

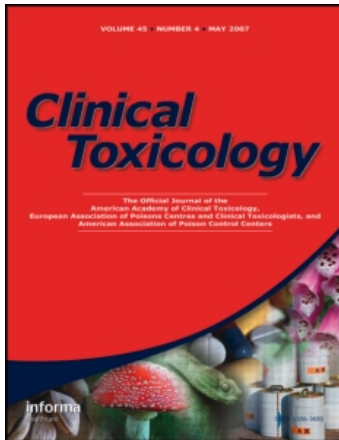
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ARTICLE

Emerging epidemic of fatal human self-poisoning with a washing powder in Southern Sri Lanka: a prospective observational study

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Introduction. Self-poisoning is a public health problem in Sri Lanka. A new laundry detergent consisting of a sachet each of 1.2 g of potassium permanganate and 12.5 g of oxalic acid has become a popular agent among the youth for self-poisoning. **Method.** Prospective clinical data and major outcomes were recorded in all patients admitted to a referring and a referral hospital. Serial biochemistry was performed in 20 patients. Postmortem examinations were performed in some patients. **Results.** There were 115 patients. The majority developed symptoms of the gastrointestinal tract within the first 24 h. There were 18 deaths. Ingestion of oxalic acid was associated with a case fatality ratio of 25.4% (95% CI = 14–39), while ingestion of both potassium permanganate and oxalic acid was associated with a case fatality ratio of 9.8% (95% CI = 3.2–21). Ingestion of more than one sachet was associated with a significantly higher risk of death (risk ratio = 13.26, 95% CI = 3.2–54, $p < 0.05$). Majority of the deaths occurred within an hour since ingestion. Postmortem examinations revealed mucosal ulceration in the majority of deaths. **Discussion.** This case series brings to light an emerging epidemic of fatal self-poisoning in Sri Lanka from a compound that is not regulated. As deaths occur soon after ingestion, medical management of these patients is bound to be difficult. **Conclusion.** This case series highlights a fatal mode of self-poisoning that could be controlled through regulation of the manufacture and sale of the product.

Keywords Acute poisoning; Cardiorespiratory collapse; Death

Introduction

Self-poisoning is a major public health problem in rural Sri Lanka with an estimated 315 to 364 per 100,000 population per year attempting self-poisoning each year.^{1–3} Seventy-five percent of poisoning deaths in patients under 25 years are due to ingestion of paraquat and oleander while 80% of deaths in patients over 25 years are due to ingestion of pesticides, organophosphorus compounds in particular contributing to 40% of deaths⁴ in some areas of the island.

Self-poisoning due to newer agents is a continually evolving problem and introduces new challenges particularly

if there is a lack of prior human data on clinical features, biochemical abnormalities, and case fatality or if existing data are not effectively communicated to clinicians or regulators.

As part of an ongoing cohort study, we noted a number of admissions following ingestion of a laundry detergent during 2006. This laundry detergent is marketed as two sachets (Fig. 1), containing 1.2 g of potassium permanganate (KMnO₄) and 12.5 g of oxalic acid by many small-scale manufacturers and is available under several trade names. The manufacturers recommend that clothes should be soaked in KMnO₄ for 2 h and washed with dissolved oxalic acid afterward. This laundry detergent has become popular as a remover of stains over the other commercially available products and traditionally had been used to remove fungus from clothes. We report the first case series of an emerging problem of self-poisoning with a newer household laundry detergent in Southern Sri Lanka.

Potassium permanganate (CAS 7722-64-7) is an antiseptic and astringent agent with powerful oxidizing effects,

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Fig. 1. Laundry detergent sachet. Top half contains 12.5 g of oxalic acid and the bottom half contains 1.2 g of KMnO_4 .

recommended as a disinfectant and a fixative and stain in microscopy. The crystalline and concentrated forms are corrosive due to the release of potassium hydroxide when they come in contact with water. Potassium permanganate may also oxidize ferrous (Fe^{2+}) to ferric (Fe^{3+}) of hemoglobin, the resultant methemoglobinemia (Meth-Hb) is incapable of carrying oxygen effectively, leading to functional anemia and cellular hypoxia. The quoted oral rat LD50 for KMnO_4 is 1,090 mg/kg.⁵

