

# Bacterial growth and recovery on hospital biometric devices: effect of two types of disinfectants

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## Abstract

**Objectives:** The aim of the study was to evaluate the presence of bacterial contamination on biometric identification devices in a public hospital; identify the species of bacteria implicated in the contamination and assess bacterial recovery after the use of 2 types of disinfectants: alcohol 70% and isopropyl alcohol chlorhexidine.

**Design:** Before and after trial.

**Setting:** Public hospital, tertiary referral center.

**Participants:** All existing biometric identification devices in the hospital (n=20).

**Methods:** Collection of 2 microbiological samples from the fingerprint reading surface of biometric devices immediately before and after applying the solution with alcohol 70% and in separate time periods with isopropyl alcohol chlorhexidine.

**Results:** It have been identified 21 different bacterial species in a total of 78 samples, mostly *Staphylococcus epidermidis* (32 samples) and *S aureus* (7 samples). *S epidermidis* was eliminated in 61.5% of the samples after disinfecting with alcohol 70% and in 92.3% of the samples disinfected with isopropyl alcohol chlorhexidine. *S aureus* was eliminated in 33.3% and 100% of the samples, respectively. We found no bacterial growth in 10% of the devices after disinfection with 70% alcohol and in 78.9% of devices after disinfection with isopropyl alcohol chlorhexidine. We also found that there was a decrease in the frequency of species isolated after using both disinfection solutions, although isopropyl alcohol chlorhexidine appeared to be more effective.

**Conclusions:** The biometric identification devices used in this hospital seem to be safe regardless of the products used for its cleaning. The majority of the bacteria found are commensal skin microorganisms. We did not find pathogenic bacteria for immunocompetent individuals, in particular methicillin-resistant *S aureus*.

**Keywords:** bacteria, biometric authentication, biometric identification, hospital

## Introduction

The prevailing methods for worker attendance control based on identification documents and PIN codes are not able to meet the increasing demands of a stringent security; as a consequence, biometric recognition is being increasingly adopted.<sup>1</sup>

As there is a constant concern regarding the spread of infectious disease in the public health care setting, attention has been brought to the hygiene of surface areas in public places such as fingerprint systems.<sup>2,3</sup>

In previous studies, more specifically fingerprint and hand geometry studies, individuals were concerned about the cleanliness of the sensor and being contaminated by germs by touching the same device used by others.<sup>2</sup> Several studies have shown that human pathogens can be transmitted between nonliving objects by direct hand contact.<sup>4</sup> This raises the question whether or not bacteria and other pathogenic microorganisms are a potential hazard that can be transferred from one person to another by touching a common device such as registration biometric devices (RBD), particularly in health-care settings placing both healthcare workers and patients at risk. In fact *Staphylococcus aureus*, namely methicillin-resistant *S aureus* (MRSA), is an important cause of hospital-associated infections, of morbidity, mortality, and increased economic burden for hospitalized patients.<sup>5-12</sup> Regarding Portuguese data, nosocomial prevalence of MRSA remains one of the highest in Europe.<sup>13</sup>

Employee concerns about cleanliness of RBD have prompted the installation of hand sanitizer stations next to the biometric devices that are predominantly located in hospital entrances.<sup>14</sup> Therefore, alongside with the assessment of bacterial growth on

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**Table 1****Microorganisms growth by sample location**

