603)	3.724 (0.12, 1157.290)	0.653
	31-40	7	5	1.905 (0.330, 11.009)	50.303 (0.001, $1.8x10^6$)	0.464
	>40	8	3	1	1	
Residency	Rural	63	29	0.921 (0.354, 2.395)	0.230 (0.006, 9.310)	0.437
	Urban	16	8	1	1	
Number of tablets	≤1	57	14	1	1	
	>1	22	23	4.256 (1.862, 9.729)	24.138 (0.820, 710.454)	0.065

Time lag from ingestion to ED presentation	≤2	52	20	1	1	
	>2	27	17	1.637 (0.738, 3.630)	0.924 (0.051, 16.695)	0.958
Altered consciousness	Yes	9	11	3.291 (1.224, 8.849)	1057.742 (0.868, $1.2x10^6$)	0.055
	No	70	26	1	1	
Initial SBP	Hypotensive	14	33	38.304 (11.681, 125.598)	264.946 (1.175, $5.9X10^4$)*	0.044*
	Normotensive	65	4	1	1	
Abnormal laboratory value	Yes	35	17	20.886 (2.647, 164.782)	72.411 (0.445, $1.1X10^4$)	0.099
	No	43	1	1	1	
Presence of complications	Yes	24	36	82.500 (10.684, 637.039)	193.415 (0.026, $1.4x10^6$)	0.246
	No	55	1	1	1	
LOS in days	<2	24	34	25.972 (7.264, 92.865)	167.269 (4.282, 6534.394)**	0.006**
	>/=2	6	3	1	1	

Key: COR: Crude Odds Ratio, AOR: Adjusted Odds Ratio

*p < 0.05; **p < 0.01

6. DISCUSSION

The present study identified a clear demographic profile; that is, the typical patient is a young female (58.8%) in the 21–30 years age groups (45.7%) from a rural area (79.3%). This "vulnerable profile" is remarkably consistent across literature. The female predominance mirrors findings from Pakistan (59.1%) and Northwest Ethiopia (57.6%). The heavy representation of rural residents (79.3%) mirrors findings in Northwest Ethiopia and Egypt (34–36). This observed demographic pattern reflects structural and psychosocial vulnerability rather than biological susceptibility. The predominance of young females from rural areas is largely attributable to easy access to AlP in agricultural settings, combined with social stressors common during early adulthood. The consistency of this profile across regions suggests a systemic public health issue driven by availability, gender inequity, and rural healthcare limitations.

Crucially, 100% of cases from this study were intentional self-harm, primarily triggered by interpersonal conflicts. This aligns with global trends where AlP is the primary agent for suicide in agrarian societies, although it slightly diverges from the Pakistan study, which reported a small percentage (20.9%) of accidental ingestions (8,33,34,36,43). This suggests that prevention strategies should prioritize mental health support, conflict resolution mechanisms, and restriction of access to highly lethal pesticides.

Clinical presentation at present study was dominated by gastrointestinal symptoms, with 100% of patients experiencing vomiting and 93% reporting epigastric pain. These figures are higher than those reported by Bogale et al. in Northwest Ethiopia, where nausea/vomiting occurred in 74.4% of cases (36). The predominance of gastrointestinal manifestations highlights their importance as early clinical indicators of poisoning in our setting. The predominance of gastrointestinal manifestations underscores their value as early diagnostic indicators of AlP poisoning in this setting and emphasizes the importance of prompt recognition and intervention to improve clinical outcomes.

The most critical clinical finding, however, was hemodynamic instability. At admission, 40.5% of patients were hypotensive, and 46.5% eventually developed refractory hypotension. This confirms the established toxicological mechanism of AlP, where phosphine gas causes direct

myocardial injury and systemic oxidative stress. Comparison with the Moroccan study (Louriz et al.) shows a similar prevalence of initial shock (42.6%), reinforcing that cardiovascular collapse is the hallmark of severe AlP toxicity (8).

