Knowledge and Practices Relating to Acute Pesticide Poisoning Among Health Care Providers in Selected Regions of Tanzania

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ABSTRACT

BACKGROUND: Acute pesticide poisoning (APP) is commonly underdiagnosed in Tanzania. Studies in developing countries suggest that a lack of diagnostic skills among health care providers (HCPs) undermines surveillance for APP. This study aimed at characterizing experience and skills of Tanzanian HCPs regarding APP diagnosis and management.

METHODOLOGY: The population included HCPs responsible for managing APP in Kilimanjaro and Arusha regions (n = 91). The resulting sample included 66 respondents (response rate: 73%). The data were collected in 2005 using a standardized questionnaire.

RESULTS: Half of all respondents (50%) reported handling at least 1 APP case with 15% reporting handling more than 5 cases in the past. Reported experience of handling an APP case was marginally higher in respondents who reported ≥4 years of work experience in the health sector compared with those with <4 years of work experience (odds ratio = 1.32; 95% confidence interval = 0.9-1.5). Most of the respondents had high knowledge of exposure routes, reporting awareness of oral (98.5%), inhalational (93.9%), and dermal (77%) routes. The study revealed low awareness of pesticide classification by chemical groups (29%) or World Health Organization hazard (0%) and weak knowledge on pesticide label instructions (55%). Organophosphates accounted for 35% of the pesticide products reported by respondents as being responsible for poisoning. Some treatment options were incorrectly reported as first aid options, and some reported first aid options were wrong or inappropriate.

CONCLUSIONS: The study revealed that HCPs in northern Tanzania lack adequate skills to diagnose and manage APP. For effective surveillance of APP, there is a need to include training on hazards, classification, diagnosis, and health effects in the training programmes for all HCPs in Tanzania.

KEYWORDS: APP, knowledge, practice, HCPs, Tanzania

Introduction

Pesticide poisoning is a commonly underdiagnosed condition among farmers, particularly in rural areas and in many developing[1–3] and developed countries.[4] Generally, pesticide-related morbidity is higher in rural farming communities because these locations suffer a scarcity of health care workers needed to diagnose and treat acute pesticide poisoning (APP). Worldwide, studies report high proportions of farmers poisoned during pesticide application in Vietnam (61%),[5] Ivory Coast (55%),[6] India (83.6%),[7] Myanmar (40%),[8] and Pakistan (55%).[9] Health care professionals (HCPs), who are responsible for the diagnosis and management of APP, often receive limited training on pesticide hazards and management of pesticide-related illnesses and are sparsely available in rural areas, which often lack adequate health care facilities. Most of the HCPs often have limited experience of managing cases of APP due to the fact that many poisonings, in particular nonsevere occupational poisoning, are not presented to hospitals.[10–14]

This limited knowledge is exacerbated due to the fact that clinical toxicology is a dynamic field of medicine in which new diagnostic and treatment methods are constantly being developed, and the effectiveness of diagnostic and treatment techniques is constantly being updated. In addition, pesticides used by farmers change over time and new products require new diagnostic, first aid, and treatment approaches. In Tanzania, for example, there is a 5% to 10% turnover of new products each year. Lack of experience in the management of APP will therefore contribute to the inability of HCPs to diagnose and manage APP due to pesticide products with which they are not conversant. This means that surveillance systems that rely on diagnostic information from HCPs will be severely weakened if HCPs are not able to identify APP with any reliability or accuracy.

Yet, without these data, surveillance systems will be unable to capture the full extent of the problem nor effectively inform

appropriate preventive policies.[15] As a result, communities from which the data are derived are not aware of the magnitude of pesticide poisoning as a public health problem nor are they given the opportunity to take preventive actions or develop community solutions.[15]

The health care services in Tanzania are delivered and regulated by the Ministry of Health, Community Development, Gender, Seniors and Children. The structure of the health system starts at village facilities and dispensaries followed by health centres located in both rural and urban areas. The health centres refer upwards to district and private hospitals, regional hospitals, and, finally, referral hospitals at the apex of the referral chain. Health care professionals responsible for delivering health services at different levels include physicians, clinical officers or medical assistants, public health officers, and nurses, including nurse practitioners. Physicians are HCPs who are licensed to practice medicine. Clinical officers (also known as medical assistants) are HCPs trained to assist physicians in clinical procedures. Nurse practitioners are nurses trained to care for sick and injured patients and to assist physicians and clinical officers in providing clinical care. Public health officers are responsible for protecting and improving the health of a community through preventive medicine, health education, control of communicable diseases, application of sanitary measures, and monitoring of environmental hazards.

On average, the rate of medical doctors per capital in Tanzania in 2005 was 138 000:1, whereas that for clinical officers was 5000:1.[16,17] The distribution of HCPs in Tanzania is typical of developing countries. This is in contrast to most developed countries where the ratio of physicians exceeds 2 per 1000 of the population.[18]

Ngowi et al[19] reported poor competence among HCPs in the recognition, diagnosis, and management of pesticide poisoning cases, thought to be due to inadequate training in toxicology and occupational health.[19] The HCPs in the same study were also poorly equipped to deliver appropriate care to pesticide poisoning victims.[19] Similar findings of low awareness among HCPs of the problem of pesticide poisoning have been reported in other parts of East Africa,[20,21] South Africa,[3] Costa Rica,[22] and Côte d'Ivoire.[23]

Although Ngowi and colleagues[19] addressed Tanzanian health care worker practices in relation to the diagnosis and management of APP, no studies in Tanzania have examined HCP practices in relation to APP surveillance. This study therefore addresses the gap in HCP knowledge and practices related to surveillance of APP and also updates the study by Ngowi which was conducted more than 10 years ago, prior to the 1997 introduction of mandatory reporting in the health service under the Health Information Management System.

