

Retrospective record review of patients admitted to a
High-Care Unit with an Organophosphate-like
toxidrome during the COVID-19 pandemic at a regional
hospital in South Africa

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Declaration

I, **Sekanamisha Marvelyn Tema**, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the branch of Internal Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



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Dr Sekanamisha Marvelyn Tema

14 September 2025

Dedication

For Mothiba and Tabudi Tema

Publications and presentations arising from this research project

Nil

Ethics Committee Approval

The University of the Witwatersrand - Human Ethics Research Committee (Medical) approved this research—clearance certificate number: M240959. The approval certificate may be found in Appendix A.

Abstract

Background

Organophosphate, a pesticide that can be used intentionally or inadvertently to induce bodily harm, is a significant cause of morbidity and mortality globally. Beyond its devastating health consequences, the COVID-19 pandemic also put a massive strain on healthcare infrastructure globally. There is limited data available in South Africa regarding the patterns of hospital admissions and outcomes for patients presenting with organophosphate-like toxidrome during the recent COVID-19 pandemic.

Objectives

To describe the demographics of patients admitted with an organophosphate-like toxidrome during the COVID-19 lockdown period, their clinical presentations, length of stay, and the outcomes in both COVID-19-negative and COVID-19-positive patients, and to describe their comorbidities.

Methods

A retrospective descriptive data analysis was conducted on patients admitted to the High-Care Unit at Edenvale Regional Hospital and treated with atropine for organophosphate-like toxidrome from January 2020 to December 2023. Of 219 identified patients, only 128 cases were analysed. Of the 91 excluded files, 31 files could not be found, and 60 files had polypharmacy ingestion (organophosphate compound and other toxins/ drugs).

Results

The study population consisted entirely of Black African ethnicity (100%). The mean age was 31 ± 11 years, with a male predominance (62%). The most common clinical findings included pinpoint pupils (59%), Glasgow coma scale (GCS) ≤ 13 (50%), and bronchorrhea (40%). Intentional ingestion accounted for 59% of cases. The COVID-19 status was unknown for 45% of cases, 7% of cases were admitted before the COVID-19 pandemic, and only 3% of cases tested positive. The median cholinesterase level was 368 U/L (interquartile range (IQR): 200-1157). Hypertension (11%) and HIV (10%) were common comorbidities.

Atropine infusion was administered in all cases, lasting an average of 5 ± 4 days. Relapse occurred in 12.5% (16 out of 128) of cases.

Of the relapses, 87.5% were discharged, 6.25% were transferred to another hospital, and 6.25% refused hospital treatment. Mechanical ventilation was required in 58% of cases, with a median duration of 7 days (interquartile range: 5 -15). The overall survival rate for the cohort was 85.9%.

Conclusion

This study aimed to evaluate the effect of the COVID-19 pandemic on organophosphate-like toxidrome, however, no definitive conclusions could be drawn due to the small number of positive cases. Nonetheless, it provides insights into the regional epidemiology of organophosphate-like toxidrome and highlights the need for further research to understand the patterns and determinants of organophosphate-like toxidrome in South Africa. In addition, further research is needed to explore the impact of COVID-19 pandemic-related factors such as isolation, financial problems, fear and anxiety, and other mental health conditions that may have contributed to suicide and self-harm.

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Abbreviations

WHO	World Health Organisation
HIV	Human Immunodeficiency virus
AIDS	Acquired Immunodeficiency syndrome
CRP	C-Reactive Protein
WCC	White Cell Count
RBC	Red blood cell
PLTS	Platelets
HB	Haemoglobin
MCV	Mean Cell Volume
NSAIDs	Non-steroidal anti-inflammatory drugs
AChE	Acetylcholinesterase
IMS	Intermediate syndrome
PPE	Personal Protective Equipment
OPIDP	Organophosphorus Induced Delayed Polyneuropathy
POP	Peradeniya Organophosphorus Poisoning
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
TB	Tuberculosis

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Chapter 1: Literature Review

1.1 General Introduction

Mental health is a serious public health concern, and its impact is also felt by those close to the affected individuals. One of the most devastating effects of mental health problems is suicide. According to a 2019 report from the World Health Organization (WHO), roughly 703 000 deaths occurred globally every year due to suicide. More people died from suicide than from HIV/AIDS, homicide, malaria, breast cancer, and war. The report also showed a male predominance based on age, with the suicide rate being 2.3 times higher in males than in females [1].

In 2019, the African continent had the highest suicide rate, approximately 11.2 per 100 000 population, versus a rate of 9.0 per 100 000 population globally. It was also noted that, compared to females, the prevalence of suicide is significantly higher in males, and these findings were not limited to the African region. The suicide rate is 2.3 times higher in males than in females. The suicide rate for males in the African continent is 18.0 per 100 000 population, versus the global average of 12.6 per 100 000 population. Lesotho reported the highest suicide rate at 29.4 per 100 000 population in the African region. South Africa was reported to have the fifth-highest suicide rate (13.6 per 100 000) after Zimbabwe (23.5 per 100 000), the Central African Republic (16.1 per 100 000), and Eswatini (14.1 per 100 000) [2].

The COVID-19 pandemic was the first of its kind to bring the whole world to a standstill. It was a period filled with anxiety and uncertainty. Measures such as working from home, physical and social distancing, the use of protective equipment, and shutting down schools and universities were introduced by government authorities to restrict the spread of the infectious virus. Despite the implementation of these measures, the number of new infections and related deaths continued to rise. The number of suicidal thoughts and attempts also increased [3].

People may attempt suicide using different methods. A study conducted in the emergency department at Charlotte Maxeke Johannesburg Academic Hospital revealed that methods used in suicide attempts included polypharmacy ingestion, ingestion of household chemicals, paracetamol overdose, organophosphate/ carbamate poisoning, non-steroidal anti-

inflammatory drugs (NSAIDS) overdose, opioid use, methanol/ethylene glycol, and unidentified substances [4].

1.2 Organophosphate-like toxidrome

1.2.1 Introduction

Organophosphate-like substances are commonly used as pesticides and insecticides, which can lead to human poisoning due to their widespread use. Organophosphate-like toxidrome, whether unintentional or intentional, is a frequent occurrence due to the simple availability and low cost of the compounds. Given their common use and associated risk of poisoning, clinicians must familiarize themselves with the clinical presentations and management of organophosphate-like toxidrome.

1.2.2 Incidence

Pesticide poisoning, notably organophosphate-like toxidrome, is a global health issue. The incidence of organophosphate self-poisoning varies greatly among regions. In low- to middle-income countries in the Western Pacific region, the incidence was 48.3%, compared to 0.9% in low- to middle-income countries in the European region [5]. Between 2010 and 2014, there were almost 110 000 pesticide self-poisoning deaths annually, accounting for 13.7% of suicides worldwide [5]. This study also noted that the incidence was on a downward trend. The downward trend was due to the introduction of regulations to access these toxic substances and also the movement of people from rural to urban areas [5].

A Johannesburg study conducted on 288 subjects, covering the period of November 2016 to October 2017, revealed that the most frequently ingested substance for intentional self-poisoning was organophosphate compounds/carbamates, accounting for 25% of the cases [4]. The results are similar to those of a cohort carried out by Favara at a local hospital's critical care unit in the Eastern Cape province of South Africa [6]. In this 5-year review of 419 subjects, Favara found that 55% of individuals admitted with intentional self-harm presented with organophosphate-like toxidrome [6].

At Chris Hani Baragwanath Academic Hospital, a study was undertaken to compare the burden of organophosphate-like toxidrome across two separate periods in patients admitted to the Intensive Care Unit (ICU) [7]. The results showed an increase in the burden of disease,

with 32 patients admitted in 2017 compared to 9 admitted in 2012. The length of stay in the ICU was noted to be considerably longer in 2017 compared to 2012, likely due to carbamate ingestions in 2012 rather than a true organophosphate compound.

The overall incidence of organophosphate poisoning in South Africa remains unknown. Although a few studies have been conducted, three of which are from Gauteng province, none provided data about incidences [8-10]. A study conducted on 61 patients at Tygerberg Hospital in the Western Cape showed an increase in the number of individuals admitted to the intensive care unit with organophosphate-like toxidrome [11]. The increases were notably higher during the final two years of the seven-year review period.

1.2.3 Sex

Of the five studies conducted in South Africa, four reported a predominance of male patients. The male predominance was 56%, 68.2%, 58.9%, and 63%, respectively [8-11]. No reasons were provided for the observed male predominance. In contrast, a cohort by Favara *et al.*, which reviewed 419 patients admitted to a critical care unit with self-harm, reported a female predominance of 53.2% [6]. However, Favara's cohort was not exclusively focused on organophosphate-like toxidrome, even though the majority of patients (232 out of 419) had ingested organophosphate-like toxidrome. No further breakdown regarding sex was provided for patients with organophosphate poisoning in the study.

1.2.4 Age

South African studies have shown that most organophosphate-like toxidrome cases occur in young people below the age of 40 years, particularly the 20-30 age group [8-10]. Similar findings were observed in studies from Turkey [12] and India [13]. An epidemiological study conducted by Razwiedani *et al.* in the Tshwane district of South Africa found that children aged between 1-10 years accounted for the second-highest prevalence rate (23.2%), following the 20-30-year age group, which had the highest prevalence (23.7%) [10]. The youngest individual affected in the study was 10 months old. While reasons for this prevalence in this age group were not specified, potential contributing factors may include improper storage and/or inadequate cleaning after the use of the substance.

1.2.5 Race

In Bruins' cohort of 129 patients at Chris Hani Baragwanath Academic Hospital, Black Africans constituted 99.2% of the participants, with only one Indian participant (0.8%) in the study [9]. A Western Cape study published in 1987 reported a higher incidence in the Coloured population (50 patients), followed by the White population (9 patients), and lastly by the Black population (2 patients) [11]. These findings probably reflect the local population demographics under the most socio-economic strain.

1.2.6 Reason for Ingestion

There are various reasons why organophosphate-like toxidrome may occur, including accidental ingestion, intentional self-exposure, and chemical warfare. Studies show that the most common reason for ingestion was suicide or a suicide attempt, and exposure to the poisonous substance was intentional [9,10,14-16]. In a Turkish study examining determinants of mortality in organophosphate poisoning, 86.1% of the patients were found to have been exposed through intentional suicide attempts [16]. A systematic review that analysed deaths from self-poisoning with pesticides between 2006 and 2015 found that one in seven (110,000) of 798,000 suicides that occurred globally in 2012 was due to self-poisoning using pesticides [5]. The increased risk of poisoning with organophosphate compounds stems from their widespread use and ready availability [17].

1.2.7 Pathophysiology

The neurotransmitter acetylcholine plays a vital role in maintaining normal body functions. It can be found in both sympathetic and parasympathetic ganglia, throughout all postganglionic parasympathetic nerves, in postganglionic sympathetic nerves that connect to sweat glands, and at skeletal neuromuscular junctions. It works by binding to nicotinic and muscarinic receptors [18].

Exposure to organophosphate compounds can occur through various routes, including ingestion, skin absorption, injection, or inhalation. The specific molecule, exposure method, dosage, and rate of molecule breakdown all affect the onset and intensity of symptoms [19]. Acetylcholine is broken down by the enzyme acetylcholinesterase (AChE). AChE is found in

skeletal tissues, erythrocyte membranes, and nervous tissues. AChE activity is inhibited by exposure to organophosphate compounds.

The resultant accumulation of acetylcholine leads to the stimulation of cholinergic synapses within the central and peripheral nervous systems. Initially, inhibition of AChE is reversible, however, the phosphorylated enzyme may undergo a process known as “aging,” resulting in the irreversible inhibition of AChE. As a result, nicotinic and muscarinic receptors become overstimulated, triggering the manifestation of symptoms [18,20,21].

