ANALYSIS

Improving poisoning diagnosis and surveillance of street pesticides

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An effective surveillance system is required to reduce pesticide exposures and poisonings, especially from street pesticides (illegal, unlabelled, and decanted agricultural pesticides used predominately for urban household purposes). Poisoning from any pesticide class, not only organophosphates, constitutes a medically notifiable condition in South Africa. Current practice, however, is to report only organophosphate cases, resulting in severe under-reporting. The lack of data concerning the link between poisonings and street pesticides has led to the mistaken assumption that urban populations are not at risk from significant pesticide exposures and poisonings. Without accurate statistics, healthcare professionals and policy makers are unaware of the contribution of street pesticide poisonings to the overall health burden. Accurate diagnosis is a prerequisite for notification and subsequent surveillance. An algorithm has been developed to enable healthcare professionals to improve the diagnosis and notification of pesticide poisonings.

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Pesticide poisoning constitutes a notifiable medical condition in South Africa (SA) (National Health Act 61, 2003; referred to as 'poisoning agricultural stock remedies').[1] Legislation requires the notification of poisoning from any pesticide registered under Act 36 of 1947 to the national Department of Health (DoH). Despite this, current practice is to report only those resulting from organophosphate-containing pesticides (OPs). Failure to report poisonings from other pesticides – such as carbamates, pyrethroids, organochlorines and coumarin rodenticides – violates legislation and results in gross under-reporting,[2] leading to flawed national statistics and limited government commitment to mitigate the problem.

Extensive pesticide use and exposure in SA (Table 1) increases the potential for a high burden of poisoning and long-term health effects. These factors remain a low public health priority, however, as a result of difficulties in estimating overall burden.[3] Two problem areas, in relation to surveillance data, are the non- and misdiagnosis of poisoning cases.[4] Non-diagnosis results from the assumption that poisoning symptoms are due to some other cause (disease, illness or exposure). Even in the recognition of poisoning, the class of pesticide may be misdiagnosed (e.g. OP poisoning is assumed in the event of carbamate exposure). Both scenarios play a significant role in incorrect or non-treatment and in inadequate or non-notification.

Training in the diagnosis of and routine screening for pesticide exposure is inadequate, especially in relation to exposed urban populations and non-OP exposures. In a study of physicians in the USA, 69% had never made a pesticide poisoning diagnosis and 53% had not considered making such a diagnosis; a further 64% believed that they lacked sufficient education to address patients' questions about pesticides.[5] If pesticide exposure is not routinely considered in the diagnostic process – by conducting an environmental health history – the symptoms of patients attending urban healthcare facilities or those from non-agricultural areas may not be diagnosed adequately.[6] Symptoms of fatigue, nausea, sore throat, muscle cramps, headache and stomach cramps may well be treated as 'flu, when they also typically relate to pesticide exposure.[7] Incorrect diagnosis not only results in poor and ineffective treatment, but also impedes notification.

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Street pesticides

Accurate notification of poisonings plays a vital role in the monitoring and control of street pesticides – inexpensive and predominantly illegal products sold in SA at train stations, informal markets and taxi ranks, and door-to-door by vendors.[8] Laboratory results from samples of these pesticides reveal that the active ingredients are mainly organosphosphates (e.g. methamidophos, chlorpyrifos), pryrethroids (e.g. cypermethrin) and carbamates (e.g. aldicarb – the most acutely toxic pesticide sold).[9] While registered for agricultural use under Act 36 of 1947, these acutely toxic pesticides are illegally decanted and sold in concentrated or diluted form in unlabelled containers, or as granules. These readily accessible products are effective in controlling poverty-related pests (e.g. bed bugs, cockroaches, flies, and rats) and are less expensive than registered household products. For example, unlabelled aldicarb is colloquially referred to as 'two-steps', in reference to how many steps rats and mice take before death.[9]

A recent study linked child poisoning cases in SA to street pesticides and indicated that the incorrect documentation in clinical case notes may result in the underestimation of the prevalence of such cases.[10] The challenge for healthcare professionals is linking poisonings to products that are illegal, unlabelled and of varying formulations/concentrations. Street pesticides use occurs in many countries (e.g. the USA, Zimbabwe, Tanzania, Brazil, the Dominican Republic, Mozambique);[9] therefore, there is a global need to improve identification of the extent to which these pesticides contribute to morbidity and mortality.

