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Epidemic of self-poisoning with seeds of the yellow oleander tree (*Thevetia peruviana*) in northern Sri Lanka

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Summary Deliberate self-harm is an important problem in the developing world. Ingestion of yellow oleander seeds (*Thevetia peruviana*) has recently become a popular method of self-harm in northern Sri Lanka – there are now thousands of cases each year. These seeds contain cardiac glycosides that cause vomiting, dizziness, and cardiac dysrhythmias such as conduction block affecting the sinus and AV nodes. This paper reports a study of the condition's mortality and morbidity conducted in 1995 in Anuradhapura General Hospital, a secondary referral centre serving 750 000 people in Sri Lanka's north central province. 415 cases were admitted to the hospital during 11 months; 61% were women and 46% were less than 21 years old. A prospective study of 79 patients showed that 6% died soon after admission. 43% presented with marked cardiac dysrhythmias which necessitated their transfer to the coronary care unit in Colombo for prophylactic temporary cardiac pacing. The reasons for the acts of self-harm were often relatively trivial, particularly in children; most denied that they wished to die. Unfortunately, the case fatality rate for oleander poisoning in Sri Lanka is at least 10%. This epidemic is not only causing many unnecessary deaths, it is also putting immense stress on the already stretched Sri Lankan health services. There is an urgent need for an intervention which could be used in rural hospitals, thus preventing the hazardous and expensive emergency transfer of patients to the capital.

keywords Oleander; poisoning; deliberate self-harm; cardiac dysrhythmias; children

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Introduction

Deliberate self-harm is an important but under-recognized problem throughout the developing world (Desjarlais *et al*. 1997; Eddleston *et al*. 1998). The recent Global Burden of Disease study estimated that 786 000 people died from self-inflicted injuries in 1990 – 75% of them in the developing world – making it the 12th most common cause of death (Murray & Lopez 1996, 1997). Poisoning with agrochemicals is particularly common – Jeyaratnam has estimated a worldwide incidence of 3 million cases each year, with 220 000 deaths (Jeyaratnam 1990). These poisons are far more toxic than those commonly used in the industrialized world, resulting in the high fatality rates found in rural agricultural regions, e.g. 20–30% in Sri Lanka compared to $< 1\%$ in the UK (Hettiarachchi & Kodithuwakku 1989). Although the importance of self-harm in the developing world is now being recognized, there is still a dearth of research into its epidemiology and management.

Sri Lanka has one of the highest suicide rates in the world (Ganeswaran *et al*. 1984; Ministry of Health 1997). Intentional self-poisoning with agricultural pesticides is the commonest cause of hospital death in many rural districts, of far greater importance than all cardiac disease and all 'tropical diseases' combined (Ministry of Health 1997; van der Hoek *et al*. 1998). Self-poisoning is, however, a continually changing problem, as one method of poisoning becomes popular and replaces another. A new method has recently appeared in Sri Lanka and spread throughout the north of the island. It has become so popular that, although unheard

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of in many parts of the island only eight years ago, it now threatens to overwhelm the country's health services.

Yellow oleander (*Thevetia peruviana*; Apocynaceae) is cultivated throughout the tropics as an ornamental tree because of its beautiful yellow flowers (Figure 1; Pearn 1989). Unfortunately, its seeds contain highly toxic cardiac glycosides including thevetins A and B and neriifolin (Langford & Boor 1996). Ingestion of the seeds produces a clinical picture very similar to that of digoxin poisoning: vomiting, diarrhoea, dizziness, bradycardia, sinus and AV node block and other cardiac dysrhythmias (Sreeharan *et al*. 1985; Saravanapavananthan & Ganeshamoorthy 1988; Micromedex 1995). Fatal, DC shock-resistant, ventricular fibrillation or refractory cardiogenic shock may ensue in severely poisoned patients. Many patients with moderate poisoning show PR interval prolongation and progression to AV dissociation that must be treated with temporary cardiac pacing.

For many years, yellow oleander was a rare cause of accidental poisoning in Sri Lanka. Then in 1980, two schoolgirls in the northern city of Jaffna committed suicide by eating oleander seeds. Their story was widely reported in local newspapers and appears to have stimulated others to follow their lead – the city's hospital admitted 23 cases of intentional yellow oleander poisoning in 1981, 46 in 1982, and 103 in 1983 (Saravanapavananthan & Ganeshamoorthy 1988). The method has continued to gain popularity ever since and there are now probably several thousand cases each year across the north of the island. As part of a collaboration between Oxford and Colombo Universities, we have studied this epidemic of self-harm at Anuradhapura General Hospital, a secondary referral centre for the approximately 750 000 people living in Anuradhapura District.