The overall in hospital mortality rate of 31.9% is almost comparable with study from Tehran (31%) and Northwest Ethiopia (31.2%) (33,36). However, current study is significantly lower than the 56.36% reported in Pakistan or the 72.5% in Egypt (34,35). It sits slightly below the 37% pooled mortality rate identified in a recent Ethiopian meta-analysis by Altaye et al. (44). The variation in mortality may be attributed to differences in the quantity ingested, the freshness of the tablets, or the specific medical protocols used, such as the aggressive use of magnesium sulfate and calcium gluconate, which were administered to nearly half of the patients in present setup (33–36).

Hypotension (low SBP) at presentation emerged as a massive predictor of death ($p = 0.044$). This confirms that cardiovascular collapse is the primary driver of AlP lethality, aligning with Louriz et al. (Morocco) who found shock to be an independent predictor of mortality (RR = 3.82), and Bogale et al. (Ethiopia), where deaths occurred exclusively in the hypotensive group (8,36). The study by Qureshi et al. (Pakistan), Deraz et al. (Egypt) and Shadnia et al. (Tehran) reported prevalence of hypotension is high and shock is a cardinal sign of severe poisoning that contribute for high mortality (33,34). The profound association between hypotension and mortality underscores the toxicological impact of phosphine gas on myocardial tissue, leading to refractory shock which is the most common complication in present study, occurring in 46.5% of cases.

Hospital stay (LOS) was another predictor of death in present study, with a stay of less than two days showing a strong association with death ($p = 0.006$). This finding reflects the fact that all deaths in the present study occurred early, often within the first 24 hours of admission, whereas patients who survived beyond the initial 48-hour critical window were highly likely to be discharged alive, highlighting the acute and aggressive nature of AlP toxicity. This observation is nearly consistent with findings from the Tehran study, in which all recorded deaths occurred within the first 24 hours of hospitalization (33). However, these results contrast with reports from northwest Ethiopia, where an average hospital stay of two days was not significantly associated with outcome, as well as with a Moroccan ICU-based study in which the mean time to

death was 64 ± 47 hours (8,36). Given that multivariable analysis in the present study also identified hypotension at presentation as a strong independent predictor of mortality, the association between short LOS and death likely reflects early disease severity rather than the duration of hospitalization itself. Collectively, these findings suggest that the first 48 hours after presentation represent a critical "golden period," during which successful stabilization markedly improves survival.

Altered consciousness and quantity of AlP tablets ingested were identified as clinically important variables associated with mortality. In the crude (bivariate) analysis, altered consciousness was a significant predictor of death (COR = 3.29); however, in the final multivariable model, it reached only borderline statistical significance (p = 0.055). This finding contrasts slightly with the Moroccan study by Louriz et al., in which a lower GCS score remained an independent predictor of mortality (RR = 3.26, p = 0.022) (8). The discrepancy may be explained by the strong correlation between altered mental status and profound hypotension in the present study, with hypotension emerging as the dominant determinant of mortality.

Similarly, ingestion of one or more tablet showed a strong association with mortality in the crude analysis (COR = 4.26), but this association diminished to borderline significance in the multivariable model (p = 0.065). In contrast, the northwest Ethiopia study by Bogale et al. reported that non-survivors ingested a significantly higher mean number of tablets compared with survivors (1.6 vs. 1.0 tablets, p = 0.006) (36). The number of tablets ingested represents a direct proxy for toxic dose, with lethal thresholds in adults estimated to range from 150 to 500 mg—well below the content of a single 3-g tablet (43). In the present study, however, the dose–response effect was likely captured indirectly through initial SBP measurements. Patients who ingested larger quantities were more likely to present with shock, thereby rendering blood pressure a more immediate and statistically dominant predictor than the reported dose itself.

Overall, although altered consciousness and ingestion of more than one tablet were significantly associated with mortality on bivariate analysis, their effects were attenuated in the multivariable model due to strong collinearity with initial hemodynamic status. These findings suggest that while mental status and ingested dose contribute to disease severity, their independent prognostic

value diminishes once patient progresses to profound hypotension. In such cases, initial SBP serves as the most powerful and clinically relevant predictor of survival.

