

Bacteriological Survey of American Cockroaches in Hospitals

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Abstract: This study aimed to determine the presence of pathogenic bacteria which *P. americana* (L.) carries on the body surface. These insects were collected from three of the city hospitals of Iran. Fifteen cockroaches were caught from mentioned hospitals using direct collection. The washing fluid from the external surface of each cockroach was cultured. The isolated bacteria were identified using bacteriological analysis. Results showed that all the cockroaches were positive for at least three bacteria. Nine different species of medically important bacteria were isolated and identified. The most common bacteria found were *Escherichia coli*, 86.7% and *Proteus vulgaris*, 73.3%. In addition to these bacteria, *Bacillus cereus*, 66.7%, *Streptococcus faecalis*, 60%, *Staphylococcus aureus*, 60%, *Enterobacter cloacae*, 53.3%, *Shigella*, 33.3%, *Serratia*, 13.3% and *Staphylococcus epidermidis*, 6.7%, were the least recorded of all the samples analyzed. It was found that the cockroaches collected from Sina hospital carried all nine bacterial species. Results exhibited the presences of American cockroaches in the hospitals threaten the health of patients.

Key words: American Cockroach • Bacteria • Hospital • Iran

INTRODUCTION

Human habitation is associated with 30 of the 4000 species of cockroach in the world; but mostly three species are considered pests in Iran. They are the American cockroach (*Periplaneta americana*), German cockroach (*Blattella germanica*) and Oriental cockroach (*Blatta orientalis*) [1]. *Periplaneta americana* (Blattodea: Blattidae) is reddish-brown with light colored edges to body; its wings appear longer than the body length: quite large at 1.1 to 1.7 inches and it prefers warm, humid areas. The American cockroach breeds in a secure site which consists very simply of food, water, humidity, warmth, preferably in and around underground sewer facilities or utility networks from which they may venture into buildings. American

cockroach activity is found in older row homes, areas of high humidity, such as basements, boiler rooms, steam tunnels and sewers; it only takes one pregnant female to create an infestation and cockroach numbers can increase exponentially if conditions are favourable [2]. None of *Periplaneta* species are native to the Americas; despite the name, *Periplaneta americana* was introduced to the United States from Africa as early as 1625 [3].

Cockroaches are medically important as many illnesses and health problems have been associated with them [4]. They carry viral and bacterial pathogens on their bodies and in their faeces which can cause, poisoning, diarrhea and dysentery. Cockroaches isolated from hospitals and residential areas carry medically important microorganisms [5].

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Hospital-acquired infections have emerged as a cause of death and illness in people over recent years [6, 7]. In hospitals, cockroaches have been detected inside sick rooms, the intensive therapy zone, surgical section, kitchen and medicine store [8].

The American cockroach is a vector of bacteria. Over 100 species of bacteria have been isolated from domestic cockroaches [9]. In a study which was carried out in Morocco, *Escherichia coli*, *Klebsiella* spp., *Providencia* spp., *Staphylococcus* spp. and *Enterococcus* spp species were isolated from American cockroaches [10]. In another study which was performed in two hospitals in Kurdistan Province, Iran; the most common bacteria on external parts of American cockroach, German cockroach and Oriental cockroach was *Escherichia coli* [11]. In a survey which has been presented in Khorramshahr city, Khuzestan Province, Iran; pathogenic bacteria were isolated from the external surfaces of 100% of the American cockroaches examined; the following bacterial pathogens were recovered from their body surface: *Klebsiella*, *Pseudomonas*, *Escherichia coli*, *Staphylococcus*, *Enterobacter*, *Streptococcus*, *Serratia*, *Bacillus* and *Proteus* [12].

The aim of the present study was to isolate human pathogenic bacteria from external surfaces of *Periplaneta americana* collected from three hospitals (Arya, Sina and Amir-almohmenin) of Ahvaz (Khuzestan Province), Iran.

MATERIALS AND METHODS

At the onset of this investigation cockroaches were collected randomly from three hospitals of Ahvaz County (Khuzestan Province, Iran) in 2006. Five *Periplaneta americana* cockroaches were caught from different types of wards in each hospital, using sterile test tubes and transported to the microbiology laboratory. Diagnosis was done by the modulus taxonomic keys.

The cockroaches were unmoved by frigidity at 0°C for 5 minutes. Sterile normal saline (0.9%) by 5 CC was added to each test tube and the cockroaches were thoroughly washed and transferred to secondary sterile tubes with forceps. After that tryptic soy broth (TSB) plates with 5% sheep's blood medium were prepared, the cockroach washings were added and left for 24 hours incubation at 37 °C for bacterial growth. A mix of TSB with

5% sheep blood is widely used for the determination of hemolytic reactions of *Streptococcus* and *Enterococcus*. The yield solution, also was transferred to a culture media blood agar and MacConkey's agar plates under sterile conditions; and incubated for 24 hours. The various bacteria colonies on the blood and MacConkey's agar media were identified by colonial morphology, Gram staining and biochemical tests according to standard methods [13-15].

