

TIME FROM INGESTION TO FIRST MEDICAL CONTACT AND EMERGENCY DEPARTMENT SEVERITY AMONG WHEAT PILL (ALUMINIUM PHOSPHIDE) POISONING CASES: A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Objective: To determine the association between time from wheat pill (aluminium phosphide) ingestion to first medical contact and severe clinical presentation at emergency department (ED) arrival, and to describe the distribution of care-seeking intervals and the proportion presenting with severe poisoning.

Study Design: Prospective observational analytical study.

Settings: Accident & Emergency Department, Jinnah Postgraduate Medical Centre (JPMC), Karachi.

Period: Four months from February 2025 to May 2025.

Material & Methods: 191 adults with suspected acute oral aluminium phosphide ingestion presenting within 24 hours were enrolled by non-probability purposive sampling. Time from ingestion to first qualifying medical contact and to JPMC arrival were recorded from records or attendant/patient report. Arrival Poisoning Severity Score (PSS) was assigned within 30 minutes of arrival using published organ-system criteria; PSS grade 3 was classified as severe. Data were analysed with medians (IQR) or means (SD), chi-square/Fisher exact and Mann-Whitney U tests, and crude and adjusted binary logistic regression (adjusting for age, quantity ingested and referral status). Two-sided $p < 0.05$ was significant.

Results: Median time to first medical contact was 1.42 hours (IQR 0.89–2.00) and to JPMC arrival 2.43 hours (IQR 1.63–3.28). Ninety-one of 191 patients (47.6%, 95% CI 40.7–54.7%) had severe arrival PSS. Time to first contact was not associated with severe presentation, unadjusted (OR 1.12 per hour, 95% CI 0.85–1.48, $p = 0.409$) or adjusted for age, quantity ingested and referral status (adjusted OR 1.15, 95% CI 0.86–1.54, $p = 0.356$). Referral status and quantity ingested were also not significantly associated with severity ($p = 0.937$ and $p = 0.076$, respectively).

Conclusion: Nearly half of wheat pill poisoning presentations at this centre were severe at arrival, but time from ingestion to first medical contact was not independently associated with severity. Delay reduction strategies should not be assumed to alter arrival severity without further, adequately powered study.

INTRODUCTION

Aluminium phosphide tablets, widely known in South Asia as “wheat pills” because of their use as a grain fumigant, release phosphine gas on contact with gastric moisture or ambient humidity.¹ Ingestion, whether accidental or in the setting of deliberate self-harm, can rapidly precipitate refractory vomiting, severe metabolic acidosis, circulatory collapse and cardiac dysfunction, and no specific antidote exists; outcome therefore depends heavily on how quickly supportive resuscitation is instituted.^{1,2} Historical hospital case series from Pakistan have reported case-fatality figures as high as 60% or more, and although such figures should not be read as a current national rate, they illustrate why aluminium phosphide poisoning remains one of the most lethal acute poisonings managed in South Asian emergency departments.^{3,4} More recent work has sharpened this picture. A 2024 Egyptian cohort found that 58.3% of aluminium phosphide patients had a severe Poisoning Severity Score (PSS) at assessment and that overall mortality reached 61.1%, though the interval to hospital did not differ significantly by survival status in that cohort.⁷ Physiological severity scores derived from vital signs at arrival – shock index, the glucose/potassium ratio, and electrocardiographic pattern – have each been shown to track mortality risk in aluminium phosphide poisoning in recent series, underscoring that the clinical state at the moment of arrival, however it comes about, is what ultimately drives outcome.^{9,10,11} Separately, a large prospective cohort of acute poisoning presentations in Sindh reported that delayed reporting was independently associated with higher odds of death, but that analysis pooled multiple poison classes and did not evaluate initial severity specifically after wheat pill ingestion.⁶ Local Pakistani data on wheat pill poisoning itself remain confined largely to descriptive case series and mortality audits, with dosage, arterial blood gas derangement and referral pathway described but the time-to-care question left largely unaddressed.^{2,3,5}

Karachi's emergency services manage a substantial and ongoing burden of wheat pill ingestion, yet local prospective evidence linking the time of first medical contact – as distinct from time to arrival at a tertiary centre – to severity at ED arrival is limited. Patients who first seek help at a local clinic or ambulance may have a short interval to first contact but a much longer interval to definitive emergency assessment, and it is not established whether this earlier step in the care pathway itself predicts how sick a patient looks on arrival. The present study was therefore designed to determine, in a prospective JPMC ED cohort, the association between time from ingestion to first medical contact and severe clinical presentation at arrival, and, secondarily, to describe the distribution of both time intervals, estimate the proportion of severe presentations, and compare severity by referral status and reported quantity ingested.

