ORIGINAL ARTICLE

Eucalyptus Oil Poisoning in Young Adults: A Case Series Highlighting Rhabdomyolysis as a Critical Complication

SHABBIR SHEKHLI[1,*], SOUWMYA SHUBRA DATTA[1], VIJAY KUMAR S S[2]

[1]Department of Emergency Medicine, RajaRajeswari Medical College and Hospital Bangalore, Karnataka – 560074, India
[2]Department of Emergency Medicine, Kanachur Institute of Medical Sciences, Mangalore-575018, India

Abstract

Introduction: Eucalyptus oil is a volatile hydrocarbon produced by the distillation process from Eucalyptus leaves. The oil can be absorbed through dermal exposure, inhalation, and ingestion. The symptoms of poisoning may include nausea, vomiting, diarrhea, dizziness, difficulty breathing, and coma, and seizures and kidney injuries have been reported as some of the complications. The poisoning-related complications are more common in children than adults.
Case presentation: In this study, we included six adult patients who presented to the emergency department and developed rhabdomyolysis as a complication during their hospital stay. All the cases had a history of eucalyptus oil intoxication. The mean age of the cohort, comprising two males and four females, was 25±4 years. The average amount of eucalyptus oil exposure was 14±7 mL. Two patients underwent dialysis, and one required mechanical ventilatory support. All six cases were discharged from the hospital after complete recovery.
Discussion: Rhabdomyolysis is a rare complication of eucalyptus oil poisoning. The study participants initially presented a wide spectrum of complaints, such as asymptomatic (n=1), convulsions (n=3), pain in the abdomen (n=1), and vomiting(n=1). Surprisingly, patients asymptomatic at presentation also developed rhabdomyolysis. The typical treatment for eucalyptus oil poisoning involves supportive care and close monitoring of vital signs. Patients who developed eucalyptus oil-associated rhabdomyolysis were treated with intravenous fluid, diuretics, and corticosteroids.
Conclusion: Rhabdomyolysis is a rare complication following ingestion of eucalyptus oil. Awareness of this complication is vital for early diagnosis and proper treatment, especially in regions where eucalyptus oil is readily available and used.

Keywords: Rhabdomyolysis, Eucalyptus oil poison, Toxicology, Essential oil poison, Emergency room

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INTRODUCTION

Essential oils are naturally occurring compounds derived from plants or plant parts [1]. The most common essential oils are eucalyptus, lavender, tea tree, lemon, and peppermint. Eucalyptus oil has been traditionally used as an herbal remedy for various common ailments [2]. Currently, it is used in mouthwashes, cough drops, ointments, and balms. 1,8-cineole, also referred to as eucalyptol, has been identified as the primary active metabolite causing toxic effects [3]. Previous studies have revealed a lower incidence of this poisoning among adults than in the pediatric age group [4], whereas seizure was a more common complication in children than adults. However, the exact mechanism following eucalyptus oil intoxication is yet to be elucidated. Rhabdomyolysis is a medical condition caused by damage to skeletal muscle, manifested as asymptomatic with elevated creatinine kinase to life-threatening conditions associated with electrolyte imbalance, acute renal failure, and disseminated intravascular coagulopathy. Although toxins can lead to rhabdomyolysis, the connection with eucalyptus oil has not yet been documented. To date, only one case report shows the occurrence of rhabdomyolysis after a patient experienced tonic-clonic seizures following ingestion of eucalyptus oil [5]. In contrast, our study demonstrated that all patients developed rhabdomyolysis regardless of their initial symptoms. To the best of our knowledge, this is the first case series describing eucalyptus oil-associated rhabdomyolysis in young adults. Therefore, clinicians should be knowledgeable about this condition, which has been inadequately described in the literature.

CASE REPORT

This case series presents six patients who experienced eucalyptus oil intoxication and subsequently developed rhabdomyolysis during their hospitalization (Table 1). The average age of the patients, with two males and four females, was 25±4 years. Upon arrival at the hospital, initial resuscitation was performed in the emergency room,

*Correspondence to: Dr. Shabbir Shekhli, Department of Emergency Medicine, Rajarajeswari Medical college and Hospital Bangalore-560074, India.
Email: drshabbir9880033401@gmail.com. Tel: +919880033401

followed by admission to either the intensive care unit or emergency ward based on the hemodynamic stability of the patients. Also, baseline vitals and results of arterial blood gas analysis (ABG), blood glucose level, and electrocardiogram findings were recorded at the time of admission. The diagnosis of rhabdomyolysis was established based on the evidence of discolored urine, metabolic acidosis in ABG, and elevated creatine phosphokinase levels. Treatment for all patients started with the administration of crystalloids as the first line, and diuretics and corticosteroids were added as necessary. Some patients underwent hemodialysis. Following successful treatment, all patients were discharged from the hospital. The in-hospital management of all the cases has been described in supplementary appendix 1. Informed and written consent was obtained from the patients for research and publication of the data with confidentiality.