Methods

Study site

Anuradhapura is a town of around 15,000 inhabitants that acts as the administrative centre of Anuradhapura District in the arid North Central Province of Sri Lanka. The district has a population of 750 000 of whom the great majority are rural farmers. The official statistics for 1991 give an infant

Figure 1 The yellow oleander tree (*Thevetia peruviana*) grows widely in gardens and hedges in northern Sri Lanka and many other regions of the tropics and subtropics. Its fruits are green when new but become black with time. Each fruit contains 2 seeds. Removing a seed's skin reveals the kernel, which is the part most commonly eaten in Sri Lanka.

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mortality rate of 21 per 1,000 live births and a maternal mortality rate of 45 per 100 000 live births for the district, compared to national means of 17.7 and 42, respectively (Ministry of Health 1997). Less than 6% of the population live in houses with piped water; 28% use unprotected wells or rivers. 26% of houses have no attached lavatory while 32% use pit latrines. The average income for a labourer is about 500 rupees (£6) per month (De Silva 1989).

Retrospective analysis

In Anuradhapura, all patient records are classified at discharge according to the International Classification of Disease: either version 9 (World Health Organization 1978) up to December 1995 or version 10 since January 1996. These records were searched for details of patient age, sex, and outcome (discharged/transferred or died).

Hospital records are forwarded every quarter to the Sri Lankan Health Statistics Unit in Colombo where district and national totals are compiled. The annual records for the districts of Anuradhapura, Polonnaruwa, Kurunegala, Colombo, and Galle were retrieved for the years 1983–95 for the following diagnoses: (i) organophosphate and carbamate poisoning (ii) other poisoning and toxic effects (iii) appendicitis, and (iv) normal vaginal delivery, using the ICD-9 classification.

Because of the ongoing war in Sri Lanka, there has been no national census since 1981 – all subsequent population figures have been estimates. Large-scale internal and external population displacements, variation in the use of medical facilities (particularly during the JVP uprising of the late 1980s), and difficulties in getting accurate statistical returns from some parts of the country will have affected the reported population of each district and therefore hospital admissions during this time.

We retrieved the data for appendicitis and normal vaginal delivery in an attempt to control for such variation. There was no indication of an increase in hospital admissions for these conditions which might have accounted for the large increase in self-poisoning admissions. Due to the lack of accurate population estimates for the 13 years, the 1994 estimate was used to calculate all incidences. There was an estimated 30% increase in population between 1981 and 1995 (Ministry of Health 1995, 1997) which, together with the absence of any large-scale increase in admissions for other conditions, suggests that population variation could not account for the marked increase in poisoning admissions during the last several years.

Prospective study

All patients admitted to Anuradhpura General Hospital with a history of yellow oleander poisoning were seen by one of the study physicans soon after their admission to a medical ward. After the ward nurses had attempted to induce vomiting, patients were questioned about the number of seeds taken, the time of ingestion, whether they had vomited soon after ingestion, why they had tried to harm themselves, and whether they had taken other poisons or alcohol in addition.

Patients were monitored on a three-lead ECG monitor and a 12-lead ECG was taken. A blood sample was taken for measurement of serum electrolyte and cardiac glycoside concentrations (Eddleston *et al*. unpublished observation). Patients were followed throughout their hospital stay and the outcome noted (died, transferred to Colombo, discharged well). It proved impossible to follow the patients once they had been transferred – patients who died in transit were not brought back to Anuradhapura in the ambulance and patients who were discharged from Colombo went home directly without returning to Anuradhapura. No system for following up these patients within the health service is currently in place.

Results

Anuradhapura General Hospital is a large government district general hospital receiving patients from across the province and referrals from areas to the north and east. Most patients present to more peripheral elements of the government health service. Poisoned patients are assessed in these health centres and symptomatic cases then transferred to Anuradhapura by ambulance for initial management. This journey can take over an hour, and the wait for an ambulance even longer since the province's ambulances have to cover a large number of health centres and are often not immediately available. Patients from the area surrounding the town are brought in three-wheel taxis or cars directly to Anuradhapura hospital by their relatives. All acutely ill patients go to the government service; the small private sector supplies only a very limited amount of care and nearly all of this is ambulatory.

