Hospital Gowns as a Vehicle for Bacterial Dissemination in an Intensive Care Unit

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The microbiota from the uniforms of 31 professionals from the general intensive care unit was analyzed. The samples were collected in duplicate at the beginning and at the end of the work period. Total viable counts of microorganisms were determined; there was a significant increase in the counts at the end of the period, when compared with those obtained at the beginning. No significant difference was observed between the first and second counts obtained from the cuffs. However, differences were observed for the samples from the abdominal region. Among the isolated pathogens 11/18 were *Staphylococcus aureus*, 2/18 were *Acinetobacter baumannii*, 2/18 were *Klebsiela pneumoniae* and 1/18 were *Serratia rubidae*. Some of these isolates were multi-resistant to antibiotics. Emphasis should be placed on reducing the spread of these pathogens in the hospital, making sure that biosafety protocols are followed by the staff.

Key Words: Gown, bacteria, hospital infection, cross contamination.

So-called hospital infections are among the main causes of morbidity and mortality in hospitals. Also, they increase hospital stays and costs [1]. Health professionals can harbor many pathogens on their bodies, mainly on their hands and nostril surfaces [2]. However, there are few studies concerning the presence of microorganisms on hospital clothing.

The increasing rate of hospital infections, especially those caused by multi-resistant *Staphylococcus aureus* is causing a certain apprehension due to the possibility of microorganism transmission via hospital staff uniforms [3]. The gowns that are usually used in surgery rooms offer a reasonable level of protection, especially the disposable synthetic ones [4]. Nevertheless, routine gowns used in many sections of Brazilian hospitals, including the Intensive Care Units (ICUs), are made of cotton fabric and are reutilized. This kind of material, and continuous rewashing, diminishes the efficiency of such garments. The concern about hospital clothing in developed countries is so intense that in Europe a committee was created to normalize and standardize what kind of raw materials should be used for these garments [5].

One of the hardest challenges in the combat of hospital infections is to detect which microorganisms are the most likely to be involved. The authors believe that pathogen transference is possible from one patient to other (cross infection) by gowns that act as vehicles of transference.

Therefore, the presence of bacteria in gowns and their possible dissemination should be investigated. To analyze such a possibility, we investigated the presence and total viable count of microorganisms occurring in gowns of health professionals of an intensive care unit, as well as their resistance profiles.

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Materials and Methods

Samples were collected from 31 health professionals of the ICU of the Cajuru Universitary Hospital, in Curitiba, Parana, Brazil. Among the professionals who had their gowns analyzed, we included 13 nursing assistants, 11 physiotherapy trainees, 3 physicians, 2 physiotherapists, 1 nurse and 1 laboratory technician. The collection areas for long–sleeved gowns were the cuffs, and for short-sleeved gowns, the abdominal region. These are the regions with the highest probability of being contaminated [4]. The samples were collected at the beginning and at the end of work period, in order to determine if there was acquisition of microorganisms during patient care.

Microorganism counts were carried out using contact plates (Rodac-type plates) containing MacConkey Agar and Letheen Agar (Newplus I® Kit, Newprov Art. Laborat., Pinhais, Brazil). The total viable and Gram-negative counts were determined after 48 hours of incubation at 35ºC.

For the isolation of pathogens, 4cm^2 areas of each gown were sampled, with moist swabs that were inoculated in Letheen Broth tubes. After 24 hours, the Letheen Broth cultures were transferred to selective media: MacConkey Agar, XLD Agar, Cetrimide Agar and Mannitol Salt Agar (Newplus II® Kit, Newprov Art. Laborat., Pinhais, Brazil). All colonies isolated in the selective media were submitted to identification to the species level. The presence of suspected pathogens was confirmed by automated identification tests (Vitek® System-BioMerieux, Marcy L´Etoile, France).

The antibiotic susceptibility tests were carried out according to the Kirby–Bauer method. The different antibiotics used are listed in Table 2.

Statistical analyses were performed using the Kruskal-Wallis non-parametric method.