This study therefore aimed to characterize the knowledge and experience of HCPs in selected health facilities in Tanzania in the diagnosis and management of APP, common first aid measures, use of reporting systems, notification practices, and ability to interpret pesticide labels for the purpose of strengthening surveillance of APP among farmers and community.

Materials and Methods

Population and sample

The population included all physicians, clinical officers, and nurse practitioners working in Kilimanjaro and Arusha regions and who were directly responsible for diagnosing and treating potential APP cases. The Kilimanjaro and Arusha regions were chosen because they have agricultural activities typical of rural Tanzania and are geographically located close to Tropical Pesticides Research Institute (TPRI) that facilitated logistics for data collection.

An intended sample size of 91 participants was based on a priori estimate of 17% of HCPs treating cases of APP (as reported by Ngowi et al[19]), a confidence level of 95%, and a margin of error of 8%.

Data collection

Participants were interviewed using a semistructured questionnaire on their management of APP cases and how they record and report the cases through the Health Management Information System. They were also asked about their knowledge and practices that contribute to surveillance of APP, their knowledge on pesticide label instructions, their experience in handling APP, the type of first aid measures recommended for APP, and their knowledge of adverse health effects of pesticides, precautionary measures contained on pesticide labels, and the classification of pesticides by World Health Organization (WHO) hazard class and by chemical groups. The data were collected by the principal investigator and 2 assistants between January and December 2005. The assistants were laboratory technicians working at TPRI for more than 15 years in pesticide-related research. For the study, the technicians received refresher training on pesticide classification, first aid measures for pesticide poisoning, pesticide labels, and how to administer the questionnaire for HCPs.

The data collection tool was pretested in January 2005 using a small sample of HCPs (n = 10) in selected facilities in Arusha Municipality before use in the main study.

Data analysis

Univariate descriptive statistics were estimated for frequencies and percentages of all categorical or numerical variables. For the purpose of analysis, data were categorized as per Table 1.

Cross-tabulations were conducted as follows:

1. The variable knowledge on first aid (low vs high) was compared by the variable ever handled a pesticide poisoning and by years of working experience to identify associations with high knowledge of first aid measures.

Table 1. Categories of the data variables used in the study.

VARIABLE	CATEGORIES	INTERPRETATION
Having handled a pesticide poisoning case	Yes	Respondents who have ever handled a poisoning case
	No	Respondents who have never handled a poison case
Knowledge on first aid	Low knowledge	Respondents reporting only 1 correct first aid option
	High knowledge	Respondents reporting ⩾2 correct options
Knowledge on routes of exposure	Low knowledge	Respondents reporting ⩽2 correct routes of exposure
	High knowledge	Respondents reporting 3 or more correct routes of exposure
Familiarity with adverse health effects	High familiarity	Respondent reporting 'Yes'
	Low familiarity	Respondents reporting 'No or only fair familiarity'
Knowledge on pesticide classification	Low knowledge	Respondents reporting no knowledge of any correct chemical group
	High knowledge	Respondents reporting ⩾1 correct chemical group
Years of work experience	Short experience	Respondents with <4 years' experience
	Long experience	Respondents with >4 years' experience
Education level	Low education level	Diploma or less
	High education level	Higher than diploma
Health care facilities	Government	Facilities owned by government
	Private	Facility owned by private firms

2. The variable familiarity with adverse health effects (low vs high) was compared by respondents' educational level to identify whether education was associated with high familiarity with health effects of pesticides.
3. The variable knowledge on pesticide classification (low vs high) was compared by respondents' education level to identify whether education was associated with high knowledge of the WHO pesticide classification system.
4. The variable knowledge on routes of exposure (low vs high) was compared by respondents' years of working experience to identify whether years of experience was associated with high knowledge of routes of exposure.
5. The variable ever handled a pesticide poisoning case vs never handled any case was compared with respondents' years of working experience to identify whether increased years of experience was associated with treating cases of APP.
6. The variable high education vs low education was compared with years of working experience to identify whether long service was associated with education level.
7. The variable type of health care facility (Government or private) was compared with knowledge on first aid, knowledge on routes of exposure, familiarity with health effects, knowledge on pesticides classification, level of education, years of working experience, and status of handling of APP cases.

χ^2 testing was used to compare distributions of dichotomous variables. To measure the strength of association between categorical independent and dependent variables, prevalence risk ratios were estimated with 95% confidence intervals. SPSS statistical package version 16[24] and Stata Version 10.0[25] were used to analyse the data.

Ethical considerations

Participants gave informed consent prior to participation in the study and were free to decline participation without any fine or penalty. To ensure confidentiality, names were replaced by special codes, which were used in data analysis. The participants were assured that their responses would not affect their performance assessments by their managers. The study protocol was approved by TPRI ethical committee and the National Institute of Medical Research in Tanzania (REF NIMR/HQ/Vol XI/371) as well as the University of Cape Town Health Sciences Faculty Research Ethics Committee (328/2004).

Results

Of the 91 HCPs approached, 25 declined to participate, leaving a sample of 66 HCPs from 32 facilities who were finally interviewed, representing a response rate of approximately 73%. In most facilities, there were 1 or 2 respondents (Table 2). However, in the larger facilities, the number of respondents ranged up to 6.

