

Microbiological investigation of ties and shirts in a Teaching Hospital, in São Paulo (SP), Brazil

Investigação microbiológica entre diferentes indumentárias em Hospital Escola em São Paulo (SP) Brasil

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Abstract

Objectives: In this article, we aim to compare the contamination rates between neckties physicians in a large Brazilian hospital to those of lawyers. We also intend to compare the contamination rates between neckties and shirts from those two groups. We believe that neckties often serve as a fomite, carrying potentially harmful bacteria and, directly or indirectly, contaminate patients. **Methods:** We collected swab samples from doctors' neckties and shirts at a large teaching hospital in São Paulo city center and assessed their degree of contamination. The findings were compared against necktie and shirt swab samples taken from law students (control group) of a University in São Paulo city center. The contamination levels of both fomites were assessed, together with the susceptibility profile of bacteria not from normal microbiota. **Results:** Contamination of doctors' neck ties was greater than that of law students' neckties ($p < 0.05$), where pathogenic bacteria were detected in both groups. No statistically significant difference in contamination of shirts was found between the groups. Bacteria that make up normal human microbiota (*Staphylococcus epidermidis*, *Staphylococcus aureus*, *Micrococcus sp*, and *Bacillus subtilis*) were the most prevalent. **Conclusions:** In

this study, both pathogenic bacteria and normal microbiota bacteria were found, highlighting the susceptibility of neckties of doctors and law students to bacterial contamination. These garments can act as a vehicle for spreading antibiotic-resistant bacteria in the community.

Keywords: Microbiology, Cross Infection, Fomites, Clothings, Humans

Resumo

Introdução: Diversos objetos podem agir como fômites para a contaminação bacteriana. Jalecos, aventais e camisas são normalmente higienizados, enquanto gravatas não. Estas poderiam transportar microorganismos capazes de colonizar outras áreas e, direta ou indiretamente, contaminar indivíduos debilitados. Assim, mesmo médicos que realizam higienização adequada das mãos podem se recontaminar pelo contato com gravatas. **Materiais e métodos:** Coletamos amostras com swabs das gravatas e camisas dos médicos de um hospital escola de grande porte no centro de São Paulo e avaliamos seu grau de contaminação. Comparamos os achados a um grupo controle com swabs de gravatas e camisas de estudantes de direito de uma universidade no centro de São Paulo. avaliamos as possibilidades da contaminação das foram avaliadas para ambos os fômites, além do perfil de sensibilidade das bactérias que não pertencem à microbiota normal. **Resultados:** A contaminação das gravatas de médicos foi superior à de advogados ($p < 0,05$), evidenciando bactérias patogênicas em ambos os grupos. Não houve diferença estatisticamente significativa na contaminação de camisas entre os grupos. Bactérias que compõem a microbiota normal humana foram mais frequentes (*Staphylococcus epidermidis*, *Staphylococcus aureus*, *Micrococcus sp*, bacilo *Subtilis*). **Discussão:** Neste estudo, encontramos bactérias patogênicas e bactérias da microbiota normal, evidenciando a susceptibilidade das gravatas de médicos e estudantes de medicina à contaminação bacteriana, podendo atuar na comunidade como meio de transporte para bactérias resistentes aos antibióticos.

Descritores: Microbiologia, Infecção Hospitalar, Fômites, Roupas, Humanos

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Introduction

The necktie is the traditional dress of lawyers, but its use has spread beyond the courtroom to include hospitals and doctors' offices. A traditional item of apparel, the necktie can be seen in famous paintings such as "The First Operation with Ether - by Robert C. Hinckley, 1893 - Boston Medical Library". However, after the teachings of Pasteur, the formal, dark clothing used repeatedly, gradually gave way to white clothing, coats and scrubs, which were washed more frequently. The use of white uniform steadily spread to hospitals, appearing first in classrooms then corridors and clinics. In surgical theaters, sterile scrubs are used to protect patients, as suggested by Dixon⁽¹⁾. Despite this protection, risk of contamination through other objects and surfaces remains⁽²⁾.

Many objects can act as fomites for bacterial contamination, both inside and outside hospitals. White coats, ID card lanyards, pens and even purses are common contaminants in health services⁽³⁾. Other sources of contamination found outside the hospital setting include cell phones, bus hand-rails and particularly hands⁽⁴⁾.

White coats, scrubs and shirts are normally washed and hygienized⁽⁵⁾, whereas neckties tend not to be washed regularly. Patients are in hospital because they are ill, and often cough, sweat, vomit and touch physicians. To what extent do contaminated ties transmit a myriad of bacteria and virus via corridors, from one ward to another, corridor to canteen, or from one admissions sector to another⁽⁶⁾, to subsequently colonize other areas and contaminate⁽⁷⁾ other patients, elderly, children and the sick? According to Weber et al.⁽⁸⁾, such contamination indeed occurs. In Weber's study, doctors' ties colonized by bacteria were placed in contact with mannequins. High levels of mannequin contamination by bacteria from the ties were found.