Interestingly, in the present study, the time lag between AlP ingestion and hospital arrival was not a significant predictor of outcome ($p = 0.958$), despite the majority of patients (62.1%) presenting within the first two hours. This finding contrasts with Karakaya (2025), who reported that delays beyond 2–4 hours are associated with worse prognosis (43). However, several other studies including cohorts from Tehran (Shadnia et al.), Egypt (Deraz et al.), and Felege Hiwot similarly demonstrated that clinical severity at presentation, particularly a low SBP and GCS, is a far stronger predictor of mortality than the elapsed time since ingestion (33,35,36).

Emphasizing that while early hospital presentation remains desirable, these observations support the concept that the magnitude of the initial physiological insult outweighs the duration of pre-hospital delay in determining survival. ALP rapidly releases phosphine gas upon contact with gastric acid, leading to inhibition of cellular respiration by up to 70%. This process begins within 10–15 minutes of exposure, leaving an extremely narrow therapeutic window for effective gastric decontamination. Consequently, by the time many patients reach the ED, systemic toxicity is already well established (43). Taken together, these findings indicate that prognosis in AlP poisoning is primarily dictated by the patient's clinical state at arrival particularly hemodynamic and neurological stability rather than the absolute time elapsed before medical intervention.

7. LIMITATION OF THE STUDY

- Its retrospective, single-center design and reliance on secondary data resulted in incomplete documentation for some clinical and laboratory variables.
- In a proportion of cases, the specific poison type could not be definitively confirmed due to the absence of container labels, patient uncertainty, or lack of toxicological confirmation, which reflects common diagnostic challenges in emergency settings.

8. CONCLUSION AND RECOMMENDATION

8.1. CONCLUSION

AlP poisoning represents a high case fatality rate. Present study found that AlP poisoning predominantly affected young females from rural areas, and all cases resulted from intentional self-harm, most commonly following interpersonal conflicts.

Although gastrointestinal symptoms were universally present, mortality in AlP poisoning was primarily driven by cardiovascular collapse, with hypotension emerging as the key determinant of poor outcome.

Initial hypotension and hospital stay of less than two days were the key independent predictors of mortality in aluminum phosphide poisoning, emphasizing the critical importance of hemodynamic status during the first 48 hours. Other clinical variables, including altered consciousness and ingested dose, showed only borderline statistical significance.

8.2. RECOMMENDATION

For Regulatory and Governmental Bodies (National, regional and Zonal level)

- There is a need to strengthen regulatory oversight of AlP, including tighter control of its distribution and restricted access in local markets, given its frequent use for intentional self-harm in this setting.
- The establishment of functional poison control centers should be prioritized to improve toxicological surveillance, enhance data quality, and support clinicians through timely, evidence-informed guidance in the management of poisoning cases.
- In agricultural contexts, authorities may also consider the gradual introduction of safer and less toxic alternatives for grain preservation as a long-term risk-reduction strategy.

For Healthcare Facilities and Clinicians at Asella Referral and Teaching Hospital

- Healthcare providers should emphasize early recognition and prompt supportive management of AlP poisoning, with particular attention to rapid identification and correction of hypotension.
- The development and implementation of standardized treatment protocols at the institutional and national levels, incorporating current best evidence for supportive care—including the judicious use of agents such as magnesium sulfate and calcium gluconate—may help improve consistency of care in resource-limited settings.

For Future Research

- Further prospective, multicenter studies with standardized data collection at the national level are needed to provide robust evidence on supportive treatments and guide context-appropriate management guidelines for AlP poisoning.

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8. ANNEXES

ANNEX I

Table 6: logistic regression (bivariables and multi variables) analysis of variables among Aluminium phosphide poisoning patients (n=116) presenting to Asella referral and teaching hospital, December 2025.