Table 2. Health care providers interviewed by facility in northern Tanzania.

REGION	FACILITY	NUMBER INTERVIEWED	FACILITY STATUS	GOVERNMENT OR PRIVATE
Arusha	Arumeru	1	District Hospital	Government
Arusha	Bagari	1	Dispensary	Private
Arusha	Ithanasheri	4	Hospital	Private
Arusha	Leguruki	2	Health centre	Government
Arusha	Mbuguni	2	Health centre	Government
Arusha	Mount Meru	1	Regional Hospital	Government
Arusha	Nambala	2	Dispensary	Private
Arusha	Nsengon	1	Dispensary	Government
Arusha	Olasiti	1	Dispensary	Private
Arusha	Old Arusha Clinic	3	Hospital	Private
Arusha	Shree Hindu	6	Heath centre	Private
Arusha	Saint Elizabeth	2	Hospital	Private
Arusha	TAG	1	Dispensary	Private
Moshi	KCMC	5	Referral Hospital	Government
Moshi	Mawenzi	5	Regional Hospital	Government
Arusha	Elerai	2	Dispensary	Private
Arusha	Karangai	1	Dispensary	Government
Arusha	KIA	1	Health centre	Private
Arusha	Kikatiti	1	Dispensary	Private
Arusha	Kimnyaki	1	Dispensary	Government
Arusha	Kisongo	2	Dispensary	Private
Arusha	Kwale	2	Dispensary	Private
Arusha	Maji ya chai	2	Dispensary	Government
Arusha	Maroroni	1	Dispensary	Government
Arusha	Nduruma	1	Health centre	Government
Arusha	Moshi Arusha Occupational Health	1	Hospital	Private
Arusha	Patandi	1	Dispensary	Private
Arusha	Poli	1	Dispensary	Government
Arusha	Sikh Temple	1	Dispensary	Private
Arusha	Selian	3	Hospital	Private
Arusha	Kingori	1	Dispensary	Government
Arusha	Levolosi	1	Health centre	Government

Abbreviation: KCMC, Kilimanjaro Christian Medical Centre.

Most of the respondents were men (63.7%) and they were from both private (53%) and government (47%) facilities in Arusha and Kilimanjaro regions. The facilities included a referral hospital, 2 regional hospitals, a district hospital, and 5 other private hospitals, health centres (n = 6), and dispensaries (n = 16). Most of the respondents were clinical officers (57.5%) and their experience in medical services ranged from 1 to more than 24 years. Although the largest category had experience of

5 years or less (55%), the range of experience was wide and there were 3 participants with experience of more than 20 years in the field (Table 3).

Respondents' most frequent responses regarding knowledge on first aid and treatment in cases of pesticide poisoning included washing the contaminated area with water (n = 23), inducing vomiting if ingested (n = 22), and giving the poisoned victims fresh milk (n = 19). Nineteen respondents (30%) reported they do not know any first aid or treatment strategy used for victims poisoned by pesticides (Table 3).

Table 3 indicates that many responses listed treatment options that were either incorrect or inappropriate, reported as first aid, such as administration of atropine or intravenous fluids, use of antihistamines, use of antibiotics, gastric lavage, or first aid measures (17.6%). For example, giving milk, antibiotics, and hydrocortisone are both ineffective and potentially dangerous; the use of personal protective equipment (PPE) is only useful for prevention, and isolation of the victim is plainly mistaken (Table 3).

Exactly, 50% of the respondents reported that they had never previously handled a pesticide poisoning case, 34.8% reported handling between 1 and 5 cases, and 15% handling 6 or more cases (Table 4). The proportion of respondents who have handled an APP case was marginally higher among staff with long work experience (odds ratio = 1.32; 95% confidence interval [CI] = 0.9-1.5) compared with low experience.

When asked about the availability of medical laboratory testing, 53% of respondents indicated that their facilities had laboratories available on site, but none conducted any testing for biomarkers to diagnose pesticide poisoning. All the respondents reported having no standard diagnostic procedure for APP, and all reported that they documented poisoning cases in the general Health Statistics Abstracts Reference Books ('Mtuha') and patient register book. Reporting poisoning cases and other disease conditions in this register is mandatory according to the Ministry of Health, Community Development, Gender, Seniors and Children.

Familiarity with adverse health effects of pesticides reported by respondents was poor. Only 5 respondents (8%) reported having a high familiarity with the health effects of pesticides, whereas 50% admitted to having no awareness of pesticide toxicity (Table 4). However, a much higher proportion reported knowledge of routes of absorption. Most of the respondents reported knowledge of possible pesticide exposure routes as oral (98.5%) and inhalational (93.9%), whereas knowledge about absorption through the skin as a route was slightly lower (77%; Table 4).

Most of the respondents (71%) were unaware of the classification of pesticides by chemical group, and all respondents were unaware of the WHO hazard classification system for pesticides. Pesticide chemical groups reported correctly by the respondents included organophosphates (37.8%), organochlorines (12.1%), carbamates (12.1%), and pyrethroids (1.5%).

Table 3. Experience and knowledge of health care providers (n = 66).