RESULTS

Results of bacterial identification showed that all the cockroaches tested are positive for 3-9 of the following; *Bacillus cereus*, *Streptococcus faecalis*, *Staphylococcus aureus*, *Enterobacter cloacae*, *Shigella*, *Serratia*, *Proteus vulgaris*, *Escherichia coli* and *Staphylococcus epidermidis*.

Results showed that 7 bacteria were identified on cockroaches from Arya hospital. All cockroaches were infected by *Staphylococcus aureus* and *Escherichia coli* and the remaining 5 bacteria randomly infected 1-5 cockroaches (Figure 1).

Results from Sina hospital showed 9 bacteria were present among the captured cockroaches. Only one bacterium, *Bacillus cereus*, was common to all cockroaches and 6 bacteria randomly infected 1-5 cockroaches. However, two bacteria, *Serratia* and *Staphylococcus epidermidis*, were found on only one cockroach each (Figure 2).

<i>Escherichia coli</i>	<i>Serratia</i>	<i>Proteus vulgaris</i>	<i>Enterobacter cloacae</i>	<i>Staphylococcus aureus</i>	<i>Streptococcus faecalis</i>	<i>Bacillus cereus</i>	Bacteria
							Cockroaches
							No1
							No2
							No3
							No4
							No5
100	20	80	60	100	80	40	Percentage of Total Frequency

Fig. 1: Isolation of pathogenic bacteria from five cockroaches collected in Arya Hospital, Ahvaz, South-West of Iran in 2006

<i>Escherichia coli</i>	<i>Shigella</i>	<i>Serratia</i>	<i>Staphylococcus epidermidis</i>	<i>Proteus vulgaris</i>	<i>Enterobacter cloacae</i>	<i>Staphylococcus aureus</i>	<i>Streptococcus faecalis</i>	<i>Bacillus cereus</i>	Bacteria
									Cockroaches
									No1
									No2
									No3
									No4
									No5
80	60	20	20	60	60	40	40	100	Percentage of Total Frequency

Fig. 2: Isolation of pathogenic bacteria from five cockroaches collected in Sina Hospital, Ahvaz, South-West of Iran in 2006

<i>Escherichia coli</i>	<i>Shigella</i>	<i>Proteus vulgaris</i>	<i>Enterobacter cloacae</i>	<i>Staphylococcus aureus</i>	<i>Streptococcus faecalis</i>	<i>Bacillus cereus</i>	Bacteria
							Cockroaches
							No1
							No2
							No3
							No4
							No5
80	40	80	40	40	60	60	Percentage of Total Frequency

Fig. 3: Isolation of pathogenic bacteria from five cockroaches collected in Amir-Almohmenin Hospital, Ahvaz, South-West of Iran in 2006

In total, seven bacteria were present in the samples of cockroaches collected from Amir-Almohmenin hospital. Although each cockroach was infected by four bacteria, there was no pattern to be seen, infection was random. *Escherichia coli* and *Proteus vulgaris* were each found to infect four individual cockroaches (Figure 3).

Among the three hospitals it was found that Sina hospital was most infected.

All the American cockroaches were infected by at least three bacteria. *Escherichia coli* was the most common bacterium and 86.7% of cockroaches were infected by this (bacterium). In descending order the remaining bacteria results were as follows; *Proteus vulgaris*, 73.3%, *Bacillus cereus* 66.7%, *Streptococcus faecalis* 60%, *Staphylococcus aureus* 60%,

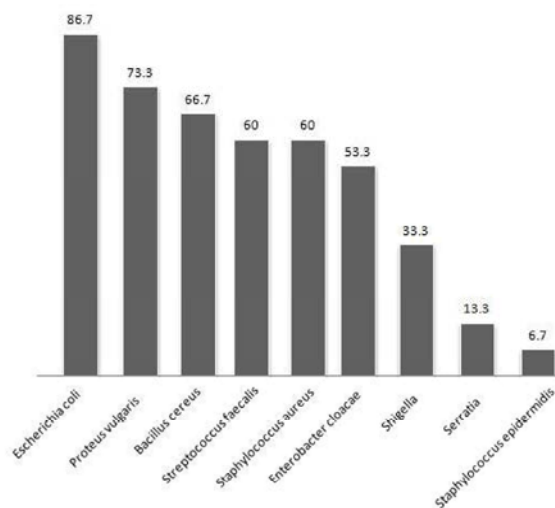


Fig. 4: Identification results of pathogenic bacteria extracted from 15 cockroaches in three hospitals (Amir-Almohmenin, Sina, Arya) Ahvaz, South-West of Iran in 2006

Enterobacter cloacae 53.3%, *Shigella* 33.3%, *Serratia* 13.3% and *Staphylococcus epidermidis* 6.7% (Figure 4). It should be noted that *Staphylococcus epidermidis* was extracted from only one of the 15 cockroaches, which was captured in Sina hospital.