Under the English Health Act of 2007, an initiative called Bare Below the Elbows⁽⁹⁾ was created aiming to reduce hospital contamination by advising against wearing accessories such as rings, bracelets, wrist watches, ID card lanyards and neck ties in hospital environments, as well as artificial nails and uncovered breached skin. All staff having direct contact with patients or a patient's environment must observe the guideline.

Neckties can be a reservoir for bacteria⁽¹⁰⁾, not necessarily contaminating patients directly. Thus, even doctors that perform proper hand hygiene can become recontaminated by touching their neck tie, accidentally or intentionally. Contamination is not confined to traditional neckties; bow ties⁽¹¹⁾, usually used by gynecologists and obstetricians in England precisely to lower the risk of contact and contamination, showed

the same levels of contamination as traditional straight ties. This finding suggests that the problem is inherent to the tie itself and not its length.

The question remains as to why doctors insist on using neckties, given their potential as fomites and superfluous function. Their use is based on the assumption that ties improve doctors' appearance in the eyes of patients. However, analysis of patient opinions⁽¹²⁾ about doctors' dress revealed that having a neat and professional appearance was more important than traditional dress.

We collected swab samples from doctors' neckties and shirts at a large teaching hospital in São Paulo city center and assessed their degree of contamination. These findings were compared against necktie and shirt swab samples taken from law students of a University in São Paulo city center. Based on these results, contamination levels of doctors' neckties and shirts were compared against those of the control group.

Materials and Methods

We collected swab samples from doctors' neck ties and shirts at a large teaching hospital in Sao Paulo city center and assessed their degree of contamination. These findings were compared against necktie and shirt swab samples taken from law students (control group) of a University in São Paulo city center. These results revealed the comparative levels of contamination of neckties and shirts. To this end, the susceptibility profile of bacteria not from normal microbiota was determined. The participants were approached throughout the day and asked to fill out a survey on use of neckties and to provide free and informed consent. After collection of samples, these were seeded onto a culture medium and incubated for 48h at 36°C. Subsequently, species were identified using the Gram method, as well as catalase and coagulase tests. After identification of the bacterial agents, the disc diffusion (Kirby-Bauer) susceptibility test was applied.

This research was submitted for review and approval by the Ethics Committee of the Institution (project # 1.580.388).

Results

Contamination levels of doctors' neckties were greater than those of law students' neckties ($p < 0.05$). Pathogenic bacteria were found on neckties in both groups. The organisms found on neck ties, in order of frequency, are listed in Table 1.

No statistically significant difference in contamination of shirts between the two groups was found. The organisms found on shirts, in order of frequency, are given in Table 2. Normal human microbiota was

Table 1

Bacteria present on neckties of doctors and law students.

Microorganism	DOCTORS		LAW STUDENTS	
	Number	Frequency	Number	Frequency
<i>Staphylococcus epidermidis</i>	17	34%	5	10%
<i>Micrococcus sp</i>	5	10%	7	14%
<i>Bacillus subtilis</i>	3	6%	3	6%
<i>Staphylococcus aureus</i>	2	4%	2	4%
<i>Enterococcus sp</i>	0	0%	0	0%
<i>Corynebacterium sp</i>	0	0%	1	2%
<i>Klebsiella pneumoniae</i>	1	1%	0	0%
<i>Streptococcus viridans</i>	0	0%	1	2%

Table 2

Bacteria present on shirts of doctors and law students.

Microorganism	DOCTORS		LAW STUDENTS	
	Number	Frequency	Number	Frequency
<i>Staphylococcus epidermidis</i>	12	24%	6	12%
<i>Micrococcus sp</i>	5	10%	12	24%
<i>Bacillus subtilis</i>	3	6%	2	4%
<i>Staphylococcus aureus</i>	3	6%	2	4%
<i>Enterococcus sp</i>	3	6%	0	0%
<i>Klebsiella pneumoniae</i>	1	2%	0	0%
<i>Corynebacterium sp</i>	0	0%	1	2%
<i>Streptococcus viridans</i>	0	0%	0	0%
VRE	1	2%	0	0%
<i>Pseudomonas aeruginosa</i>	0	0%	1	2%
<i>Escherichia coli</i>	0	0%	1	2%
<i>Rhodotorula sp</i>	1	2%	0	0%

the most prevalent bacteria found (*Staphylococcus epidermidis*, *Staphylococcus aureus*, *Micrococcus sp* and *Bacillus subtilis*).

Discussion

In this study, pathogenic bacteria and bacteria from normal microbiota were found, demonstrating that neckties of doctors and law students are prone to bacterial contamination. These neckties can act as a vehicle spreading antibiotic-resistant bacteria in the community.