VARIABLE	N
Occupation of respondents	
Medical assistant or clinical officer	38
Medical officer	18
Assistant clinical officer	8
Nurses with special qualification to treat	2
Years of experience	
1-5	36
6-10	20
11-20	7
20+	3
Education level	
Certificate	6
Diploma	42
Degree	18
Knowledge on first aid and treatment in case of pesticide poisoning[a]	
Do not know	19
Atropine injection	8
Gastric lavage	14
Keep airway clear	4
Wash contaminated area	23
Administer antihistamine	8
Administer IV fluid if necessary	18
Administer inactivated charcoal if indicated	3
Administer oxygen if necessary	2
Administer fresh milk	19
Give water	3
Give health education	1
Induce vomiting if ingested	22
Hydrocortisone injection	1
Monitor vital signs	3
Isolate victim	1
Place in a ventilated area	3
Administer antibiotics	3
Give cream	1
Use PPE	1

Abbreviations: IV, intravenous; PPE, personal protective equipment.
[a]Respondents could give more than 1 answer; answers were not mutually exclusive.

Table 4. Experience and knowledge of health care professionals on the management of pesticide poisoning in northern Tanzania (n = 66).

VARIABLE	EXPERIENCE AND KNOWLEDGE/PARAMETER	PERCENTAGE (N = 66)
Availability of medical laboratory testing at the facility	Available	53
Availability of laboratory testing for the diagnosis of APP at the facility	Available	0
Self-reported familiarity of the respondents with adverse pesticide health effects	Low familiarity	92
	High familiarity	8
Knowledge of pesticide entry routes to the body (responses not mutually exclusive)	Dermal	77
	Oral	98
	Inhalation	94
	Wound	2
	Eyes	2
	Blood	2
Ever handled a pesticide poisoning case	Yes	50
No. of cases handled	0	50
	1-5	34.8
	6-10	9.1
	10+	6.1

Abbreviation: APP, acute pesticide poisoning.

Most respondents (55%) reported that they had no knowledge of pesticide label safety instructions. Of the 45% reporting some knowledge, the most common label instructions reported by respondents included instructions regarding storage out of reach of children (n = 30) and use of PPE (n = 27). Less common instructions reported were related to washing after handling (n = 7), refraining from eating while handling pesticides (n = 8), keeping pesticides away from food (n = 4), and avoiding pollution of the environment or water bodies (n = 5). Eleven respondents (17%) reported awareness of the signal word 'poisonous'.

Products reported by the HCPs as commonly associated with poisoning included both specific agents (n = 31) and non-specific agents (n = 19). Organophosphates comprised 35% and pyrethroids comprised 16% of specific agents named. However, most commonly, the respondents were not able to specify a specific pesticide agent (n = 35; Table 5).

Associations with knowledge among HCPs

There were marginally significant associations between educational levels of the respondents and high familiarity with pesticide health effects (Prevalence Risk Ratio [PRR] high educated/low educated = 2.44; 95% CI = 1.05-5.65) and with high knowledge of pesticides classification (PRR high educated/low educated = 2.8; 95% CI = 1.3-6.2; Table 6).

There was a significant association between the status of health care facility with high knowledge on pesticide classification (PRR private facility/government facility = 1.5, 95% CI = 1.1-2.1) (Table 7).

Discussion

This study updates and expands the scope of a previous investigation in Tanzania (Ngowi et al[19]) into health care provider's knowledge and practices regarding poisoning arising from pesticides. The profile of pesticide agents now reflects usage shaped by Tanzania's ratification of the Stockholm and Rotterdam conventions, domesticated into National Law, as a result of which there are newer active ingredients and formulations which demand a new investigation of knowledge and practices. Moreover, this study includes vegetable growing areas, with smaller production units, and including smaller health care facilities. Most importantly, this study generates information for the first time on reporting of APP by health workers through local health information systems, a crucial element for effective public health surveillance of APP.

The respondents in this substudy were HCPs who had working experience ranging from 1 to 24 years. The study revealed poor knowledge on pesticide poisoning management, lack of familiarity with the adverse health effects of pesticides, low knowledge about pesticide chemical groups, and WHO categories but better knowledge about routes of dermal

Table 5. Agents reported to be associated with poisoning as experienced by the health care professionals in northern Tanzania.

PRODUCT	CHEMICAL GROUP	WHO HAZARD CLASS	FREQUENCY
Reported by active ingredient			
Zinc phosphide	IN	Ib	4
Copper	IN	III	2
Chlorpyrifos	OP	II	3
DDT	OC	II	2
Cypermethrin	PY	II	2
Profenofos	OP	II	5
Deltamethrin	PY	II	3
Paraquat	OT	II	2
Diazinon	OP	II	2
Bromodiolone	OT	I	1
Sulphur	IN	U	2
Endosulfan	OC	II	2
Amitraz	CA	II	1
Subtotal			31
Reported by general term			
Acaricides	—	—	5
Bed bug insecticide	—	—	1
Fumigant	—	—	2
Herbicide	—	—	1
Insecticide	—	—	3
Flower spray	—	—	1
OP	—	—	5
Rat poison	—	—	1
Subtotal			19
Unknown			35

Abbreviations: CA, carbamates; IN, Inorganic; OC, organochlorines; OP, organophosphates; OT, Other categories; PY, pyrethroids; WHO, World Health Organization.

exposure. One intuitive explanation is that clinicians with longer working experience likely may have handled APP cases which might have made them more knowledgeable. However, this was not supported by data in Table 6 where long service was not associated with any of the knowledge measures. Another explanation could be the fact that the respondents interviewed in the study period who were more recent graduates did not cover details about pesticides and their toxicity in their study curriculum, and APP was not given much priority

due to a perception that it is rare in hospitals. This may explain why many poisoning agents are frequently reported with non-specific names for the causative agents, such as acaricides, bed bug insecticide, flower spray, and other 'unknown' terms. This clearly limits the extent to which HCP reports can support effective surveillance for APP.