DISCUSSION

In the current study, we observed a slight female predominance over males among patients with eucalyptus poisoning. Existing literature revealed that poisoning is more common in children than adults, and the majority of the instances are unintentional or accidental [5]. Since our participants were 20–30 years-old, poisoning in these individuals is presumed to be the result of intentional consumption to threaten their lives.

Historically, eucalyptus oils have been used in aromatherapy by local applications and inhalation techniques. Of the total six cases, one had poisoning by inhalation and others by oral ingestion. A small case series published in 2020 reported two poisoning incidents by oral ingestion and one by local application [6]. Essential oils are volatile lipophilic hydrocarbons that primarily consist of terpenes, phenols, and nitrogen. These molecular components facilitate easy absorption through oral ingestion, inhalation, and local applications [7]. Patients of eucalyptus oil poisoning initially present nausea, diarrhea, and burning sensations in the mouth and throat; convulsions, depression of the central nervous system, rhabdomyolysis, and failure of both the kidneys and the liver may be rare occurrences [8]. Of the six cases in our study, three had convulsions, two had vomiting, and one was asymptomatic at the time of presentation in the emergency room. Similar presentations were observed in various studies. Ittyachen et al. reported two cases of eucalyptus oil poisonings in adults who presented convulsions [4]. Mathew reported two cases—one with convulsions and two with altered

Table 1. Clinical details of cases

Variables	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Age (years)	22	23	19	28	30	26
Sex	F	M	F	M	F	F
Time since exposure	2 h	2 h	3 h	6 h	30 min	4 h
Amount of exposure (mL)	15 (ingestion)	25 (ingestion)	20 (ingestion)	5 (inhalation)	10 (ingestion)	10 (ingestion)
Complaints	Convulsions	Giddiness, vomiting, Convulsions	Pain abdomen, vomiting	Vomiting, leg cramps	Ingested eucalyptus oil	Convulsions
Gastric lavage performed	Yes	Yes	No	No	No	No
Activated Charcoal use	No	No	No	No	No	No
Blood pressure (mmHg) (D1)	110/60	150/60	120/70	120/70	110/60	150/80
Respiratory rate (per min) (D1)	24	30	18	20	18	20
Pulse (per min) (D1)	114	148	98	88	90	110
Temperature (D1)	afebrile	afebrile	afebrile	afebrile	afebrile	afebrile
SpO2 (D1)	94%	90%	98%	94%	96%	98%
ECG*” (D1)	ST*	ST	SR**	SR	SR	ST
GRBS (mg/dL)	185	129	130	140	148	150
GCS on presentation	12/15	9/15	15/15	15/15	15/15	15/15
ABG finding	Metabolic Acidosis (D2)	Metabolic Acidosis (D1)	Metabolic Acidosis (D2)	Metabolic Acidosis (D2)	Metabolic Acidosis (D2)	Metabolic Acidosis (D2)
Urine myoglobin	+++	++++	++++	++	+	++
Hospital stay (days)	7	10	9	6	5	5
Dialysis needed	No	Yes	Yes	No	No	No
Ventilator Required	No	Yes	No	No	No	No

D1 – Day 1, D2 – Day 2, M – Male, F – Female, ECG*” – Electrocardiogram, GRBS – Generalised random blood sugar, GCS – Glasgow coma scale, ST* – Sinus tachycardia, SR** – Sinus rhythm

sensorium. These complications could be attributed to the epileptogenic properties of eucalyptus oil related to active metabolite 1,8 cineole [9].

The earliest case presented to the emergency room was asymptomatic and within 30 min of poisoning, whereas subsequent cases were presented after 2 h with a range of clinical presentations. Literature confirmed that the rationale for variation in the time-dependent manifestations of clinical symptoms is due to the chemical components of essential oils. The clinical symptoms can manifest within minutes to hours based on factors such as the route of ingestion, amount, and type of essential oil [3].

Herein, clinical symptoms were examined in five cases, which revealed that these patients had ingested or been exposed to more than 10 mL of the substance. The probable oral lethal dose to humans is 0.05–0.5 mL/kg [10]. The maximum oral dose is 600 mg, and the dermal dose level is 20% per day. Becker et al. evaluated the safety of eucalyptus oil ingredients for cosmetic purposes and showed that the oral use of this product is permitted for individuals aged ≥12 years, while skin applications are suitable for those aged ≥4 years [10].

Gastric lavage was performed on the first and second cases due to the unavailability of initial information regarding the offending substance from either the patient or their attendant. However, the current guidelines recommend against performing gastric lavage in cases of essential oil poisoning as it is associated with an increased risk of aspiration [11].

All patients established severe metabolic acidosis on the second day of admission, except case two, which developed the complication on the first day. Similar findings were documented in two adult case reports of eucalyptus oil poisoning who developed metabolic acidosis on day one of admission. The comparison of our data to previous studies showed a correlation between the quantity of eucalyptus oil ingested or exposed with the time of onset and severity of metabolic acidosis.