Development of a pesticide poisoning algorithm

We established a Pesticide Policy Reference Group with multiple stakeholders from academia and government, to advise a multi-faceted project on street pesticides and child poisonings.[8,9] With ethics approval from the University of Cape Town (UCT), the project entailed: *(i)* collecting narratives of poisoning cases at Red Cross War Memorial Children's Hospital (RCWMCH) in Cape Town, *(ii)* conducting reviews of poisoned children's records, *(iii)* interviewing informal sellers of street pesticides, *(iv)* analysing samples of street pesticides, and *(v)* conducting a township-based household survey.[8,9] This research revealed that healthcare professionals face problems with the diagnosis, treatment and notification of poisoning cases – especially those involving street pesticides.

Table 1. Examples of extensive pesticide use in South Africa

Sector	Use (not exhaustive)	Comments
Agriculture	Crops Grain storage/silos Soil treatment Weed control Horticulture (fruit, flowers, greenhouse production)	Large commercial and small-scale farming operations
Borders	Mosquito control on commercial airlines Control of foot-and-mouth disease Phytosanitary control	Required spraying inside planes prior to flight by some destinations
Household	Insect control Rodent control Mosquito repellents Lice and scabies shampoo/lotion Flea/tick control on pets/animals Garden plants/pests (roses, snails) Fungicide-containing paints Germ/microbial control (soaps, disinfectants, mouth washes)*	Home and home garden uses by individuals and commercial pest control operators
Forestry	Removal of alien vegetation Timber treatments Fungal and insect treatments	Government or municipal operations
Leisure areas	Public parks and gardens Golf courses Sports grounds Hotels/resorts buildings and grounds	Commercial pest control operators or staff of company
Laboratories	Research	Industry, government, universities
Migratory pest control	Quelea bird control Locust control Other migratory pests	By government and farmers
Public health	Malaria control Community control of cockroaches, rats, bedbugs and other pests	Government or municipal operations
Public places	Schools Hospitals Public buildings (restaurants, shops and malls, churches) Office buildings Land fills Weed control on roads, pavements and verges	Commercial pest control operations
Transport	Movement of pesticide products on land and sea Fungicides on boat bottoms	Municipalities; government
Veterinary purposes	Livestock treatment Larvicides added to chicken feed for fly control Manage treatment Ear treatment	
Unregistered uses	Street pesticides Problem animal control Human self-harm Homicides Killing fish for consumption/sale	Agricultural pesticides decanted and sold for domestic use

* Registered as pesticides in other countries, but not in SA.

A specific concern was the identification of poisonings from exposure to unlabelled products. The review of the records of all suspected pesticide poisoning cases at RCWMCH between 2004 and 2006 (*N*=80) illustrated a link between suspected poisonings and street pesticides, and highlighted the importance of the provision of enough descriptive and appropriate information by physicians to establish this link (Table 2). While accurate statistics are not available owing to inherent complexity, this study estimated that at least 50% of suspected pesticide poisoning cases were related to street pesticides.

A critical issue is the standardisation of healthcare professionals' descriptive information to improve notification of these cases. Although resources are available to support healthcare professionals in

Table 2. Examples of case report poisoning narratives implicating street pesticides – RCWMCH 2004 - 2006

'Child was found by the aunt with presenting symptoms. His 12-year-old cousin said that the child had drunk from a juice bottle containing cockroach poison which was kept under the bed. The poison looked like milk.'

