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Contamination Assessment in Surgery Support Rooms in a *Real-Time* Routine of the Hospital Environment

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Abstract

Background: One of the most severe problems in patients care is hospital-acquired infections and adversely effect on the mortality and morbidity despite available antimicrobial therapy and advances in supportive care.

Objective: The researchers were willing to determine the contamination of inanimate hospital environments by bacterial agents and their susceptibility to various antimicrobial agents.

Material and methods: Microbiological examination was performed by means of environmental collection at twenty-six different points using a passive method in which plates were exposed in an appropriate room to receive surgical waste and were kept before being sent to incineration. The sampling points are: the air surface, wall, sink, waste container, floor, and door handle were analyzed using a contact swab technique and deposit in Petri dishes with rich medium.

Results: After appropriate standard techniques of incubation, time, and temperature, the results have surprisingly indicated a low-level of contamination in the room, and all the surfaces analyzed, except for the door handle.

Discussion: Those findings bring a window of opportunity for new technologies on controlling the dissemination of virulent agents, mainly bacteria, with antimicrobial tools that bring less risk for the human being. We concluded that the area of contamination is a bit far from the manipulation of contaminated surgical instruments or any other medical supply in this chain.

Conclusion: It is widespread to find in Hospitals microbes that inhabit skin and organs, including pathogenic agents. Poor hand hygiene and the inadequate use of gloves are the primary way to spread contamination to different hospital areas. The present work finds the importance of continuous training and guidance to control the dissemination of disease by hospital workers.

Keywords: Hospital environment; Hospital infection; Bacterial contamination.

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Introduction

The presence of microorganisms in hospital environments is quite frequent. Most of these microorganisms are common species brought by patients and workers through by shoes, cell phones, hands of professionals from medical teams, patients, and visitors. In healthy individuals, these microorganisms are harmless; however, they can lead to severe hospital infections for debilitated patients. Many of these microorganisms are resistant to standard asepsis procedures [1]. Nosocomial infections are more than a century old a critical indicator that affects hospitals' in the quality of health care. Results of previous studies show that at least one-third of all nosocomial infections are preventable. A significant proportion of infections resulting from cross-contamination and transmission of microorganisms by the hands of health care workers are the main route of spread bacterial contamination of hospital staff's hands is a dynamic process that results from multiple factors [2]. Nanoparticles appear as an alternative with great potential to contain microbial contamination in these environments [3]. Recently, the FAPESP (São Paulo Research Foundation) magazine, the Research Support Foundation of the State of São Paulo, one of the main agencies for promoting scientific and technological research in Brazil, stressed the importance of ways of prevention and places of more significant contamination by bacteria for patients in ICUs [1] (Figure 1).

Purpose: This work aimed to evaluate and analyze the air and different surfaces of a Private Hospital about microbial contamination in a specific room that received physical and biological disposals of surgeries. This study is an important indicator to identify critical point and suggest some biocides coating using copper nanoparticles. Nanoparticles are known to have antimicrobial properties. In this scenario, copper nanoparticles applied to paints can be used a biocides coating in different environments and hospital infrastructures such as transport trolleys and door handles where contact with the hands of individuals is quite frequent and a possible source of contamination.

Methodology

Sampling: The experiment evaluated the environmental contamination of the purging area of the surgical center of a Private Hospital on 11/29/2019 at 9:00 am with the usual routine of activities in the room. The tests are carried out by applying sterile wet cotton swabs moistened with 0.85% saline solution on the surfaces (door handles, wall, sink, and waste container) and by Petri dishes exposition with nutrient agar medium on the different place of this environment.

Samples are collected from the purging area of the surgical center of a Private Hospital on 11/29/2019 at 9:00 am with a 30-minute exposure period as shown at Figure 2.

The swabs were swollen with 0.85% saline and rolled over the wallsurfaces in approximately 30 cm^2 with the aid of a sterilized mold. Handle doors and trolleys handle for medical waste transportation were sampled without the sterilized mold. Before sampling, operates clean your hands with soap and water, wear gloves and asepsis with 70% alcohol.

All the Petri plates received an adhesive label with company name, place, date and time of collectionand the responsible operator. After defines the area of analysis sterile swab rolling the area delimited bythe mold for not less than 20 seconds. The smear was made vertically, horizontally and, finally, diagonally, continuously rotating the swab so that the entire cotton surface comes into contact with the sample. Immediately, it was seeded in the plates containing culture medium, aseptically, in striations. The seededplates were incubated at 30°C for approximately 24 and 48 hours. Some plates exposed with lid open were also incubated in the same conditions.