Most of the respondents had little experience in the management and treatment of APP. Half of the respondents reported that they had never handled any pesticide poisoning cases, and among those who had, most had attended 5 or fewer cases in their careers. One reason for low experience could be the fact that pesticide poisoning cases are infrequently present to hospitals in Tanzania,[19,26] a finding also reported in India.[27] This implies that HCPs infrequently come into contact with APP cases. Alternatively, if they did attend cases but the diagnosis was missed, the provider did not know that they had treated an APP case.

The study also revealed that a large proportion of respondents had misconceptions about appropriate first aid. For example, 19 respondents (29%) considered milk a first aid option for APP and about one-third of respondents (33%) reported inducing vomiting as one of the options for first aid for APP. In fact, providing milk may give a false sense of security and delay proper treatment and hence may increase health risks. Similarly, induction of vomiting is not appropriate for all products and may be contraindicated for certain agents. For example, pyridyls are corrosive products which can damage the oesophagus and upper airway if vomiting is induced. If the victim is unconscious, inducing vomiting could also result in potentially fatal aspiration of vomitus. The recommendation of using milk reflects a widespread misconception among HCPs. A previous Tanzanian study involving extension officers between 1991 and 1993 also reported the use of milk and inducing vomiting as options for first aid, along with other options such as use of lamb oil, fresh cattle dung, and salted water.[28] This suggests that perceptions about the use of milk as an antidote for poisoning is prevalent among not only HCPs but also the agriculture extension officers. Misconceptions about the use of milk as an antidote to a range of workplace hazards are widespread in the region.[29,30]

A similar study conducted in United States involving a survey of primary care physicians revealed poor knowledge of the health risks associated with agriculture, and it recommended the training of HCPs working in rural areas to address these health problems.[31]

The responses regarding the availability of laboratory testing indicate that although laboratories are available, none conduct any testing specific to diagnose pesticide poisoning. This finding agrees with data from record reviews at health care facilities in Tanzania in which most of the cases were diagnosed through history and clinical signs.[32] This probably reflects a lack of equipment, expertise, and necessary consumables. The lack of laboratory capacity to confirm diagnosis, a

Table 6. Associations of knowledge about pesticides with work experience, education, and management of APP among HCPs in northern Tanzania.

VARIABLE		KNOWLEDGE		*P* VALUE[a]
KNOWLEDGE ON FIRST AID				
		N	HIGH KNOWLEDGE (%)	
Ever handled APP case	Yes	32	31.4	.67
	No	34	26.5	
Years of working experience	Low	16	25	.70
	High	50	30	
Level of education	Low	48	31.3	.47
	High	18	22.2	
KNOWLEDGE ON ROUTES OF EXPOSURE				
		N	HIGH KNOWLEDGE (%)	
Ever handled APP case	Yes	32	65.5	.21
	No	34	79.4	
Years of working experience	Low	16	62.5	.29
	High	50	76.0	
Level of education	Low	48	27.1	.95
	High	18	27.8	
FAMILIARITY WITH HEALTH EFFECTS				
		N	HIGH FAMILIARITY (%)	
Ever handled APP case	Yes	32	9.4	.59
	No	34	5.9	
Years of working experience	Low	16	0.0	.18
	High	50	10.0	
Level of education	Low	48	4.2	.08
	High	18	16.7	
KNOWLEDGE ON PESTICIDE CLASSIFICATION				
		N	HIGH KNOWLEDGE (%)	
Ever handled APP case	Yes	32	37.5	.21
	No	34	23.5	
Years of working experience	Low	16	37.5	.47
	High	50	28.0	
Level of education	Low	48	20.8	.006
	High	18	55.6	

Abbreviations: APP, acute pesticide poisoning; HCPs, health care professionals.
[a]'*P*' value is based on χ^2 test.

widespread phenomenon worldwide, for example, in India[33] and also in the Southern African region,[34] may contribute to underdiagnosis of APP cases reported in hospitals. If few cases are formally diagnosed, few will be reported, and surveillance data will underreport the extent of the problem and policymakers may not see the importance of building capacity

Table 7. Association of status of health facility and knowledge on first aid, knowledge on routes of exposure, familiarity with health effects, knowledge on pesticide classification, level of education, years of working experience, and handling of APP cases among HCPs in northern Tanzania.

FACILITY	VARIABLE		P VALUE[a]
KNOWLEDGE ON FIRST AID			
	N	HIGH KNOWLEDGE (%)	
Government	23	30.4	.82
Private	43	27.9	
KNOWLEDGE ON ROUTES OF EXPOSURE			
	N	HIGH KNOWLEDGE (%)	
Government	23	73.9	.87
Private	43	72.1	
FAMILIARITY WITH HEALTH EFFECTS			
	N	HIGH KNOWLEDGE (%)	
Government	23	8.7	.80
Private	43	7.0	
KNOWLEDGE ON PESTICIDES CLASSIFICATION			
	N	HIGH KNOWLEDGE (%)	
Government	23	13.0	.02
Private	43	39.5	
LEVEL OF EDUCATION			
	N	HIGH EDUCATION (%)	
Government	23	21.7	.46
Private	43	30.2	
YEARS OF WORKING EXPERIENCE			
	N	HIGH WORKING EXPERIENCE (%)	
Government	23	82.6	.34
Private	43	72.1	
EVER HANDLED APP CASE			
	N	YES (%)	
Government	23	39.1	.27
Private	43	53.5	

Abbreviations: APP, acute pesticide poisoning; HCPs, health care professionals.
[a]'P' value is based on χ^2 test.

for laboratory diagnosis, which in turn exacerbates the problem of underreporting. There is therefore a need to advocate for better diagnostic facilities, especially in rural health facilities to make the laboratory diagnosis of APP possible. Also, given that there is poor knowledge among HCPs, better training in clinical diagnosis is also critically important.