In the present study, we observed that the cases that manifested rhabdomyolysis had acute kidney injury (Figure 2B). Shanmugam et al. conducted kidney biopsies on cases with similar presentations and found that acute kidney injury was caused by significant pathological changes in the glomerulus and the presence of atypical red globular casts in the tubules that tested positive for myoglobin stain [12]. A review on poisoning-induced acute kidney injury established that the development of acute kidney injury is a result of a complex interplay of mechanisms that target renal tubular cells, making them vulnerable to toxic insults [13].

In the current study, all patients tested positive for myoglobin in urine, and creatinine phosphokinase levels peaked within 72 h (Figure 1). Notably, a correlation was established between decreased urine output and increased serum creatinine and CPK values (Figure 2A). All six cases developed rhabdomyolysis, while only three cases exhibited convulsions, which could be due to the toxic metabolites of the eucalyptus oil. The oxidative stress caused by the metabolic byproducts of eucalyptus oil can be detrimental to muscle cell membranes and cause cell lysis [14]. A survey of existing studies indicated that the exact mechanism underlying the occurrence of rhabdomyolysis is controversial. Based on the data from in vitro studies, a

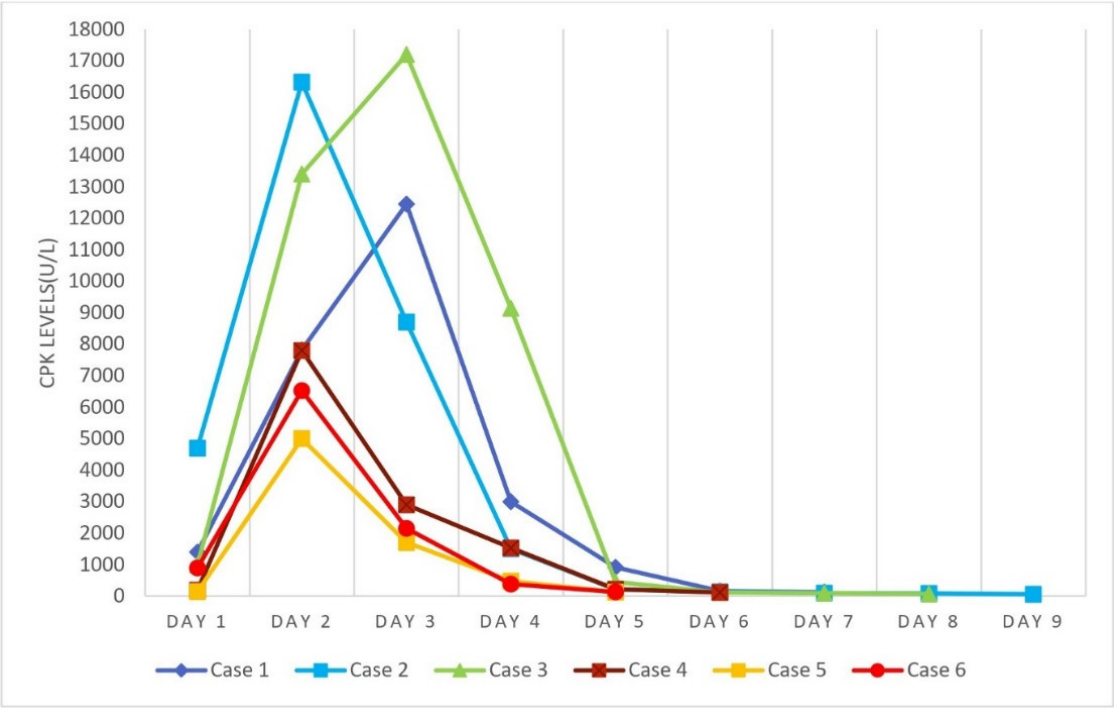
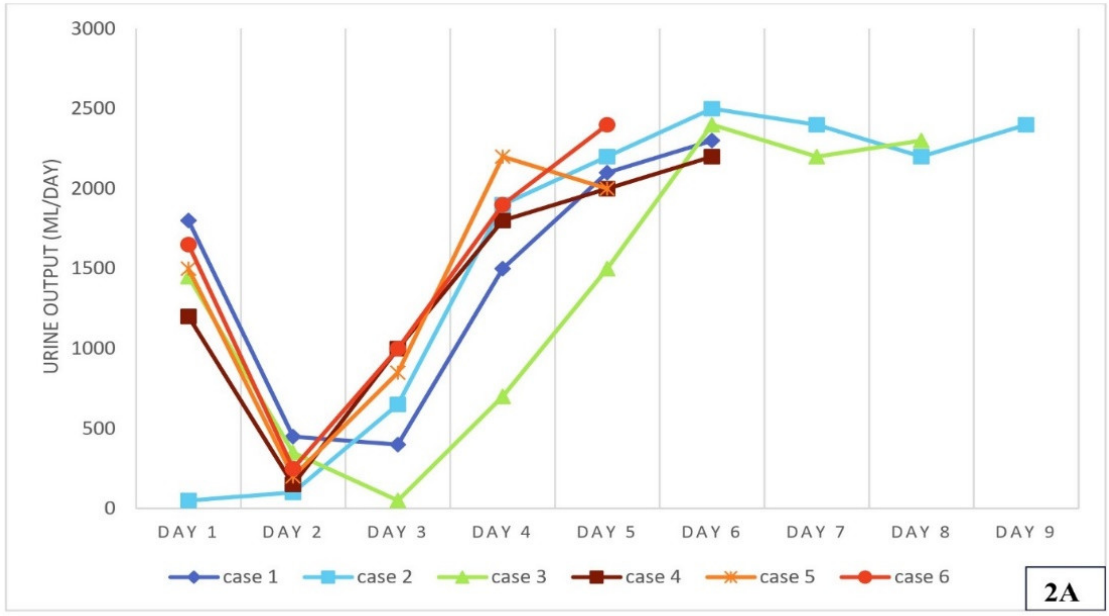


