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Pest management and pesticide used in some Hospitals of Benghazi

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ABSTRACT

Public health pest management involves the control of insects or other vectors that transmit diseases to humans. These pests include mosquitoes, cockroaches, bedbugs and domestic rodents. Chemical pesticides assisted in containing the spread of infection and helped reduce infestations with pests. On the other hand, it may have a high-risk acute toxicity and/or chronic effects, which are dangerous, especially to children. Furthermore, they can cause cancer, neurologic damage, delayed development, reproductive dysfunction, and death in many parts of the world, generally through occupational exposure and accidental poisoning of patients. The current study was based on public hospitals in Benghazi city of Libya using questionnaires to collect data in 2013 and then completed in 2015-2016. The results showed a high level of infestation in the hospitals that were studied. The major insect pest species was the German cockroach (*Blattella germanica*). Insect control agents containing permethrin, cypermethrin, deltamethrin were used. In addition to different formulations such as baits, traps, gel baits that contain hydramethylnon, imidacloprid, chlorpyriphos.

The study acknowledges the benefits those pesticides carried out to hospitals, but also understanding their potential harm and side effects. The most important finding is that pesticides are used extensively in Benghazi's hospitals. More than 15 different pesticides are presently applied in hospitals, such as fog, spray, and powder pesticides. They are applied in mostly all areas, including areas that contain patients. On the bright side, the study finds that hospitals in Benghazi have started to use less toxic pesticides and try to use other pesticides in safe ways.

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1. Introduction

The Hospital's public areas including Kitchens, cafeterias, patient rooms and offices, and the movement of materials, many sick people, numerous hospital staff, visitors and different kinds of hospital equipment–all these factors influence the creation of favorable conditions for the spread of pests. Therefore, they are repeatedly treated with a variety of pesticides. Pest species that had invaded the hospitals included the German (*Blattella germanica*) and Oriental (*Blatta orientalis* L.) cockroaches, (Gliniewicz *et al*., 2006) Pharaoh's ants and other ant species (Man & Lee 2014).

It is known that many of the species that colonized hospitals are carriers of pathogenic bacteria internally or on the surface of their bodies. Menasria *et al*., (2014) have isolated about 174 bacteria species from 39 German cockroach specimens collected from two public hospital environments in Tebessa city (northeast Algeria). In the past years, there have been public concerns rising about the side effects of pesticides on human health, which are more dangerous to children, the elderly and the sick patients. Several studies considered the effects of pesticides on people with direct exposure, not only those who spray pesticides, but also who mix and load the pesticides, spread it, clean, and dispose of containers. Cancer related to direct pesticide exposure is one of the most studied topics during the last decade. Various studies have found a relation between direct exposure to pesticides and the risk of cancer (Greenburg *et al*., 2008; Moon *et al*., 2009). London *et al*., (2012) have suggested that repeated pesticide exposure results in neurobehavioral and neuro-developmental effects among pesticide applicators. Various studies have been carried out examining the effects of pesticide exposure on neurological function such as Parkinson's disease. Evidence relating to long periods of farm work with decreasing levels of performance has been found. The most relevant issue may be chronic exposure to pesticides (Kamel *et al*., 2006; Moretto and Colosio 2013). Because of the children's physiology, they are more sensitive than adults to many toxic chemicals as well as pesticides. Children are at risk for pesticide exposure from different sources and at a higher level than adults. The respiratory rate of children, their heart rate and metabolism are significantly different from adults (O'leary *et al*., 2015). A study has examined the levels of pesticides in plasma from a NYC minority group of 230 mother and infant pairs, pesticides were identified in about 83% of the plasma samples found. These pesticides included organo-phosphate insecticides and fungicides (Whyatt *et al*., 2003; Just *et al*., 2015). Both Whyatt *et al*., (2009) and Huen *et al*., (2012) reported a link between maternal urinary metabolites and organophosphates in maternal or cord blood. The influence of pesticide exposure on overall health and several diseases such as myocardial infarction (Dayton *et al*., 2010), dyspnea, hepatitis, (Azmi *et al*., 2006), hearing loss (Crawford *et al*., 2008), quality of sperm (Perry *et al*., 2011) and thyroid diseases (Goldner *et al*., 2010) have been reported.

The aims of our study were to evaluate infestation levels in some of Benghazi's hospitals and examine forms of pesticide used in these hospitals.

2. Materials and Methods

This study was carried out in six public hospitals of Benghazi, Libya in 2013 and then completed in 2015-2016. The data were collected through questionnaires answered by infection control specialists and cleaning companies that are responsible for pest control at the hospitals. It contained questions about the pests most often observed in different rooms, methods of infestation assessment, what kinds of insecticides were used, and who makes

critical pesticide application decisions. The questionnaires also contained questions about records of pesticide applications and a written policy regarding pesticide use in the hospital. In determining the validity of questionnaires, we used questionnaires that have been used by the Attorney General of New York State 1995. Data set was exported to SPSS V.21. All data was coded prior to being entered in a computer.