Retrospective study

Retrospective study of the hospital's records revealed that 415 cases of intentional oleander poisoning were admitted in the 11 months between April 1995 and March 1996. During this same period, 323 cases were seen in the smaller Polunnaruwa General Hospital 100 kilometres to the south-east.

The Anuradhapura patients were young (mean 24.8 years, range 11–71) and predominantly female (F/M = 1.6 : 1). Many were very young – one 11-year-old presented to Anuradhapura and 12% of female cases were under 16 years (Figure 2). Young people in their second decade predominated – more than 50% of women and 35% of men were under 21.

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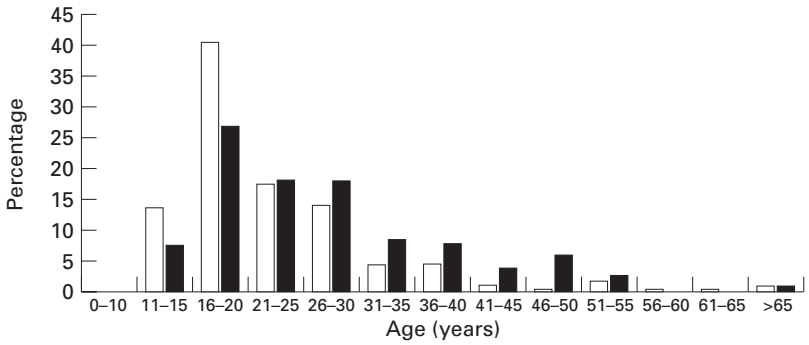

Figure 2 Age of male and female patients admitted with oleander poisoning to the adult wards of Anuradhapura General Hospital between April 1995 and March 1996. ■ Male; □ Female.

There is no central record of the number of oleander poisoning cases since the districts have only recently begun to collect separate statistics as the epidemic has soared. However, until 1996, oleander poisoning fell within the Sri Lankan classification of 'other poisoning and toxic effects' (World Health Organization 1978) and the incidence of this diagnosis has increased more than four-fold over the last seven years in Anuradhapura (Figure 3a). A similar situation exists in other northern districts such as Kurunegala (Figure 3a) and Polunnaruwa, but no such increase has