1.2.8 Clinical Features

Factors such as the route of exposure, tissue concentration of the substance, body mass index, and the type of compound determine the rate of onset, duration, and severity of toxicity [22,23]. Following oral and/or respiratory exposure, symptoms occur within three hours, whereas toxicity resulting from skin absorption may take up to 12 hours to manifest [23].

The manifestation of clinical features results from overactivation of nicotinic and muscarinic receptors, with the expression of symptoms depending on the location of these receptors. Overstimulation of nicotinic receptors results in mydriasis, tachycardia, delayed atrioventricular conduction, atrial/and ventricular fibrillation, muscle weakness, cramps, hypertension, fasciculations, confusion, agitation, seizures, paralysis, tremors, ataxia, coma, and respiratory failure. The overstimulation of muscarinic receptors results in bronchospasm, bradycardia, miosis, salivation, lacrimation, emesis, urination, stomach cramps, blurred vision, hypotension, and diarrhoea [18,20,23,24]. Depression of the central respiratory drive, combined with respiratory muscle weakness, can lead to respiratory failure with hypercapnia, potentially resulting in death [22,24].

The manifestations of organophosphate-like toxidrome can be divided into three groups: acute syndrome, intermediate syndrome, and delayed syndrome. The features of acute syndrome, already described above, occur minutes to hours following exposure to an organophosphorus compound. In Bruins’ retrospective analysis of 129 patients at Chris Hani Baragwanath Academic Hospital, the most frequently observed clinical features included decreased level of consciousness (GCS <13), fasciculations, seizures, diarrhoea, miosis, and excessive salivation [9]. Miosis was observed in 96.1% of the cases. Similar findings were reported in another South African study, where miosis (55.2%) was the most common clinical

presentation [8]. In India, a cohort conducted by Sanjay *et al.* reported that the most common clinical features on presentation were vomiting (89.47%), salivation (85.76%), miosis (68.42%), sweating (60.99%), and restlessness (50.15%) [15].

Intermediate syndrome, occurring in 10–40% of poisonings, is a neurological disorder that manifests 24–96 hours following exposure. It is characterized by facial weakness, decreased deep tendon reflexes, areflexia, inability to flex the neck, slow eye movement, limb weakness, difficulty swallowing, and respiratory muscle weakness [12,14,15,24]. Features of intermediate syndrome have also been reported 114 hours post-exposure [20].

The delayed syndrome, also called Organophosphate-Induced Delayed Polyneuropathy (OPIDP), manifests one to five weeks after exposure to an organophosphate compound. Symptoms include pins and needles sensations, pain in the calves, muscle weakness, toe drop, atrophy of limb muscles, and paralysis. Eventually, death occurs, as this syndrome does not respond to oxime or atropine therapy [18,20,24].

1.2.9 Laboratory Investigations

Laboratory testing can be performed to confirm exposure to organophosphate compounds. Cholinesterase activity can be assessed using the red-cell cholinesterase and pseudocholinesterase (butyrylcholinesterase) tests. While these tests aid in diagnosis, results are not immediately available. The red-cell cholinesterase test serves as an indicator of the severity of poisoning, while the pseudocholinesterase test confirms exposure to organophosphates [8,18]. Organophosphate poisoning is indicated by a decrease in the red-cell cholinesterase levels of more than 50% of normal. Red-cell cholinesterase is a sensitive marker; however, its measurement can be challenging, making it less readily available. When red-cell cholinesterase measurement is unavailable, plasma cholinesterase testing may be used. However, results should be interpreted cautiously, as conditions such as malnutrition, septicemia due to burns, liver cirrhosis, neoplasia, and obstructive jaundice can also lead to a decrease in plasma cholinesterase levels [19,24]. The sensitivity of plasma cholinesterase varies depending on the specific organophosphate compound to which the patient has been exposed [25].

1.2.10 Peradeniya Organophosphate poisoning (POP) score

The Peradeniya organophosphorus poisoning scale is used to evaluate the prognosis and severity of organophosphorus poisoning based on symptoms observed at the time of presentation. A score is assigned to each of five clinical parameters: level of consciousness, fasciculation, pupil size, respiratory rate, and convulsions. Each parameter is scored from 0 to 2, depending on the clinical presentation. The scores are then summed to generate a total score, which classifies the patient's condition as mild (0–3), moderate (4–7), or severe (8–11) [26,27]. A higher mortality and an increased need for ventilatory support were observed in patients classified as having severe Peradeniya organophosphorus scale scores compared to those with moderate or mild scores [15,26,27].

1.2.11 Treatment

The management of patients with organophosphate toxicity can be separated into two main groups: specific and supportive measures [28].

1.2.11.1 Supportive Measures

These measures largely depend on the clinical presentation.

1.2.11.1.1 Maintenance of Airway, Breathing, Circulation (ABC)

Airway maintenance is crucial and should be prioritized in management [18,25]. Airway management involves clearing secretions, administering oxygen, and performing endotracheal intubation where necessary [24]. Failure to maintain the airway can result in respiratory failure and subsequent death. Endotracheal intubation is a vital component of airway management and must be considered early, especially in patients with seizures, bronchospasms, bronchorrhea, and decreased levels of consciousness [18].

A South African study conducted by Bruins *et al.* reported that 99.2% of the patients required intubation and mechanical ventilation [9], and one patient required prolonged ventilatory support for 24 days. In Vanessa Khonje's cohort of 134 patients at a regional hospital in Gauteng province, 53.7% required mechanical ventilation [8].

1.2.11.1.2 Decontamination

If exposure occurs through the skin, contaminated clothing should be removed and the affected area should be thoroughly washed. In case of eye exposure, rinse with normal saline, ringer's lactate, or tap water. Healthcare providers must wear appropriate personal protective equipment to prevent self-contamination [18,24,25].

1.2.11.1.4 Medications

Atropine

It is the first-line treatment for organophosphate poisoning. It acts on muscarinic receptors by competing with acetylcholine for binding. However, nicotinic receptor-mediated manifestations respond poorly to atropine [18,28]. The initial dose ranges from 1 to 5 mg intravenously. If there is no response, the dose should be escalated by doubling every 2–5 minutes until atropinization is achieved [18,25].

Indicators for atropinization include systolic blood pressure >80 mmHg, clear lungs on auscultation, pupils not pinpoint, dry axillae, and heart rate > 80 beats per minute [21]. Once atropinization is achieved, a continuous infusion of atropine is administered for maintenance [24,25].

Oximes

Pralidoxime reactivates phosphorylated acetylcholinesterase. It is most effective when administered before aging of the organophosphate-inhibited acetylcholinesterase occurs. However, this can be a limiting factor, as patients often present several hours after exposure, rendering the drug ineffective [18,21,25].

Glycopyrrolate (Rubinol)

It is a long-acting antimuscarinic drug with peripheral effects. Its impact on the central nervous system is minimal because it does not penetrate the blood-brain barrier. It is also considered safe for use during pregnancy, as it does not cross the placental barrier [29].

Glycopyrrolate, when used in conjunction with Atropine, is more effective than atropine alone [29] and has been associated with decreased mortality [30].

Benzodiazepines

These drugs work by enhancing GABA-A receptor activity [21,24]. They are first-line agents for controlling seizures and reducing anxiety and agitation [24]. Benzodiazepines are also used in intubated patients to maintain sedation [25].

1.2.12 Outcome

Length of Stay

The duration of hospital stay is directly associated with the use of a ventilator. Two South African studies found that intubated patients had a longer average hospital stay than non-intubated patients [8,9]. In Khonje's cohort, the median stay for ventilated patients was 11 days compared to 5 days for non-intubated patients [8].

In another South African study conducted in the Gauteng province, comparing two separate periods (2012 versus 2017), it was observed that patients in 2017 had a prolonged hospital stay, with a median of 7 days compared to 2 days in 2012 [7]. It was speculated that this was because patients in 2012 likely experienced carbamate poisoning rather than a true organophosphate poisoning.

Mortality

The mortality rate in organophosphate poisoning varies widely. A retrospective South African study undertaken at an academic hospital in Soweto found a 5.4% mortality rate (7 out of 129 patients) [9]. This four-year review included only patients admitted to the High-Care and critical care units.

A lower mortality rate of 3.4% was reported by Razwiedani and Rautenbach in a cross-sectional study of 207 patients in South Africa's Tshwane district [10]. Other South African studies reported mortality rates of 7.64%, 13.4%, and 16%, respectively [6,8,11].

Globally studies reported the following mortality rates: from Pakistani, a very low mortality rate of 0.05% (147 of 2708) [31], from Turkey a mortality rate of 9.1% [12], from India, a mortality rate of 8% [13], and Korea, a mortality rate of 19.1% [32], respectively.

Several factors, including age, Glasgow Coma Scale score, serum acetylcholinesterase levels, the amount of substance ingested, time elapsed after ingestion of organophosphate, and respiratory failure requiring mechanical ventilation, are associated with increased mortality [13,32].

1.3 COVID-19 disease

In 2019, cases of viral pneumonia were described in clusters in Wuhan, People's Republic of China. The disease was caused by a new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus. One of the unique features of this virus was its ability to spread rapidly [33]. The outbreak was formally declared a global pandemic by the World Health Organization on 11 March 2020. This was after it rapidly spread and infected people in multiple countries in a short time [34].

The clinical presentation varies widely, from asymptomatic cases to severe respiratory distress and multi-organ failure, and the symptoms are nonspecific. Fatigue, Fever, and dry cough were the most common presenting symptoms. Loss of appetite, high temperature (above 38 degrees Celsius), shortness of breath, confusion, and pressure in the chest or persistent chest pain were associated with severe COVID-19 disease [33,35].

The impact of the COVID-19 pandemic was not only on physical health; it also impacted the mental health of individuals. Vindegaard and Benros conducted a study to assess the potential impact of SARS-CoV-2 on mental health [36]. Their systematic review comprised 43 studies: 2 studies conducted on COVID-19 positive patients, 19 studies on the general public, 2 studies on individuals with pre-existing psychiatric disorders, and 20 studies on healthcare workers. Of the individuals who tested positive for COVID-19, higher levels of depressive and post-traumatic stress symptoms (PTSS) were reported. Individuals with existing mental health disorders reported a deterioration in their mental health symptoms [36].

Decreased psychological well-being, along with increased levels of anxiety, depression, and post-traumatic stress disorder, were reported in the general public [36,37].

Healthcare workers reported poor sleep quality, increased anxiety, depression/ depressive symptoms, and psychological distress [36].

1.4 Suicide and mental health in South Africa

Suicide and mental health are significant concerns in South Africa. The country has a high rate of suicidal behaviour, with 23 people committing suicide daily, and 460 attempts for every suicide [38]. Several factors, such as mental health illnesses, substance abuse, previous suicidal attempts, previous traumas, chronic physical illnesses, poor coping skills, and financial problems, amongst others, are associated with increased risk for suicidal behaviour. Individuals who engage in suicidal behaviour often have an undiagnosed mental health illness, which remains untreated if not recognised [38]. Mental health illnesses such as mood disorders, anxiety disorders, depression, and substance use disorders are common in South Africa, and many individuals do not receive sufficient mental health care [39]. Shortage of professionals, lack of finances, inadequate mental health policies, and their implementations have led to significant gaps in addressing mental health disorders [39].

A KwaZulu-Natal study by Khuzwayo *et al.* reported that sexual assaults, harassment, cyberbullying, substance use, and physical violence are associated with increased risk for suicidal behaviour amongst teenagers [40]. A female predominance of 50.4% was noted in the study.

Chapter 2: Study Design

2.1 Study Aim

The aim of this study was to describe the profile of patients who were admitted to the High-Care unit at Edenvale Regional Hospital with an organophosphate-like toxidrome and were treated with atropine between 01 January 2020 and 31 December 2023.

2.2 Study Objectives

1. To conduct a retrospective record review of patients admitted to the High-Care unit of a regional hospital with or without COVID-19 infection and presenting with an organophosphate-like toxidrome.
2. To describe the demographic profile of these patients.
3. To determine the average length of stay in the High-Care unit for this cohort.
4. To identify and describe outcomes for both COVID-19-positive and COVID-19-negative patients admitted with an organophosphate-like toxidrome.
5. To describe the co-morbidities of these patients.