The role of Poison Control Centres (PCCs) in providing guidance to health professionals has been noted as an important strategy in some countries.[35] However, as the WHO[36] points out, many parts of the world lack access to PCCs, particularly Africa and parts of the Eastern Mediterranean and Western Pacific regions, and there is no fully operational PCC in Tanzania able to provide this kind of support to health care providers facing a case of possible APP. In a continent so lacking in key human resources for health, addressing this gap through establishing a PCC is an ambitious goal which is unlikely to be realized without sizable donor support and careful attention to sustainability.

Most of the HCPs (55%) could not report any safety instructions when interpreting pesticide labels. Failure to interpret the label information may result in poor diagnosis and treatment as the label carries important information for the diagnosis and management of APP. Even if the label is available in an APP case, it would appear that the HCP will not be able to interpret the label and handle the patient appropriately. Taking into account that laboratory diagnosis is unavailable, HCPs should be trained on, among other things, how to interpret label information for the identification and treatment of APP cases. This is particularly important, given the lack of a PCC in Tanzania able to provide timely and accurate guidance on pesticide poisoning to HCPs, a problem common to much of Africa and parts of the Eastern Mediterranean and Western Pacific regions.

It is striking that the proportion of HCPs reporting previous experience in managing a case of pesticide poisoning was much lower in this study (50%) than reported by Ngowi et al[19] (80%). The difference could be due to the nature of facilities visited. Although the study by Ngowi and colleagues visited mainly dispensaries and lower level facilities (65.3%), this study included fewer health care workers from dispensaries (44%). Because dispensaries are mostly located in rural areas they are more likely to attend to poisoning cases, potentially including less severe occupational injuries. Health care professionals working in these facilities may therefore have more experience in handling APP cases. Because facilities with higher status, for example, hospitals, receive more severe cases, which are less common, this could account for the smaller proportion of HCPs in this study experienced in the management of poisoning cases. The findings in this study are consistent with that of a study conducted in East Africa more than a decade ago,[20] which found that more than 40% of the HCPs interviewed could not recognize pesticide poisoning cases.

The problem of management of APP found in this study is also a problem in developed countries. For example, in a study conducted in Washington, DC, and surrounding areas, it was reported that most of the HCPs interviewed frequently did not diagnose pesticide toxicity from patient history and examination. Most relied on PCC for assistance with management of APP cases. They expressed less understanding and more uncertainty about chronic toxicity. Exactly 64% of practitioners and

69% of nurses felt poorly prepared to answer patients' questions. In all, 40% of practitioners and 26% of nurses felt that it was important to obtain more information on pesticides.[37]

This study found that knowledge about pesticide classification was significantly higher in private than government facilities (39.5% vs 12.0%; *P* = .02). This could arise from the fact that the proportion of health care workers who have handled APP was somewhat higher in private facilities than government facilities (53.5% vs 39.1%) but not statistically significantly so (*P* = .27). By handling APP cases, HCPs may come across different agents and their labels or containers, and this may, over time, make them knowledgeable. It may also be the result of private facilities being able to attract HCPs with greater education because knowledge about pesticide classification and adverse health effects of pesticides was higher in respondents with high education (Table 6). This association is to be expected as respondents who are graduates usually receive more intensive training, and hence would be likely to have more knowledge on pesticide health effects and classification.

Regarding documentation of poisoning cases, it was found that all HCPs reported documenting all poisoning cases in the Health Statistics Abstracts Reference Books ('Mtuha') and patient register book. However, this may be an overstatement because, in theory, documentation of poisoning cases is mandatory. Other Tanzanian studies in the same period found serious problems in HCP reporting – incomplete registers, damaged pages,[32] as well as failure to record cases.[26]

Regarding agents, the study found that most of the specifically known agents reported to be associated with poisoning (87%) were of WHO class I or II. These products are, by definition, either highly or moderately hazardous, and their association with poisoning by the HCPs was consistent with their toxic nature. Although these products are restricted in Tanzania, their handling and use are not well controlled due to weaknesses in enforcement. Furthermore, among the specifically known agents, 25% of the products reported as associated with APP were OPs. Organophosphates are cholinesterase-inhibiting agents, and although they were reported in low proportion in this substudy, their involvement in poisoning cannot be underestimated. The proportion of unknown agents (41.3%) was high indicating that many HCPs either rarely handle APP cases or the limited cases reported to them lack information.

Study limitations

The study results may be weakened by a number of possible biases:

Information bias. Health care professionals might have claimed greater familiarity with adverse health effects of pesticides than actually was true, implying that knowledge and familiarity might, in reality, have been worse than found in this study.