3. Result and Discussion

The data about pest presence in six public hospitals in Benghazi are shown in Table 1. It can be seen that the species most often found in the hospitals was the German cockroach.

Table 1: Distribution of Pests in Benghazi Hospitals

Pest name	Number of Hospitals	Percentage of Pets in Benghazi Hospital (%)
German cockroach	6	100
Flies	6	100
American Cockroach	6	83.33
Bedbugs	5	33.30
Ants	3	50
Rodents	3	50

They were observed in 80% of the areas tested (mentioned in the table below) in each hospital and all of them were infested (100%). It was followed by the American cockroach *Periplaneta americana*–in hospitals (83.8%). Other insects present in hospital buildings were flies (houseflies, mosquitoes), ant species, bedbugs and rodents. The most prevalent pest has been *B. germanica*. According to respondents, it has invaded, mostly the kitchen, then storage rooms, corridors and laundry rooms. It was also observed in patient's rooms, sterilization rooms, operating theatres and consulting rooms. Table 2 presents the distribution of *B. germanica* in different areas of the hospitals. The fact that these insects were found in sterilization rooms and operating theatres could be alarming.

Table 2: Distribution of *B. germanica* in different areas of Benghazi Hospitals

Area of the hospital	Number of Hospitals	Percentage of *B. germanica*
Kitchens	5	83
Storage rooms	5	83.3
Corridors	5	83.33
Laundry rooms	4	66.6
Patient's rooms	4	66.6
Sterilisation rooms	2	33.3
Operating theatres	1	16.6
Others	1	16.66

The habits of cockroaches and flies in feeding and reproduction are the reason why they are important mechanical vectors of human pathogens. They are engaged in mechanical transfer of nosocomial infections and multiple antibiotic-resistant bacteria (MDR) in the hospital's environment (Pallavali et al., 2017). Another study has reported many species of bacteria including *Streptococcus, Klebsiella, Enterobacter,* and *Serratia* that were isolated from cockroaches present in health care facilities (Elgderi, 2006). The enteric bacteria isolated from the hospital cockroaches were resistant to at least six different types of antibiotics (Elgderi, 2006). Bouamama, *et al.*, have isolated 251 bacteria from the American cockroaches and houseflies exterior. The predominant bacterial species included *Escherichia coli, Klebsiella* spp., *Providencia* spp. *Staphylococcus* spp. and *Enterococcus* spp. (Bouamama *et al.*, 2010). This showed no difference between the species of bacterial strains from American cockroaches and houseflies (Bouamama *et al.*, 2010). The methods of infestation assessment in the corresponding hospitals are shown in Table 3. Infestation was assessed visually or not assessed. In case one of the hospital staff sees an insect in one of the hospitals areas, they notify the office of infection control at the hospital, and provide instructions to the cleaning company that applies pesticides in the places where the insects have been identified.

Table 3: Distribution of *Methods* of Pets Infestation Assessment in Benghazi Hospitals

Method of Pets Infestation Assessment	Number of Hospitals	Percentage of Methods of Pets Infestation Assessment (%)
Not assessed\staff notify	4	66.60
Assessed visually	1	16
Not assessed\applied a pesticides routinely	1	16

In other cases, pesticides were applied routinely about four times a year. Pesticides that are being used for pest management in the studied hospitals are presented in Table 4 and they largely belonged to the pyrethroid group, but several organophosphates and carbamates were used as well.

Table 4: Distribution of used pesticides in Benghazi Hospitals

Type of pesticides	Group	Number of hospitals	Percentage of pesticides used in Hospitals (%)
Trap, gel bait, insect glue, rodents glue, boric acid naphthalene	Less toxic pesticides	6	100%
Cypermethrin	Pyrethroide	3	50
Bromadiol	Rodenticides	3	50
Daltamethrin	Pyrethroide	2	33.30
Cyfluthrin	Pyrethroide	2	33.33
Chlorpyrifos	Organophosphate	2	33.33
Diazinon	Organophosphate	2	33.33
Tobocida	Rodenticides	2	33.33
Contrainsect	Organophosphate	1	16.66
Difenacuom	Rodenticides	1	16.66
Methomyl	Carbamate	1	16.66

The pyrethroids that were used: cypermethrin, deltamethrin and cyfluthrin in 50%, 33.3% and 33.3% respectively of the examined hospitals. A carbamate compound methomyl was used in 16.6% of the hospitals and organophosphate group I (highly hazardous) –Chlorpyrifos, Diazinon and Contrainsect were used in 33.3%, 33.3% and 16% of hospitals respectively. Rodenticides that were used in the examined hospitals were Tobocida, Bromadiol and Difenacuom.