RBD	Before disinfection with alcohol 70%	After disinfection with alcohol 70%	Before disinfection with isopropyl alcohol chlorhexidine	After disinfection with isopropyl alcohol chlorhexidine
1	<i>Kocuria kristinae/ Staphylococcus epidermidis</i>	<i>S aureus</i>	<i>S epidermidis</i>	Negative
2	<i>Bacillus pumilus/ S epidermidis</i>	<i>Corynebacterium spp/ S epidermidis</i>	<i>S epidermidis</i>	Negative
3	<i>S saprophyticus</i>	<i>Bacillus</i> gram-positive unidentified	<i>S epidermidis</i>	Negative
4	Negative	<i>Rothia mucilaginoso</i>	<i>S warneri/S aureus</i>	Negative
5	<i>S aureus/S hominis</i>	<i>S epidermidis</i>	—	—
6	<i>Pseudomonas putida/S epidermidis</i>	<i>Bacillus</i> spp	<i>S epidermidis</i>	Negative
7	<i>S epidermidis</i>	<i>Micrococcus luteus/lylae</i>	<i>P oryzihabitans</i>	Negative
8	<i>S epidermidis</i>	<i>S epidermidis</i>	<i>S epidermidis</i>	Negative
9	<i>S epidermidis</i>	Negative	<i>S aureus</i>	Negative
10	<i>M luteus</i>	Negative	<i>S epidermidis</i>	Negative
11	<i>S epidermidis</i>	<i>S warneri</i>	<i>S epidermidis</i>	Negative
12	<i>S epidermidis/S warneri/ M luteus/lylae</i>	<i>B licheniformis</i>	<i>S epidermidis</i>	Negative
13	<i>S saprophyticus</i>	<i>Paenibacillus pabuli/ S epidermidis</i>	<i>S epidermidis</i>	<i>S epidermidis</i>
14	<i>S aureus/S epidermidis</i>	<i>S epidermidis</i>	<i>P oryzihabitans/ S epidermidis</i>	<i>S caprae</i>
15	<i>S epidermidis/S saprophyticus</i>	<i>S saprophyticus</i>	<i>S epidermidis</i>	Negative
16	<i>K rosea</i>	<i>S hominis</i>	<i>S epidermidis/ S haemolyticus</i>	<i>Corynebacterium</i> spp
17	<i>S aureus</i>	<i>S aureus</i>	<i>Micrococcus</i> spp	<i>S hominis</i>
18	<i>S epidermidis/S warneri</i>	<i>S epidermidis</i>	<i>S epidermidis</i>	Negative
19	<i>S epidermidis</i>	<i>Corynebacterium</i> spp	<i>S saprophyticus</i>	Negative
20	<i>S epidermidis</i>	<i>S epidermidis</i>	<i>S hominis</i>	Negative
Total of samples	20	20	19	19

RBD = registration biometric device.

RBDs it is also important to determine the efficacy of disinfection measures to prevent their contamination.

In this sense, the aims of the present study were to evaluate the contamination and identify the species of bacteria existing on the RBD in a public hospital and to assess bacterial recovery after the use of 2 types of disinfectants: alcohol 70% and isopropyl alcohol chlorhexidine (0.5% chlorhexidine gluconate and 70% alcohol).

## Methods

This study included all biometric devices (n=20) existing in a central university hospital. Samples were collected from the devices in 2 different phases: immediately before and after disinfection with alcohol 70% and an isopropyl alcohol chlorhexidine solution. The first phase of the study took place between December 2013 and March 2014 and included 2 microbiological samples collected from each of the 20 RBD (before and after disinfection with alcohol). The second phase was accomplished between June and October 2014, using the same procedure, yet applying isopropyl alcohol chlorhexidine solution. Between the 2 phases, one of the devices was removed (1 located in the central entrance) and for that reason, in the second phase only 19 devices were tested.

Sampling was performed by the Hospital's Occupational Health Department technician and all samples were collected by the same person. Samples were collected from the fingerprint

reading surface of the RBD using swabs in the Maximum Recovery Diluent – Histone-Like Proteins culture.

The sampling procedure consisted in moving a sterilized swab into the RBD fingerprint reading surface in zigzag fashion; this procedure was performed 2 times. Then the swab was inserted into the culture medium and shaken to homogenize the sample. Finally, the sample was placed in a thermal bag. Once these procedures were completed, the RBD was pulverized with the disinfection solution and after 10 seconds the sample area was cleaned with a sterilized gauze soaked with the same disinfection solution and the sampling was repeated.

## Results

A total of 78 samples from the RBD fingerprint reading surface were obtained (Table 1).

It was identified 21 different species (Table 2), mostly *S epidermidis* (34 samples) and *S aureus* (7 samples).

*S epidermidis* was eliminated in 61.5% and in 92.3% of the samples after disinfecting with 70% alcohol and isopropyl alcohol chlorhexidine respectively. *S aureus* was eliminated in 33.3% and in 100% of the samples after disinfecting with alcohol 70% and isopropyl alcohol chlorhexidine, respectively.