Figure 1. Graph depicting changes in daily CPK levels (units/L) of the patients



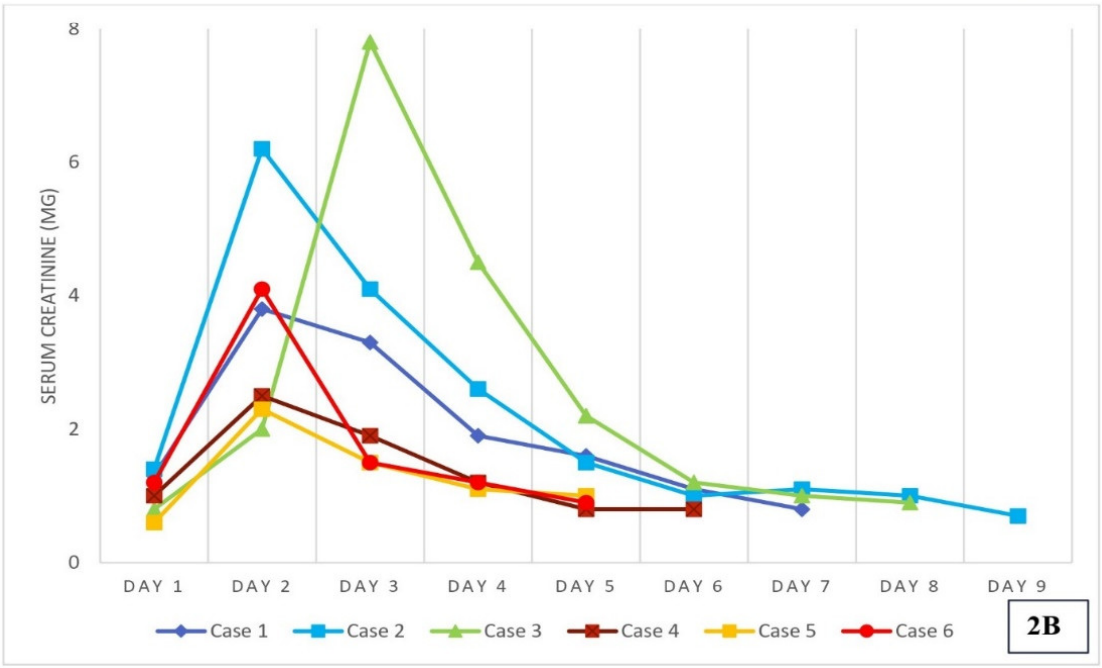


Figure 2A: Graph depicting changes in daily urine output (mL/day) of the patients.
Figure 2B: Graph depicting changes in the daily creatinine value (mg) of the patients.

pathophysiology model has been developed and illustrated in Figure 3 [15, 16].

All patients diagnosed with rhabdomyolysis received diuretics and corticosteroids until they achieved adequate urine output and their metabolic acidosis was resolved, except for those requiring hemodialysis. The drug formulation and dose selection were based on the treating physician's interest and experience. A literature review suggested that loop diuretics can be used in patients with myoglobinuric renal impairment to initiate diuresis and convert anuric to oliguric renal failure [17]. In another case report, a pulse dose of methylprednisolone was administered following unsuccessful attempts at improving urine output and increasing CPK levels despite adequate fluid therapy. The rationale for steroids in these cases was that muscle necrosis in rhabdomyolysis causes significant inflammation, supported by a successful decrease of CK levels following therapy. Biopsies in cases of rhabdomyolysis revealed minimal inflammation following the use of corticosteroids, indicating a significant pharmacological effect [18].

