Short Communication

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Non-biting flying insects as carriers of pathogenic bacteria in a Brazilian hospital

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ABSTRACT

Introduction: Insects have been described as mechanical vectors of nosocomial infections. **Methods**: Non-biting flying insects were collected inside a pediatric ward and neonatal-intensive care unit (ICU) of a Brazilian tertiary hospital. **Results**: Most (86.4%) of them were found to carry one or more species of bacteria on their external surfaces. The bacteria isolated were Gram-positive bacilli (68.2%) or cocci (40.9%), and Gram-negative bacilli (18.2%). **Conclusions**: Insects collected inside a hospital were carrying pathogenic bacteria; therefore, one must consider the possibility they may act as mechanical vectors of infections, in especially for debilitated or immune-compromised patients in the hospital environments where the insects were collected.

Keywords: Microorganisms. Insecta. Public Health.

Some non-biting flying insects, particularly the common housefly (*Musca domestica*), have sporadically been described as possible mechanical vectors of agents of nosocomial infections because they may carry human pathogens and also due to their ubiquity including in the hospital environments[1-4].

In Brazil, there are some reports showing that ants and cockroaches harbor pathogens in hospitals[5,6], but there is no report on non-biting flying insects. Therefore, our aim was to investigate the presence of potentially pathogenic bacteria on the external surface of flying insects collected inside a Brazilian health care institution.

Flying insects were randomly collected in eight rooms of a pediatric ward and a neonatal intensive care unit (neonatal-ICU) of a Brazilian tertiary-care teaching hospital that has 290 beds. The insects were caught during their flight during different nights. Each insect collected was placed alive on to a 5% sheep blood agar plate, allowing contact of its external surface with the culture medium. After removing the insect using sterile forceps, the plate was incubated at 37ºC under aerobic conditions and was examined daily for bacterial growth. The insect samples were preserved in alcohol and subjected to entomological examination.

The morphology of isolated bacteria was observed using Gram staining. The Gram-positive cocci (GPC) or Gram-positive bacilli (GPB) were separately cultured on sheep blood agar and the Gram-negative bacilli (GNB) on MacConkey agar for further identification in species by using standard bacteriological procedures.

A total of 22 flying insects were collected: 5 (22.7%) were caught inside the neonatal-ICU and 17 (77.3%) in different rooms of the pediatric ward. They belonged to Diptera Linné, 1758 (9; 40.9%), Hymenoptera Linné, 1758 (4; 18.2%), Coleoptera (Linné, 1758) (3; 13.6%), *Lepidoptera* Linné, 1758 (3; 13.6%), Orthoptera (Olivier, 1811) (1; 4.5%), Homoptera (Linné, 1758) (1; 4.5%), and Trichoptera Kirby, 1813 (1; 4.5%).

The **Table 1** shows the insects and the isolated bacteria from insect samples, numbered from 1 to 22. Among the 22 insects, 19 (86.4%) were found carrying one or more species of bacteria on the external surfaces. Bacterial growth was not observed for 3 insects, 2 of the Diptera (supressão) and 1 of the Orthoptera (supressão). These three samples were caught in wards 84 and 86 on different nights (insect samples 2, 5 and 20), as demonstrated in **Table 1**.

The bacteria isolated from the sampling flying insects were GPB (15/22; 68.2%), GPC (9/22; 40.9%), and GNB (4/22; 18.2%). One of the GPB isolated from a moth-fly (*Telmatoscopus albipunctatus,* Diptera) captured inside neonatal-ICU (insect sample 7) was identified as *Nocardia cyriacigeorgica*. The other GPB (14/22; 63.6%) were spores forming of the *Bacillus* genus. All GPC isolated were coagulase-negative staphylococci (8/22; 36.4%), except one, which was identified as *Micrococcus* spp. (insect sample 16). Three of the four GNB isolated belonged to Enterobacteriaceae family of the species *Proteus mirabilis* and *Enterobacter gergoviae*. One GNB was characterized as a non-fermented rod of the *Pseudomonas* genus (insect sample 15).