Numerous studies have addressed acute toxicity of rodenticides in vertebrates such as owl's liver and kidney and the effects of low- level exposure to multiple rodenticides, linked to wildlife mortality. (Rattner *et al.*, 2014a; Rattner *et al.*, 2014b; Fisher 2006), and one of these studies have addressed acute toxicity of rodenticides in pig liver and muscle tissue under laboratory conditions. Indeed, during the 12-hour period after exposure, warfarin concentrations in rumen extracts did not decrease at all and only moderate (albeit significant) decreases in Bromadiolone and Chlorophacinone concentrations have been recognized (Berny *et al.*, 2006). Moreover, it will therefore have the same effect on humans.

The most interesting finding is that all hospitals were using less toxic pesticides such as boric acid (bait and powder), fly traps, gel baits, insect glue, rat glue and naphthalene in addition to the previously mentioned. Also, it has been found that one

hospital (16.66%) used products of an unknown source and unknown active substances which is something negative, since many of the information is known from the knowledge of the active ingredient, for example, first aid. The most important criterion for choosing the insecticide formulation was both financial and efficiency reasons.

The current study found that all hospitals are using one product or more under the organophosphate group and Carbamates group as well. The organophosphate and Carbamate pesticides were involved in more poisonings than any other type of pesticide because they interfere with the activity of cholinesterase. A study has been collected from the hospitals located across Japan, which found that Organophosphate insecticides are the most frequent inducer of clinical cases, followed by bipyridylium herbicide and carbamate insecticide (Costa *et al.*, 2014). The use of organophosphorus (OP) pesticides—chlorpyrifos (3,5,6-trichloro-2-pyridinol (TCPy)) and pyrethroid in door were related with an increase in TCPy concentrations in children's urine (Trunnelle *et al.*, 2014). The effects of organophosphates and carbamates are similar since they both inhibit enzyme cholinesterase. The Environmental Protection Agency (EPA) classified some pesticides as restricted use pesticides for pesticides with risks that effect humans or non-target organisms. Related to the previously mentioned, we found Methomyl uses in one hospital which is classified as a Restricted Use Pesticide. We found in the reported hospitals, that the pesticides which are applied was in many forms, such as sprays, powders, fogs, mixed with baits and in traps. Each form of pesticide application can result in human exposure, while the probability of exposure could be reduced with some crack or crevice treatments, baited traps, or other safe methodology. All hospitals (100%) said that they use the least toxic possibility when selecting pesticides, but only some seem to limit themselves to pyrethrin, boric acid, and pyrethroid formulations.

The majority of hospitals rely on cleaning companies in pest control operations with pesticides being the main element. Only in a few hospitals, these companies work under the supervision of the office of infection control. This is a positive step towards using pesticides with highly specialized knowledge. Only 33.33% of the examined hospitals had pest control measures as a part of a system of prevention of hospital-acquired infection.

Our results found that there is no records of the results from the evaluation for future reference in almost all the hospitals. A written policy was found in one out of hospital, which had record keeping as well Table 5.

Table 5: Distribution of used Pesticides Policies in Benghazi Hospitals

Types of Pesticides Policies and evaluation	Number of Hospitals	Percentage of Policies and evaluation in Hospitals (%)
No records of policies	5	83
Record of a written policy	1	16.60
Evaluation for future	0	0
Evaluation after pesticides application	0	0

Regarding evaluation and record keeping, there is no evaluation of the results of pest control after pesticides application (100%). It is extremely important to evaluate the results of pest management programs. This can be done in several ways, such as monitoring pest populations or infection before and after treatment, comparative damage ratings, etc. Adoption of a written policy, provides procedural guidelines for the hospital and assures that these laws are adhered to each time a pesticide is used and help to follow the procedure for pest management.

4. Conclusion

Pest control in hospitals is a very difficult subject. It can be more complicated because of the unique structural features of the buildings, some of the medical and aesthetic requirements and restrictions on the use of pest management techniques Sticky traps were not used. This refers to the power of traditional pest control methods, such as spraying pesticides without monitoring instead of integrated pest management procedures (IPM).

The pesticides used at the hospitals included active ingredients that may cause acute toxic reactions such as skin and or respiratory irritation, headache, nausea, dizziness, vomiting, visual conflicts and sensory and behavioral disturbances. The chronic toxic effects appear after repeated exposure to the active ingredients, which may develop years after exposure, including cancer and reproductive effects. Effects to the inert ingredients cannot be assessed because these ingredients are usually not known on the label of pesticides. Programs to combat pests in hospitals should be directed more to the use of non-chemical measures to eradicate insects and measures of physical control. We recommend the limited use of pesticides for reasons related to the health of patients and hospital staff, as well as increased insect chemical pesticide resistance. In only one hospital the insect control procedures were a part of the system of prevention of nosocomial infections.

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