MATERIAL & METHODS

Study Design: Prospective observational analytical study.

Settings: Accident & Emergency Department, Jinnah Postgraduate Medical Centre, Karachi.

Duration: Four months from February 2025 to May 2025..

Sample Size: Using the WHO single-population-proportion formula $n = Z^2 p(1-p)/d^2$ (95% confidence, $Z=1.96$), with $p=0.5833$ (severe PSS proportion from ElMehy and Sharif⁷) and absolute precision $d=0.07$, the calculated sample size was 190.6, rounded up to 191.¹⁷

Sampling Technique: Non-probability purposive sampling; all eligible presentations during the study period were approached.

Inclusion Criteria: Adults ≥ 18 years presenting alive to the ED with suspected oral aluminium phosphide ingestion within 24 hours, for whom the patient or a reliable attendant could provide a plausible ingestion time, and who (or whose

authorised representative) provided written consent.

Exclusion Criteria: Mixed or uncertain poison exposure; inhalation-only exposure; a previous poisoning episode already enrolled; arrival after 24 hours; and unresolvable timing despite records and attendant interview. Haemodynamic instability was not an exclusion criterion; clinical stabilisation took priority, with deferred consent per approved IRB procedure.

Data Collection Procedure: Trained investigators prospectively screened ED presentations, confirmed eligibility with the treating clinician, and interviewed the patient or attendant using a structured proforma recording ingestion and first-contact times (with source), age, sex, approximate tablet quantity, presentation pathway (direct or referred), and pre-JPMC care. Arrival vital signs, Glasgow Coma Scale, ECG and blood gas findings obtained for clinical care were recorded from the medical record; no research-only investigation was performed. A trained assessor assigned the arrival Poisoning Severity Score from findings in the first 30 minutes after arrival, using the published organ-system criteria.¹⁶ PSS grades 0–2 were classified as non-severe and grade 3 as severe; no grade-0 presentations occurred in this sample.

Data / Statistical Analysis: Data were entered and coded in SPSS version 26. Continuous variables were tested for normality (Shapiro-Wilk) and, being non-normally distributed, summarised as median (interquartile range),

with mean $\pm$ SD reported alongside; categorical variables were summarised as frequency (percentage). The primary exposure, time to first medical contact, was analysed continuously (hours) and, for descriptive comparison, in the pre-specified categories ≤ 1 , >1 –2 and >2 hours. Severity groups (severe vs non-severe PSS) were compared using the chi-square or Fisher exact test for categorical variables and the Mann-Whitney U test for continuous/time variables. Crude and adjusted binary logistic regression estimated odds ratios for severe presentation, adjusting for age, quantity ingested and referral status; linearity of the logit for time to contact was checked with a quadratic term. Two-sided $p < 0.05$ was considered significant, with 95% confidence intervals reported throughout.

Ethical Approval: The study was approved by the institutional Research & Ethics/JPMC IRB prior to enrolment. Written informed consent was obtained from each participant or an authorised representative; study IDs replaced patient names and the linkage sheet was stored securely with restricted access.

RESULTS

A total of 191 patients met the inclusion criteria and were enrolled. The median age was 34 years (IQR 22.5–55.0; mean 38.7 ± 18.4 years), and 102 (53.4%) were female. Most patients ingested a small quantity, with a median of 1.0 tablet (IQR 0.5–2.0). One hundred and sixteen patients (60.7%) presented directly to JPMC and 75 (39.3%) were referred from another facility. Baseline, exposure and arrival characteristics are summarised in **Table I**.