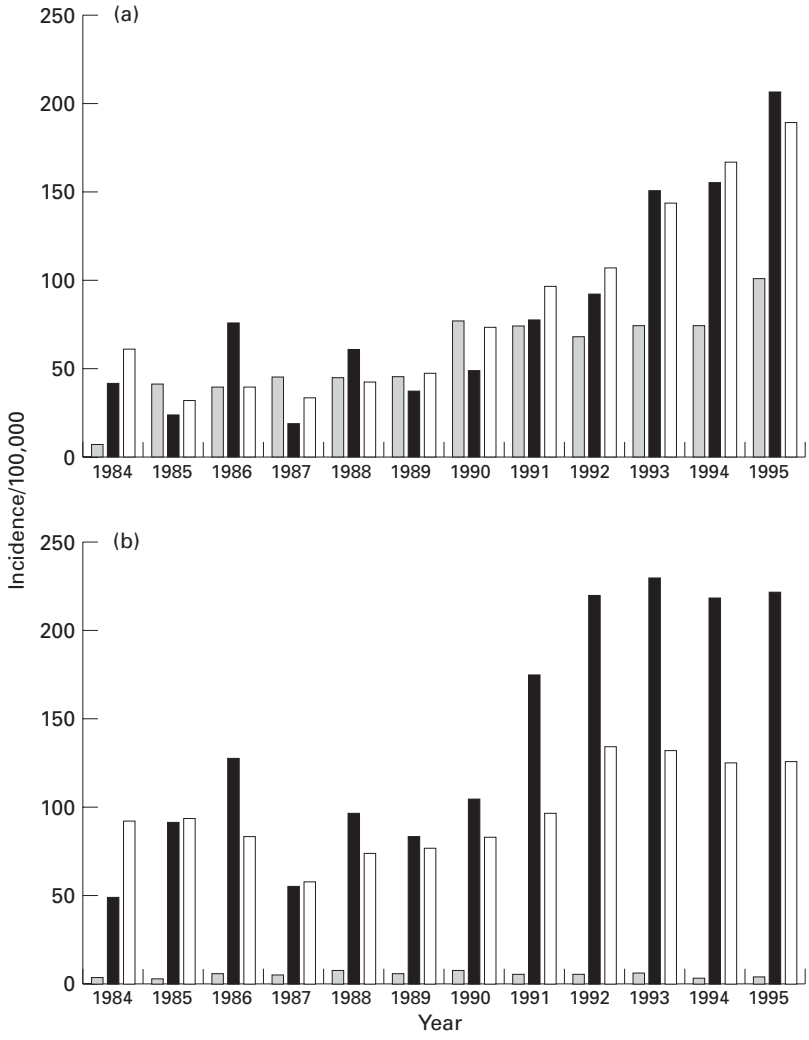

Figure 3 Incidence of (a) other poisonings and (b) organophosphate and carbamate poisoning in three Sri Lankan districts between 1984 and 1995. The incidence of both types of poisonings markedly increased in the more northern districts of Anuradhapura and Kurunegala. The recent small rise in 'other poisonings' in Colombo reflects the patients transferred with oleander poisoning to the capital's CCU from across the north of the island. ■ Colombo; ■ Anuradhapura; □ Kurunegala.

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occurred in the southern district of Galle. The recent small increase in numbers in Colombo (Figure 3a) represents the patients transferred from the northern half of the island to the city's CCU. The marked increase in incidence in the north does not simply reflect a change in method since the incidence of pesticide poisoning in this region also doubled during this time (Figure 3b).

Prospective studies

We followed 79 patients who presented to Anuradhapura General Hospital with oleander self-poisoning between June and September 1995 to evaluate morbidity and mortality. The commonest symptoms were vomiting and abdominal pain. Most patients with abnormal ECGs presented with bradycardia due to sinus bradycardia, arrest or exit block, or to AV node dysfunction (Figure 4). Two presented with supraventricular tachycardia. Five (6%) of 79 patients died soon after admission. Thirty-four patients (43%) either presented with or progressed into second or third degree AV block. These patients were transferred to the coronary care unit (CCU) 220 km away in Colombo for temporary cardiac pacemaking. The ambulance journey takes about four hours – for some patients this was too long a delay and at least one of our patients died during transfer. The remaining 40 patients were kept under observation in the medical wards for 24–48 h before being discharged without medication.

Formal psychiatric assessment was not possible. However, the oleander seeds were normally eaten with little premeditation, commonly in response to situations such as family arguments or love affairs which were disapproved of by family or community. The precipitating event in children was often relatively trivial – for example, being scolded for refusing to go to the shops or for getting up late. None of these patients had taken the seeds by accident; one said that she had taken it because of a bet with her sister. Most patients stated that they did not really want to die. Approximately 50% of the men but few women were under the influence of alcohol at the time of the attempt.

Lethal dose

Although previous authors have suggested that between four and seven seeds are a lethal dose (Sreeharan *et al.* 1985; Saravanapavananthan & Ganeshamoorthy 1988), we did not find any simple relationship between the number of seeds ingested and outcome. The six patients who died admitted to ingesting 10, 5, 8, 1, 5, and 2 seeds. In contrast, of the seven patients who reported eating 10 seeds or more, one died, two were transferred to the CCU and four were discharged well.

The timecourse was also quite variable. One patient remained in sinus rhythm for three days before developing second degree AV block which required transfer to Colombo. This is important since patients are normally only observed for 48 h before being discharged home.

Discussion

This epidemic of self-harm has been gaining momentum during the last 15 years. Saravanapavananthan and Ganeshamoorthy (1988) described 170 patients who had presented to Jaffna Hospital in the three years between 1981 and 1983. There are now thousands of cases each year and hundreds of deaths. Many children and young adults are dying in this epidemic, yet it is virtually unheard of outside of the hospitals that admit these patients.

In our study, 5 of 79 patients died in Anuradhapura. Studies from the Colombo CCU suggest that 5–10% of patients who reach them also die (Ranasinghe *et al.* 1995; Galappatthy *et al.* 1995). An unknown number die before reaching the secondary hospital or in transit between the secondary hospitals across the north of the island and the CCU. Ambulances are drawn from across the health region and the drivers are instructed to deliver any patients dying in transit to the nearest health post, so it was not possible to calculate accurately the number of deaths. Overall, the death rate is at least 10% and quite probably higher.