2.3 Study Design and Population

This was a retrospective, descriptive study. The study included all adolescents (≥ 14 years) and adults admitted to the High-Care unit of Edenvale Regional Hospital who were treated with atropine for an organophosphate-like toxidrome between 01 January 2020 and 31 December 2023. An inclusion criterion was applied to select patients, and all those who met the criteria were included in the analysis.

2.4 Data Collection Procedure and Measurement Tool

A total of 219 names and file numbers were identified from the High-Care admission book at Edenvale Regional Hospital. Of these, only 188 files were retrieved from records. 31 files were missing, and 60 files were excluded from the analysis due to polypharmacy ingestion. As a result, 128 patients were included in the data analysis. A data collection sheet (Appendix B) was created and used to gather data. The data was then entered into REDCap. Once data capturing was complete, it was exported without identifiers for statistical analysis.

2.5 Inclusion Criteria

- All patients aged 14 years and above (the High-Care unit only admits patients from 14 years and above)
- All adolescents and adults admitted to the High-Care unit with a history of organophosphate-like substance ingestion and/or clinical signs of organophosphate toxicity, and treatment with atropine infusion.

2.6 Exclusion Criteria

- All patients admitted to other wards with an organophosphate-like toxidrome.
- All patients with a diagnosis of polypharmacy toxin ingestion.

2.7 Data Analysis

The data analysis was conducted using IBM SPSS Statistics software version 28. The raw data were extracted from REDCap in SPSS syntax format. The analysis was performed using inferential and descriptive statistical methods. Frequencies and percentages were calculated for categorical variables, including age groups, gender, race, reason for ingestion, mechanical ventilation, and patient outcomes. The association between variables such as age group and outcomes was assessed using chi-square tests, with a p-value of <0.05 considered statistically significant. Continuous variables will be assessed for normality. Depending on the distribution, data will be summarised using means and standard deviations or, where appropriate, medians and interquartile ranges.

2.8 Ethical Considerations

Authorisation to conduct the study was granted by the Chief Executive Officer of Edenvale Regional Hospital. Ethical approval was granted from the Human Research Ethics Committee (Medical) at the University of Witwatersrand (Reference: M240959).

National Health Research Database granted clearance for the study, reference number: GP_202407_090. Following amendments to the study protocol, a new clearance was issued, with reference number: GP_202504_013.

Each patient was assigned a participant number, and all identifiers were removed before exporting data for statistical analysis.

2.9 Funding

As anticipated, the costs of the project were minimal and were self-funded.

Chapter 3: Results

During the study period (01 January 2020 to 31 December 2023), a total of 2077 admissions to the high-care unit were recorded. Of these, 14 % (291) were due to suicide and self-harm. Further review of patient files revealed that 219 cases presented with organophosphate-like toxidrome. However, only 128 cases were included in the final cohort for analysis. Ninety-one patients were excluded, of which 31 patients' files could not be retrieved, and the remaining 60 files either lacked a diagnosis of organophosphate-like toxidrome or involved polypharmacy ingestion (organophosphate compounds in combination with other substances).

Demographic Characteristics

Age

The mean age was 31 ± 12 years, with patient age ranging from 14 to 73 years. The most affected age group was 20–29 years (33.6%), followed by 30–39 years (28.1%) and 14–19 years (16.4%). Only one patient was aged 70 years or older. *See Table 1.*

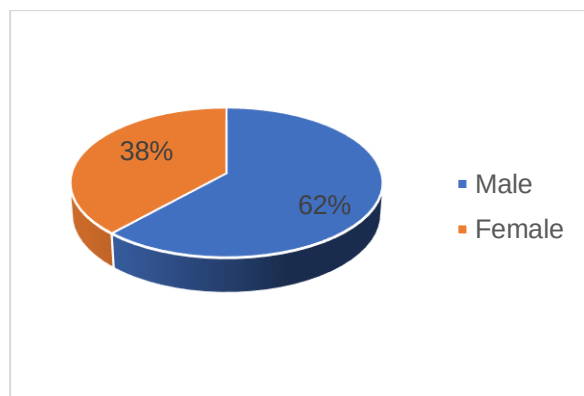
Table 1 shows demographics, POP score, reason for ingestion, relapses, ventilator use, and outcome

Variable	Number (Percentage)
Age	
• 14-19 years:	21 (16.4%)
• 20-29 years:	43 (33.6%)
• 30-39 years:	36 (28.1%)
• 40-49 years:	20 (15.6%)
• 50-59 years:	5 (3.9%)
• 60-69 years:	2 (1.6%)
• 70-79 years:	1 (0.8%)
• >80	0
Sex distribution	
Male	79 (62%)
Female	49 (38%)
Ethnicity	
Black	128 (100%)
Peradeniya Organophosphorus poisoning (POP) score	
Mild: 0-3	74 (58%)
Moderate: 4-7	54 (42%)
Severe: 8-11	0
Reason for ingestion	
Intentional	75 (58.6%)
Unintentional	38 (29.7%)
Unknown	15 (11.7%)
Relapses	
Patients with relapses	16 (12.5%)
Patients without relapses	112 (87.5%)
Ventilator use	

Intubated	74 (58%)
Non intubated	54 (42%)
Outcomes	
Death	13 (10.2%)
Discharged	110 (85.9%)
Refusal of hospital treatment	2 (1.6%)
Transfer out	3 (2.3%)

The sex distribution in the study reveals a male predominance of 62%, while females comprised 38%. *See Figure 1.*

Figure 1: Sex distribution



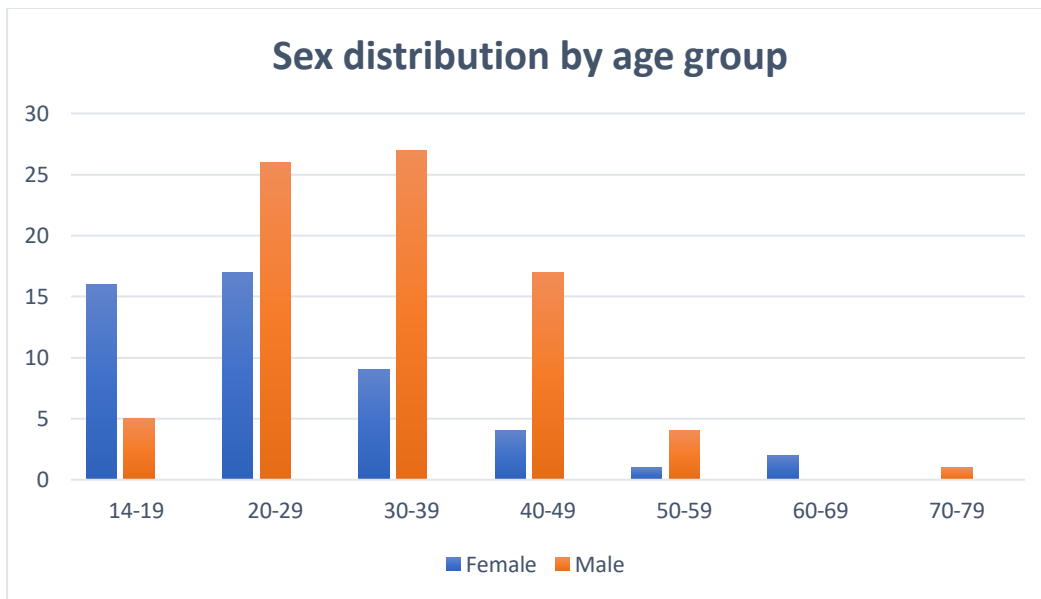
When age groups were considered, a female predominance of 76.2% was noted in the 14–19 age group and 100% (2 patients) for the 60–69 age group. All other age groups showed a male predominance, as illustrated in *Figure 2*. A statistically significant association exists between sex distribution and age group distribution (P-value = 0.002), as shown in *Table 2*.

Table 2: Sex distribution by age

Age group	Sex distribution		Total (n=128)	P-value
	Male (n=79)	Female (n=49)		
14 - 19	5	16	21 (16.4%)	
20 – 29	26	17	43 (33.6%)	
30 – 39	27	9	36 (28.1%)	

40 – 49	16	4	20 (15.6%)	0.002
50 - 59	4	1	5 (3.9%)	
60 - 69	0	2	2 (1.56%)	
70+	1	0	1 (0.78%)	
Total			100%	

Figure 2: Sex Distribution by Age



All subjects involved in the study were of black African ethnicity. See *Table 1* on page 15.

History of Ingestion and Reasons

Among the 128 cases analysed, 58% of the patients intentionally ingested the compound, 30% were unintentional exposures, and in 12% of the patients, the intent was unknown. The unknown category included patients who died, those who declined to disclose the reason for ingestion, and cases where the reason for ingestion was not documented in the patient records.

Among the 75 cases of intentional ingestion, the most common reasons were:

- Family issues/ conflict (25.3%)

- Relationship issues (24.0%)
- Unknown/ not disclosed (21.3%)
- Financial issues (10.7%)
- Academic problems (5.3%)

Other less frequent reasons included suicidal ideation, grief and loss, psychological trauma, conflict with non-family members, pregnancy-related stress, and legal issues, each contributing 1–2% of cases. See Table 3.

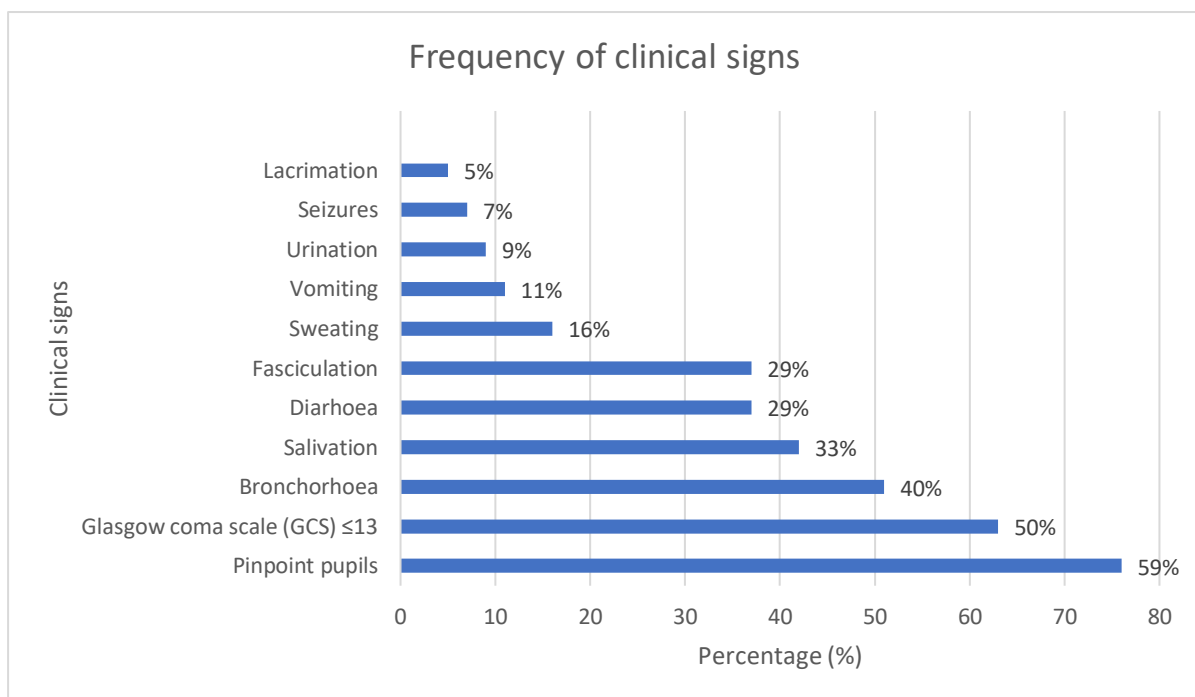
Table 3: intentional reasons

Variable	Option	Frequency	Percent
Intentional reason (n=75)	Family issues/ conflicts	19	25.3%
	Relationship and social issues	18	24.0%
	Unknown/ Not disclosed	16	21.3%
	Financial issues	8	10.7%
	Academic problems	4	5.3%
	Suicide ideation	2	2.7%
	Grief and loss	2	2.7%
	Conflict with non-family members	2	2.7%
	Psychological trauma	1	1.3%
	Legal issues	1	1.3%
	Pregnancy-related stress	1	1.3%

Organophosphate Clinical Signs

The most notable clinical signs included pinpoint pupils (59%), GCS ≤ 13 (50%), bronchorrhea (40%), and salivation (33%). Diarrhoea and fasciculations were each observed in 29% of cases. Sweating (16%), vomiting (11%), urination (9%), and seizures (7%) were less commonly observed. Lacrimation was the least common sign, observed in only 5% of cases. See Figure 3.