Counting: The correlation between the number of colony-forming unit, sampled area, and the sampling time is determined with the following equation:

$$\text{No. UFC/m}^2 = \frac{\text{Count of colony-forming unit (UFC)}}{[\text{plate area in m}^2] \times [\text{plate exposure time in hours}]}$$

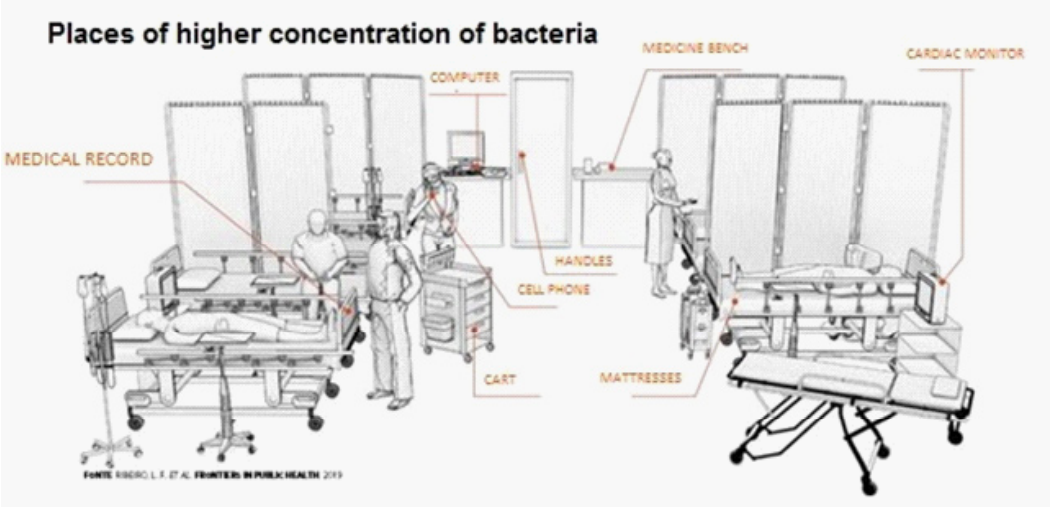


Figure 1: Places with higher bacteria concentrations. Source: Article: Bacteria in the ICU. Fapesp Magazine, October 2019.

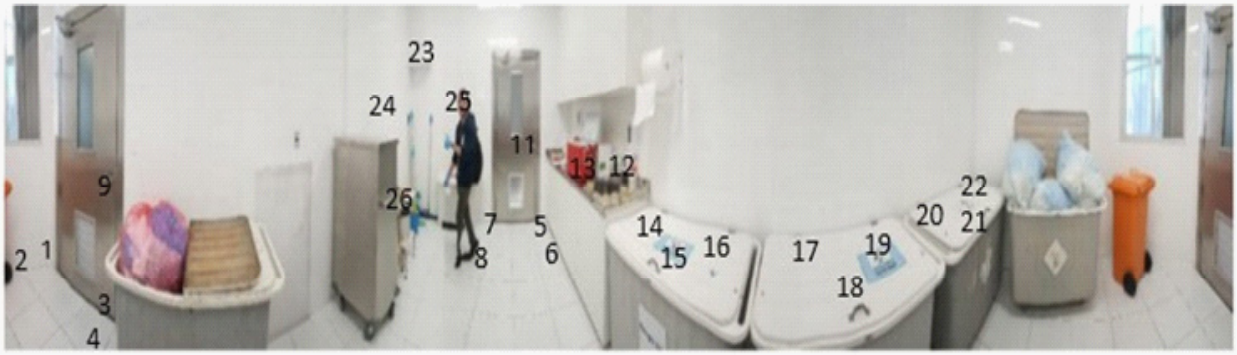


Figure 2: Room panoramic view with identification place sample.

Results

Considering passive sampling, Petri dishes with 10 cm in diameter and the exposure time as 0.5 hours, the results about Colony forming unit (CFU/plate) are presented at Table 1.After the incubation time, plaques were observed where there was a growth of microorganisms and others where there was no growth. The highest count was made on the external door's handle. Below, photographs of plaques with growth of microorganisms from the collection points of the experiment.According to the studies by Pasquarella et al. (2000), the passive sampling technique for collecting viable microorganisms that settle on the Petri dish without measuring the airflow evaluated, simulates the exposure of a surface to contaminants. The same study report that the concentration of microorganisms in an ultra-clean environment of up to CFU / m^3 measured by active sampling would correspond to up to 350 UFC / m^2.h by passive sampling [4].