The large number of patients is straining the medical services. During 1995, each patient transferred from Anuradhapura was accompanied by one of eight medical house officers. Since these house officers have to supply 24-h cover for over 300 patients, the loss of just one is serious and this practice was therefore abandoned in early 1996. Patients are now sent to Colombo without an accompanying doctor. During one night, 7 patients with oleander poisoning were transferred to Colombo from the female ward alone, requiring the use of five ambulances.

In Colombo, the transferred patients also strain resources. Each patient occupies a bed in the CCU for 3–5 days and many require temporary pacing (on average for 2.2 days) (Galappatthy *et al.* 1995; Ranasinghe *et al.* 1995). On several nights, the CCU has received seven patients from northern hospitals for pacing – filling almost half (7/16) of their beds.

The timecourse and outcome after eating oleander seeds is highly variable. Sri Lankans usually eat the seeds whole which probably reduces the bioavailability of the cardiac glycosides. (In contrast, Tamils in south India crush the seeds to make a drink from which the cardiac glycosides might be more quickly absorbed.) Some Sri Lankan patients became poisoned after many hours suggesting that seed fragments are still present in the gastrointestinal system.

The seeds are highly irritant to the gastrointestinal tract, inducing persistent vomiting and diarrhoea in severe cases. The combination of alcohol and seeds, both of which can

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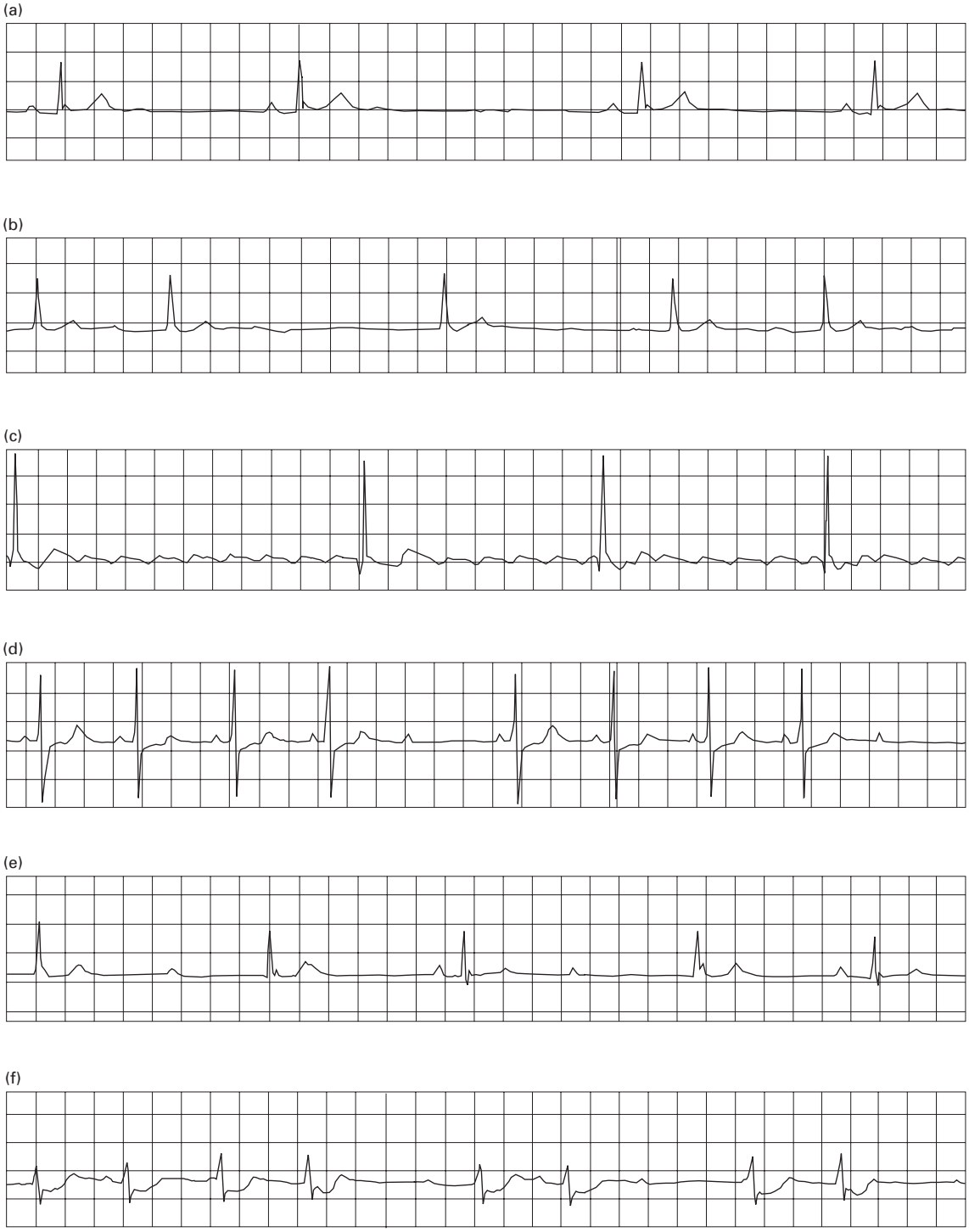