Selection bias. Selection bias might also have affected the findings in that HCPs who declined to participate might

have done so because they were not conversant with APP or may have been reluctant to disclose their lack of experience in managing APP. Again, this implies that estimates for knowledge and for experience with APP reported in the study were likely to be overestimated than is the case in reality – ie, a problem of over-reporting. However, the omission of the HCPs from facilities in far-off remote areas may countereffect this overestimation if nonparticipants were used to seeing APP cases. Consequently, the direction of misclassification due to this selection bias is not obvious.

Representativity. The health facilities involved in the study included at least 1 respondent from referral hospitals, regional hospitals, district hospitals, health centres, dispensaries, and other hospitals. Although not selected in a truly random manner, the spread of facilities and practitioners suggest that the sample includes HCPs who typically staff such facilities and see cases of APP. Nonetheless, it is possible that the sample of facilities may differ from other facilities in the country. The findings should not be generalized without further studies to confirm the patterns in a representative sample of HCPs.

Reporting bias. Although interviews were conducted on an individual basis, in some situations respondents had opportunity to interact with other interviewed respondents before they underwent their own interview. In such situations, their answers were potentially influenced by their colleagues resulting in some degree of homogeneity of reporting. This would cause respondents to provide unrealistic responses which could have either underestimated or overestimated the knowledge and practices of HCPs in relation to APP.

Another important limitation is recall bias. Respondents may have poor memory of some events in particular events that took place more than 3 months earlier. This may partly explain low reported experience with APP.

Conclusions

The findings suggest that most HCPs in the selected health care facilities in northern Tanzania lacked adequate skills in the diagnosis and management of APP and had very poor knowledge about what to do about APP. The limited ability to diagnose APP cases results in failure to recognize all poisoning cases arising from pesticide exposure, and this contributes to underreporting of APP cases. A strong surveillance system requires HCPs who are sufficiently skilled to make the diagnosis of APP and report it effectively.

To fill this gap, there is a need to include training on pesticide hazards, classification, and health effects in the training programmes for all categories of HCPs in Tanzania. To develop practical skills, it is recommended that HCPs undergo practical training at institutions with experience in the management and study of pesticides, such as the TPRI, which is the sole institution dealing specifically with pesticides in Tanzania and

therefore best placed to support clinicians in matters related to pesticides. Currently, TPRI has training programmes on pesticides in place conducted twice annually.

Although this study was undertaken in 2 regions of northern Tanzania, and can only be generalized to these areas, the services and farming areas are fairly typical of other part of Tanzania. For this reason, it is believed that the findings might well reflect a similar situation in the rest of the country. However, there is a need to conduct further studies in other parts of Tanzania to see whether the findings are replicated.

Author Contributions

EEL designed the study, oversaw data collection in the field, conducted the data analysis, and led the interpretation and drafting and revisions of the manuscript. AVN guided the study design and data collection and participated fully in the interpretation of findings, comments on the manuscript, and its revisions. HM participated fully in the interpretation of findings, comments on the manuscript, and its revisions. LL guided the study design, statistical data analysis, and interpretation and commented on the manuscript and its revisions. All authors read and agree with manuscript results and conclusions and finally approved the final manuscript.

Disclosures and Ethics

The study protocol was approved by the National Institute of Medical Research (NIMR) in Tanzania (REF NIMR/HQ/Vol XI/371) as well as University of Cape Town (UCT) Health Science Faculty Research Ethics Committee (REF:328/2004). Consent for participation was implemented by signing a special form which was administered by the researcher. The authors have read and confirmed their agreement with the ICMJE authorship and conflict of interest criteria. The authors have also confirmed that this article is unique and not under consideration or published in any other publication, and that they have permission from rights holders to reproduce any copyrighted material. The external blind peer reviewers report no conflicts of interest.

