An Intentional Aconite Overdose: A Case Report

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ABSTRACT

Background: Aconite is one of the most toxic known herbs, widely used for centuries as an essential Chinese medicine, but also for deliberate poisoning throughout history. Clinically indicated in herbal medicine for a range of ailments from headaches to muscle spasm, unfortunately the narrow therapeutic window may lead to a range of toxic presentations. The mechanism of action of the pharmacologically active compounds in Aconite relate to the activation of voltage gated sodium channels within a range of tissue including myocardial, neuronal and smooth muscle leading to persistent cellular activity. Case presentation: We report on a rare case of a fifty year old male with intentional aconite overdose presenting with refractory cardiovascular instability from persistent life threatening arrhythmias, respiratory failure and seizure activity. Conclusion: An overview of Aconite, its history, pharmacological effects, treatment of overdose and outcomes is presented.

Keywords: Aconite, cardiovascular

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Background

Aconitum is a genus of over two hundred species of flowering plants which contain active ingredients containing aconite and the related alkaloids, lycocanitine and napelline. Chinese herbalists have actively used aconite for centuries for the treatment of muscular-skeletal disorders due to its analgesic and anti-inflammatory properties. It is derived from the plant Aconitum napellus, also known as Monkshood or Wolfsbane. However, only a few cases have been described in western literature in the past twenty years, despite being one of the most toxic plants in the UK.

Presentation relates not only to the site of absorption of aconite but also plasma concentration of active alkaloids, which varies within the individual parts of plants such as their roots or leaves but also between plants and the processing techniques used during agriculture[1].

Aconite's pharmacokinetic data has been clarified by several studies [2,3]. Following enteral absorption, aconite mediates a range of cellular effects via voltage-gated sodium channels. Poisoning, with myocardial complications, usually develops within 15-30 minutes following ingestion of the plant leaves or roots. The effects of poisoning are classically dose related [4]. Aconite alkaloids undergo elimination by first-order kinetics primarily via renal excretion, with a minor pathway involving cytochrome P450 (CYP 3A)[5]. Aconite's half-life (t½) exhibits significant inter-individual variability up to sixteen hours but also variation between other alkaloids within the same family [6].

The structure-activity relationship of aconite is yet to be fully elucidated. Classically, aconite binds avidly and induces direct confirmation change to open voltage-gated sodium channels by binding site two of the alpha-subunit, with increased preferential binding to highly active channels, which promotes persistent channel opening, enhancing intracellular [Na⁺] and [Ca²⁺], maintaining membrane depolarisation [7]. Myocardial cells classically enhance automaticity, but such activity is also observed in neuronal tissue and finally striated and smooth muscles.

Case Presentation

A fifty-year-old professionally educated Caucasian male was found collapsed within a public area. Local hospitality staff informed emergency services. A suicide note stating he had consumed a quantity of Wolfsbane root and alcohol, was found with him. Paramedics ar-
rived within ten minutes. Their assessment identified a confused, intoxicated, cyanotic individual with sporadic episodes of rigidity, tachycardia (105 beats.mins⁻¹), hypotension (97/63 mmHg) and hyperventilation (45 breaths.mins⁻¹), frothing at his mouth. An electrocardiogram (ECG) (Figure 1) was performed identifying an irregular rhythm with left bundle branch block, multifocal ectopic and first degree AV block. Supportive care was initiated, an 18 gauge cannula was inserted and fluid administered (1000ml of Ringers Lactate Solution).

He was transferred to an emergency department of a large tertiary centre (England, UK). During the transfer journey he required intermittent assistant ventilation with a bag valve mask due to periods of apnoea. On arrival at the emergency department, he suffered a seizure, which spontaneously resolved in three minutes. A medical history was taken and the patient was examined revealing a Glasgow Coma Scale score of 12, with progressive respiratory failure and haemodynamic instability (BP 60/40 mmHg) secondary to monomorphic ventricular tachycardia, bigeminy and atrial fibrillation (Figure 2). Advice was sought from the UK National Poisons Information Service, following which three hundred milligrams of amiodarone (Hameln pharma, Hameln, Germany) and three grams of magnesium (Martindale pharma, Essex, UK) was administered via a large-bore cannula.

He was intubated following rapid sequence intubation (RSI) with ketamine (1 milligrams/kg) (Hameln pharma, Hameln, Germany), alfentanil (10 micrograms/kg) (Panpharma, Luitre, France) and rocuronium (Hameln pharma, Hameln, Germany) (1 milligrams/kg) to maintain cardiovascular stability.