'Child was found eating flour – rat poison, unsure how much. It comes in black pellets, in unmarked plastic bags and was bought at the shop.'

'Mom brought poison from someone at the station – comes in pellet form. Poison mixed with food and left for mice to eat. Child was hungry so she ate poison/food mixture.'

'Mom bought rat poison from a street vendor – black granules, unlabelled in a box. She woke up and found the child with the dish of poison in his hands with the granules in his mouth.'

'Mother found child chewing on an unopened plastic, containing rat poison. Granules. Child found eating granules out of a small hole in the packet.'

'An unknown substance for cockroaches was sprayed in the room that the child slept in. The child was treated and discharged but returned the next day with the same symptoms. She presumably slept in the same room again.'

'A flea poison that was bought on the street was used on the child's bed for bed bugs and the child slept on the sprayed sheets.'

'Granny gave 5 ml of chlorpyrifos thinking it was cough syrup. She then notified the social worker once she realised what she had done.'

'Granny gave 1 tsp of cockroach poison to the child thinking it was flu medicine.'

'Mom accidentally gave child a teaspoon of cockroach poison. She thought that it was medicine given by hospital.'

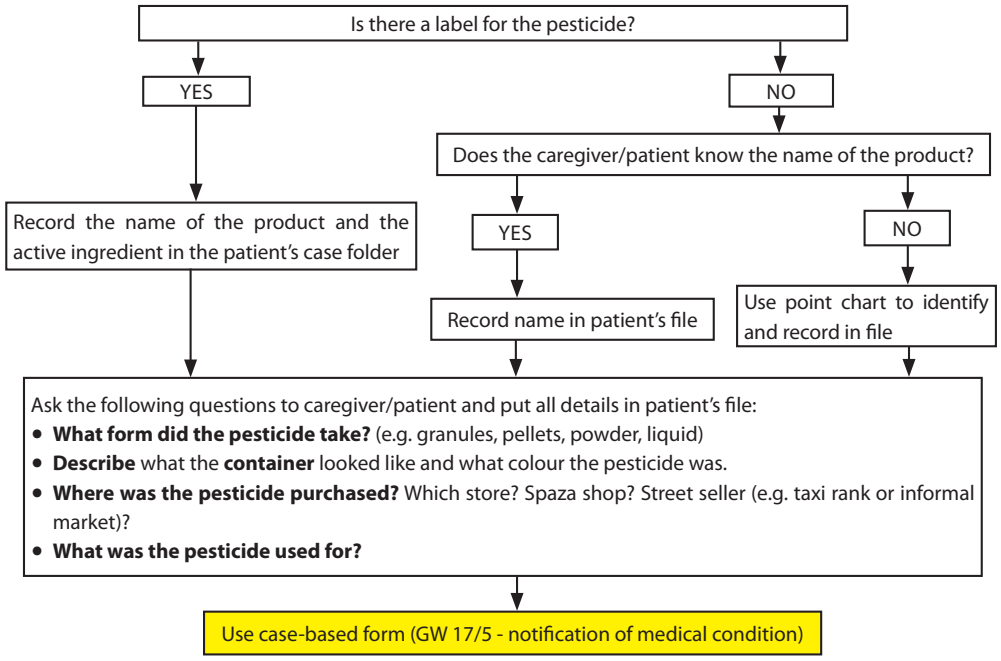
Improving notification of pesticide poisonings

IDENTIFYING TYPE OF PESTICIDE(S) INVOLVED

The first healthcare professional to come into contact with a patient presenting with pesticide poisoning is required by law to notify the Department of Health (http://www.doh.gov.za/docs/dns-fhtml).

Notify ALL pesticide poisonings regardless of the active ingredient. Do not report ONLY organophosphate poisonings.

Identify the pesticide involved and provide detailed information in the patient's file. Use the flow chart below:



Record all information in as much detail as possible so the national Department of Health (DoH) can monitor the occurrence of pesticide poisonings, develop and implement intervention strategies and scrutinise the strategies' effectiveness

Fig. 1. Algorithm for improving the notification of pesticide poisonings.