Results

After 48 hours of incubation, the counts varied from 0 to 660 colony forming units (CFU)/plate (0 to 33 CFU/cm^2). A significant increase in CFU counts was detected at the end of the work period in comparison with the samples collected at the beginning (p=0.02). After 48 hours of incubation, the average count of the first collection was 45.1 CFU/plate (2.2 CFU/cm^2), and this increased to 97.6 CFU/plate (4.9 CFU/cm^2) at the end of the work period. When the cuffs were examined alone, there was a significant difference between the first and second counts (p=0.027, with average counts of 40.6 and 56.5 CFU/plate, respectively). In an analogous manner, there were significant differences for the counts from the abdominal region when comparing the first and the second samples (p=0.005, with average counts of 52.2 and 162.4 CFU/plate, respectively).

The Gram-negative counts oscillated from 0 to 9 CFU/plate (0 to 0.45 CFU/cm^2), with an average of 0.1 and 0.5 CFU/plate, for the first and second counts, respectively. This difference was not significant (p=0.25). The mean Gram-negative counts for the abdomen and cuffs were also not significantly different (p=0.27).

Pathogens were isolated from 48% (15/31) of the gowns. Among the isolated pathogens, 39% (7/18) were Gram-negative and 61% (11/18) were Gram-positive. All Gram-positive isolates were identified as *Staphylococcus aureus*. Among the Gram-negatives, 11% (2/18) were *Acinetobacter baumannii*, 11% (2/18) were *Klebsiella pneumoniae*, 11% (2/18) were *Stenotrophomonas maltophilia*, and 5.5% (1/18) were *Serratia rubidae*. Two pathogens occurring simultaneously were found in three gowns (Table 1). We did not detect *Escherichia coli* or *Pseudomonas* spp. The susceptibility profiles of the pathogens are given in Table 2. Among the *Staphylococcus aureus* isolates, none were resistant to methicillin (MRSA). Four of the 18 Gram-negative bacteria strains were considered multi-resistant.

Discussion

The role of garments as infection sources and vehicles was previously reported by some authors [6-8].

Table 1. Pathogenic bacteria isolated from health professionals' gowns in an intensive care unit

Nº	Sampling area	Occupation	Identification
1	ABD	PHY	*Serratia rubidae*
2	ABD	NA	Absent
3	ABD	NA	Absent
4	ABD	NA	*Klebsiela pneumoniae* *Staphylococcus aureus*
5	ABD	NA	*Staphylococcus aureus*
6	ABD	NA	*Staphylococcus aureus*
7	ABD	NA	*Staphylococcus aureus* *Acinetobacter baumannii*
8	ABD	NA	*Staphylococcus aureus*
9	CUFFS	PHY	*Staphylococcus aureus*
10	CUFFS	PHY	*Staphylococcus aureus*
11	CUFFS	PT	Absent
12	CUFFS	PT	Absent
13	CUFFS	PT	*Klebsiella pneumoniae*
14	CUFFS	PT	Absent
15	CUFFS	PT	Absent
16	CUFFS	PHY	Absent
17	CUFFS	LT	Absent
18	CUFFS	N	Absent
19	CUFFS	NA	Absent
20	ABD	NA	*Stenotrophomonas maltophilia*
21	ABD	NA	*Staphylococcus aureus*
22	CUFFS	PHY	*Stenotrophomonas maltophilia*
23	CUFFS	PT	Absent
24	CUFFS	NA	Absent
25	CUFFS	PT	*Staphylococcus aureus* *Acinetobacter baumannii*
26	CUFFS	PT	Absent
27	CUFFS	PT	Absent
28	CUFFS	PT	Absent
29	CUFFS	PT	Absent
30	ABD	NA	*Staphylococcus aureus*
31	ABD	NA	*Staphylococcus aureus*

ABD: abdominal region; NA: nurse assistant; N: nurse; PT: physiotherapy trainee; PHY: physician; LT: laboratory technician.