REFERENCES

1. Kuye RA, Donham KJ, Marquez SP, et al. Pesticide handling and exposures among cotton farmers in the Gambia. *J Agromedicine*. 2008;12:57-69.
2. Ngowi AVF, London L. Action on pesticides under the program on work and health in southern Africa (WAHSA). *Afr Newslett Occup Health Saf*. 2006;16:15-19.
3. London L, Bailie R. Notification of pesticide poisoning: knowledge, attitudes and practices of doctors in the rural Western Cape. *S A Fam Pract*. 1999;20:117-120.
4. Alarcon WA, Calvert GM, Blondell JM, et al. Acute illnesses associated with pesticide exposure at schools. *JAMA*. 2005;294:455-465.
5. Murphy HH, Hoan NP, Matteson P, Abubakar AL. Farmers' self-surveillance of pesticide poisoning: a 12-month pilot in northern Vietnam. *Int J Occup Environ Health*. 2002;8:201-211.
6. Doumbia M, Kwadjo KE. Pratiques d'utilisation et de gestion des pesticides par les maraîchers en Côte d'Ivoire – Cas de la ville d'Abidjan et deux de ses banlieues (Dabou et Anyama). *J Appl Bioscience*. 2009;18:992-1002.
7. Mancini F, Van Bruggen AHC, Jiggins JLS, Ambatipudi AC, Murphy H. Acute pesticide poisoning among female and male cotton growers in India. *Int J Occup Environ Health*. 2005;11:221-232.
8. World Health Organization (WHO). *Health Situation and Trends Assessment: Health Situation in the South-East Asia Region 1998–2000*. New Delhi, India: WHO Regional Office for Southeast Asia; 2002.
9. Khan DA, Shabbir S, Majid M, Ahad K, Naqvi TA, Khan FA. Risk assessment of pesticide exposure on health of Pakistani tobacco farmers. *J Expo Sci Environ Epidemiol*. 2010;20:196-204.
10. Ajayi OC, Akinnifesi FK, Sileshi G. Human health and occupational exposure to pesticides among smallholder farmers in cotton zones of Côte d'Ivoire. *Health*. 2011;3:631-637.
11. Cole DC, Sherwood S, Paredes M, et al. Reducing pesticide exposure and associated neurotoxic burden in an Ecuadorian small farm population. *Int J Occup Environ Health*. 2007;13:281-289.
12. Rao CS, Venkateswarlu V, Surender T, Eddleston M, Buckley N. Pesticide poisoning in South India – opportunities for prevention and improved medical management. *Trop Med Int Health*. 2005;10:581-588.
13. Murray D, Wesseling C, Keifer M, Corriols M, Henao S. Surveillance of pesticide related illness in the developing world. *Int J Occup Environ Health*. 2002;8: 243-248.
14. Kishi N, Hirschhorn M, Djajadisastra LN, Strowman SS, Dilts R. Relationship of pesticide spraying to signs and symptoms in Indonesian farmers. *Scand J Work Environ Health*. 1995;21:124-133.
15. FAO. *Farmers self-surveillance of pesticide poisoning episodes* (FAO programme for community IPM in Asia, Field document). Rome, Italy: FAO; 2001.
16. United Republic of Tanzania. List of pesticides registered in Tanzania 2006, Made under Section 18 of the Plant Protection Act, 1997 and Plant Protection Regulations GN 401 of 1999.
17. United Republic of Tanzania, Ministry of Health and Social Welfare. Annual health statistical abstracts. April 2006.
18. WHO Statistical Information System (WHOSIS). World Health Statistics 2007. http://www.who.int/whosis/whostat2007/en/index.html. Accessed January 27, 2012.
19. Ngowi AV, Maeda D, Partanen TJ. Assessment of the ability of health care providers to treat and prevent adverse health effects of pesticides in agricultural areas of Tanzania. *Int J Occup Med Environ Health*. 2001;14:349-356.
20. Mbakaya CF, Ohayo-Mitoko GJ, Ngowi VA, et al. The status of pesticide usage in East Africa. *Afr J Health Sci*. 1994;1:37-41.
21. Ohayo-Mitoko G. *Occupational Pesticide Exposure Among Kenyan Agricultural Workers: An Epidemiological and Public Health Perspective* [PhD thesis]. Wageningen, The Netherlands: Department of Epidemiology and Public Health, Wageningen Agricultural University; 1997.
22. Wesseling C, Mc Connel R, Partanen T. Agricultural pesticide use in developing countries: health effects and research needs. *Int J Health Serv*. 1997;27: 273-308.
23. Ajayi OC. Pesticide use practices, productivity and farmers' health: the case of cotton-rice systems in Côte d'Ivoire, West Africa. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.468.7470&rep=rep1&type=pdf. A publication of the pesticide policy project, Special Issue publication series no. 3. Hannover. Published November 2000.
24. *Statistical Package for Social Scientists (SPSS)* (for Windows). Release 16.0, Standard Version; 2007.
25. *Stata Corporation*. STATA Version 10.0, Statistics/Data Analysis; 2007. http://www.stata.com. Accessed October 8, 2016.
26. Lekei EE, Ngowi AV, London L. Farmers' knowledge, practices and injuries associated with pesticide exposure in rural farming villages in Tanzania. *BMC Public Health*. 2014;14:389.
27. Mancini F, Van Bruggen AHC, Jiggins JLS, Ambatipudi AC, Murphy H. Acute pesticide poisoning among female and male cotton growers in India. *Int J Occup Environ Health*. 2005;11:221-232.
28. Ngowi AVF. *Health Impacts of Pesticides in Agriculture in Tanzania* [PhD thesis]. Tampere, Finland: Tampere University Press; 2002.
29. Goring D. Health effects of exposure to spices in a spice packing factory. *Occup Health South Afr*. 2003;9:19-23.
30. Rees D. Does milk supplementation prevent occupational illness? *Natl Saf J*. 2002;62:5.
31. Peek-Asa C, Zwerling C, Stallones L. Acute traumatic injuries in rural populations. *Am J Public Health*. 2004;94:1689-1693.
32. Lekei EE, Ngowi AV, London L. Hospital-based surveillance for acute pesticide poisoning caused by neurotoxic and other pesticides in Tanzania. *Neurotoxicology*. 2014;45:318-326.
33. Prajapati T, Prajapati K, Tandon R, Merchant S. Acute chemical and pharmaceutical poisoning cases treated in civil hospital, Ahmedabad: one year study. *Asia Pacific J Med Toxicol*. 2013;263-67.
34. Work and Health in Southern Africa (WAHSA). Pesticide laboratory capacity in the SADC region – a vital link in pesticide risk reduction (Policy brief). Durban, South Africa: Work and Health in Southern Africa; 2008.
35. Laborde A. New roles for poison control centres in the developing countries. *Toxicology*. 2004;198:273-277.
36. World Health Organization (WHO). Poisoning information, prevention and management. International Programme on Chemical Safety. http://www.who.int/ipcs/poisons/centre/poisons_centres/en/. Accessed December 18, 2016.
37. Balbus JM, Harrey CE, McCardy LE. Educational needs assessment for pediatric health care providers on pesticide toxicity. *J Agromedicine*. 2006;11:27-38.