Table 3. Examples of pesticide active ingredients responsible for poisoning

Organophosphates	**Carbamates**
Methyl parathion	Aldicarb
Ethal parathion	Carbofuran
Malathion	Oxamyl
Diazinon	Methomyl
Fenthion	Formetanate
Dichlorvos	Methiocarb
Chlorpyrifos	Aminocarb
Trichlorfon	Mecarbam
	Bendiocarb
	Propoxur
Anticoagulants	
Brodifacoum	
Difethialone	
Chlorofacinone	**Herbicides**
Coumachlor	Glysophate
Difenacoum	Atrazine
Diphacinone	Nicosulfuran
Warfarin	Fenoxaprop
	Alachlor
	Pendimethalin
	Halosulfuran-methyl
Pyrethroids	Paraquat
Allethrin	Triclopyr
Bifenthrin	Clopyralid
Cypermeter	Picloram
Permethrin	
Deltamethrin	
Organochlorines	*N,N*-diethyl-meta-toluamide
Lindane (lice shampoo)	**(DEET — mosquito repellent)**

identifying signs and symptoms of pesticide poisonings, no literature is available via easily accessible resources to improve notification.

The Health Risk Management Programme (HRMP) at UCT therefore developed an algorithm for 'Improving Notification of Pesticide Poisoning' (Fig. 1) (http://www.coehr.uct.ac.za/publications/pestrel.php). The algorithm outlines the decision-making process to be followed when presented with a case of poisoning, particularly when the poison is unlabelled. To aid more accurate product (and active ingredient; Table 3) identification, it includes a point chart to enable caregivers/patients to point out the product (or a similar one) causing the poisoning. Regular algorithm monitoring and updating is required to ensure that it remains current, and research is needed to measure the algorithm's effectiveness in improving notification.

International poisoning surveillance

The algorithm is intended to promote compliance with international pesticide poisoning surveillance systems. SA is a signatory to the Rotterdam Convention, which requires countries to monitor severely hazardous pesticide formulations (SHPF): 'chemicals formulated for pesticidal use that produce severe health or environmental effects observable within a short period of time after single or multiple exposure, under conditions of use'.[11] In order for the convention to monitor and determine what constitutes an SHPF (e.g. street pesticide formulations), the Designated National Authority (DNA) in the country (the Department of Environmental Affairs in SA) must submit Pesticide Incident Report Forms (PIRFs) for poisonings from all pesticide classes. To comply with the Rotterdam Convention, the DoH replaced the old pesticide poisoning 'Epidemiological Investigation: Toxicology Form' with the PIRF in January 2011.[12] Although the PIRF will aid in reporting poisonings associated with street pesticides, the current linear system of reporting may prevent these cases from reaching the DNA and Rotterdam Convention Secretariat.

Conclusion

The algorithm presented here has the potential to assist the notification of all pesticide poisonings, but particularly those from street pesticides. Accurate surveillance data are needed to illustrate this public health problem and associated burden. Although efforts are being made by the DoH and the Department of Agriculture to remove these pesticides from the streets, prosecution of informal vendors will have little effect on limiting access to the products as long as the problem of poverty-related pests is not simultaneously addressed. Healthcare professionals will have to continue recognising poisonings from these products.

Through application and broad implementation of the algorithm, statistics on the scope of the problem might foster national and international commitment to better controlled access to highly hazardous pesticides. Further research is needed on alternative mechanisms to improve the current notification system (e.g. mobile phone texting reporting to a central database) and health professionals' training in pesticide exposure recognition. Use of the algorithm for improved reporting is an important first step, especially to protect vulnerable children and draw attention to the importance of notifying all pesticide poisoning cases, and not just those involving OPs. Finally, it should be noted that the current poisoning notification surveillance system does not address a registry for chronic health effects resulting from pesticide exposures.

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