Although contamination predominantly involved microbiota bacteria, the fact that they were present in a hospital environment with vulnerable patients is cause for concern. The results found are consistent with the literature showing the contamination potential of neckties. Although the presence of pathogenic bacte-

ria was not statistically significant, these forms were found in both groups. The finding of multi-resistance bacteria (generally associated with hospitals) in the control group was unexpected. The greater contamination of neckties compared to shirts indicates that the non-washing of ties increases the risk of contamination and spread of bacteria.

The most commonly found bacteria for both doctors and law students were commensal bacteria that pose little risk. However, even some bacteria from normal microbiota, such as *Staphylococcus aureus*, have high pathogenic risk.

Staphylococcus aureus can be associated with both community-acquired and hospital-acquired infections. The most common infections involve the skin (cellulitis, impetigo) and wounds at different sites. More severe episodes, such as bacteremia, pneumonia, pericarditis and meningitis, can also occur.

In 1960, methicillin was launched as an alternative drug for penicillinase-producing strains. By 1961, however, reports of methicillin-resistant strains were being reported and referred to as methicillin-resistant *Staphylococcus aureus* (MRSA). This type accounts for 50% of *S. aureus* strains found in ICUs^(13,14). Initially, MRSA was observed in hospitals only, but it is now clear that MRSA can also be community-acquired. All of the *S. aureus* colonies found in the present study were susceptible to methicillin.

Other bacteria considered part of normal microbiota, although possibly pathogenic, such as the *Streptococcus viridans* group, were also found. These are alpha-hemolytic bacteria resistant to optochin and tend not to grow on broth containing high concentrations of sodium chloride. They are usually part of normal microbiota of the upper respiratory tract, particularly of the different ecological niches of the oral cavity. As etiological agents, they are associated with bacteremia, endocarditis, abscesses, and genitourinary tract and wound infections. They are also major causes of sepsis and bacteremia in cancer patients. Infections caused by these microorganisms in immunosuppressed patients can progress with serious consequences, such as the development of septic shock.

Enterococcus sp. is normally found in the intestine and female genital tract. A total of 14 species have been described⁽¹⁵⁾, where *E. faecalis* and *E. faecium* are the two species that normally promote colonization and infections in humans. The emergence of this pathogen over the last two decades, among other factors, is in part due to its intrinsic resistance to commonly used antimicrobials. VRE (Vancomycin-Resistant Enterococci)⁽¹⁶⁾ was not found on neckties, but a VRE colony was isolated from one of the shirt samples.

Klebsiella pneumoniae is found in feces of 30% of normal individuals and, to a lesser degree, in the nasopharynx. *K. pneumoniae* is a major cause of pneumonia, bacteremia and infections in other organs.

This bacterium is increasingly relevant in hospital-acquired infections and as an opportunistic pathogen, often causing infections in immunocompromised patients. Diabetic and alcoholic patients have colonization rates of 35% by *K. pneumoniae* in the oropharynx, a fact which favors the development of pneumonia secondary to this micro-organism. Infections by this agent mainly affect the urinary and respiratory tracts, leading to severe bacteremia and aspirative pneumonia, associated with high morbidity and mortality rates.

In the hospital setting, *K. pneumoniae* colonization rates increase commensurately with length of hospital stay. The bacterium has multi-resistant strains, referred to as KPC (*Klebsiella Pneumoniae* Carbapenemase).

These bacteria are resistant to practically all antibiotics⁽¹⁷⁾ and are able to transmit resistance to other bacteria they come into contact with. In the present study, only one *K. pneumoniae* colony was isolated, where this proved KPC positive.

One of the aspects investigated was the frequency of changing and hygienization of the neckties. While physicians changed their ties more often than the law students ($p < 0.05$), these were not washed after use. Consequently, the ties act as reservoirs, harboring bacteria from microbiota and the environment, as well as pathogenic and multi-resistant bacteria. Another factor contributing to contamination of neckties is that, even when white coats are fastened (worn to protect clothes from fluids and contamination), ties remain exposed to aerosols and other microparticles. The risk of spread of these bacteria to areas outside the hospital environment is significant, while there is also risk of intra-hospital contamination. Neckties, however, act as an unnecessarily fomite, given they are not an obligatory item of apparel and have no impact on patients' perceptions of physicians⁽¹²⁾.

More regular washing of ties can help reduce contamination risks for doctors that feel the need to wear them; as can performing hand hygiene according to WHO recommendations: before touching a patient, before aseptic procedures, after body fluid exposure risk, and after touching patient surroundings.

These study results are consistent with the literature^(1,5,7,8,10-11) confirming the contamination potential of neckties. This study is the largest conducted in Brazil to date and the first to use a control group outside the hospital setting that is representative of the general population.

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