Figure 3: Frequency of clinical signs



Vital Signs

The results were obtained upon arrival in the emergency department and are summarized in Table 4.

Table 4: Vital Signs

Variable	variable documented	Minimum	Maximum	Mean	Standard Deviation
Temperature (°C)	122	35	37.8	36.3	0.6
Oxygen Saturation (%)	126	40	100	92	12

Pulse rate (beats/minute)	128	29	156	100	24
Respiratory rate (breaths/minute)	126	10	91	21	8
Systolic Blood Pressure (mmHg)	127	44	244	134	26
Diastolic Blood Pressure (mmHg)	127	25	149	83	20

COVID-19 Status

A total of 4 patients tested positive for COVID-19, 58 patients tested negative for the virus, 57 patients' COVID-19 status was not known, and 9 patients were seen before the COVID-19 pandemic. Among the COVID-19-positive group, only one patient died, and 3 were discharged. Of the 58 patients who tested negative, 47 were discharged, 7 died, 3 were transferred to the ICU of another hospital, and 1 refused hospital treatment. Of the 9 patients admitted before the COVID-19 pandemic, one patient died, another patient refused hospital treatment, and seven were discharged. Of the 57 patients with an unknown COVID-19 status, 53 were discharged and four demised, as shown in *Table 5* on pages 20 & 21. There was no statistically significant difference in outcomes between the groups based on COVID-19 status (p-value = 0.378).

Table 5: COVID-19 status and associated outcomes

COVID-19 test						
Outcome	Positive (n=4)	Negative (n=58)	Unknown (n=57)	Before COVID (n=9)	Total (n=128)	P Value
Discharge	3 (75.0%)	47 (81.0%)	53 (93.0%)	7 (77.8%)	110 (85.9%)	0.378
Death	1 (25.0%)	7 (12.1%)	4 (7.0%)	1 (11.1%)	13 (10.2%)	
Transfer to other hospital	0.0%	3 (5.2%)	0.0%	0.0%	3 (2.3%)	

Refusal of hospital treatment	0.0%	1 (1.7%)	0.0%	1 (11.1%)	2 (1.6%)	
Total	100.0%	100.0%	100.0%	100.0%	100.0%	

Laboratory Investigations

Most of the laboratory investigations were performed in the emergency department upon the patients' arrival. In cases where the initial specimens were rejected by the laboratory, recollection was carried out, and the new samples were subsequently submitted to analysis.

The median cholinesterase level was 368 U/L (IQR: 200–1157), with the lowest recorded level being 100 U/L. The white cell count had a median of $12.9 \times 10^9/L$ (IQR: 8.7-17.1). Haemoglobin levels had a median of 14.4 g/dL (IQR: 13–15.7), while the mean cell volume was 93.1 fL (IQR: 88.7–98.6). The platelet count had a median of $265 \times 10^9/L$ (IQR: 223–319).

Electrolyte and renal function assessments showed a median sodium level was 140 mmol/L (IQR: 138-142) and a median potassium level of 3.9 mmol/L (IQR: 3.5-4.4). Urea had a median of 3.8 mmol/L (IQR: 3.2–5.0), while creatinine was 72 $\mu\text{mol/L}$ (IQR: 58–85). The estimated glomerular filtration rate (eGFR) had a median of 60 mL/min/1.73m² (IQR: 60–60.3).

Protein and liver function parameters indicated that total protein levels had a median of 66 g/L (IQR: 62–73), and albumin levels a median of 40 g/L (IQR: 36–44). Total bilirubin was 10 $\mu\text{mol/L}$ (IQR: 6–15), while conjugated bilirubin was 3 $\mu\text{mol/L}$ (IQR: 2–4). Alanine transaminase (ALT) had a median of 22 U/L (IQR: 17–34), while aspartate transaminase (AST) was 36 U/L (IQR: 28–59). The median alkaline phosphatase level was 79 U/L (IQR: 62–95), and the median gamma-glutamyl transferase (GGT) level was 30 U/L (IQR: 18–55).

Blood gas analysis revealed a mean pH of 7.28 ± 0.16 , while the partial pressure of arterial oxygen averaged $60 \pm 48\text{mmHg}$, reflecting possible hypoxemia in some patients. The partial pressure of carbon dioxide had a mean of $48 \pm 28\text{ mmHg}$, while bicarbonate levels averaged $19.8 \pm 5.3\text{ mmol/L}$. Additionally, the base excess had a mean of $-4.6 \pm 6.3\text{ mmol/L}$.

Table 6: Laboratory Investigations

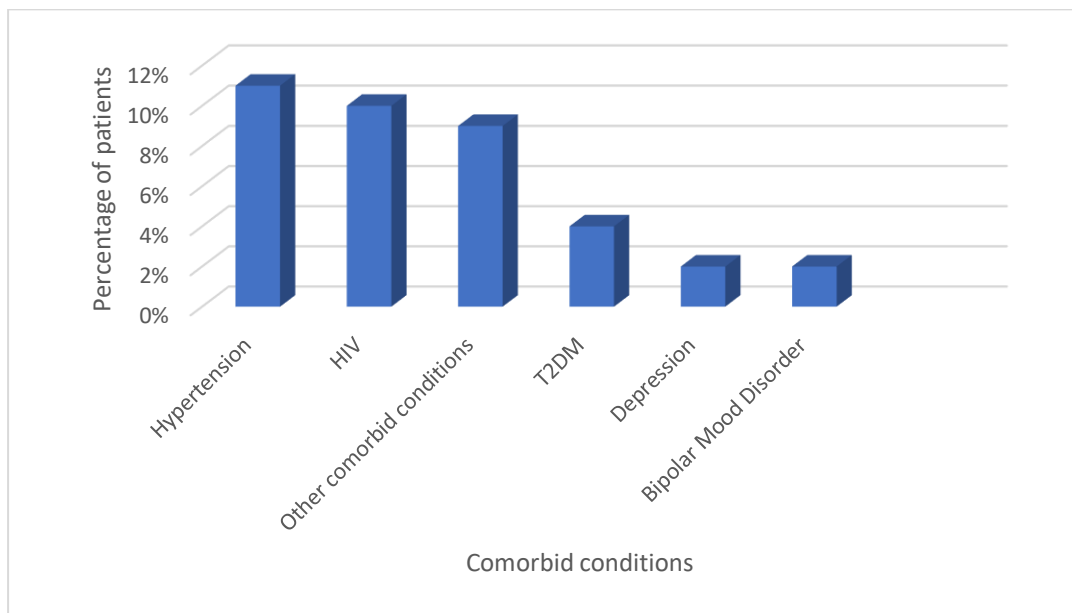
Variable	Normal reference range	Variable documented	Minimum	Maximum	Mean (SD)	Median (IQR)
Cholinesterase level U/L	4620 - 11500	92	100	8444		368 (200-1157)
White cell count (x 10/L)	3.92-10.40	127	1.3	30.2		12.9 (8.7-17.1)
Haemoglobin (in g/dL)	13.4-17.5	127	8.4	19.9		14.4 (13-15.7)
Mean cell volume (in fL)	83.1-101.6	123	3.5	135.0		93.1 (88.7-98.6)
Platelet count (x 10/ L)	171-388	127	46	765		265 (223-319)
Sodium (in millimoles per liter)	136-145	128	117	150		140 (138-142)
Potassium (in millimoles per liter)	3.5-5.1	127	2.0	6.1		3.9 (3.5- 4.4)
Urea (in millimoles per liter)	2.1-7.1	128	1.20	13.0		3.8 (3.2- 5)
Creatinine (in micromoles per liter)	64-104	128	22	156		72 (58- 85)
Estimated glomerular filtration rate (in mL/min/1.73m)	> 60	122	33	139		60 (60-60.3)
Total Protein (in g/L)	60-78	103	47	103		66 (62-73)
Albumin (in g/L)	35-52	103	26	57		40 (36-44)
Total Bilirubin (in umol/L)	5-21	103	1	47		10 (6-15)
Conjugated bilirubin (umol/L)	0-3	104	0	21		3 (2-4)

Alanine transaminase (in U/L)	10-40	103	6	248		22 (17- 34)
Aspartate transaminase (in U/L)	15-40	104	13	420		36 (28-59)
Alkaline phosphatase (in U/L)	53-128	103	10	239		79 (62- 95)
Gamma-glutamyl transferase (in U/L)	< 68	100	3	188		30 (18- 55)
PH	7.35-7.45	120	6.82	7.65	7.28 (0.16)	
Partial Pressure of Arterial Oxygen (in mmHg)	83-108	118	12	284	60 (48)	
Partial pressure of carbon dioxide (in mmHg)	35- 45	119	15	107	48 (28)	
Bicarbonate (in millimoles per liter)	22.0-26.0	118	-11	32	19.8 (5.3)	
Base excess (in millimoles per liter)	-2.0 – 3.0	118	-25.0	24.9	-4.6 (6.3)	

Comorbidities

Among the reported comorbidities, hypertension was the most prevalent, affecting 11% of individuals, followed closely by Human Immunodeficiency Virus (HIV) at 10%. Mental health conditions such as depression (2%) and bipolar mood disorder (2%) were also reported. Notably, anxiety disorder was not reported at all. Nine percent (9%) of comorbid conditions were due to 3 pregnant patients, 3 epileptic patients, 1 patient with syphilis, and 4 patients who used cannabis. These findings highlight the presence of both physical and mental health comorbidities, with a higher prevalence of chronic illnesses, including hypertension and HIV, compared to psychiatric conditions.

Figure 4: Comorbidities



Ventilation, Atropine, & Adjunct Medications

Mechanical ventilation was required in 58% of cases, with an average duration of 7 ± 5 days. Atropine infusion was administered in all cases, lasting an average of 5 ± 4 days.

Adjunct medications were also used, with midazolam being the most common (33% of cases), followed by glycopyrrolate (14%), haloperidol (8%), risperidone, and inotropes (2% each).