Among six cases, two underwent dialysis due to severe metabolic acidosis (Table 2 in supplementary appendix 1) and oliguria. Hemodialysis was indicated in poisoning

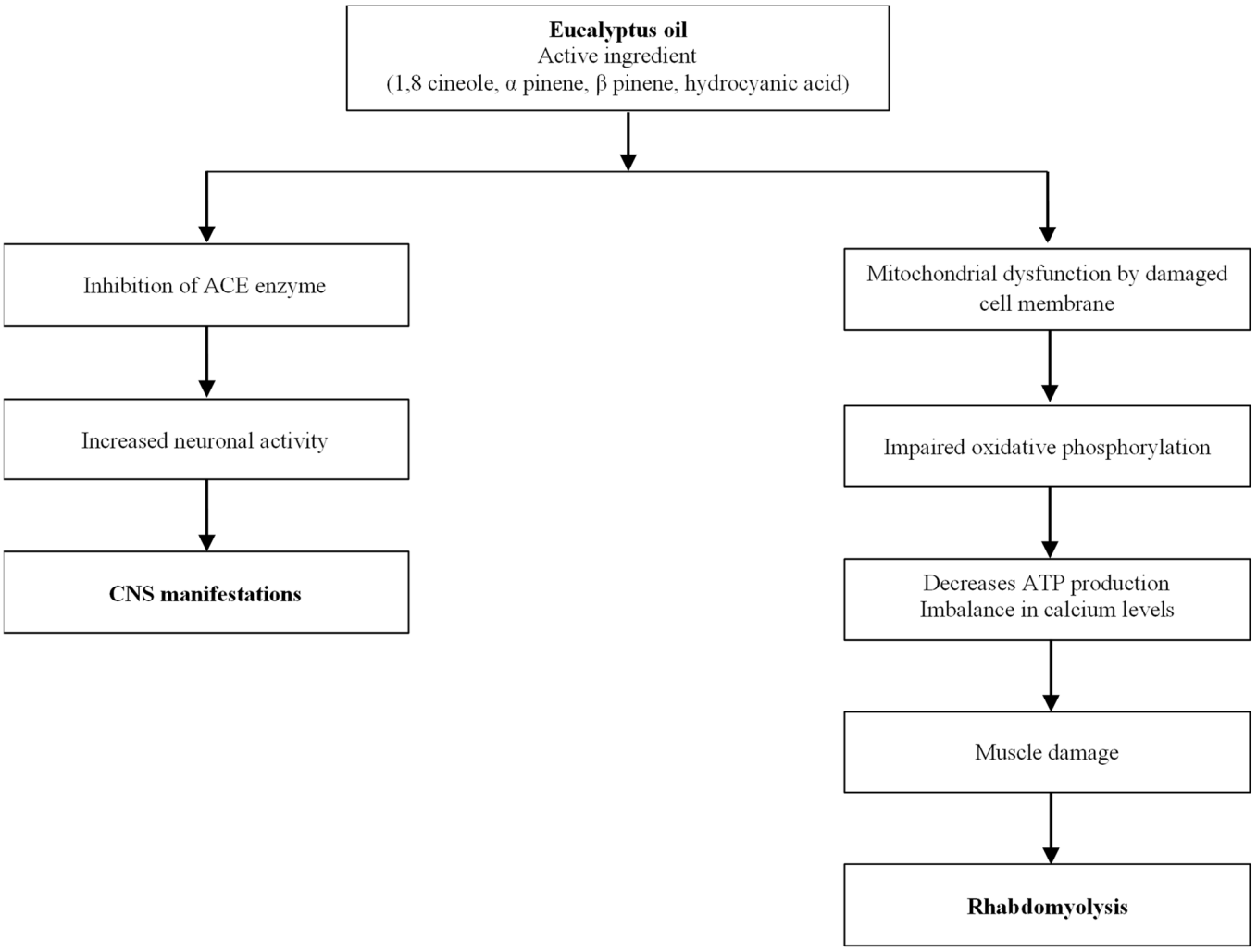


Figure 3. Pathophysiology pathway of rhabdomyolysis

patients in the event of severe metabolic acidosis (pH <7), hyperkalemia (>6.5 mEq/L), azotemia, and refractory pulmonary edema [19]. The choice of hemodialysis depends on the patient's hemodynamic parameters. Figure 4 illustrates the clinical management pathway for eucalyptus oil poisoning and its complications. Analysis revealed two critical factors probably contributing to the occurrence of this condition: first, the quantity of eucalyptus oil ingested or exposed, and second, the strength of eucalyptus oil, which is the percentage of 1,8 cineole present in the prepared formulations (for example 80% of eucalyptus oil is more hazardous than 20%). Therefore, future research in this particular area may further establish the possible causative factors between eucalyptus oil and rhabdomyolysis.

CONCLUSION

This case series highlights the instances of eucalyptus oil poisoning presented in emergency departments, emphasizing its potential association with rhabdomyolysis. Regular monitoring of CPK levels and renal function for 72 h following ingestion of eucalyptus oil is crucial for prompt diagnosis and treatment. Thus, improved awareness and understanding of these cases would help healthcare professionals enhance patient outcomes. In addition, continual research in this area can aid in comprehending and developing effective management strategies.

