

# Bacterial growth on the hands of health care workers: implications for preventing nosocomial infections

Crescimento bacteriano nas mãos dos profissionais de saúde: implicações na prevenção de infecções hospitalares

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## ABSTRACT

**Objective:** to analyze bacterial growth in samples collected from the hands of health professionals after hygiene with soap and water. **Methods:** cross-sectional analytical study, carried out with healthcare professionals by collecting samples (print) from the digital pulp of the dominant hand on plates containing chromogenic culture medium for microbiological analysis regarding the presence of colonies. Fisher's and Chi-square tests were used. **Results:** 73 samples were collected and 67 (91.8%) showed bacterial growth. Methicillin-resistant *Staphylococcus aureus* was detected in 19 (26.0%). A significant association between colonies with multidrug-resistance profile and the time of performance ( $p=0.030$ ) and profession ( $p=0.041$ ) was highlighted. **Conclusion:** there was bacterial growth in samples after hand hygiene, with higher growth of multidrug-resistant bacteria among nursing professionals and those with longer time of work. These results may contribute to detect the gaps about the measures adopted for infection prevention.

**Descriptors:** Bacterial Growth; Health Personnel; Cross Infection; Hand Disinfection.

## RESUMO

**Objetivo:** analisar o crescimento bacteriano em amostras coletadas das mãos de profissionais de saúde após higiene com água e sabão. **Métodos:** estudo transversal analítico, realizado com profissionais de saúde por meio da coleta de amostras (print) das polpas digitais da mão dominante, em placas contendo meio de cultura cromogênico, para análise microbiológica em relação à presença das colônias. Utilizaram-se o Teste de Fisher e Qui-quadrado. **Resultados:** foram coletadas 73 amostras e 67 (91,8%) apresentaram crescimento bacteriano. O *Staphylococcus aureus* metilcilina resistente foi detectado em 19 (26,0%). Destaca-se associação significativa entre colônias com perfil de multirresistência e o tempo de atuação ( $p=0,030$ ) e profissão ( $p=0,041$ ). **Conclusão:** houve crescimento bacteriano nas amostras após higiene das mãos, com maior crescimento de bactérias multirresistentes entre profissionais de enfermagem e àqueles com maior tempo de atuação. Estes resultados podem contribuir para detectar as lacunas acerca das medidas adotadas para a prevenção de infecções.

**Descritores:** Crescimento Bacteriano; Pessoal de Saúde; Infecção Hospitalar; Desinfecção das Mãos.

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## Introduction

Bacteria are simple, single-celled organisms that inhabit the human body, and are found in many different environments, such as air, water, and food. Although many are not considered pathogenic, others can cause various life-threatening diseases. Considering the hospital context, (multi)resistant bacteria represent a great risk for patients, especially those who require invasive procedures or are hospitalized for a long time<sup>(1)</sup>.

Prophylaxis methods, such as hand hygiene, are directly related to hospital infection control, and their effectiveness is associated with knowledge, awareness, and empowerment of health professionals. It is worth noting that the technique removes the transient microbiota from the hands, found in the superficial layers of the skin and acquired through external sources<sup>(2)</sup>.

Based on these actions, good hand hygiene practices become indispensable to avoid any damage related to the assistance provided. In this sense, the hands of health professionals can be a source and vehicle of germ transmission, which will cause assistance-related infections. Currently, these infections are an international concern, since they result from several variables, such as professional performance, quality of available materials and the hospital structure offered<sup>(3)</sup>.

Although good adherence to hand hygiene is scientifically proven to reduce infection rates and that this strategy is widely recommended, studies have reported insufficient adherence rates to this measure, as shown in a 2021 survey conducted in a reference hospital in infectious diseases that found only 34.1% adherence to hand hygiene by professionals from two Intensive Care Units; and in another study the average adherence rate by health professionals was 40%<sup>(3-4)</sup>.

The healthcare environment is considered a medium of concentration, transmission, and dissemination of microorganisms, where there is the possibility of cross transmission of microorganisms by the contact of hands of health professionals with patients,

surfaces, and utensils of professional use<sup>(5)</sup>. In this sense, identifying the microorganisms present on the hands of health care professionals can contribute to detect the gaps in the measures adopted to prevent infections and to elucidate the possible origin of health care-related infections.

Thus, this research can be a managerial tool to minimize damage to health and provide higher quality care to patients. Furthermore, there is a scarcity of studies in the literature that address bacterial growth after hand hygiene with soap and water and that use similar methodologies.

In light of the above, the present study aimed to analyze bacterial growth in samples collected from the hands of health professionals after hygiene with soap and water.