Table 7: Ventilator, Atropine, and adjunct medications

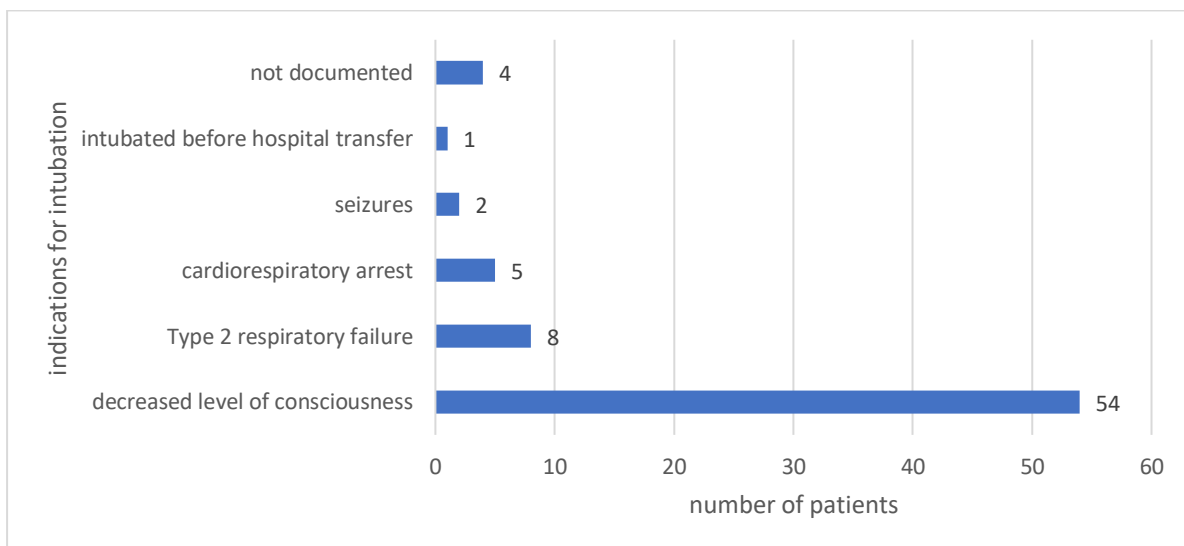
Variable	Option	Frequency	Percent / Mean $\pm$ SD
Mechanical ventilator	Yes	74	58%
	No	54	42%
Ventilator use duration			7 ± 5
Atropine infusion	Yes	128	100%
Atropine infusion use duration			5 ± 4
Adjunct medication use	Midazolam	42	33%

	Glycopyrrolate	18	14%
	Haloperidol	10	8%
	Risperidone	2	2%
	Inotrope use	2	2%

Indications for Intubation

Among the 74 indications for intubation illustrated in *Figure 5*, the most common indication was a decreased level of consciousness, accounting for 54 cases (73%). Other reasons included Type 2 respiratory failure (8 cases), cardiorespiratory arrest (5 cases), and seizures (2 cases). One patient was already intubated upon arrival at the emergency department. In 4 cases, no reason for intubation was documented in the patient's records.

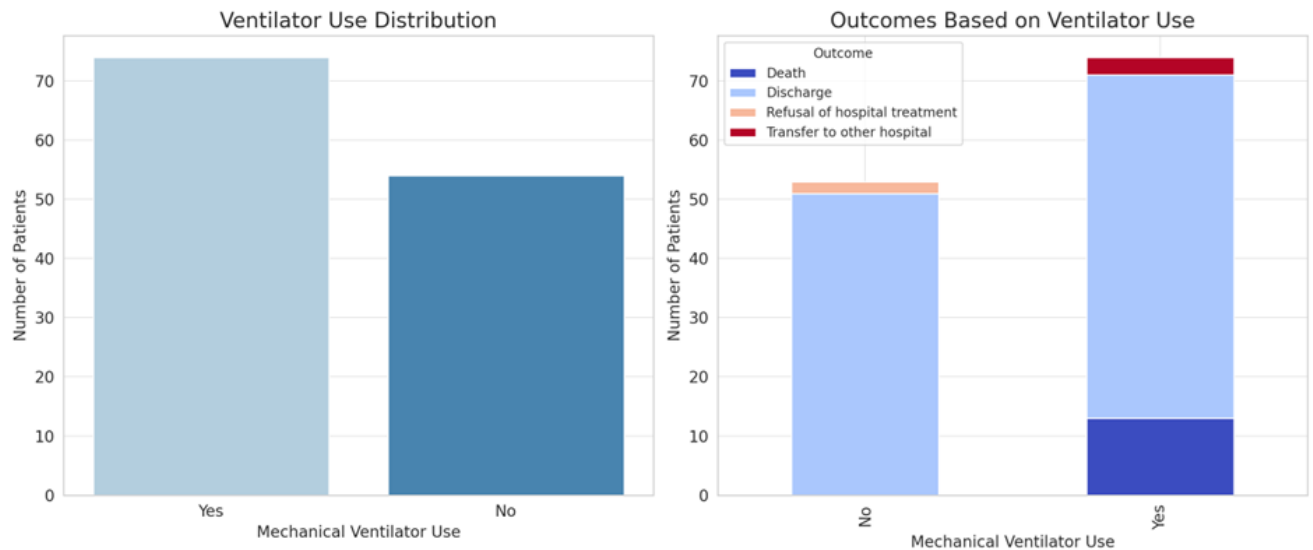
Figure 5: Indications for intubation



Ventilator use and associated outcomes

Of the 128 participants, 58% (74 patients) required intubation, of whom 17.6% (13 of 74 patients) did not survive, 78.4% (58 patients) were discharged, and 4% (3 patients) were transferred to another hospital. In contrast, non-ventilated patients had a more favourable outcome, with 52 of 54 patients discharged to the ward, while 2 patients refused hospital treatment.

Figure 6: Ventilator use and its associated outcome



Relapse Cases

Only 16 patients (12.5%) of 128 patients experienced relapse, with an average length of stay of 5 days (range: 1–13 days). Among these, 15 patients (including one patient who refused hospital treatment) were discharged, and one patient was transferred to the Intensive Care Unit of another hospital for further management.

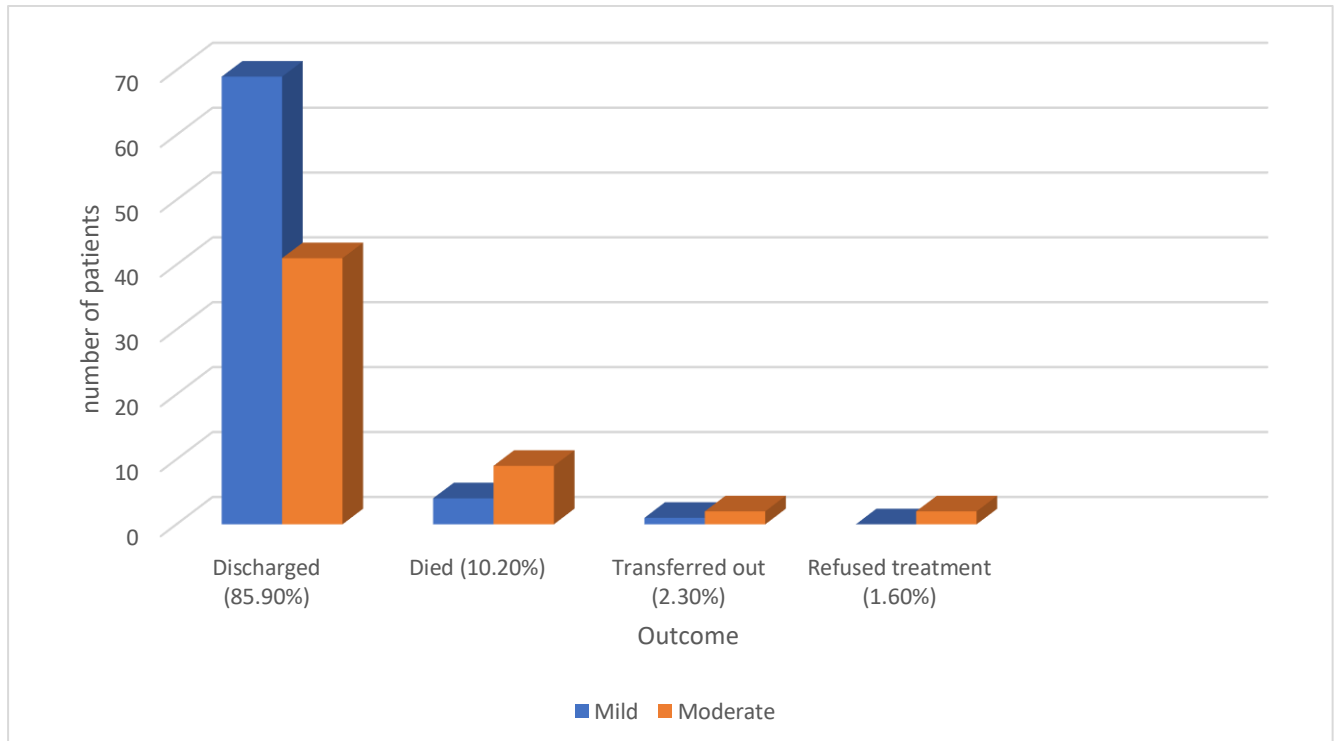
Peradeniya Organophosphate Poisoning (POP) Score

A total of 74 cases were classified as mild, and 54 cases as moderate based on the POP score. There were no cases classified as severe based on the Peradeniya score. Among the 74 mild cases, 31 required intubation and ventilation. Meanwhile, 43 of 54 moderate cases underwent intubation and ventilation, as shown in *Table 8*. A P-value <0.001 indicated that the association between POP score severity and ventilator use is statistically significant.

Table 8: Association between POP score and ventilator use

	Peradeniya Organophosphorus Poisoning Score			P-value
Mechanical ventilator	Mild 0-3 (n=74)	Moderate 4-7 (n=54)	Total (n=128)	
Yes	31 (41.9%)	43 (79.6%)	74 (57.8%)	0.000
No	43 (58.1%)	11 (20.4%)	54 (42.2%)	
Total	100.0%	100.0%	100.0%	

Figure 7: Outcome based on POP scores

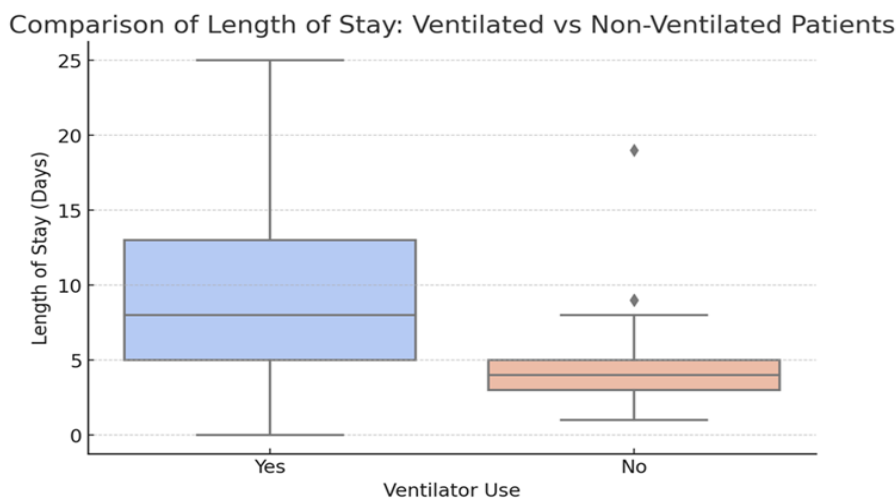


Higher POP scores were associated with increased mortality, with 9 deaths occurring in the moderate group compared to 4 deaths in the mild group.

Length of In-Hospital Stay

The duration of in-hospital stay in the High-Care unit ranged from 0 to 25 days, with a median of 5 days (IQR: 4 -11). The median length of stay was significantly longer in ventilated patients (7 days; IQR: 5–15; range: 25 days) compared to non-ventilated patients (4 days; IQR: 2–6; range: 1–20 days). A P-value <0.001 showed that the difference in length of stay between ventilated and non-ventilated patients was statistically significant. See figure 8.

Figure 8: length of stay in ventilated vs non-ventilated patients



Outcome

Most patients were successfully discharged, totalling 110 patients (85.9%). However, 13 patients (10.2%) did not survive. 3 patients (2.3%) were transferred to the Intensive Care unit of another hospital, and therefore their outcome in terms of discharge or death is not known. 2 patients (1.6%) refused hospital treatment and were subsequently discharged from the High-Care unit. See figure 8 on page 27.

Chapter 4: Discussion

128 files were analysed in this retrospective review of patients with an organophosphate-like toxidrome at Edenvale Regional Hospital for the period 01 January 2020 to 31 December 2023. Of the 90 patients that were excluded, 31 files could not be found, and the other 60 files either had polypharmacy ingestion or did not have the diagnosis of organophosphate-like toxidrome.