Oxalic acid (CAS 6153-56-6) is a colorless, crystalline, toxic organic compound used as a reducing agent in photography, bleaching, and dust removal. Human reports of clinical toxicology are relatively rare but include local corrosive effects, formation of oxalate calcium complex resulting in hypocalcemia and renal toxicity. The quoted oral rat LD50 for oxalic acid is 7,500 mg/kg.⁶

Method

Study design, setting, and patients

Prospective data were collected from a primary hospital and a tertiary referral hospital to establish case fatality ratio (CFR) and clinical signs and to minimize the effects of referral bias. Prospective clinical information [symptoms, pulse rate, blood pressure, respiratory rate, and biochemical data (Table 1)] was collected on all patients presenting to a large referral hospital in south of Sri Lanka [General Hospital Karapitiya (GHK)] with a history of poisoning with the laundry detergent between January 2007 and September 2008 (Fig. 2). This study was nested into an ongoing cohort of all human self-poisoning, which has ethical approval from Ethical Review Committees of Sri Lanka Medical Association (SLMA) and University of Ruhuna. Exposure was confirmed by positive identification of the product labels. Demographic details including the time of ingestion, amount ingested, coingestants, clinical observations, and major outcomes were recorded by on-site study physicians twice daily on specifically designed data collection forms until death or discharge, and data were fed into a purpose-designed clinical database on a handheld computer. Serial blood and urine samples were taken from consenting patients for the estimation of renal and liver function.

At the District Hospital Hiniduma (DHH), medical officer in charge has been collecting prospective data independent of the main cohort described above. Major outcomes, basic demography, transfer patterns, and postmortem findings of patients presenting with self-poisoning with the detergent were incorporated into the study. All transferred patients were followed up at the GHK.

A retrospective review of postmortem records was undertaken in four other referring hospitals of the south (District

Table 1. Symptoms, signs, and biochemistry of prospective admissions

	KMnO_4 + oxalic acid (N = 51)		KMnO_4 (N = 13)	Oxalic acid (N = 51)
	KMnO_4 1.2 g (IQR 1.2–2.4)	OA 12.5 g (IQR 12.5–25)	1.2 g (1.2–12.2)	12.5 g (IQR 12.5–12.5)
Ingested amount ^a				
Age ^a	24 (IQR 20–28)		19 (16–34)	24 (19–37.5)
Hospital stay days ^a	4 (IQR 4–5)		4 (IQR 4–5)	4 (IQR 4–5)
Deaths and CFR (95% CI)	5, 9.8 (3.2–21)		0	13, 25.4 (14–39)
Epigastric pain, nausea, vomiting (%)	95		73	60
Hematemesis (%)	10		0	16
Weakness and headache (%)	20		27	30
Serum creatinine ^a	1.7 (0.91–4.4)		NA	NA
SGPT ^a (IU/L)	25.5 (10–43.5)		NA	NA
Na^a (mmol/L)	135 (130–144)		NA	NA
K^a (mmol/L)	4.1 (3.8–4.2)		NA	NA
Laryngeal edema	1		0	0
Skin burns	0		1	0

SGPT, serum glutamic pyruvic transferase; NA, not available; 95% CI, 95% confidence interval.

^aMedian and interquartile range.

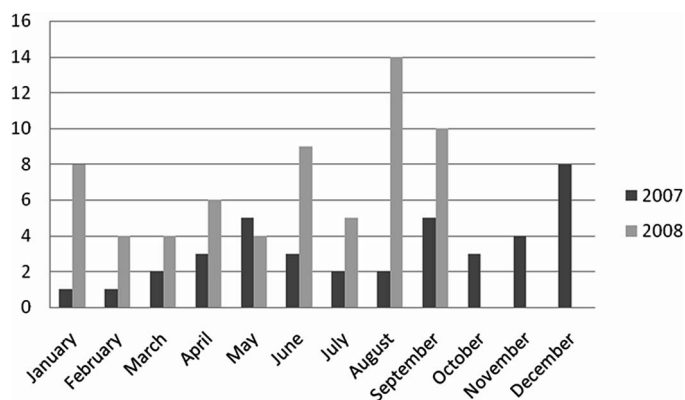


Fig. 2. Cases of self-poisoning with the laundry detergent admitted to GHK during 2007 and 2008.