## Methods

This was an analytical cross-sectional study, carried out in a medium-sized public hospital with high patient turnover and medium- and high-complexity services, located in a city in the coastal lowlands of Rio de Janeiro. This study met the guidelines recommended by Strengthening the Reporting of Observational studies in Epidemiology (STROBE).

The sample was selected by convenience, and the professionals who were in the units selected for the study at the time of data collection were invited. The eligible population consisted of 188 health professionals working in the hospital in the sectors selected for the research (imaging center, pediatrics, intensive care center, obstetrics, inpatient units, and nutrition). Upon acceptance to participate in the research, the data collection period occurred from May 2019 to February 2020. Inclusion criteria were health team professionals (physicians, nurses, nursing technicians, physical therapists, nutritionists, psychologists, radiology technicians), regardless of the time of professional and institutional practice. Health professionals who did not work in direct patient care and health professionals in administrative positions were excluded.

Data collection was directed to the characterization of the participating professionals and the collection of samples for microbiological analysis. After the participant consent and recruitment processes, the study team waited for the participant to perform their work activities and sample collection took place immediately after hand hygiene, before the participant touched any object, surface, or people. The participants were also observed as to the first object touched and the first procedure performed after the sample collection. It is noteworthy that non-participant observation was performed by the study team and that there was no intervention in the hand hygiene practice performed by the professionals.

Samples for microbiological analysis were collected by printing (microbiological capture) the digital pulp of all fingers of the professional's dominant hand on Petri dishes containing chromogenic culture medium and culture medium for phenotypic characterization of Methicillin-resistant *Staphylococcus aureus* (MRSA) after hand washing with soap and water using the technique recommended by the National Health Surveillance Agency<sup>(6)</sup>. Two samples per participant were collected (plates with chromogenic medium and plates with selective and differential medium for MRSA isolation), and the dominant hand was chosen because it is the most used for manipulating and touching objects, surfaces, and patients. All collections were performed by previously trained researchers of the study team, using aseptic technique to ensure material sterility<sup>(7)</sup>.

The plates, Laborclin® brand, were identified with an alphanumeric code corresponding to the participant, stored in a Styrofoam box containing two artificial ice devices for temperature maintenance and transported to the University's Microbiology Laboratory at the end of each day's data collection for incubation in a 37°C oven for 24 hours. After the incubation period, the plates were analyzed and stored in the laboratory refrigerator. The microbial growth was analyzed according to the interpretation suggested by

the manufacturer regarding the presence or absence of colonies.

Chromogenic culture medium was used for culture and presumptive identification of the following microorganisms: 1) blue/dark blue colonies refer to *Klebsiella sp.*, *Enterobacter sp.*, *Serratia sp.*, *Citrobacter sp.* (KESC); 2) blue-green colonies for *Enterococcus spp.*, *Streptococcus agalactiae*, *Streptococcus pyogenes*; 3) magenta stained colonies for *Escherichia coli*, *Staphylococcus saprophyticus*; 4) white or yellowish colonies for *Staphylococcus spp.* including *S. aureus*, *Candida sp.* and other enterobacterial species; and 5) light to dark brown colonies for *Proteus sp.*, *Providencia sp.*, *Morganella sp.* (PPM).

The data collected were entered into an Excel® spreadsheet, using double entry, processed in the Statistical Package for the Social Sciences, version 21, and analyzed using descriptive statistics with measures of central tendency (mean, median) and dispersion (standard deviation), as well as maximum and minimum. The Shapiro-Wilk test was used to verify data normality. To verify the presence of associations, the Fisher's exact test and the Chi-square test were used. The significance level adopted was 0.05. The outcome variables were blue colony growth (yes or no) and MRSA colony growth (yes or no), and the independent variables were gender (male or female), profession (nursing professional or other healthcare professionals), length of practice ( $\leq 10$  years or  $> 10$  years), weekly workload (up to 30 hours or over 30 hours) and having more than one employment relationship (no or yes) and sector (imaging center or pediatrics or nutrition intensive care center or obstetrics or inpatient units).

Data were collected after approval by the Ethics and Research Committee of the Faculdade de Ciências Humanas of the Universidade Federal Fluminense (opinion: 3,148,879/2019; Certificate of Ethical Appreciation Submission: 07669218.8.0000.8160) and consent of the institution that makes up the study setting. All ethical aspects were contemplated in respect

to the Resolutions of the National Health Council for studies with human beings, and the Informed Consent Form was applied, protecting the confidentiality of information, and ensuring the anonymity of the participants.