DISCUSSION

The presence of cockroaches has health implications, for example nosocomial infection, as the insects move freely from areas, within and around hospitals, which may harbour pathogenic organisms [16]. In houses and in places with poor standards of hygiene, heavy infestations of cockroaches, such as the preidomestic American cockroach (*Periplaneta americana* L.) and the domestic German cockroach (*Blattella germanica* L.) can occur.

In a study carried out at the medical centres of Khorramshahr County in Iran, pathogenic bacteria were isolated from the external surfaces of all the American cockroaches; the following bacterial pathogens were recovered: *Klebsiella* (47.9%), *Pseudomonas* (37%), *Escherichia coli* (30.1%), *Staphylococcus* (24.6%), *Enterobacter* (19.2%), *Streptococcus* (15.1%), *Serratia* (8.2%), *Bacillus* (4.1%) and *Proteus* (2.7%) [12]. Results showed that pathogenic bacteria present in the Ahvaz samples were also present in Khorramshahr with the exception of *Shigella*. It is interesting to note that the top two bacteria in the Khorramshahr samples, *Klebsiella* and *Pseudomonas*, were not present in the Ahvaz samples.

In another experiment which was carried out in Sanandaj, located in western Iran, 7 different types of bacteria were detected in *Periplaneta americana* collected from houses [17]. By comparison it can be seen that although there is a much higher frequency of cockroaches in domestic dwellings the infection rate is considerably higher in cockroaches found in medical establishments. We can say the cockroaches from hospitals are much more likely to be found contaminated with medically important bacteria than those from the houses [18]. Cockroaches should be eradicated not only from hospital but residential dwellings too. It is obvious that medical patients are more vulnerable to infections which hasten the need for the eradication of pathogen carrying cockroaches. This action should also be carried forward to include domestic dwellings. We have commented that infection in cockroaches from medical establishments is more concentrated, but the lower concentration found in cockroaches from domestic dwellings can have the same impact. Infestation of cockroaches occurs in areas of insanitary, low cost, highly populated housing, where residents probably suffer from ill health due to poor diet and are poorly educated. We should consider the location of the medical establishment, in particular Sina Hospital, it should be noted that this is situated in a suburb of Ahvaz which is highly populated. Here not only were there more bacteria found, concentration was higher and we found two bacteria not present in other hospital samples.

In an experiment which was performed in ten districts of Tangier, Morocco, 11 bacteria were extracted from 50 American cockroaches captured in houses; *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus species*, *Escherichia coli*, *Enterobacter spp.*, *Klebsiella spp.*, *Serratia spp.*, *Proteus vulgaris*, *Proteus spp.*, *Shigella spp.* and *Salmonella spp.* [10]. The number of extracted bacterial species was more than found in our experiment; this difference could be due to inadequate sanitation, pollution of Morocco's water and land resources. In Tangier, (Morocco) the average temperature is 16.7°C (62 °F) which is much lower than Ahvaz. Perhaps this lower temperature is more favorable for bacterial growth and species variation than the 50°C of Ahvaz where it may be harder for some of the bacteria to survive.

In this investigation nine different kinds of bacteria species were extracted from American cockroaches found in three hospitals at Ahvaz. The presence of the

cockroaches in hospitals can threaten hospitalized patients health. Cockroaches feed on filth and faeces and they potentially can disseminate infections by the faecal-oral route [19]. *Staphylococcus aureus* Gram-positive bacteria is the most frequent cause of nosocomial infections [20] and is carried by cockroaches [21]. *Staphylococcus sp.*, *Bacillus sp.* and *Escherichia coli* are also carried by cockroaches and can cause diarrhea [10]. We did not find any *Salmonella sp.* in this study but these bacteria can be carried by cockroaches [22].

Results of the present study showed that all cockroaches were found to be contaminated with at least three bacteria. Among three hospitals it was found that cockroaches from Sina hospital were the most infected. The most common bacterium found was *Escherichia coli* at 86.7%. Hospital authorities should look at contamination on two levels; removing possible sources of bacteria and the eradication of pests, plus a disinfection regime which staff, patients and visitors should follow.

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