Figure 4 Cardiac rhythms of patients presenting with yellow oleander poisoning: (a) sinus bradycardia; (b) bradycardia with mixed atrial/nodal rhythm; (c) atrial flutter with variable AV block; (d) Mobitz type II 2nd degree AV block; (e and f) 3rd degree AV block with irregular ventricular escape rhythms. Most patients presented with sinus bradycardia, sinus arrest or exit block, and/or AV node block. The sites of escape rhythms often showed arrest or exit block. Ventricular tachydysrhythmias were uncommon and in our experience associated with a high mortality.

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induce vomiting, may explain why intoxicated men were rarely found to be seriously poisoned. The ingestion of 1–2 seeds by a young child was more dangerous since small amounts of seeds did not always induce vomiting. It proved more useful to monitor the degree of poisoning by following the cardiac rhythm rather than trying to infer it from the number of seeds said to have been taken.

International opinion is now turning against the use of gastric emptying in the management of acute drug overdoses (Vale 1997; Henry & Hoffman 1998). The use of activated charcoal is more widely promoted but, even here, there is no evidence that its use has any effect on clinical outcome (Chyka & Seger 1997). However, the situation with oleander poisoning may be slightly different in that the seeds are not fully broken down before ingestion and we have seen chunks in vomitus after gastric emptying. Future studies will need to determine the best method of gut decontamination in oleander overdose.

Although the yellow oleander tree is common throughout the tropics and subtropics, the use of its fruits for suicide attempts is only a problem in Sri Lanka and southern India. There have been no reports of its suicidal use in nearby countries where the tree is also common, such as Malaysia, Indonesia and Thailand[1], and only occasional reports from central and northern India (Modi 1988; Saraswat *et al.* 1992; Ahlawat *et al.* 1994). Accidental poisonings have been reported from across the world, for example the Solomon Islands, Brazil and Australia (Pearn 1989). However, intentional poisonings in these regions are very uncommon (Pearn 1989).

Control of this epidemic must involve both lowering the high incidence of deliberate self-harm in Sri Lanka and improving the medical management of these patients (Eddleston *et al.* 1998). Future socio-political stability in the island combined perhaps with local attempts to prevent acts of self-harm may have some effect. Further sociological and psychiatric research should help elucidate the cause of the epidemic.

However, in the immediate future, better medical treatments are urgently required both to relieve the burden that oleander poisoning is imposing on the medical services and to reduce the case fatality (Eddleston 1997). Polyclonal anti-digoxin antibodies (Antman *et al.* 1990; Kelly & Smith 1992) neutralize the cardiotoxic effects of common oleander leaves in dogs (Clark *et al.* 1991). These antibodies have also been used in clinical practice to treat poisoning due to ingestion of oleander leaves (Shumaik *et al.* 1988; Safadi *et al.* 1995) and bufadienolides (Centers for Disease Control & Prevention 1995; Brubacher *et al.* 1996). The response has been mixed and there has been no clinical trial to test their efficacy – all reports so far have been of single cases. It is essential that a clinical trial of these antibodies is carried out to determine their efficacy. The current cost of treating oleander poisoning will then need to be evaluated against the cost of the antibodies. If such therapy is judged to be economical and enters clinical practice in Sri Lanka, it will be important to determine whether the availability of an antidote for oleander poisoning influences its use for acts of deliberate self-harm.

[1] Personal Communications from: National Poisons Centre, Penang, Malaysia; Pharmacy, Dr. Soetomo Teaching Hospital, Surabaya, Indonesia; Medicinal Plant Information Centre, Mahidol University, Bangkok, Thailand.

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