After disinfection with alcohol 70%, total absence of bacterial growth was only present in 10% of RBDs which contained *S epidermidis* and *Micrococcus luteus* before the disinfection procedure. This type of disinfectant was able to decrease the

**Table 2**  
Efficacy of disinfection solutions

Agent	Number of samples with agent growth (alcohol 70%)		Number of samples with agent growth (isopropyl alcohol chlorhexidine)		Samples per specie (n)
	Before disinfection	After disinfection	Before disinfection	After disinfection	
<i>Staphylococcus epidermidis</i>	13	7	13	1	34
<i>S aureus</i>	3	2	2	0	7
<i>S warneri</i>	2	0	1	0	3
<i>S saprophyticus</i>	3	1	1	0	5
<i>S hominis</i>	1	0	1	0	2
<i>S haemolyticus</i>	0	0	1	0	1
<i>Bacillus pumilus</i>	1	0	0	0	1
<i>Kocuria kristinae</i>	1	0	0	0	1
<i>K rosea</i>	1	0	0	0	1
<i>Pseudomonas putida</i>	1	0	0	0	1
<i>P oryzihabitans</i>	0	0	2	0	2
<i>Micrococcus spp</i>	0	0	1	0	1
<i>Micrococcus lylae</i>	1	0	0	0	1
<i>M luteus</i>	2	0	0	0	2
<i>B licheniformis</i>	0	1	0	0	1
<i>Bacillus spp</i>	0	1	0	0	1
<i>Bacillus gram-positive unidentified</i>	0	1	0	0	1
<i>Corynebacterium spp</i>	0	2	0	1	3
<i>Rothia mucilaginosa</i>	0	1	0	0	1
<i>Paenibacillus pabuli</i>	0	1	0	0	1
<i>S caprae</i>	0	0	0	1	1
Negative samples	1	2	0	15	17
Total of samples	20	20	19	19	78

number of colonies of *S epidermidis* in 3 out of 5 samples. It did not decrease the number of colonies of *S aureus* or *S saprophyticus* (Table 3).

We found no bacterial growth in 78.9% of RBDs after disinfection with isopropyl alcohol chlorhexidine which was able to eliminate the following microorganisms: *S aureus*, *S saprophyticus*, *S warneri*, *S hominis*, *S haemolyticus*, *Pseudomonas oryzihabitans*, and *Micrococcus* species (spp).

We also found 7 new microorganisms, in a total of 9 samples, that were not present before disinfection namely *Rothia mucilaginosa*, *Bacillus* spp, *Bacillus licheniformis*, *Bacillus* gram-positive unidentified, *Paenibacillus pabuli*, *S caprae*, and *Corynebacterium* spp.

**Discussion**

To the best of our knowledge, this is the first study conducted in biometric devices in healthcare facilities. Although several species

of microbiological agents were found, none of them constituted a risk for health care workers.

Noncritical inanimate objects in the healthcare environment (items that come into contact with intact skin such as bed rails, linens, countertops, and floors) are unlikely to transmit infectious agents directly to patients, although they contribute to secondary transmission by contaminating healthcare worker’s hands.<sup>15</sup> A study concerning bacterial survivability on biometric devices showed that *Escherichia coli* and *S aureus* can survive on an infrequently touched surface.<sup>2</sup>

A study about vancomycin-resistant enterococci (VRE) on fingertips and environmental surfaces (countertops, bedrails, telephones, and stethoscopes) concluded that VRE are capable of prolonged survival on hands, gloves, and environmental surfaces which may serve as potential reservoirs for nosocomial transmission of VRE.<sup>15,16</sup> Other objects such as mobile phones can be infected by several microbes, most of which belonged to the natural flora of the human body as well as airborne fungi and soil.<sup>17</sup>

**Table 3**  
Number of colonies of bacteria that persist after disinfection with 70% alcohol and isopropyl alcohol chlorhexidine

Agent	Number of colonies (colony-forming unit/mL)		Number of colonies (colony-forming unit/mL)	
	Before disinfection with alcohol 70%	After disinfection with alcohol 70%	Before disinfection with isopropyl alcohol chlorhexidine	After disinfection with isopropyl alcohol chlorhexidine
<i>Staphylococcus epidermidis</i>	10 <sup>4</sup> -10 <sup>5</sup>	10 <sup>4</sup> -10 <sup>5</sup>	>10 <sup>5</sup>	>10 <sup>5</sup>
	>100	1		
	>10 <sup>5</sup>	>10 <sup>5</sup>		
	>10 <sup>5</sup>	10 <sup>4</sup> -10 <sup>5</sup>		
	>10 <sup>5</sup>	10 <sup>3</sup> -10 <sup>4</sup>		
<i>S aureus</i>	>10 <sup>5</sup>	>10 <sup>5</sup>		
<i>S saprophyticus</i>	>10 <sup>5</sup>	>10 <sup>5</sup>		