Age

The mean age was 31 years (± 12), indicating that most patients were young adults. The relatively large standard deviation suggests variability in age. Our findings are comparable to those of a Pakistani study, which reported a mean age of 27.3 years ± 11.4 [16]. A South African reported a mean age of 30 years (± 13), while a study from Turkey reported a mean age of 25.8 years (± 11.8) [9,14]. In our cohort, the age group 14-39 accounted for 78.1% of the study participants, with the 20-29 age group having the highest number of patients (33.6%).

Ethnicity

Our study found that black Africans constituted the overwhelming majority, making up 100% of the study population. These findings are consistent with those of a South African study conducted by Bruins *et al.*, which reported that 99.2% of the participants were of Black African ethnicity [9]. Our findings align with the demographics of the local population.

Sex distribution

The sex distribution of patients in this study indicates a higher proportion of males (62%) compared to females (38%). Similar trends have been observed in 4 other South African studies that reported a male predominance [8-11]. In another South African study, Dunga *et*

al. found an overall female prevalence of 61.6% compared to 38.4% in males [41]. However, it was noted that the cohort included some participants who had ingested an organophosphate compound and a non-organophosphate compound. A further analysis of patients who only ingested an organophosphate compound showed a male predominance of 51.1% (136) compared to 48.9% (130) females. Globally, research findings on sex distribution vary significantly. Some studies report a higher prevalence in males, reinforcing the male predominance observed in this study [15,32,42], whereas other studies have shown a female predominance [12,14,16,43,44]. This demonstrates that sex distribution is not uniform. In our study, further analysis of sex distribution by age groups showed a female predominance in the 14-19 age group. This may be due to the psychological effects seen in females during adolescence, however, this needs to be investigated further.

Clinical presentation and vital signs

Our findings of miosis, $GCS \leq 13$, bronchorrhoea, and salivation as the most common clinical signs are in keeping with those reported in another South African study conducted at a regional hospital by Khonje *et al* [8]. A GCS of ≤ 13 was associated with an increased risk of mortality [45].

Blood pressure measurements showed a mean systolic of 134 mmHg (SD $\pm$ 26) and a mean diastolic of 83 mmHg (SD $\pm$ 20). A mean respiratory rate of 21 bpm (SD $\pm$ 8), a mean temperature of 36.3 °C (SD $\pm$ 0.6), and a mean oxygen saturation of 92% (SD $\pm$ 12). The vital signs findings are comparable to those found in Bruins's cohort of 129 patients [9].

Peradeniya Organophosphorus Poisoning Scale

In our cohort, 57.8% of participants were classified as mild cases, and 42.2% as moderate, based on the POP scale. No severe cases were observed. These findings are consistent with those reported in a cohort conducted in India [27]. In our study, 41.9% of patients classified as having mild poisoning were intubated and ventilated, while 79.6% of those with moderate poisoning were ventilated. In comparison, Mundhe *et al.* reported that among 323 patients in their study, intubation and ventilation were required in 6 of 112 mild cases, 61 of 121 moderate cases, and 57 of 90 severe cases [15].

Blood Results

Cholinesterase levels were done in 71.9% (92 of 128 cases), with a median of 368 U/L (IQR: 200-1157), and the lowest value was 100 U/L. In a study by Khonje et al., the median cholinesterase level was 208.5 U/L (IQR: 129.8-545.5) [8]. A reduction of either red-cell cholinesterase or pseudocholinesterase by 10-20 % signifies moderate poisoning, while a decline of 50% is observed in severe cases [46]. A Turkish study reported that, upon admission to the emergency department, 69.6% of male patients and 74.1% of female patients had serum cholinesterase levels reduced by 50% or more [12].

The overall renal function and electrolytes in our study were normal. Acute kidney injury has been described. Mundhe et al. reported that 10.53% of patients in their study developed renal failure [15]. The underlying mechanisms of renal injury are not well understood, and the limited literature presents various hypotheses. The proposed mechanisms are oxidative stress due to high intratubular organophosphate concentrations, rhabdomyolysis, and hypovolaemia resulting from dehydration [47].

The overall mean of indicators of liver damage or hepatic function in our study was within normal limits. Literature revealed a notable correlation between specific organophosphate exposure and indicators of liver injury or hepatic function [48].

Albumin was recorded in 80.5% (100 of 128) of the participants, with a median of 40 g/L (IQR: 36-44) and a minimum value of 26.00 g/L. A reduction in serum albumin levels, either alone or accompanied by an elevation in C-reactive protein (CRP) levels, is linked to a worse prognosis in patients with organophosphate poisoning [23].

The mean arterial PH was 7.28 (range 6.82–7.65), with a mean PaO₂ of 60 mmol/L, with the lowest 12 mmol/L, indicating overall hypoxaemia on presentation. On presentation, patients were hypercapnic with a mean PaCO₂ of 46 mmHg (range 15–107 mmHg). Our findings align with those reported in Bruins' study, which noted patients presenting with acidaemia (mean PH 7.16), hypercapnia (mean PaCO₂ 52 mmHg), and hypoxaemia (mean PaO₂ 79 mmHg) [9].

COVID-19 Status

Out of the 128 patients, 62 were tested for COVID-19 infection. Among those who tested, 94% (58 of 62 patients) had negative results, whereas only 6% (4 of 62 patients) tested positive for COVID-19 infection. Nine patients presented before the COVID-19 pandemic, whereas the COVID-19 status of 57 patients was unknown.

The breakdown of the unknown tests according to the years is as follows:

2023 - 38 patients

2022 - 13 patients

2021 – 1 patient

2020 – 5 patients.

There is no documentation in the patient's records indicating that the test was conducted. The most likely explanation for the absence of tests in 2022 and 2023 is that South Africa's state of disaster was lifted in April 2022, after which routine COVID-19 testing was discontinued [49].

Published data to date support the notion that the COVID-19 pandemic had both physical and psychological impacts on patients and society. Pathirathna *et al.* reported an increase in suicide as one of the effects [50]. They also reported risk factors that were thought to have contributed to this increase in suicide, namely anxiety, financial loss, preexisting mental health conditions, depression, domestic conflicts, and violence. Anxiety was higher in females and young adults, while individuals with higher education levels reported poorer mental well-being [51].

Loss of relatives, social isolation, and psychiatric and medical complications were factors identified in the 1918-1919 Influenza pandemic to be associated with increased suicide [52]. The loss of relatives and social isolation can lead to increased stress, lack of support, and loneliness. This makes it difficult to cope with stress and other challenges, subsequently leading to suicidal thoughts and behaviour. A scoping review by Shoib *et al.* investigating the

association between suicidal behaviour and loneliness found a positive correlation between loneliness and suicidal behaviour, regardless of the presence or absence of mental disorders [53]. The lockdown restrictions in place significantly limited movement within and between countries, resulting in the disruption of support structures and leading to isolation and loneliness. People experiencing loneliness and social isolation are five times more likely to die from suicide, and this risk is especially high among young adults [54].

Comorbidities

25% of participants had comorbid conditions, either a physical or a mental health condition. The most prevalent comorbid conditions were hypertension (11%) and HIV (10%). Onyeka reports that the impact that the physical ailment has on a person's daily life is a stronger predictor of suicide risk than the number of medical conditions that a person has, especially among younger individuals [55]. In Ahmedani's cohort of patients who died by suicide between 2000 and 2013, seventeen medical conditions, including HIV/AIDS, traumatic brain injury, sleep disorders, and others, were linked to an increase in suicide risk [56].

In our cohort, diabetes mellitus contributed 4% of comorbidities. Pompili's study reported that patients with diabetic mellitus had an increased suicidality, lacked motivation, and had less future expectation [57]. There is a lack of data in South Africa on the influence of diabetes mellitus on suicidality.

Depression (2%) and bipolar mood disorder (2%) were the only 2 mental health conditions noted in our study population. Orsolini *et al.* reported that major depressive disorder was associated with increased suicidal behaviour [58]. In Shoib's scoping review, it was reported that social isolation is a common feature observed in individuals with depression, and this was a risk factor for suicide [53]. It was found that, although there is a positive correlation between loneliness and suicide, depression demonstrated a correlation that was twice as strong with suicide. In Dome's review of suicide risk in bipolar disorder, it was documented that the suicide rate for patients with bipolar disorder was 10-30 times higher than the general population [59].

Pregnancy, epilepsy, syphilis, and cannabis use accounted for a combined 9% of the comorbid conditions found. A systematic review showed a strong correlation between cannabis usage and suicidal thoughts and attempts in the general population, people with

bipolar disorder or major depression, and military veterans [60]. The study also noted that heavy intake, prolonged use, and younger age of initiation of cannabis were associated with worse suicidal outcomes. Pregnancy-related risk factors for suicide include being a teenager and cultural stigmatization for being unmarried and pregnant [61]. Notably, two of the three pregnant patients in our study were teenagers.

Management & outcome

Treatment

All the participants in our study received an infusion of atropine for maintenance. 14% (18 of 128) of these also received glycopyrrolate. Atropine is the main medication used for the treatment of acute organophosphate toxicity. It reverses symptoms by countering the effects of excessive stimulation of acetylcholine at the muscarinic receptors [28]. Oximes were not used in any of our cases. The literature review shows that oximes are not effective against some organophosphate compounds; however, the studies in which they were used have been criticised for their small sample sizes [62,63].

Other medications used in our cohort were midazolam, haloperidol, risperidone, and inotropes (dobutamine). Inotropic support was used in two hypotensive patients. Midazolam was used in 41 patients, and the reasons for use were agitation, restlessness, and to keep ventilated patients sedated. Either risperidone or haloperidol was used in patients with hallucinations or psychosis secondary to atropine.

Outcome

87.5% of the patients had a favourable outcome and were discharged. This percentage includes those who refused hospital treatment. 10.2% of participants did not survive, and death occurred only in ventilated patients. The outcome in 2.3% of the participants is unknown because they were transferred out to another hospital for further treatment.

Of the 128 participants, 58% (74 patients) required intubation, of whom 17.6% (13 of 74 patients) did not survive. In contrast, non-ventilated patients had a more favourable outcome, with 52 of 54 patients discharged to the ward, while 2 patients refused hospital treatment.

Mortality

Three patients who were transferred out to other hospitals were excluded when determining the mortality rate. Our cohort revealed a mortality rate of 10.2%. South African studies show a variable mortality rate for organophosphate poisoning [8,9,41]. The lowest mortality rate was seen in a cohort from the Tshwane district at 3.4% [10], and the highest mortality rate was observed in the Western Cape at 16% [11]. A review of the literature showed a variable mortality rate [12,14,15,64], with one study reporting a very low mortality rate of 0.05% (147 of 6539 patients) [31].

Our mortality rate of 10.2% was observed exclusively in ventilated patients, with no deaths reported in the non-ventilated group. A Johannesburg study found a mortality rate of 18.2% in ventilated patients compared to 7.1% in non-ventilated patients [8]. However, these findings, as reported by Khonje *et al.*, were not statistically significant ($p = 0.07$). In Bhattad's cohort, only patients who were intubated had an unfavourable outcome [65]. No mortality was observed in the non-ventilated group. Several factors, such as leucocytosis, increased creatinine, low cholinesterase level, increased amylase, low glasgow coma scale, prolonged hospital stay, tracheostomy, ventilatory support, higher APACHE II score, and an increased ingested dose of organophosphate compound, were associated with increased mortality [14,32,64,66]. The findings are comparable to those in our study, in which blood investigations revealed leucocytosis (mean WCC: $13.2 \times 10^9/L$), reduced cholinesterase levels (mean: 1037 U/L), and a low glasgow coma scale score (as the most common clinical sign on presentation).