Hospital Akuressa, District Hospital Morawaka, District Hospital Deniyaya, and a large General Hospital Matara) to establish whether the problem is widespread in the province. We also searched the database of 20,000 prospective admissions with self-poisoning in two other provinces of Sri Lanka to determine whether the problem was localized to the province.

Results

At the referral hospital (GHK), there were 1,995 patients with self-poisoning admitted during the study period. Laundry detergent was ingested by 103 (61 females) patients accounting for 5.2% of all cases admitted with self-poisoning to GHK during the study period. During the first 10 months in 2007, there were 24 patients while during the same period in 2008, there were 64 patients (Fig. 1). All survivors had a median blood pressure of 116/76 mmHg (IQR 110–120), pulse of 83 (IQR 77–88), median respiratory rate of 19 (IQR 18–20), and median Glasgow Coma Scale of 15 on admission to hospital.

Combined, GHK and DHH received 115 patients with self-poisoning with the laundry detergent. Forty-two patients dissolved the contents in water while the remainder ingested the solid form of the detergent. One hundred and thirteen patients ingested this detergent for deliberate self-harm while a pregnant patient ingested it as an abortifacient and there was one accidental ingestion. Majority of the patients developed symptoms of the gastrointestinal tract within the first 24 h (Table 1). There were 18 deaths (12 at DHH and 6 at GHK). Fifty-one patients ingested both KMnO_4 and oxalic acid of whom five died. Fifty-one ingested oxalic acid alone and 13 patients died. Thirteen patients ingested KMnO_4 alone and there were no deaths. Ingestion of oxalic acid was associated with an overall CFR of 25.4% (95% CI = 14–39) while ingestion of both KMnO_4 and oxalic acid was associated with an overall CFR of 9.8% (95% CI = 3.2–21). Twelve out of 26 patients admitted to DHH died (CFR = 46.2%, 95% CI = 27.9–65.2).

Number of sachets ingested was accurately recordable in 93 patients. Thirty-five patients ingested two or more sachets of both KMnO_4 and oxalic acid and 16 patients died. Fifty-eight patients ingested one or less and only two died. Ingestion of more than one sachet is associated with a significantly higher risk of death (risk ratio = 13.26, 95% CI = 3.2–54, $p < 0.05$).

The retrospective survey identified 21 additional deaths at three other hospitals of the south. All these deaths occurred within a few hours since ingestion. District Hospital Akuressa recorded no deaths. The main database did not reveal patients in the other provinces.

At DHH, 11 patients died within 1 h of ingestion in transit to the hospital while the 12th patient who was admitted soon after ingestion with an unrecordable blood pressure died within 20 min of admission. At GHK, four patients died within 24 h of ingestion. One patient developed ventricular tachycardia and fibrillation resulting in immediate death. Patients who died within 24 h were all hypotensive (<70 mmHg) on admission. Two patients died at 11 and 13 days post ingestion due to renal failure and septicemia.

Postmortem examination was performed in all acute deaths (16). There was macroscopic evidence of superficial erosions of esophagus, oropharynx, and larynx in all the patients. Some patients had pale and swollen kidneys. One patient had cerebral edema and two had congested lungs. One patient had bleeding into the pericardium and adrenal glands.

Serial biochemistry was performed in 20 consenting patients who ingested both KMnO_4 and oxalic acid. Median serum creatinine was 1.7 mg/dL (IQR 0.91–4.4, normal range = 0.5–1.3 mg/dL) on day 2. Median serum creatinine on day 3 was 1.15 mg/L (IQR 0.86–4.1). Thirty-five percent of patients had red cells in urine on days 2 and 3 post ingestion. Twenty-eight percent had evidence of renal failure (raised creatinine over 1.3 mg/L) by the third day of self-ingestion. Two patients required hemodialysis and both survived. Serum Na, K, and SGPT remained within normal limits. All survivors were treated symptomatically with intravenous fluid replacement, pain relief with paracetamol, and proton pump inhibitors when indicated.

Discussion

This case series brings to light an emerging epidemic of self-poisoning due to a new laundry detergent freely available over the counter in Sri Lanka. An examination of databases that include data from other regions of Sri Lanka shows that these poisonings were localized to the southern province. This detergent has become popular as the variation of presentations between referral hospitals suggests that there may be geographic localization within the province.