## Results

Seventy-three healthcare professionals participated in the study, 52 (71.2%) from nursing and 21 (28.8%) from other healthcare areas such as physicians, dieticians, speech therapists, physical therapists, and radiology technicians. Regarding the sectors in which these professionals worked, 5 (6.8%) worked in the imaging center, 7 (9.6%) in pediatrics, 8 (10.9%) in inpatient nutrition, 14 (19.1%) in the intensive care unit, 18 (24.6%) in obstetrics including prepartum and rooming-in, and 21 (28.8%) in inpatient units such as medical and surgical clinics.

Of all the participants, 51 (69.8%) had more than one employment relationship, 54 (73.9%) had worked for more than 10 years, with a mean of 17.4 years (standard deviation (SD) = 9.0) and mean weekly workload of 36.7 hours (SD = 11.9). It is noteworthy that there was a predominance of female professionals, corresponding to 56 (76.7%), while males were equivalent to 17 (23.2%) with a mean age of 46.3 years (SD = 9.5, minimum = 27, maximum = 67).

Most 67 (91.8%) of the samples collected from the hands of health professionals after hand washing with soap and water presented bacterial growth in a chromogenic medium. It is noteworthy that in 100% of the samples with bacterial growth, more than one type of chromogenic colony was verified. Regarding bacterial growth, according to the coloration of the colonies, the most prevalent was white or yellowish referring to *Staphylococcus spp.*, *S. aureus*, *Candida sp.* and enterobacteria in 65 (89.1%) of the samples, followed by 57 (78.8%) blue referring to the KESC group (Table 1). As for the MRSA culture media, 19 (26.03%) samples showed bacterial growth with a multidrug-resistance profile.

**Table 1** – Bacterial growth of samples collected from the hands of health professionals after hand washing with soap and water. Rio de Janeiro, RJ, Brazil, 2020

Variables	Yes	No
	n (%)	n (%)
Chromogenic colonies	67 (91.8)	6 (8.2)
Blue colonies ( <i>Klebsiella sp.</i> , <i>Enterobacter sp.</i> , <i>Serratia sp.</i> , <i>Citrobacter sp.</i> )	57 (78.8)	16 (21.2)
Blue-green colonies ( <i>Enterococcus spp.</i> , <i>S. agalactiae</i> , <i>S. pyogenes</i> )	5 (6.8)	68 (93.2)
Magenta colonies ( <i>Escherichia coli</i> , <i>Staphylococcus saprophyticus</i> )	28 (38.3)	45 (61.7)
White or yellow colonies ( <i>Staphylococcus spp.</i> , <i>S. aureus</i> , <i>Candida sp.</i> and <i>enterobacteria</i> )	65 (89.1)	8 (10.9)
Brown colonies ( <i>Proteus sp.</i> , <i>Providencia sp.</i> , <i>Morganella sp.</i> )	1 (1.3)	72 (98.7)
Methicillin-resistant <i>Staphylococcus aureus</i> colonies	19 (26.1)	54 (73.9)

It is noteworthy that after hand hygiene with soap and water and sample collection in this study, 41 (56.2%) objects touched by healthcare professionals were hospital materials, while 32 (43.8%) were personal use objects. Also, of the participants who had positive samples for bacterial growth, 25 (37.3%) performed administrative procedures after sample collection, 12 (17.9%) performed procedures with the patient, among them, aspiration of the upper airways, venous puncture, and vesical catheterization, and 30 (44.8%) performed other types of activities such as having meals and leaving the work sector.

Among the associations analyzed, a statistically significant result was obtained between the growth of blue colonies and the variable gender ( $p=0.020$ ), and between the growth of MRSA colonies and the length of professional experience ( $p=0.030$ ) and profession ( $p=0.040$ ) (Table 2). This means that there was greater growth of KESC colonies on the hands of female healthcare workers compared with men, and greater MRSA bacterial growth on the hands of those with longer practice and among nursing staff.

**Table 2** – Association between bacterial growth of KESC group colonies and MRSA colonies and individual variables of healthcare workers (n=73). Rio de Janeiro, RJ, Brazil, 2020