Length of stay

In our cohort, the median length of stay was 5 days, with a range of 0 to 25 days, indicating considerable variability in the duration of hospitalisation among patients. These findings are comparable with results from other studies [8,9,14,31]. A study comparing the burden of organophosphate poisoning over two separate periods (2012 versus 2017) was conducted in an intensive care unit in Soweto, South Africa [7]. The results revealed that in 2017, the total median length of stay was significantly longer, at 8 days (interquartile range: 4–17),

compared to just 2 days (interquartile range: 2–3) in 2012. The reason given for these results was that the 2012 cohort had not ingested a true organophosphate but rather a carbamate, which is short-lived and has a milder presentation.

When the participants were divided based on ventilator status, our study revealed that the ventilated group had a longer mean and median length of stay compared to the non-ventilated group. The findings are consistent with those of two South African studies conducted in the Gauteng province, which reported that ventilated patients had a prolonged length of hospital stay as opposed to non-ventilated patients [8,9].

Chapter 5: Conclusions

The study was designed to assess the effect of the COVID-19 pandemic on organophosphate poisoning; however, due to the small number of patients' files analysed who were positive for COVID-19, no definitive conclusions could be made. Nonetheless, it provides insights into the epidemiology of organophosphate poisoning in the region during the COVID-19 pandemic. The COVID-19 pandemic had a profound impact on the mental health of individuals across the globe, and it was influenced by factors such as social isolation, economic instability, pre-existing mental health conditions, and heightened fear. Lockdown and physical distancing intensified loneliness and despair, leading to new or worsening psychiatric conditions. Furthermore, economic fallout, from job losses and reduced economic opportunities, likely compounded mental health challenges. The COVID-19 pandemic was the first pandemic to bring the world to a complete halt. It was a time of uncertainty with overall increased stress, depression, and anxiety. However, the actual impact of the COVID-19 pandemic on the incidence of patients admitted with an organophosphate-like toxidrome needs to be investigated further.

Chapter 6: Limitations

- As the study was limited to one centre, its results may not be generalizable
- Another limitation was that, because the study was conducted retrospectively, several files could not be found, and also, the data in some files was not complete. Patient records are not electronic and have to be stored manually, and therefore may be lost or misplaced.
- The analysed data does not include patients who were treated with Atropine for organophosphate-like toxidrome in the emergency department and subsequently admitted to a ward other than the High-Care unit or transferred out. Due to a limited number of beds in the High-Care unit, once full capacity is reached, patients are either transferred out to other hospitals or kept in the resuscitation area in the emergency department until they can be admitted to the ward.

Chapter 7: References

- [1] World Health Organization. Suicide worldwide in 2019. Global Health Estimates. 16 June 2021. <https://www.who.int/publications/i/item/978924006643> (accessed 18 January 2025).
- [2] World Health Organization. Suicide in the WHO African Region. https://files.aho.afro.who.int/afahobckpcontainer/production/files/iAHO_Suicide_Regional_Fact_sheet_August2022.pdf (accessed 18 January 2025).
- [3] Yan Y, Hou J, Li Q, Yu NX. Suicide before and during the COVID-19 Pandemic: A Systematic Review with Meta-Analysis. *International Journal of Environmental Research and Public Health*. 2023;20(4):3346.
- [4] Laher AE, Motara F, Gihwala R, Moolla M. The profile of patients presenting with intentional self-poisoning to the Charlotte Maxeke Johannesburg Academic Hospital emergency department, South Africa. *South African Medical Journal*. 2022;112(5):347–51.
- [5] Mew EJ, Padmanathan P, Konradsen F, Eddleston M, Chang S Sen, Phillips MR, et al. The global burden of fatal self-poisoning with pesticides 2006-15: Systematic review. Vol. 219, *Journal of Affective Disorders*. 2017;219:93–104.
- [6] Favara DM. The burden of deliberate self-harm on the critical care unit of a peri-urban referral hospital in the Eastern Cape: A 5-year review of 419 patients. *South African Medical Journal*. 2012;103(1):40–3.
- [7] Omar S, Bahemia IA, Toerien L, San Pedro KM, Khan AB. A retrospective comparison of the burden of organophosphate poisoning to an Intensive Care Unit in Soweto over two separate periods. *African Journal of Emergency Medicine*. 2021;11(1):118–122.

- [8] Khonje V, Hart J, Venter J, Deonarain S, Grossberg S. Acute organophosphorus toxicity in a regional hospital in Johannesburg, South Africa: A retrospective chart review. *African Journal of Emergency Medicine*. 2023;13(2):104–108.
- [9] Bruins J, Menezes CN, Wong ML. Organophosphate poisoning at Chris Hani Baragwanath Academic Hospital 2012 - 2015. *African Journal of Thoracic and Critical Care Medicine*. 2019;25(3):104-110.
- [10] Razwiedani LL, Rautenbach PGD. Epidemiology of Organophosphate Poisoning in the Tshwane District of South Africa. *Environmental Health Insights*. 2017;11:1-4.
- [11] Bardin PG, Van Eeden SF, Joubert JR. Intensive care management of acute organophosphate poisoning. A 7-year experience in the western Cape of acute. *South African Medical Journal*. 1987;72(9):593-597.
- [12] Yurumez Y, Durukan P, Yavuz Y, Ikizceli I, Avsarogullari L, Ozkan S, et al. Acute organophosphate poisoning in university hospital emergency room patients. *Internal Medicine*. 2007;46(13):965–969.
- [13] Muley A, Shah C, Lakhani J, Bapna M, Mehta J. To identify morbidity and mortality predictors in acute organophosphate poisoning. *Indian Journal of Critical Care Medicine*. 2014;18(5):297–300.
- [14] Sert AA, Tarlkçl Klllç E, Akdemir MS, Kavak GÖ. Retrospective Analysis of Organophosphate Poisonings in an Intensive Care Unit in Turkey: A Single-Center Study. *Dubai Medical Journal*. 2018;1(1-4):13-18.
- [15] Mundhe SA, Birajdar S V., Chavan SS. The clinico-demographic study of morbidity and mortality in patients with organophosphate compound poisoning at tertiary care hospital in rural India. *International Journal of Advances in Medicine*. 2017;4(3):809.
- [16] Gündüz E, Dursun R, Icer M, Zengin Y, Gullu M, Durgun H, et al. Factors affecting mortality in patients with organophosphate poisoning. *Journal of Pakistan Medical Association*. 2015;65(9):967-972.
- [17] Patil G, Murthy N, Nikhil M. Contributing Factors for Morbidity and Mortality in Patients with Organophosphate poisoning on Mechanical Ventilation: A Retrospective Study in a Teaching Hospital. *Journal of Clinical and Diagnostic Research*. 2016;10(12):18–20.

- [18] Karunarathna I, Bandara S, Jayawardana A. Comprehensive Management of Organophosphate Poisoning: Pathophysiology, Diagnosis, and Treatment. 2024.
- [19] Okolonkwo BN, Amadi CF, Chimekagbe OE. Organophosphates Toxicity: Pathophysiology, Diagnosis, and Treatment. Asian Journal of Biochemistry, Genetics and Molecular Biology. 2022;12(2):27–37.
- [20] Peter JV, Sudarsan TI, Moran JL. Clinical features of organophosphate poisoning: A review of different classification systems and approaches. Indian Journal of Critical Care Medicine. 2014;18(11):735–745.
- [21] Bajracharya SR, Prasad PN, Ghimire R. Management of Organophosphorus Poisoning. Journal of Nepal Health Research Council. 2016;14(34):131–138.
- [22] Eddleston M. Poisoning by pesticides. Medicine. 2020;48(3):214-217.
- [23] Zoofaghari S, Maghami-Mehr A, Abdolrazaghnejad A. Organophosphate Poisoning: Review of Prognosis and Management. Advanced Biomedical Research. 2024;13:82
- [24] Geetha V, Lakshmi Prasanna J, Umar S, Ajay C. Management of Organophosphorus Poisoning. International Journal of Research and Analytical Reviews. 2022;9(4):931-948.
- [25] Buckley N. Organophosphate poisoning: straight to the point. British Medical Journal Best Practice. 2024.
- [26] Regmi G, Arjyal B, Khanal K, Pyakurel K, Shahi R. Correlation of Peradeniya Organophosphorus Poisoning Scale (POP) and outcome of Organophosphorus poisoning. Birat Journal of Health Sciences. 2020;5(1):986–989.
- [27] Malaviya NB, Parikh R, Pancholi K, Belim OB. Assessment of the Peradeniya Organophosphorus Poisoning Scale as a Severity and Prognostic Marker in Patients With Acute Organophosphorus Poisoning Presenting to an Emergency Medicine Department. Cureus. 2023;15(6):e40277
- [28] Chowdhary S, Bhattacharyya R, Banerjee D. Acute organophosphorus poisoning. Clinica Chimica Acta. 2014;431:66–76.
- [29] Khalaf MA, Hashem MA, Abd-Elaziz Abd-Elzaher M, Abd El-Azeem Taghian AS. Comparison of Efficacy and safety of Atropine and Glycopyrrolate in the Treatment

- of Acute Organophosphorus Comparison of Efficacy and safety of Atropine and Glycopyrrolate in the Treatment of Acute Organophosphorus Poisoning in Minia Poison Control Center. *Minia Journal of Medical Research*. 2020;31(2): 241-245.
- [30] Arendse R, Irusen E. An atropine and glycopyrrolate combination reduces mortality in organophosphate poisoning. *Human and Experimental Toxicology*. 2009;28(11):715–720.
- [31] Ather N, Ara J, Khan E, Sattar R, Durrani R. Acute organophosphate insecticide poisoning. *Journal of Surgery Pakistan*. 2008;13(2):71-74.
- [32] Kang EJ, Seok SJ, Lee KH, Gil HW, Yang JO, Lee EY, et al. Factors for determining survival in acute organophosphate poisoning. *Korean Journal of Internal Medicine*. 2009;24(4):362–367.
- [33] Singhal T. A Review of Coronavirus Disease-2019 (COVID-19). *Indian Journal of Pediatrics*. 2020;87(4):281-286.
- [34] Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. *Acta Biomedica*. 2020;91(1):157-160.
- [35] Ishrath A, Ahmed MM, Pal N, Muppidi S. Covid-19 (Pandemic): A Review Article. *Journal of Research in Medical and Dental Science*. 2021; 9(10):281-288.
- [36] Vindegaard N, Benros ME. COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity*. 2020;89:531-542.
- [37] Xiong J, Lipsitz O, Nasri F, Lui LMW, Gill H, Phan L, et al. Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *Journal of Affective Disorders*. 2020;277:55-64
- [38] Alabi AA. Management of self-harm, suicidal ideation and suicide attempts. *South African Family Practice*. 2022;64(1):e1-e4.
- [39] Edeh NC, Eseadi C. Mental health implications of suicide rates in South Africa. *World Journal of Clinical Cases*. 2023;11(34):8099–8105.