Table 2. Resistance profile of isolated pathogens (%)

Antibiotic	*S. aureus* (n = 11)	*A. baumannii* (n = 2)	*S. maltophilia* (n = 2)	*K. pneumoniae* (n = 2)	*S. rubidae* (n = 1)
Amikacin	0%	100%	50%	0%	0%
Ampicillin	0%	100%	100%	100%	100%
Cephalothin	0%	100%	100%	100%	100%
Cefoxitin	0%	100%	100%	0%	0%
Ceftriaxone	NA	100%	100%	100%	100%
Ceftazidime	NA	50%	100%	0%	0%
Ciprofloxacin	0%	0%	0%	0%	0%
Clindamycin	0%	NA	NA	NA	NA
Chloramphenicol	0%	100%	100%	0%	0%
Erythromycin	18%	NA	NA	NA	NA
Gentamicin	0%	100%	50%	0%	0%
Oxacillin	0%	NA	NA	NA	NA
Sulfametoxazol-Trimetoprim	0%	100%	50%	0%	0%
Tetracycline	0%	0%	0%	0%	0%
Vancomycin	0%	NA	NA	NA	NA

NA - not applicable.

However, almost all the published papers centered their focus on physicians' (mostly surgeons) clothing. We evaluated the contamination of gowns of other professionals that compose the medical staff and are in daily contact with institutionalized patients.

The bacteria isolated from hospital gowns were mainly Gram-positive when we evaluated total viable bacterial counts; this situation had previously been described [9]. However, when we examined the frequency of types of pathogens, 39% (7/18) were gram negative and 61% (11/18) were gram positive. We also found a strong increase in total counts at the end of the work period. Therefore, we suggest that gowns of health professionals can pick up bacteria from patients. These may be disseminated within the environment or even to other patients, putting their lives at risk. There is evidence that bacteria coming from the surgeon's gowns causes 20% of the infections after surgery [10]. However, the development of new synthetic materials gave rise to a significant decrease in this index [11].

We found that there is a considerable population of microorganisms in the gowns of medical staff, and this population grows during the work period. This is evident from the rise of bacteria counts from 45.1 CFU/plate (2.2 CFU/cm^2) in the first evaluation, to 97.6 CFU/plate (4.9 CFU/cm^2) in the second count. Another important point that should be considered is that in 48% of the gowns (15/31) at least one pathogen was isolated. Also, we found that bacterial counts in the second samplings were higher in the abdominal region than in the cuffs (p=0.027). These results are, in part, in disagreement with those related in other reports [6,12], which concluded that cuffs and pockets were the most contaminated areas. However, in both of these publications, only physicians were included, whereas in our study we evaluated the contamination in the gowns of physiotherapy trainees and nurse assistants, who usually contact the patient more frequently.

In order to determine if the increase of total viable and Gram-negative bacilli counts were or not concordant, a correlation coefficient was applied. It showed a slight disparity between the two counts (r=-0.083). This result may be explained, at least in part, by the supposition that most of the viable microorganisms are coagulase-negative staphylococci [13] and some Gram-negatives attach very poorly to fabrics [7,13].

We detected certain pathogens, which are commonly related to hospital infections (e.g. *S. aureus*, *K. pneumoniae* and *A. baumannii*). This observation reinforces the need for more care with clothing. The only Gram-positive pathogen isolated (*S. aureus*) did not have a problematic resistance profile. However, most of the isolated Gram-negative bacteria were multi-resistant or had some resistance to antibiotics commonly used in therapy. The similar resistance profile of some microorganisms of the same species (e.g., *A. baumannii*) isolated from different gowns suggests that these could have had a common source of contamination. A molecular investigation of these isolates would be of value to confirm such a hypothesis. Emphasis on the possibility of spreading these pathogens via health professionals or between patients in the hospital environment should be made, especially in hospitals or clinics where bio-safety standards are not observed. It is known that the more a gown is re-utilized the greater the susceptibility to contamination and, by inference, the less protection afforded to the user and to the patients [14]. The use of reusable cotton gowns should also be analyzed to determine if they are really economical or if the adoption of synthetic, semi-synthetic or even disposable materials would have greater cost-benefit, resulting in a better quality of service for the patient [15].

We believe that a re-education program applied to health professionals would help to diminish bacterial contamination through hospital gowns, especially in the ICUs where the rate of hospital infections is very high.

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