Variables	Bacterial Growth			MRSA growth		
	No n(%)	Yes n(%)	p-value	No n(%)	Yes n(%)	p-value
Gender						
Male	7 (41.1)	10 (58.9)	0.020*	7 (41.1)	10 (58.9)	0.120 <sup>†</sup>
Female	9 (16.1)	47 (83.9)		12(21.4)	44 (78.6)	
Profession						
Nursing	12 (23.1)	40 (76.9)	1.000 <sup>†</sup>	17 (32.7)	35 (67.3)	0.040*
Others Healthcare Professional	4 (19.1)	17 (80.9)		2 (9.5)	19 (90.5)	
Time of performance (years)						
≤10	3 (15.8)	16 (84.2)	0.530 <sup>†</sup>	9 (47.4)	10 (52.6)	0.030 <sup>†</sup>
>10	13 (24.1)	41 (75.9)		10 (18.5)	44 (81.5)	
Workload (hours)						
Up to 30	4 (16.7)	20 (83.3)	0.550 <sup>†</sup>	3 (12.5)	21 (87.5)	0.060*
>30	12 (24.5)	37 (75.5)		16 (32.6)	33 (67.4)	
Employment relationship						
One employment relationship	5 (22.7)	17 (77.3)	0.910*	9 (40.9)	13 (59.1)	0.050*
More than one employment relationship	0 (0.0)	51(100)		10 (19.6)	41 (60.4)	
Section						
Obstetrics	5 (27.8)	13 (72.2)	0.310*	16 (88.9)	2 (11.1)	0.080 <sup>†</sup>
Pediatrics	0 (0.0)	7 (100.0)		7 (100.0)	0 (0.0)	
Admission Unit	4 (9.1)	17 (80.9)		11 (5.4)	10 (4.6)	
Intensive Care Center	6 (42.9)	8 (57.1)		9 (64.3)	5 (35.7)	
Imaging Center	0 (0.0)	5 (100.0)		3 (60.0)	2 (40.0)	
Nutrition	1 (12.5)	7 (87.5)		8 (100.0)	0 (0.0)	

\*Chi-square test; <sup>†</sup>Fisher's exact test; KESC: *Klebsiella* sp., *Enterobacter* sp., *Serratia* sp., *Citrobacter* sp.; MRSA: methicillin-resistant *Staphylococcus aureus*

## Discussion

This study has limitations because it did not consider the technique used by the participants nor the conditions of the institutional environment for hand hygiene, understanding that these factors can contribute to the removal, or not, of the transient microbiota from the hands of health professionals. The present study was limited to a specific population of healthcare professionals from a public hospital in the coastal lowlands of Rio de Janeiro, constituting a single hospital reality, which makes it difficult to

generalize the results found. It is also noteworthy that the number of samples collected was limited by the need to interrupt data collection with the beginning of the coronavirus disease pandemic (COVID-19).

Despite this, the results were irrefutable in the sense of evidence of bacterial growth and the possibility of spreading these bacteria in a hospital environment through the hands of healthcare professionals. Furthermore, it is worth mentioning the need for further studies on the theme in different healthcare practice settings.

It is worth emphasizing the importance of performing hand hygiene with soap and water, since it contributes to the identification of the main microorganisms found on the hands of health professionals, which can facilitate the identification of the origin of the main health care-related infections in the study setting. Based on these actions, the data found can serve as a subsidy for the creation and implementation of new actions that seek to elucidate bacterial growth on the hands of health professionals and the importance of a satisfactory execution of hand hygiene in the hospital environment.

The findings of this research corroborate a study that investigated the presence of microbial contamination of the hands of employees of a health center and found bacterial growth in 21 of 29 samples collected<sup>(5)</sup>. This finding raises a great concern about the possibility of dissemination of potentially pathogenic microorganisms in the hospital environment, since the professionals who participated in this study with positive samples for bacterial growth performed several activities, including patient care. Additionally, they touched hospital objects and left the sector, which could disseminate these bacteria to other environments.

The transmission of microorganisms can happen through direct or indirect contact with patients and their surroundings, which may vary according to the activity performed, since the skin is a potential reservoir of microorganisms and can transfer them from one surface to another. It is noteworthy that standardized and recommended hand hygiene techniques can considerably reduce the microbial load on the hands of health professionals and especially on those of nursing staff, which is identified as more susceptible to infection by multiple resistant microorganisms in their work environment, due to the characteristics of their activities<sup>(2,8)</sup>.

Healthcare-related infections are considered a major cause of death in all ages, besides generating high costs to patients and their families and burdening

healthcare systems. However, they are preventable through simple and low-cost practices, such as hand hygiene, which is the main measure to reduce these infections and the spread of antimicrobial resistant pathogens<sup>(8-9)</sup>. In this study, it was observed that even after hand hygiene there was bacterial growth. Therefore, it is necessary to identify the factors that may be related to the inefficiency of the technique performed by the participating professionals.

These colonies diverge from those found in a study carried out with healthcare professionals in an adult and neonatal intensive care unit that found Gram-negative *Enterobacter spp.* bacteria in most of their collected samples<sup>(10)</sup>. However, the analysis of hand samples from employees of a health service in the southern region of the country found the prevalence of *Staphylococcus aureus* in most samples collected, corroborating the results found in this research. It is noteworthy that both species are responsible for a large part of health care-related infections, especially *Staphylococcus aureus*, which is commonly found in the Intensive Care Unit and responsible for causing bloodstream, catheter-related, skin, and soft tissue infections, as evidenced in a study that retrospectively evaluated 11,995 hospitalizations in the state of Rio Grande do Sul<sup>(5,11)</sup>.