In our study, insects from Diptera (supressão) were found more frequently (40.9%) inside the hospital than flying insects (supressão) such as Hymenoptera (18.1%), Lepidoptera (13.6%), and Coleoptera (13.6%). We observed that flying

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TABLE 1 - Bacteria isolated from external surface of the flying insects caught at different sites in a Brazilian hospital according to the orders of the insects sampled

Insect order (n/%)	Sample	Hospital site	Bacterial isolates
Diptera (9/40.9)	1	neonatal-ICU	GPB and GNB
	2	room ward 86	without growth
	3	room ward 88	GPB
	4	room ward 93	GPB
	7	neonatal-ICU	GPB
	10	room ward 79	GPB and GPC
	15	neonatal-ICU	GPB, GPC, and GNB
	20	room ward 86	without growth
	22	room ward 92	GPC
Hymenoptera (4/18.1)	8	room ward 90	GPB and GPC
	13	room ward 86	GPC
	16	room ward 88	GPB and GPC
	19	room ward 88	GPC
Coleoptera (3/13.6)	11	room ward 79	GNB
	14	room ward 93	GPB
	21	neonatal-ICU	GPB and GPC
Lepidoptera (3/13,6)	12	room ward 88	GPB
	17	room ward 86	GPB
	18	neonatal-ICU	GPB and GNB
Orthoptera (1/4,5)	5	room ward 84	without growth
Homoptera (1/4,5)	6	room ward 92	GPB
Trichoptera (1/4,5)	9	room ward 78	GPB and GPC
Total	22		28

Neonatal-ICU: neonatal intensive care unit; GPB: Gram-positive bacilli; GNB: Gram-negative bacilli GPC: Gram-positive cocci.

insects were present in all rooms of the pediatric ward selected for sampling insects and also inside the neonatal-ICU. Likewise, other studies conducted in different countries have demonstrated that dipteran insects can be found inside hospitals[1-4]. Smarova et al.[7] found several other synanthropic arthropods inside several wards of a hospital but the most frequent were cockroaches and dipterans.

The majority (86.4%) of the flying insects collected in our study were carrying bacteria on their external surfaces. The presence of bacteria in the insects caught from outdoor or indoor hospitals sites is very common. Fotedar et al.[2] showed that flies caught from hospitals had a bacterial load higher than controls caught in a remote residential area. In contrast, Rahuama et al.[5] reported that insects from hospitals had a bacterial load similar to those from outdoors suggesting that isolated bacteria of the insects represents the sanitary conditions of the environment. However, insects are very mobile, having access to human feces, garbage, open wounds, and contaminated medical instruments acting as a link between infected and uninfected areas inside a hospital environment or outside.

As reviewed by Graczyk et al.[9], some insects have structures on their legs coated with a sticky substance which facilitates the insects' adherence on non-horizontal surfaces and enhances the adhesion of particles such as bacteria and other microorganisms. Small particles may also readily adhere to an insect's exterior surfaces due to their electrostatic charges. Thus, bacteria that have adhered superficially may be transported to patients and hospital environments by insects. Moreover, the transmission of human pathogens by insects may also occur via mechanical dislodgement of the exoskeleton, fecal deposition, and regurgitation[9].

In the present study, GPB of the *Bacillus* genus were the bacteria more frequently isolated from the surface of flying insects followed by coagulase-negative staphylococci (SCN), and GNB. These same bacteria were also isolated from the external surfaces and from the gut of several species of insects in other similar studies[2,6]. However, the majority of these studies observed a predominance of GNB. In our study, although only 4 out of 22 (18.2%) of the insects collected harbored BGN, the species found (*Proteus mirabilis, Enterobacter gergoviae* and *Pseudomonas* spp.) are significantly important agents of various infections in humans, especially in hospitalized patients. Regarding to *Bacillus* spp., the virulence of these microorganisms varies according to the species. *Bacillus anthracis* and *Bacillus cereus* are medically important but other species may cause serious opportunistic infections. SCN are commonly found in the normal human microbiota but they also may cause opportunistic infections. Thus, the bacteria isolated in this study are relevant because of the existence of young, debilitated, and immunocompromised patients in the hospital sites where the flying insects were collected.

It should be emphasized that we isolated for the first time one *Nocardia* strain from an insect (*Telmatoscopus albipunctatus,* Diptera) that was captured inside the neonatal-ICU, although these bacteria had previously been isolated from dust and air in hospitals[10].

Our results showed that synanthropic flying insects of different orders were found flying inside a tertiary-care teaching hospital in Brazil. The presence of these insects inside homes or hospitals is considered harmless by many people since they are very common in countries like Brazil with tropical climates[11].

In general, they cause less discomfort than other pests such as cockroaches and ants also found inside hospitals. However, as we have demonstrated that flying insects collected inside a hospital in our country were carrying potentially pathogenic bacteria, one must consider the possibility that they may act as mechanical vectors of nosocomial infections. Therefore, despite the windows of the pediatric unit of the hospital where this study was conducted have screens on windows, more stringent measures must be taken to avoid the presence of the flying insects in the intensive care units and elsewhere in the hospital.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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