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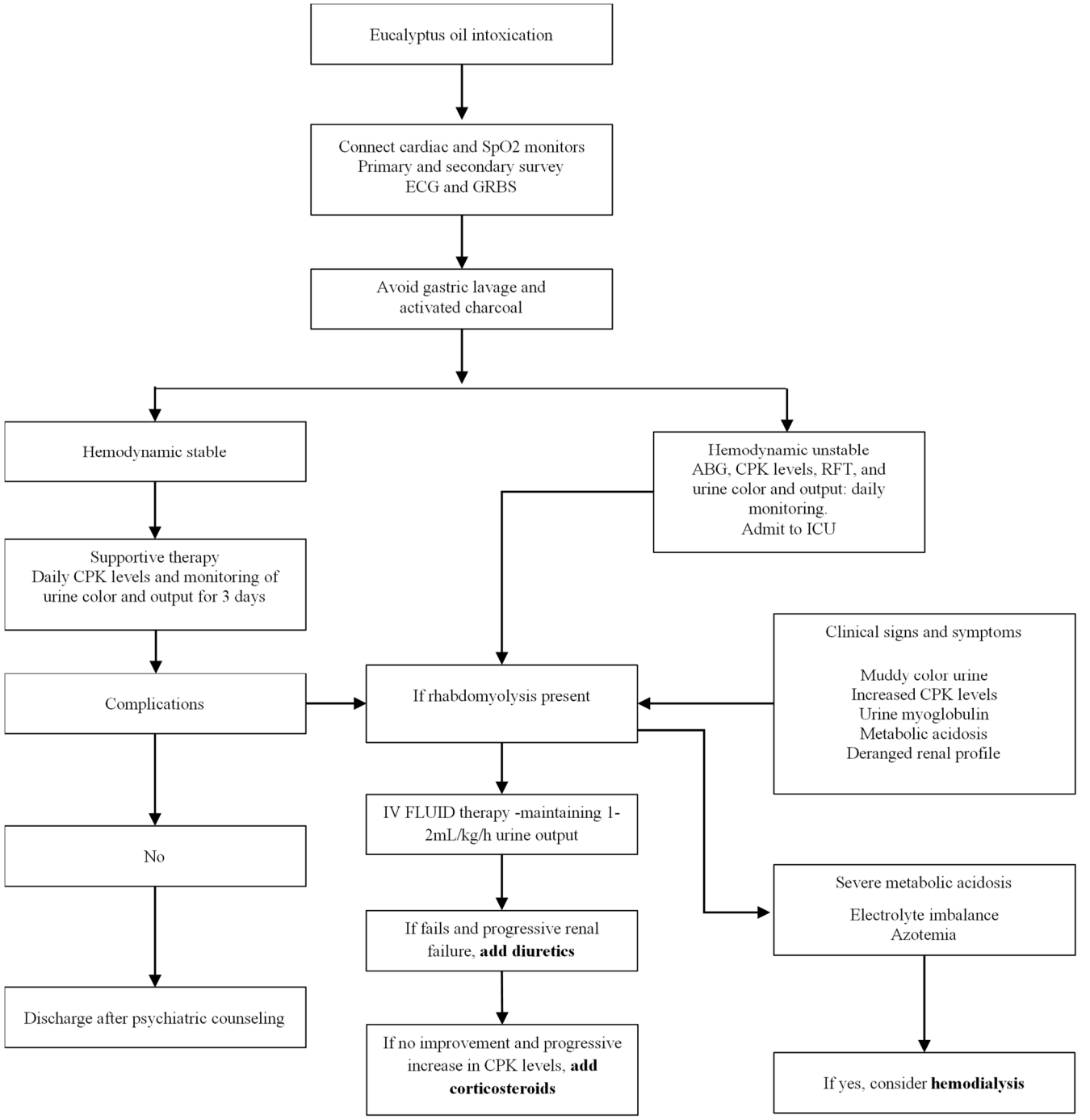

Figure 4. Management algorithm of eucalyptus oil poisoning-associated rhabdomyolysis

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Supplementary appendix 1

Case Details

Case 1:

A 22-year female was brought to the Emergency Department (ED) on 19th March 2024. Complaints of involuntary movements of upper and lower limbs, associated with drooling of saliva, lasted for 2 minutes. Gastric lavage was performed in the Emergency Room (ER) after the primary survey (table 1). Arterial blood gas was normal, and the Urine pregnancy test was negative. Blood investigations were sent and the patient was admitted to the high-dependency unit. Six hours later the patient's relative brought a container of Eucalyptus oil. On the second day, because of metabolic acidosis, high-colored urine, and increased Creatinine Phosphokinase (CPK) (Figure 1), provisionally suspected Rhabdomyolysis. Treatment tailored to crystalloids at 200ml/hour, furosemide 20mg twice daily, and Methylprednisolone 40mg thrice a day intravenously. On day 3, CPK was 12450IU, crystalloids escalated to 300ml/hour. and sodium bicarbonate 8.4% at 1meq/kg was given. On the fourth day, Urine output improved, CPK levels reduced and metabolic acidosis resolved. patient was discharged on the seventh after psychiatric counseling and revealed 10 ml consumption.