Two major groups of microorganisms are found on the skin: organisms that normally reside on it, predominately consisting of gram-positive bacteria (resident flora) and contaminants (transient flora). Unless microorganisms are introduced into the body tissues by trauma, surgery or medical devices, the pathogenic potential of the resident flora is low.<sup>2,5</sup> Temperature, humidity, and skin physiology all play a role in maintaining the skin microflora.<sup>18</sup> Transient flora, followed by cross-transmission, are responsible for most of hospital infections.<sup>5</sup>

Gram-negative bacteria, coagulase-negative staphylococci, and *S aureus*, especially MRSA, are important causes of hospital-associated infections and important causes of morbidity, mortality, and increased costs for hospitalized patients.<sup>5–12</sup> Several studies have compared the bacterial flora on the hands of patient-care versus nonpatient-care hospital personnel and patients versus healthy individuals.<sup>7,19–22</sup> A higher prevalence of antibiotic-resistant organisms on the hands of patient-care staff versus nonpatient-care staff and/or outpatients has been reported.<sup>19–21</sup> In another study,<sup>7</sup> the 5 most prevalent species of bacteria found on the hands of the 204 homemakers were *P fluorescens/putida*, *S warneri*, *Klebsiella pneumoniae*, *S aureus*, and *Enterobacter cloacae*; the 5 most prevalent species of bacteria found on the hands of the 119 nurses were *S epidermidis*, *S warneri*, *Enterococcus faecalis*, *S hominis*, and *E agglomerans*. Hands can also be potential reservoirs for hepatitis A virus, *Acinetobacter*, and *Candida* species or different *S* species.<sup>7</sup>

The most frequent microorganism that we found on hospital RBDs was *S epidermidis*. This is a commensal organism of the skin with low risks to health, except in specific states of immunosuppression. Likewise none of the microorganisms found on RBDs seems to be pathogenic to immunocompetent individuals.

Currently, *S aureus* remains one of the most important causes of infection, especially nosocomial infections. The emergence of methicillin resistance has turned this pathogenic microorganism into a therapeutic challenge worldwide.<sup>23</sup> It can colonize the skin of up to 30% of healthy people and it has a unique capacity of breaking into the skin and causing disease in previously healthy body tissues.<sup>24</sup> Infection can occur in situations of continuous lacerations of the skin or mucous membranes.<sup>25</sup> Regarding Portuguese data, nosocomial prevalence of MRSA remains one of the highest in Europe.<sup>13</sup> Recent studies concluded that public buses of Portugal's major cities (Lisbon and Oporto) are a reservoir of MRSA and may represent a mechanism to spread this microorganism in the community.<sup>26</sup> Moreover, *S aureus* can survive for long periods of time on inanimate objects, which may represent an important reservoir for dissemination.<sup>13</sup>

We found that there was a decrease in the frequency of species isolated after using both disinfection solutions, although isopropyl alcohol chlorhexidine appeared to be more effective. Indeed, this disinfection solution eliminated the most common microorganism (*S epidermidis*) in 92.3% of samples and *S aureus* was eliminated in 100% of the samples.

After disinfection, we found 7 new microorganisms in a total of 9 samples that were not present before disinfection. These results can be explained by the fact that the device's collection area may not be exactly the same in the samples before and after disinfection. An alternative justification is that it may be the disinfectants used that can be more effective for the *S aureus* and *S epidermidis* and therefore cause the selection of some species.

It should be noted that there are some issues regarding the use of disinfectant solutions: the isopropyl alcohol chlorhexidine is a

topical skin protector used before the manipulation of drainage tubes, external catheters, and it is significantly more expensive compared to the alcoholic solution and there is not a formal indication to use isopropyl alcohol chlorhexidine on skin disinfection.

### Limitations of the study

We can summarize some limitations of the study. Firstly, samples were collected in a different time of the year raising the doubt whether there is a seasonal variation of microorganisms. Furthermore, the total number of samples is relatively small.

### Conclusion

RBD's seem a safe instrument for biometric identification of healthcare workers. We have not found susceptible microorganisms that can cause diseases in immunocompetent individuals. Thus, only the immunocompromised professionals could be at higher risk and should disinfect their hands before and after biometric registration or use another identification method. Both alcohol 70% and isopropyl alcohol chlorhexidine seem effective although the latter was slightly superior.

Since we still found bacterial growth after disinfection with both products tested, hand hygiene remains an important measure to reduce transmission of infectious agents, including MRSA.

As the resident flora in different health care institutions may be very diverse, it may not accurate to extend our results to other healthcare facilities. Further studies will be needed to assess the risk of infections for patients and workers on those settings.

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### Conflicts of interest

All authors report no conflicts of interest relevant to this article.

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