Variables	Category	Treatment outcome		COR	AOR	*P*
		Live	Dead			
Sex	Male	31	17	1	1	
	Female	48	20	0.760 (0.345, 1.672)	0.324 (0.019, 5.477)	0.435
Age	≤20	30	9	0.800 (0.175, 3.664)	10.047 (0.016, 6330.754)	0.483
	21-30	34	20	1.569 (0. 373 , 6.603)	3.724 (0.12, 1157.290)	0.653
	31-40	7	5	1.905 (0.330, 11.009)	50.303 (0.001, $1.8x10^6$)	0.464
	>40	8	3	1	1	
Residency	Rural	63	29	0.921 (0.354, 2.395)	0.230 (0.006, 9.310)	0.437
	Urban	16	8	1	1	
Number of tablets	≤1	57	14	1	1	
	>1	22	23	4.256 (1.862, 9.729)	24.138 (0.820, 710.454)	0.065

Time lag from ingestion to ED presentation	≤2	52	20	1	1	
	>2	27	17	1.637 (0.738, 3.630)	0.924 (0.051, 16.695)	0.958
Alcohol abusive behavior	Yes	11	4	0.536 (0.179, 1.607)		
	No	17	5	1		
	Not specified	51	28	0.662 (0.193, 2.274)		
Previous Mental Illness	Yes	4	1	0.368 (0.115, 1.178)		
	No	19	4	1		
	Not specified	56	32	0.438 (0.047, 4.085)		
Reason for ingestion	Intentional	79	37			
	others	0	0			
Precipitating factors						
Quarrel	Yes	41	12	0.445 (0.196, 1.008)		
	No	38	25	1		
Others	Yes	3	3	2.235 (0.429, 11.646)		
	No	76	34	1		
Not specified	Yes	35	22	1.844 (0.835, 4.072)		

	No	44	15	1		
Symptom at admission						
Nausea	Yes	30	8	0.451 (0.182, 1.114)		
	No	49	29	1		
Vomiting	Yes	79	37			
	No	0	0			
Epigastric pain	Yes	75	33	0.440 (0.104, 1.867)		
	No	4	4	1		
Head ache	Yes	13	3	0.448 (0.119, 1.680)		
	No	66	34	1	1	
Altered consciousness	Yes	9	11	3.291 (1.224, 8.849)	1057.742 (0.868, $1.2x10^6$)	0.055
	No	70	26	1	1	
Initial SBP	Hypotensive	14	33	38.304 (11.681, 125.598)	264.946 (1.175, $5.9X10^4$)	0.044*
	Normotensive	65	4	1	1	
Lab work up status	Done	1	19	1		
	Not done	78	18	82.333 (10.336, 655.855)		

Abnormal lab value	Yes	35	17	20.886 (2.647, 164.782)	72.411 (0.445, $1.1X10^4$)	0.099
	No	43	1	1	1	
Laboratory abnormalities						
Leukocytosis	Yes	9	8	2.469 (0.729, 8.360)		
	No	25	9	1		
Leukopenia	Yes	6	1	0.292 (0.032, 2.644)		
	No	28	16	1		
Elevated creatinine	Yes	7	7	2.700 (O.755, 9.565)		
	No	27	10	1		
Elevated SGOT/SGPT	Yes	8	4	1.000 (0.253, 3.945)		
	No	26	13	1		
Hypokalemia	Yes	6	2	0.622 (0.112, 3.471)		
	No	28	15	1		
Hyperkalemia	Yes	7	9	4.339 (1.226, 15.361)		
	No	27	8	1		
Hypocalcemia	Yes	4	10	10.714 (2.585, 44.403)		
	No	30	7	1		