Bilevel Positive Airway Pressure (BIPAP) ventilation ensured lung-protective ventilation with a tidal volume not exceeding 8ml/kg and maximum inspiratory pressures below 30 cmH2O. Acid-base balance identified a marginal low pH with raised lactate (4.8 mmol·L⁻¹) and negative base (-6.9 mmol·L⁻¹) (Table 1). Cardiovascular stability was achieved, peripheral and central lines inserted before transfer (Figure 3).

Four hours following admission, assessment and stabilisation in the emergency department, he was transferred to the intensive care unit (ICU). He remained

![Fig. 1. 12 lead ECG, Obtained by paramedics at the pickup location](image1.png)

![Fig. 2. Rhythm strips, obtained in the emergency department, five minutes post-admission.](image2.png)
sedated with ongoing cardiovascular support via exogenous catecholamines for resistant hypotension via central venous access; noradrenaline (6 micrograms.kg⁻¹.min⁻¹) (Augettant, Lyon, France), in addition to fluid (125ml.min⁻¹ Ringers Lactate) and amiodarone (6 micrograms.kg⁻¹.min⁻¹) (Hameln pharma, Hameln, Germany). Acid-base balance normalised within four hours of being admitted to the ICU (Table 1).

Plasma troponin levels were not requested. Both hepatic and renal function were normal. Laboratory analysis of serum electrolyte remained within the normal range for potassium (3.7 mmol/l), magnesium

| Blood gas analysis | Intubation (FIO2 =1) | ICU (+4 hours) (FIO2 =0.35) |
|--------------------|----------------------|----------------------------|
| pH                 | 7.316                | 7.35                       |
| PaCO2              | 5.03                 | 5.36                       |
| PaO2               | 47.4                 | 19.4                       |
| thb                | 127                  | 125                        |
| sO2                | 100                  | 99                         |
| Electrolytes       |                      |                            |
| K                  | 3.3                  | 4.5                        |
| Ca                 | 1.07                 | 1.07                       |
| Na                 | 141                  | 142                        |
| HCO3⁻              | 19.3                 | 21                         |
| Metabolites        |                      |                            |
| Glucose            | 5.5                  | 6.5                        |
| Lactate            | 4.8                  | 2.4                        |
| Oxygen status      |                      |                            |
| xBase(Ecf)c        | -6.9                 | -2                         |

Fig 3. 12 lead ECG post amiodarone infusion, obtained in the emergency department. Two hours following admission to hospital.
(0.77 mmol/l), sodium (142 mmol/l) and calcium (2.22 mmol/l). Unfortunately, aconite plasma concentrations were requested, but not analysed.

On day two post-admission to ICU, he remained intubated and ventilated with BIPAP ventilation. Hemodynamic stability (BP 120/65 mmHg, 67 beat.min⁻¹) was achieved, and the weaning doses of noradrenaline and amiodarone were stopped (Figure 3). Three episodes of severe bradycardia were noted during early evening lasting less than one minute, all resolved spontaneously without intervention. An ECG confirmed sinus rhythm (Figure 4). Laboratory investigations remained normal.

On day three post-admission to ICU, he was successfully extubated to a 40% venture mask; he had an SaO2 of 99% and a respiratory rate of 18 breaths.min⁻¹. Respiratory and cardiovascular parameters remained stable in normal sinus rhythm. Episodes of acute agitation with tachypnoea were documented during the evening lasting three hours, which were managed with intravenous midazolam (Hameln pharma, Hameln, Germany). During the early afternoon, he was reviewed by the intensive care consultant as no further level two or three care was required. He was stepped down to an acute medical ward and reviewed by psychiatric services.

**DISCUSSION**

Aconite is a plant indigenous through northern Asia and Europe. It is commonly grown in gardens as it has attractive purple flowers. These appear similar to the hoods worn by medieval monks, hence one of its common names, monkshood. Its potent poisonous nature has long been recognised, reputedly used by shepherds as a meat poison used to kill wolves, and by association protect against werewolves, hence the name Wolfsbane. The name aconite originates from akontion, meaning dart in Ancient Greek as arrows were dipped in aconite for their poisonous effect.

Aconite poisoning remains a rare happening in the western world, and few case studies exist for individually managed cases within the United Kingdom. Notably, in 2009, a 39-year-old man was murdered by his partner, who laced his curry with aconite, resulting in fatal consequences, leading to widespread media reporting [8]. More recently, Jacobs et al. (2018), reported a case involving a 46-year-old man who required HDU admission for single organ support following cardiovascular collapse [9].