Case 2:

A 23-year male was brought to the Emergency department on the 19th of May 2023 with complaints of giddiness and vomiting for one hour. In the ER, the patient had active generalized tonic-clonic convulsions treated with Lorazepam 4mg intravenously. Oxygen started at 6L/minute after the initial assessment. The patient was intubated because of the low Glasgow Coma Scale (GCS) and airway secretions (table 1). Post Gastric lavage and Foley catheter insertion noticed high-colored 50ml urine (Figure 5). CT's Brain was normal and admitted to the intensive care unit. On the second day, Rhabdomyolysis was suspected due to the presence of metabolic acidosis, increased creatinine Phosphokinase, decreased urine output, and myoglobin in urine present. Patient relative brought the alleged liquid container found to be Eucalyptus oil. In view of severe metabolic acidosis intermittent hemodialysis was done two consecutive days. On day 4 Urine output improved CPK decreased (table 1) and he was extubated the next day. on day 10, after psychiatric counseling, the patient was discharged from the ward.

Case 3:

A 19-year female was brought to the Emergency Department on 23rd March 2023 by a friend with complaints of pain abdomen and multiple episodes of vomiting since one hour. History of consumption of 15ml of Eucalyptus oil present. During the initial assessment in the ER, the patient was conscious, oriented, and hemodynamically stable (table 1). The urine pregnancy test was negative, ABG and ultrasound abdomen were unremarkable. The patient was admitted to the emergency ward. On day 2, Rhabdomyolysis was suspected, because of patient developed agitation, and laboratory findings showed CPK increased, metabolic acidosis in ABG, and urine myoglobin present. In the intensive care unit treatment changed, crystalloids were increased to 250ml/hour, Diuretics (furosemide) 40mg per day, corticosteroid (Methylprednisolone) 40mg thrice a day, and Sodium Bicarbonate 8.4% at 1meq/kg per day intravenously. On day 3 hemodialysis was initiated and repeated on the next day. The patient's condition improved subsequently and on day 9 discharged after Psychiatry counseling.

Case 4:

A 28-year male was brought to the ER on 13/6/2022 with complaints of 3 episodes of vomiting and cramps in the legs since two hours. A history of recurrent inhalation of eucalyptus oil over 6 hours for the common cold was present. In the ER, the patient was hemodynamically stable and admitted to the emergency ward. On day two Rhabdomyolysis was suspected due to decreased urine output and laboratory parameters were reported as Serum Creatinine 2.5mg/dl, CPK > 7800IU (figure 1) metabolic acidosis in ABG, and urine myoglobin was present. crystalloids increased to 250ml/hour, diuretics (Furosemide) 20 mg per day, and Corticosteroids (Methylprednisolone) 40mg three times a day intravenously. The patient's condition improved gradually, discharged on the sixth day after psychiatric counseling.

Case 5:

A 30-year female was brought to the Emergency Department on 26/10/2023 with an alleged history of consumption of 5ml of Eucalyptus oil. The patient was conscious and oriented with vitals recorded (table 1). The next day noticed high-colored urine (figure 2), creatinine Phosphokinase 5000IU, and metabolic acidosis in arterial blood gas, this led to a provisional diagnosis of Rhabdomyolysis. Treatment modified as, crystalloids at the rate of 150ml/hour, diuretics(furosemide) 40mg per day, and corticosteroids (dexamethasone) 8 mg three times a day intravenously. The patient's condition improved gradually, discharged on the fifth day after psychiatric counseling.

Case 6:

A 26-year female was brought to the emergency department

Table 2. Blood Gas Analysis of Patients

CASES	Blood-gas values	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Case 1	pH	7.42	7.17	7.28	7.37	7.39	7.43
	$HCO3^-$ (mmol/L)	22	14	17	21	23	26
	CO2 (mm Hg)	42	28	32	37	35	38
	Anion Gap (mmol/L)	12	20	17	14	10	9
	Lactate (mmol/L)	2.8	3.3	3.1	1.9	1.1	1.4
Case 2	pH	7.11	6.9	7.26	7.40	7.41	7.40
	$HCO3^-$ (mmol/L)	14	7	18	20	24	23
	CO2 (mm Hg)	58	20	40	36	37	38
	Anion Gap (mmol/L)	22	28	19	12	11	12
	Lactate (mmol/L)	8.3	5.8	3.6	1.8	1.1	0.8
Case 3	pH	7.36	7.29	7.00	7.28	7.35	7.42
	$HCO3^-$ (mmol/L)	19	15	9	16	25	22
	CO2 (mm Hg)	43	30	25	38	41	39
	Anion Gap (mmol/L)	13	18	25	17	11	10
	Lactate (mmol/L)	3.1	3.9	4.2	2.5	1.7	1.0
Case 4	pH	7.38	7.22	7.32	7.37	7.41	-
	$HCO3^-$ (mmol/L)	21	14	20	25	24	-
	CO2 (mm Hg)	40	28	36	41	39	-
	Anion Gap (mmol/L)	10	18	16	12	12	-
	Lactate (mmol/L)	1.9	2.7	2.4	1.7	0.8	-
	K^+ (mmol/L)						-
Case 5	pH	7.40	7.29	7.32	7.44	-	
	$HCO3^-$ (mmol/L)	26	15	18	23	-	-
	CO2 (mm Hg)	37	24	32	38	-	-
	Anion Gap (mmol/L)	9	20	15	11	-	-
	Lactate (mmol/L)	2.3	2.8	1.7	1.2	-	-
Case 6	pH	7.33	7.24	7.38	7.37	-	-
	$HCO3^-$ (mmol/L)	17	14	21	25	-	-
	CO2 (mm Hg)	30	26	35	39	-	-
	Anion Gap (mmol/L)	19	24	16	12	-	-
	Lactate (mmol/L)	3.0	3.5	2.1	1.4	-	-