Others	Yes	5	2	0.773 (0.134, 4.469)		
	No	29	15	1		
Presence of complications	Yes	24	36	82.500 (10.684, 637.039)	193.415 (0.026, $1.4x10^6$)	0.246
	No	55	1	1	1	
Complication types						
Refractory hypotension	Yes	18	36	$3.2x10^9$ (0.000)		
	No	6	0	1		
ARDS	Yes	4	9	1.667 (0.449, 6.190)		
	No	20	27	1		
Pulmonary edema	Yes	1	5	3.710 (0.405, 33.943)		
	No	23	31	1		
Arrythmia	Yes	0	14	$1.8 x10^9$ (0.000)		
	No	25	22	1		
ARF	Yes	6	8	0.857 (0.255, 2.883)		
	No	18	28	1		
Electrolyte abnormality	Yes	15	11	0.055 (0.367, 0.132)		
	No	13	26	1		

Coma	Yes	2	7	2.655 (0.502, 14.053)		
	No	22	29	1		
Others	Yes	8	7	0.483 (0.148, 1.577)		
	No	16	29	1		
LOS in days	<2	24	34	25.972 (7.264, 92.865)	167.269 (4.282, 6534.394)	0.006*
	>/=2	6	3	1	1	

ANNEX II: DATA COLLECTION TOOL

Data collection tool prepared to assess clinical profile, treatment outcome, and associated factors of aluminum poisoning among acute poisoning patients presented to the adult emergency department, AU, ATRH.

Date…….... Study Site……. Code……

Encircle or write the correct response

Part 1: Socio-demographic factors

No	Questions	Response
	MRN	
1	Sex	□Male □Female
2	Age (in year)	
3	Residence	□Urban □Rular

Part 2: Exposure History

No	Questions	Response
1	Number of tablets ingested (in number)	
2	Time lag from ingestion to hospital arrival (in hours)	
4	Reason for ingestion	□ Intentional self-harm/suicidal □ Unintentional/accidental exposure □ Occupational exposure □ Other (specify) _____
5	Precipitating factors	□ conflict/quarrel, □ financial constraint, □ mental illness, □ occupational stress, □ academic pressure, □ health related distress (disabilities, chronic illness), □ substance abuse (acute alcohol intoxications, …), □ others (specify) ____
6	Alcohol abuse behavior	□yes □no □not specified
7	Presence of previous mental illness	□yes □no □not specified

Part 3: Clinical Profile

No	Questions	Response
1	Symptoms at admission	☐ Nausea; □ vomiting; ☐ Epigastric pain; ☐ Headache; ☐ Altered consciousness; ☐ Other: _____
2	Initial systolic blood pressure (SBP)	☐ <90 mmHg (hypotensive); ☐ ≥90 mmHg (non-hypotensive)
3	Laboratory abnormalities	☐ Leukocytosis (WBC >11,000/mm³); ☐ Leukopenia (WBC <4,000/mm³); ☐ Elevated creatinine (>1.2 mg/dL); ☐ Elevated SGOT/SGPT (>40 U/L); ☐ Hyperglycemia (glucose >140 mg/dL) ☐ Hypokalemia (K^+ <3.5 mmol/L); □ Hyperkalemia; ☐ Others (specify) _____
Treatment Administered and Outcome		
5	Interventions received	☐ Gastric lavage with normal saline; ☐ IV fluids (maintenance) ☐ vasopressor infusion; ☐ Magnesium

		sulfate;☐ Hydrocortisone IV; ☐ Calcium gluconate; □ digoxin □ omeprazole/cimetidine, □ Others (specify) _____
6	ICU admission?	□ yes, □ no
7	Duration of hospitalization (in days)	
Treatment Outcome		☐ Improved ☐ Expired

ANNEX III: INVESTIGATOR ASSURANCE FORM

I the undersigned Resident agree to accept all responsibilities for the scientific, ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the Research and Publication Committee and /or Department of Internal medicine, of Arsi University.

I also assert that this thesis is my original work, has not been presented for a degree in any other university and that all sources of materials used for the thesis have been accordingly acknowledged.

Name of Resident ……

Signature……

Date……

Approval of Advisors

1. Name of Advisor……

   Signature: ……..

   Date ……..

2. Name of Advisor……..

   Signature: …….

   Date ……..