Dedicated supportive treatment in critical care, particularly of cardiac arrhythmias, has improved outcomes and decreased mortality rates to less than six per
cent [10]. Cardiovascular manifestations are broadly classified into central effects via direct effects modula-
tion within the ventromedial nucleus of the hypothala-
mus resulting in episodes of bradycardia and hypoten-
sion; conversely; agonism occurs also at peripheral sites 
leading to direct myocardial effects [10]. Agonist bind-
ing occurs throughout the myocardial with the site of 
action relating to clinical presentation, receptor bind-
ing within the sinoatrial node (SAN) has been shown 
to delay action potential propagation. With regards to 
cellular biology, recent studies have highlighted a range 
of cellular pathways which are modulated by aconite. 
These include alciun homeostasis, direct neurotoxic 
apoptosis, fatty acid peroxidation and cholinergic neu-
rotransmission [11].

Aconite exerts a range of calcium-related physiologi-

cal changes. These include both enhanced regulatory 
proteins transcription of L-type calcium channels and 
more specifically, Na⁺/Ca²⁺ bidirectional exchanger 
(NCX), sarcoplasmic reticulum Ca²⁺ATPase (SER-
CA2a), and directly enhancing NCX protein activ-
ity. Overall, there is an increase in both intracellular 
[Ca²⁺] and [Na⁺] prolonging myocardial action poten-
tial duration, inducing triggered activities and delayed 
after-depolarisations [12]. A recent review article high-
lights not only the management and prevalence of car-
diac manifestations but also the importance of voltage-
gated potassium channels in myocytes [12].

Direct toxic effects mediated by aconite are wide-
spread. Peng et al. [13]. reported on direct cytotoxic 
effects via the inhibition of Na⁺/K⁺/ATPase pump, 
thus mediating cellular apoptosis. Conversely, rodent 
cell-based models report a direct correlation between 
aconite exposure and elevations in intracellular Ca²⁺ 
which mediate apoptotic pathways [14]. Moreover, Lin 
et al. 2016) reported on the direct injury observed from 
aconite on myocardial tissue which can mimic symp-
toms of acute myocardial infarction and thus stimulate 
the release of TnT [15].

Electrocardiographic manifestations following aco-
nite poisoning have been documented in both case and 
review articles [12]. Our case study presents all such 
features, supraventricular abnormalities which include 
low amplitude P-waves which are intermittently lost 
with episodes of sinus bradycardia. Ventricular pathol-
gies include bundle branch block (BBB), T-wave re-
polarisation abnormalities, QT prolongation, sustained 
ventricular tachycardia, ventricular ectopy and finally, 
the rare bidirectional ventricular tachycardia. During 
this case excretion of aconite and its related alkaloids 
lead to the reappearance of normal P-wave morphol-
ogy and atrioventricular conduction activity. Aconites 
MAO on myocardial tissue underpins these findings.

Jacobs et al. (2019) reported on a similar presentation 
with regards to acute collapse and severe cardiovascu-
lar instability; however, they implemented haemodial-
ysis for toxin clearance [9]. Supportive management is 
the mainstay of treatment with no dedicated antidote. 
This includes vigilant monitoring of vital signs, with 
supportive cardiovascular management in the form of 
intravenous fluid with rhythm control involving both 
amiodarone for tachyarrhythmias and atropine for 
bradycardia. The spectrum of disease presentation is 
diverse with many other herbal preparations present-
ing similarly [16].

The clinical presentation of aconite poisoning mir-
rors that of other poisons. Common differential diag-
noses include cardiac glycosides, andromodotoxin and 
shellfish poisoning. The highest mortality rates have 
been associated with refractory ventricular tachycardia. 
Treatment with amiodarone is the recommended first-
line treatment followed by lidocaine and phenytoin. 
Case reports have reported decreasing effectiveness of 
reverting refractory ventricular tachycardia following 
failed first-line treatment intervention [9]. Prolonged 
cardiopulmonary resuscitation during severe intoxica-
tion with cardiopulmonary bypass has been successful 
[12].

Neurological manifestations relate to both central 
and peripheral blockade [17]. Classically, activation of 
voltage-gated sodium channels results in depolariza-
tion and thus reduced nerve prorogation [4]. In vitro, 
cell-based studies by Ameri et al. [18] have reported 
on extensive central based inhibition of neuronal and 
anti-epileptiform activity. Interestingly, aconite effects 
are dose dependant, low concentrations enhance pre-
synaptic acetylcholine (Ach) release, improving muscle 
contraction, conversely higher concentrations lead to 
the prolonged opening of neuronal voltage-gated so-
dium channels and thus reduced synaptic Ach release 
[19].

**Conclusions**

An interesting yet rare case of intentional aconite over-
dose in the United Kingdom, in a patient with a diverse 
disease presentation, specifically cardiac dysrhythmias 
and neurological compromise. Early identification
with rapid treatment intervention underpins disease management.

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