Table I: Baseline, exposure and arrival characteristics of the study population (n=191)

Characteristic	Value (n=191)
Age, years – median (IQR)	34 (22.5–55.0)
Sex – Female / Male, n (%)	102 (53.4) / 89 (46.6)
Ingestion time certainty – Exact / Approximate, n (%)	149 (78.0) / 42 (22.0)
Quantity ingested, tablets – median (IQR)	1.0 (0.5–2.0)
Presentation pathway – Direct / Referred, n (%)	116 (60.7) / 75 (39.3)
Systolic BP, mmHg – median (IQR)	103 (91.5–116.5)
Heart rate, /min – median (IQR)	112 (97–126.5)
Respiratory rate, /min – median (IQR)	25 (21–29)
SpO ₂ , % – median (IQR)	96 (92–98)
Blood gas pH (n=132) – median (IQR)	7.30 (7.22–7.35)
ECG – Normal / Abnormal / Not done, n (%)	121 (63.4) / 46 (24.1) / 24 (12.6)

Characteristic	Value (n=191)
Time to first medical contact, hours - median (IQR)	1.42 (0.89–2.00)
Time to JPMC arrival, hours - median (IQR)	2.43 (1.63–3.28)
Arrival PSS - Grade 1 / 2 / 3 (severe), n (%)	29 (15.2) / 71 (37.2) / 91 (47.6)

Both time intervals were markedly right-skewed. Time from ingestion to first medical contact ranged from 16 to 357 minutes (median 85 minutes, IQR 53.5–120), and time to JPMC arrival ranged from 29 to 452 minutes (median 146 minutes, IQR 97.5–196.5). Using the pre-specified categories, 55 patients (28.8%) had first contact within 1 hour, 90 (47.1%) between 1 and 2 hours, and 46 (24.1%) after 2 hours.

Ninety-one of 191 patients (47.6%, 95% CI 40.7–54.7%) had a severe arrival presentation (PSS grade 3); 71 (37.2%) were grade 2 and 29 (15.2%) grade 1. **Figure-1** shows that the proportion with severe presentation was similar across the three pre-specified time-to-contact categories (43.6%, 50.0% and 47.8% respectively; $\chi^2=0.56$, $df=2$, $p=0.758$).

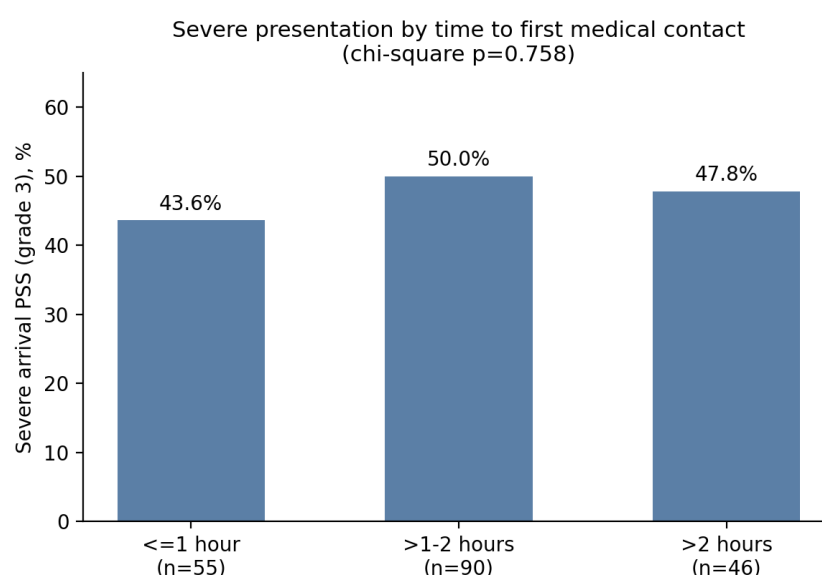


Figure-1: Proportion with severe arrival presentation by pre-specified time-to-first-contact category

On bivariate comparison (**Table-II**), time to first medical contact did not differ between patients with severe and non-severe presentations (median 1.42 hours in both groups; Mann-Whitney $U=4587.0$, $p=0.924$), as illustrated in **Figure-2**. Age, sex, ingestion-time certainty and presentation pathway also did not differ significantly between groups. Quantity ingested

showed a non-significant trend toward being higher in the severe group ($p=0.076$). As expected, ECG abnormality was strongly associated with severe presentation (all 46 abnormal ECGs occurred in the severe group; $\chi^2=67.07$, $df=2$, $p<0.001$), consistent with ECG change being a concurrent marker of physiological severity rather than an independent predictor of it.