Most deaths occurred early at the primary hospital and were associated with high amounts of ingestion of oxalic acid. The lower rate of death in the referral hospital probably reflects a survivor bias due to smaller ingestions. Only two deaths occurred after 24 h. Late causes of death and morbidity

were contributed by renal failure, a well-recognized effect of calcium oxalate.^{7,8}

The major contributor to death appears to be oxalic acid as none in the KMnO_4 group died while 13 in the oxalic acid group and five in the KMnO_4 + oxalic acid group died. Given the short interval between ingestion and death, a cardiac cause is likely, possibly from severe hypocalcemia due to the formation of calcium oxalate complexes. This has been reported in human cases of ethylene glycol poisoning^{9,10} and is supported by the fact that no apparent cause of death is found in postmortem and documentation of fatal cardiac arrhythmia in one of our cases. However, we could not estimate serum calcium levels in these patients.

A further mechanism may be direct mitochondrial toxicity and severe tissue hypoxia. Calcium oxalate has been shown to be a mitochondrial poison in experimental models.^{11,12} It could be assumed that oxalic acid can induce mitochondrial toxicity in other organs leading to death. We could not estimate serum lactate levels or an anion gap to support this possibility. Acute laryngeal edema and hypoxia that were seen in one of the cases may be another possibility.

Sublethal doses of oxalic acid and KMnO_4 taken in combination lead to renal failure 2–3 days after ingestion, which in the majority settle with supportive care, only a few requiring dialysis.

Renal failure associated with oxalic acid ingestion is most likely due to a tubular defect as the majority improved with supportive care. Konta et al. reported a case of reversible renal tubular dysfunction with electron microscopic evidence of deposition of oxalate crystals in the tubular epithelium.⁷

There were no deaths in the KMnO_4 group. There have been a few reports of deaths in the literature. Ong et al. reported a fatal case who developed disseminated intravascular coagulation, hepatic necrosis, adult respiratory distress syndrome, and renal failure 6 days after ingestion of KMnO_4 .¹³ Middleton et al. reported a fatal case who developed adult respiratory distress syndrome, cardiovascular collapse, and hemorrhagic pancreatitis after ingestion of 20 g KMnO_4 .¹⁴

Meth-Hb is a well-known side effect of KMnO_4 ingestion.¹⁵ We did not have the facility to estimate Meth-Hb levels. Meth-Hb formation is unlikely to have been a significant contributor to the deaths as there were only two deaths in patients who ingested KMnO_4 with oxalic acid.

Anecdotally there seemed to be a significant rise in the number of cases being seen over time. This was supported by the documented increase seen during our study. We believe that this increase is real as there has been no change in referral policy during that time. Sri Lanka has a history of poisonings that escalate quickly to epidemic proportions. The most notable being yellow oleander (*Thevetia peruviana*), which escalated from an index case in 1979 to account for 25% of poisoning admissions in some areas.¹⁶ There are a number of social and cultural factors that drive such outbreaks but ease of access remains an important determinant of use. Unlike oleander, it is likely that this outbreak can be terminated with appropriate regulatory action. Within Sri Lanka, the

restriction of pesticides with similar case fatality rates has been associated with a reduction of overall suicide deaths.¹⁷ Roberts et al. in their paper also demonstrated that banning of pesticides can reduce pesticide-specific deaths (e.g., endosulfan) as the import of these chemicals is highly regularized.¹⁷ These actions have occurred in a framework of regulatory control for pesticides. Although this level of regulatory control does not exist for household goods in Sri Lanka, measures should be taken and implemented to ban this laundry detergent without delay. Appropriate regulatory scrutiny of other household products too should be implemented.

Limitations

We were unable to perform serial biochemistry in all the patients. Histological examination of heart, lungs, and kidneys would have added information on the cause of death. We could not estimate blood levels of oxalic acid or KMnO_4 due to lack of laboratory facilities. However, analytical validation of history within our cohort has been shown to be accurate in the past.

Conclusions

Ingestion of this new laundry detergent can be fatal. Majority of deaths occur soon after ingestion and medical treatment for this group of patients appears to be futile. However, adherence to basic and advanced life support should be emphasized, and initiation of supportive care along with correction of metabolic abnormalities should be performed. Patients who survive for 24 h may develop self-limiting renal failure, but deaths are rare. The number of cases has doubled in 2 years and regulation of manufacture and sale of this product may be necessary to prevent further deaths.

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