on 13/05/2020 with complaints of involuntary movements of both upper and lower limbs associated with up rolling of eyes and clenching of teeth one hour back which lasted for a minute. In the ER she was conscious and oriented (table 1) history of consumption of 05 ml eucalyptus oil 2 hours back present. CT-Brain was ordered to rule out intracranial pathology, reported as normal, and shifted to the ICU. In the evening, in view of oliguria (figure 2), Creatinine Phosphokinase 6530IU, metabolic acidosis in ABG, and urine myoglobin positive provisionally diagnosed as Rhabdomyolysis. Treatment is tailored to, crystalloids at 250ml/hour and corticosteroid (hydrocortisone) 100mg three times a day intravenously. The patient's condition gradually improved, discharged on the fifth day after psychiatric counseling.

Table 3. Serum electrolyte values in patients

Cases	Serum Electrolytes	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Case 1	Sodium (mmol/L)	142	148	141	139	144	141
	Potassium (mmol/L)	3.4	5.4	4.9	4.0	3.8	4.2
	Calcium (mmol/L)	2.2	1.9	2.0	2.5	2.3	2.5
	Phosphate (mmol/L)	1.45	1.62	1.47	1.46	1.32	1.28
Case 2	Sodium (mmol/L)	136	140	143	141	144	144
	Potassium (mmol/L)	5.3	5.7	5.2	4.2	4.3	4.1
	Calcium (mmol/L)	1.7	1.5	2.0	2.4	2.5	2.4
	Phosphate (mmol/L)	1.51	1.68	1.50	1.46	1.41	1.33
Case 3	Sodium (mmol/L)	132	146	148	145	142	143
	Potassium (mmol/L)	3.6	5.0	5.3	4.8	4.5	4.1
	Calcium (mmol/L)	2.3	1.6	1.3	1.9	2.4	2.2
	Phosphate (mmol/L)	1.47	1.77	1.70	1.43	1.28	1.22
Case 4	Sodium (mmol/L)	134	148	142	140	143	142
	Potassium (mmol/L)	3.3	4.7	4.5	3.8	4.0	3.9
	Calcium (mmol/L)	2.4	2.0	2.0	2.2	2.5	2.4
	Phosphate (mmol/L)	1.41	1.53	1.46	1.30	1.18	1.27
Case 5	Sodium (mmol/L)	146	148	143	146	140	-
	Potassium (mmol/L)	3.6	4.8	4.6	4.1	4.2	-
	Calcium (mmol/L)	2.5	2.1	2.2	2.5	2.4	-
	Phosphate (mmol/L)	1.36	1.49	1.47	1.22	1.20	-
Case 6	Sodium (mmol/L)	139	145	142	140	138	-
	Potassium (mmol/L)	4.4	4.8	4.5	4.0	3.8	-
	Calcium (mmol/L)	2.6	1.9	2.2	2.6	2.5	-
	Phosphate (mmol/L)	1.44	1.54	1.50	1.38	1.29	-

Table 4. Imaging findings of Chest X-ray, USG Abdomen and NCCT head of patients

Cases	*Chest X-ray*	*USG Abdomen*	*NCCT Head*
Case 1	Normal Study	Bilaterally increased renal cortical echogenicity with hypoechoic renal pyramids	Normal Study
Case 2	Normal Study	Slightly enlarged left kidney with thickened bilateral renal cortex with heterogeneously increased bilateral renal cortical echogenicity with hypoechoic renal pyramids	Normal Study
Case 3	Normal Study	Diffusely thickened bilateral renal cortex with heterogeneously decreased bilateral renal cortical echogenicity	-
Case 4	Normal Study	Decreased bilateral renal cortical echogenicity	-
Case 5	Normal Study	Increased right renal cortical echogenicity with hypoechoic renal pyramids	-
Case 6	Normal Study	Slightly bulky bilateral kidneys with increased renal cortical echogenicity	Normal Study

USG – Ultrasonography, NCCT – Non-contrast Computed Tomography