Table-II: Bivariate comparison of severe (PSS grade 3) versus non-severe (PSS grade 1–2) presentations

Variable	Severe (n=91)	Non-severe (n=100)	Test statistic	p-value
Time to first contact, hours - median (IQR)	1.42 (0.93–2.00)	1.42 (0.85–1.99)	$U=4587.0$	0.924
Age, years - median (IQR)	34 (23–54)	34.5 (22–55.25)	$U=4743.5$	0.612
Quantity ingested, tablets - median (IQR)	1.0 (1.0–2.0)	1.0 (0.5–2.0)	$U=5209.5$	0.076

Variable	Severe (n=91)	Non-severe (n=100)	Test statistic	p-value
Sex - female, n (%)	53 (58.2)	49 (49.0)	$\chi^2=1.28$	0.257
Ingestion time certainty - exact, n (%)	73 (80.2)	76 (76.0)	$\chi^2=0.28$	0.597
Presentation pathway - referred, n (%)	36 (39.6)	39 (39.0)	$\chi^2=0.00$	1.000
Time-to-contact category ($\leq 1h$ / $>1-2h$ / $>2h$)	24 / 45 / 22	31 / 45 / 24	$\chi^2=0.56$	0.758
ECG - abnormal, n (%)	46 (50.5)	0 (0.0)	$\chi^2=67.07$	<0.001

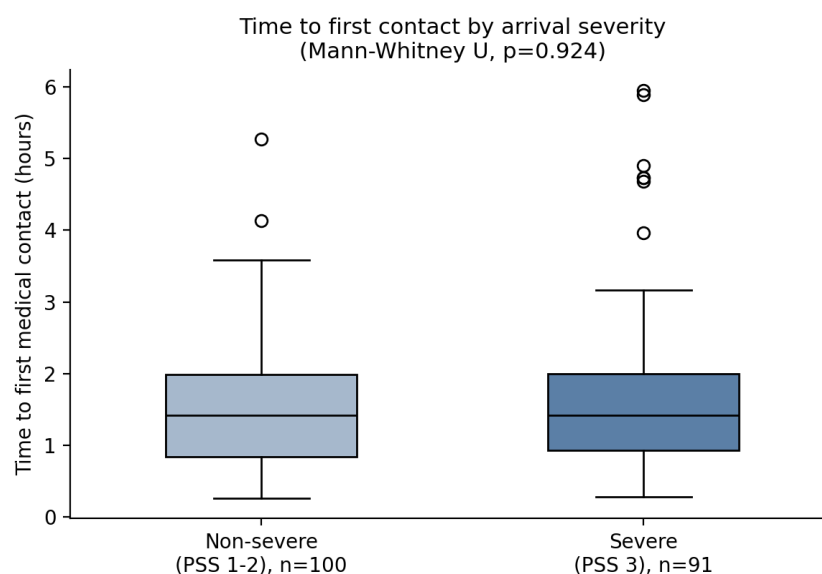


Figure-2: Distribution of time to first medical contact by arrival severity group

On logistic regression (**Table-III**), time to first medical contact was not significantly associated with severe presentation, either unadjusted (OR 1.12 per hour, 95% CI 0.85–1.48, $p=0.409$) or after adjustment for age, quantity ingested and referral status (adjusted OR 1.15, 95% CI 0.86–1.54, $p=0.356$). A quadratic term for time to contact was non-significant ($p=0.188$), supporting linearity of the exposure-outcome relationship on the logit scale and arguing

against a masked threshold effect. In the adjusted model, quantity ingested showed a positive but non-significant trend (adjusted OR 1.33 per tablet, 95% CI 0.95–1.86, $p=0.092$); age and referral status were not associated with severity. The adjusted model's Hosmer-Lemeshow goodness-of-fit was satisfactory ($\chi^2=7.41$, $df=8$, $p=0.493$), and the model explained little of the variance in arrival severity (Nagelkerke $R^2=0.026$).