Bacteria from the KESC group comprised the second group with the highest incidence and with a high growth rate in all sectors surveyed in this research. However, the intensive care unit and pediatrics stand out, corroborating a study carried out in adult and neonatal intensive care units, which observed *Klebsiella pneumoniae* as the cause of 7.3% and 11.9% of infections cases, respectively. In addition, when isolated, 70.6% presented resistance mechanisms to antimicrobials<sup>(12)</sup>.

It is also noteworthy that *Klebsiella pneumoniae* is a bacterium capable of causing infection at any anatomical site in hospitalized patients, being referred to in the literature as a cause of primary bloodstream infections, isolated and ventilator-associated pneumo-

nia, urinary tract infections and superficial incisional surgical site infection<sup>(12)</sup>. Another study that sought to evaluate the sensitivity profile of bacteria that cause infection found *Enterobacter* and *Citrobacter spp* to be the cause of 4.5% and 4.1% of infections, respectively. Furthermore, the study observed antimicrobial resistance in 27.2% of *Enterobacter* cases<sup>(13)</sup>.

Regarding *Serratia*, a study that aimed to describe the microbiological characteristics and resistance profile of microorganisms that cause healthcare-associated infections in a pediatric intensive care unit found that 11.1% of the infections reported during the study period were caused by this bacterium. The study also showed that *Klebsiella* was the cause of 22.2% of the infections reported. Considering that these microorganisms were the most found in the samples of this research, the importance of continuing education strategies is understood, since the dissemination of these microorganisms makes patients vulnerable to infections in the hospital environment<sup>(14)</sup>.

In the present study, the association of female gender with the type of bacteria was different from a study conducted in a health service in the South of Brazil, in which 90% of participating health professionals were female; however, the main microorganism isolated was *Staphylococcus aureus*. The study also pointed out that 15% of the microorganisms found and isolated from the hands corresponded to *Escherichia coli*, which was also identified by this research<sup>(5)</sup>.

*S. saprophyticus*, *Enterococcus spp.*, *S. agalactiae* and *S. pyogenes* bacteria were also identified in the samples collected from the hands of the professionals participating in the research, besides a single growth of bacteria of the PPM group, frequently causing urinary tract infections, as presented in a study that evaluated 679 positive urine cultures<sup>(15)</sup>.

Particularly regarding antimicrobial resistance, there was divergence from the literature in a study carried out with healthcare professionals, which found growth of methicillin-resistant *Staphylococcus*

*aureus* bacteria in only one of the samples collected. It is noteworthy that generally, MRSA bacteria are associated with increased costs with the use of antibiotics, in addition to the long stay of patients, a worrisome fact since the study setting is a public hospital that serves patients through the Unified Health System<sup>(10,16)</sup>.

The bacterial growth of MRSA on the hands of nursing professionals can be attributed to the fact that their work involves direct contact with patients and contaminated surfaces, since MRSA is transmitted through contact, and is described as the main causative agent of healthcare-associated infections<sup>(8,17)</sup>.

The associations related to the female gender and the nursing profession can be justified in this study, since most samples were composed of professionals with this profile. However, the high bacterial growth and the great diversity of the types of microorganisms found on the hands of professionals after hand hygiene in this study lead us to a great concern and the need to direct strategies to perform this technique correctly and satisfactorily. Several factors contribute to the success of hand hygiene, including the physical structure of the place for washing, supplies such as soap and disposable papers, as well as investment in periodic training of professionals and the use of educational strategies<sup>(18)</sup>.

## Conclusion

Bacterial growth was found in most samples collected from the hands of health professionals immediately after hand hygiene with soap and water, especially colonies of *Staphylococcus spp.* and the growth of bacteria with multidrug-resistance spectrum. Given these results, it is possible to consider that there are failures regarding good hand hygiene practices with soap and water, which may be related to the execution of the technique or inputs used. Moreover, the microorganisms found coincide with those that are most associated with healthcare-related infections.

## Collaborations

Andrade ABS, Brun LSO, Brandão P, Carvalho C, and Ávila FMVP collaborated to the conception and design or data analysis and interpretation, article writing and relevant critical review of the intellectual content. Goulart MCL collaborated to the conception and design or data analysis and interpretation, article writing, relevant critical review of the intellectual content, and final approval of the version to be published.

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