- [40] Khuzwayo N, Taylor M, Connolly C. High risk of suicide among high-school learners in uMgungundlovu District, KwaZulu-Natal Province, South Africa. *South African Medical Journal*. 2018;108(6):517–523.
- [41] Dunga BN. Intentional organophosphate poisoning: A Study in three hospitals in Johannesburg. *Wiredspace*. 2019.
- [42] Alva J, Devi ES, Chandrababu R, Abraham J, Balakrishnan JM. Epidemiologic characteristics, the length of hospital stay, and mortality of patients with organophosphate poisoning: A systematic review. *Clinical Epidemiology and Global Health*. 2025;32:101932.
- [43] Amir A, Raza A, Qureshi T, Mahesar GB, Jaffer S, Haleem F, et al. Organophosphate Poisoning: Demographics, Severity Scores and Outcomes From National Poisoning Control Centre, Karachi. *Cureus*. 2020;12(5):e8371.
- [44] Faiz MS, Mughal S, Memon AQ. Acute and Late Complications of Organophosphate Poisoning. *Journal of the College of Physicians and Surgeons Pakistan*. 2011;21(5):288-290.
- [45] Davies JOJ, Eddleston M, Buckley NA. Predicting outcome in acute organophosphorus poisoning with a poison severity score or the Glasgow coma scale. *QJM: An International Journal of Medicine*. 2008;101(5):371–379.
- [46] Prasad DRMM, Jirli P, Mahadevaiah M, Mamatha S. Relevance of plasma Cholinesterase to Clinical Findings in Acute organophosphorus poisoning. *Asia Pacific Journal of Medical Toxicology*. 2013;2(1):23-27.
- [47] Georgiadis G, Mavridis C, Belantis C, Zisis IE, Skamagkas I, Fragkiadoulaki I, et al. Nephrotoxicity issues of organophosphates. *Toxicology*. 2018;406–407:129–136.
- [48] Li W, Xiao H, Wu H, Xu X, Zhang Y. Organophosphate pesticide exposure and biomarkers of liver injury/liver function. *Liver International*. 2022;42(12):2713–2723.
- [49] South African Government News Agency. SA exits National State of Disaster. <https://www.sanews.gov.za/south-africa/sa-exits-national-state-disaster> (accessed 21 May 2025).

- [50] Pathirathna ML, Nandasena HMRKG, Atapattu AMMP, Weerasekara I. Impact of the COVID-19 pandemic on suicidal attempts and death rates: a systematic review. *BMC Psychiatry*. 2022;22(1).
- [51] Kupcova I, Danisovic L, Klein M, Harsanyi S. Effects of the COVID-19 pandemic on mental health, anxiety, and depression. *BMC Psychology*. 2023;11(1):108.
- [52] Mukhtar F, Candilis P. Pandemics and Suicide Risk: Lessons From COVID and Its Predecessors. *Journal of Nervous and Mental Disease*. 2022;210(10):799–807.
- [53] Shoib S, Amanda TW, Saeed F, Ransing R, Bhandari SS, Armiya'u AY, et al. Association Between Loneliness and Suicidal Behaviour: A Scoping Review. *Turk Psikiyatri Dergisi*. 2023;34(2):125-132.
- [54] Alothman D, Lewis S, Card T, Tyrrell E, Fogarty AW. The association between living alone, loneliness and suicide mortality and effect modification by age: A case:control study. *Journal of Affective Disorders*. 2024;352:278–280.
- [55] Onyeka IN, Maguire A, Ross E, O'Reilly D. Does physical ill-health increase the risk of suicide? A census-based follow-up study of over 1 million people. *Epidemiology and Psychiatric Sciences*. 2020;29:e140.
- [56] Ahmedani BK, Peterson EL, Hu Y, Rossom RC, Lynch F, Lu CY, et al. Major Physical Health Conditions and Risk of Suicide. *American Journal of Preventive Medicine*. 2017;53(3):308–315.
- [57] Pompili M, Lester D, Innamorati M, Pisa E DE, Amore M, Ferrara C, et al. Quality of Life and Suicide Risk in Patients With Diabetes Mellitus. *Psychosomatics*. 2009;50:16-23.
- [58] Orsolini L, Latini R, Pompili M, Serafini G, Volpe U, Vellante F, et al. Understanding the Complex of Suicide in Depression: From Research to Clinics. *Psychiatry Investigation*. 2020;17(3):207-221.
- [59] Dome P, Rihmer Z, Gonda X. Suicide Risk in Bipolar Disorder: A Brief Review. *Medicina (Kaunas)*. 2019;55(8):403.
- [60] Shamabadi A, Ahmadzade A, Pirahesh K, Hasanzadeh A, Asadigandomani H. Suicidality risk after using cannabis and cannabinoids: An umbrella review. *Dialogues in Clinical Neuroscience*. 2023;25(1):50–63.

- [61] Lindahl V, Pearson JL, Colpe L. Prevalence of suicidality during pregnancy and the postpartum. *Archives of Women's Mental Health*. 2005;8(2):77–87.
- [62] Eddleston M, Szinicz L, Eyer P, Buckley N. Oximes in Acute Organophosphate Pesticide Poisoning: a systematic review of clinical trials. *The Quarterly Journal of Medicine*. 2002;95(5):275-283.
- [63] Cherian MA, Peter J V, Cherian AM. Oximes in organophosphorus poisoning. *Indian Journal of Critical Care Medicine*. 2005;9(3):155-163.
- [64] Sontakke T, Kalantri S. Predictors of Mortality in Hospitalized Patients With Pesticide Poisoning. *Cureus*. 2023;15(7):e41284.
- [65] Bhattad P, Bhattad S. Organophosphorus poisoning: study of evaluation of clinically relevant indicators. *International Journal of Advances in Medicine*. 2022;9(10): 1027-1030.
- [66] Acikalin A, Dişel NR, Matyar S, Sebe A, Kekec Z, Gokel Y, et al. Prognostic Factors Determining Morbidity and Mortality in Organophosphate Poisoning. *Pakistan Journal of Medical Sciences*. 2017;33(3):534-539.

Chapter 8: Submissible article

Retrospective record review of patients admitted to a High-care unit with an organophosphate-like toxidrome during the COVID-19 pandemic at a regional hospital in South Africa

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Author Contributions: Sekanamisha Marvelyn Tema was the principal investigator and primary author of the protocol and manuscript. Ismail Kalla and Shabbir Alekar conceptualized the study, contributed to the design, and approved the final manuscript.

Disclosure: no conflict of interest

Abstract

Background

Organophosphate, a pesticide that can be used intentionally or inadvertently to induce bodily harm, is a significant cause of morbidity and mortality globally. Beyond its devastating health consequences, the COVID-19 pandemic also put a massive strain on healthcare infrastructure globally. There is limited data available in South Africa regarding the patterns of hospital admissions and outcomes for patients presenting with organophosphate-like toxidrome during the recent COVID-19 pandemic.

Objectives

To describe the demographics of patients admitted with an organophosphate-like toxidrome during the COVID-19 lockdown period, their clinical presentations, length of stay, and the outcomes in both COVID-19-negative and COVID-19-positive patients, and to describe their comorbidities.

Methods

A retrospective descriptive data analysis was conducted on patients admitted to the High-Care Unit at Edenvale Regional Hospital and treated with atropine for organophosphate-like toxidrome from January 2020 to December 2023. Of 219 identified patients, only 128 cases were analysed. Of the 91 excluded files, 31 files could not be found, and 60 files had polypharmacy ingestion (organophosphate compound and other toxins/ drugs).

Results

The study population consisted entirely of Black African ethnicity (100%). The mean age was 31 ± 11 years, with a male predominance (62%). The most common clinical findings included pinpoint pupils (59%), Glasgow coma scale (GCS) ≤ 13 (50%), and bronchorrhea (40%). Intentional ingestion accounted for 59% of cases. The COVID-19 status was unknown for 45% of cases, 7% of cases were admitted before the COVID-19 pandemic, and only 3% of cases tested positive. The median cholinesterase level was 368 U/L (interquartile range (IQR): 200-1157). Hypertension (11%) and HIV (10%) were common comorbidities. Atropine infusion was administered in all cases, lasting an average of 5 ± 4 days. Relapse occurred in 12.5% (16 out of 128) of cases.

Of the relapses, 87.5% were discharged, 6.25% were transferred to another hospital, and 6.25% refused hospital treatment. Mechanical ventilation was required in 58% of cases, with a median duration of 7 days (interquartile range: 5 -15). The overall survival rate for the cohort was 85.9%.

Conclusion

This study aimed to evaluate the effect of the COVID-19 pandemic on organophosphate-like toxidrome, however, no definitive conclusions could be drawn due to the small number of positive cases. Nonetheless, it provides insights into the regional epidemiology of organophosphate-like toxidrome and highlights the need for further research to understand the patterns and determinants of organophosphate-like toxidrome in South Africa. In addition, further research is needed to explore the impact of COVID-19 pandemic-related factors such as isolation, financial problems, fear and anxiety, and other mental health conditions that may have contributed to suicide and self-harm.

Appendix A



M240959 Dr Sekanamisha Marvelyn Tema

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M240959

NAME: Dr Sekanamisha Marvelyn Tema
(Principal Investigator(s))

STUDENT NUMBER: 0400667W

DEGREE: MMed - Internal Medicine

DEPARTMENT: Internal Medicine

TITLE: Retrospective record review of patients admitted to a High-care unit with an organophosphate-like toxidrome during the COVID-19 pandemic at a regional hospital in South Africa

STUDY SITE(S): Edenvale Regional Hospital

DATE CONSIDERED: 27-Sep-2024

DECISION: Approved unconditionally

CONDITIONS: N/A

NOTE: Retrospective Record Review

SUPERVISORS: Prof Ismail Kalla and Dr Shabbir Alekar

APPROVED BY: _____
Professor P. Ruff, Chairperson, HREC (Medical)

DATE OF APPROVAL: 19-Feb-2025 **EXPIRY DATE:** 18-Feb-2030

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATOR(S)

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report** in the month date of convened meeting each year until study is closed. Failure to submit annual report will result in ethics clearance certificate suspension. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Email a signed copy of ethics clearance certificate to HREC-Medical.ResearchOffice@wits.ac.za

Principal Investigator Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

REC-250208-004

Appendix B

Data Collection Sheet

Participant ID:

Race: Black ☐ White ☐ Indian ☐ Coloured ☐ Other race ☐ **Age:**

Gender: Male ☐ Female ☐

Date of admission:

Date of outcome:

Outcome: Discharge ☐ Death ☐ Transfer to another hospital ☐

Refusal of hospital treatment ☐ reason:

Relapse: Yes ☐ No ☐

Relapse atropine initiation date:

Relapse atropine stop date:

Vital parameters on presentation: Oxygen saturation:

Temperature:

Pulse rate:

Respiratory rate:

BP:

History of Organophosphate ingestion: Yes ☐ No ☐ Unknown ☐

Organophosphate clinical signs on presentation:

Salivation: Yes ☐ No ☐ Fasciculations: Yes ☐ No ☐

Urination: Yes ☐ No ☐ Bronchorrhea: Yes ☐ No ☐

Diarrhoea: Yes ☐ No ☐ Pinpoint pupils: Yes ☐ No ☐

Lacrimation: Yes ☐ No ☐ Sweating: Yes ☐ No ☐

Vomiting: Yes ☐ No ☐ Seizures: Yes ☐ No ☐

Glasgow coma scale:

Peradeniya Organophosphorus Poisoning score (POP):

Reason for Ingestion: Unintentional ☐ Intentional ☐ -reason: unknown ☐

Cholinesterase level:

COVID-19 test: Positive ☐ Negative ☐ Unknown ☐ Before COVID ☐

Full blood count: WCC: HB: MCV: Plts:

Renal function test:

Na: K: Urea: Creatinine: GFR

Liver function test:

TP: ALB: Tot Bil: Cong Bil: ALT: AST: ALP: GGT

Atropine infusion given: Yes ☐ No ☐ duration:

Adjunct meds:

Glycopyrrolate Yes ☐ No ☐ reason:

Haloperidol Yes ☐ No ☐ reason:

Midazolam Yes ☐ No ☐ reason:

Risperidone Yes ☐ No ☐ reason:

Inotrope use Yes ☐ No ☐ name: duration:

Mechanical ventilator use: Yes ☐ No ☐ **Indication for intubation:**

Number of days on ventilator:

Arterial Blood Gas: PH: PAO2: PACO2: BE: HCO3:

Comorbid conditions:

Diabetes Mellitus yes ☐ No ☐

Hypertension yes ☐ No ☐

Bipolar Mood disorder yes ☐ No ☐

Anxiety disorders yes ☐ No ☐

Depression yes ☐ No ☐

HIV yes ☐ No ☐

Other comorbid conditions:

feedback studio

Sekanamisha Tema | Retrospective record review of patients admitted to a High-Care Unit with an Organophosphate-like toxidrome during the COVID-19 pandemic at a regional hospital in South Africa

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