Table-III: Crude and adjusted binary logistic regression for severe arrival presentation (PSS grade 3)

Predictor	Crude OR (95% CI)	p	Adjusted OR (95% CI)	p
Time to first contact (per hour)	1.12 (0.85–1.48)	0.409	1.15 (0.86–1.54)	0.356
Age (per year)	–	–	1.00 (0.99–1.02)	0.890
Quantity ingested (per tablet)	–	–	1.33 (0.95–1.86)	0.092
Referred vs. direct presentation	–	–	1.14 (0.61–2.13)	0.684

DISCUSSION

In this prospective cohort of 191 wheat pill poisoning presentations, nearly half (47.6%) had a severe arrival presentation, a figure that

sits close to the 58.3% severe-PSS proportion reported by ElMehy and Sharif in a 2024 Egyptian cohort of 144 aluminium phosphide patients and considerably higher than would be

expected for an unselected acute poisoning population, underscoring that wheat pill ingestion continues to present acutely unwell to the emergency department regardless of the interval before care is sought.⁷ Local Pakistani data on this poison have so far emphasised dosage-outcome relationships and mortality audits rather than the care-seeking interval itself, and the present findings extend that literature by directly quantifying, for the first time in this setting, both the time to first medical contact and its relationship to arrival severity.^{2,3}

The central finding – that time from ingestion to first medical contact was not associated with severe presentation, either unadjusted or after adjusting for age, quantity ingested and referral status – mirrors the Egyptian cohort, in which time to hospital likewise did not differ significantly by survival status.⁷ This convergence across two different populations and slightly different endpoints (severity at arrival versus survival) suggests that once a patient has ingested a toxic quantity of aluminium phosphide, the rate and severity of phosphine-mediated organ injury may be driven more by ingested dose and individual toxicokinetics than by the interval before the first clinician sees the patient, at least within the range of delays observed here (16 minutes to just under 6 hours). This is consistent with recent work showing that physiological indices captured at the moment of arrival – the shock index, the modified shock index, and the serum glucose/potassium ratio – track severity and mortality far more strongly than upstream process measures such as time to presentation.^{9,10} Quantity ingested showed a non-significant trend toward higher severity in our adjusted model (adjusted OR 1.33 per tablet, $p=0.092$), and a larger, adequately powered study may be needed to confirm a dose-severity relationship that the present sample could only suggest.

The strong association we observed between ECG abnormality and severe presentation (all abnormal ECGs occurred in the severe group) is consistent with recent series identifying electrocardiographic pattern as a predictor of mortality in aluminium phosphide poisoning, and with mechanistic reviews describing phosphine-induced mitochondrial and myocardial toxicity as a proximate driver of the

cardiovascular collapse that defines severe presentations.^{11,14} Because ECG changes are themselves a manifestation of the same physiological derangement captured by the PSS grade, this association is best read descriptively rather than as evidence that ECG abnormality is an independent, modifiable risk factor.

Referral status also showed no association with severity in our cohort (39.6% of severe patients were referred versus 39.0% of non-severe patients, $p=1.000$), which is a reassuring finding for the local referral network, though it should be interpreted cautiously: referred patients had already received some pre-hospital care (fluids or other treatment in 40 of 75 referred cases), which may have offset any deterioration accrued during the additional transfer time and so masked a true effect of referral pathway on severity.⁶ The pattern is broadly consistent with newer machine-learning-based prognostic work in aluminium phosphide poisoning, which finds that combinations of arrival physiological and biochemical variables outperform simple process-of-care variables such as referral status in predicting outcome.¹²

Two data-quality observations from our proforma-based data collection warrant separate comment before these findings are extended to policy. Blood gas pH was obtained for only 132 of 191 patients (69.1%), reflecting our protocol's requirement that blood gas be drawn only when clinically indicated rather than obtained solely for research purposes; the resulting complete-case pH analysis should not be over-interpreted in isolation. Separately, 34 of 191 recorded Glasgow Coma Scale values exceeded the scale's maximum of 15, a field-data-entry artefact rather than a true physiological finding; because GCS was not part of the PSS grading criteria used to define our primary outcome, this artefact does not affect the severity classification, but it illustrates a recognised practical limitation of GCS recording under time pressure in a busy emergency department and should be corrected against source records in any future dataset.¹⁶ This is our study's principal limitation, together with its single-centre design, sample size adequate only for the pre-specified severe-PSS proportion rather than for detecting a small time-severity association, and reliance on attendant-reported ingestion times for a

minority of cases where documentation was unavailable.

CONCLUSION

Severe arrival presentation was common (47.6%) among wheat pill poisoning cases at this tertiary centre, but time from ingestion to first medical contact was not independently associated with severity, either unadjusted or after adjustment for age, quantity ingested and referral status. Efforts to reduce time to first medical contact remain clinically important for other reasons but should not be assumed, on this evidence, to reduce the severity of presentation without further, larger prospective study.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflict of interest.

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None.

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