Discussion

The study began to explore the zones of the different sampling points to identify potential contamination sites. Through a rigorous analysis of all the results, it can be concluded that of the 26 sampling points studied, only the external door handle presented a high number of viable microorganisms.

It should be considered that the experiment did not analyze the other areas involved in the hospital´s operations journey. The evidence of a high number of contaminations on the external handle of the discard room, rises concern about the presence of this high contamination on other surfaces that touched during this journey including elevators and areas of frequent access to the hospital's staff and even patient visitors.Biological aerosols are suspensions of viable and non-viable liquid or solid particles in the air [5]. In hospital environments, these particles can result from common physiological processes such as coughing, sneezing, coming from patients or from common hospital procedures such as: intubation, non-invasive ventilation, nebulization and surgery and even from sanitary facilities. The presence of biological aerosols in the air results from the dispersion of microorganisms, which spread and their health effects can be highly variable [6]. To minimize the concentration of biological aerosols in hospital entities' indoor air, it is extremely important that risk management implement measures (appropriate technology, ventilation systems, personal protective equipment), which aim to effectively reduce nosocomial infections [8]. Studies report that a concentration of bioaerosols in an ultra-clean environment, of up to 10 CFU / m^3 measured by active sampling would correspond to a value of up to 350 CFU / m^2.h. In operating rooms with 200 CFU / m^3, up to 7x103 CFU / m^2*h is expected [4].

Regarding the hospital environment, in the United Kingdom the maximum recommended value for biological contaminants in the air in the operating room is 35UFC / m^3, in Switzerland it is 25 UFC / m^3 in and 5 UFC / m^3 in France [9]. Surface contamination could be reduced by hand hygiene before and after contact with and with patients [9,10]. However, professionals´adherence to such practice has often been pointed out with rates below 50%, in health establishments in general. An alternative to avoid contagion is the use of copper in the coating of these structures. According to the United States Environmental Protection Agency (EPA), the metal properties cause bacteria to be eliminated by 99.9% [11]. At Dr. Salvador Allende Gossens Hospital, located in Calama, northern Chile, he installed copper in four items: bed rails, chairs, drip poles and feeding tables for six Intensive Care Units (ICUs) to determine the copper action on the total bacterial load that contaminates critical contact surfaces.

More than 80% of the bacterial population had already been eliminated, a benefit to patients and hospital workers. The Public Assistance Emergency Hospital (HUAP), located in Santiago, is an example. "In addition to providing the hospital area with copper surfaces, the hospital's local auditorium was also equipped with chairs that have copper arms, as part of a holistic approach to preventing infection" [12].

The Roberto del Rio Children's Hospital is the oldest public pediatric unit in Chile. The facility is one of three hospitals in the country specializing in medical care for children. In search of safer environments, the hospital installed a set of copper products in their ICUs. The initiative developed in conjunction with the Chilean Ministry of Health, to revolutionizing hospital hygiene standards. Bed rails, crib railings, door accessories, handrails, supports for intravenous applications, sinks, taps and work surfaces were the items that received copper [12].

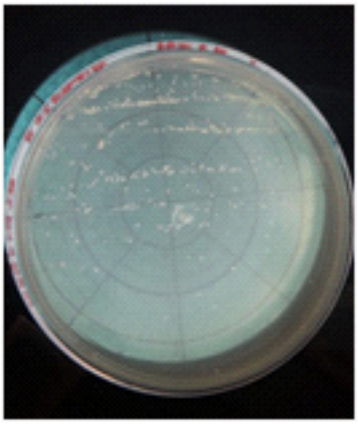
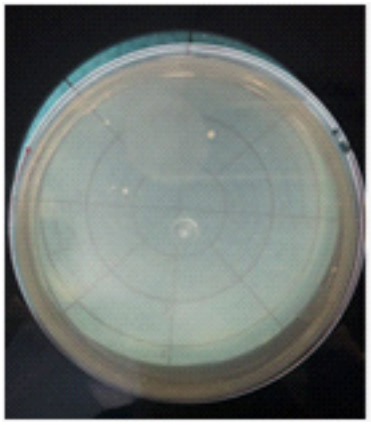
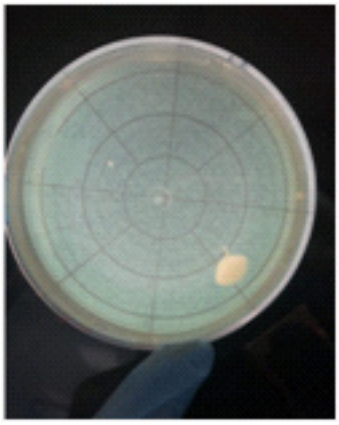
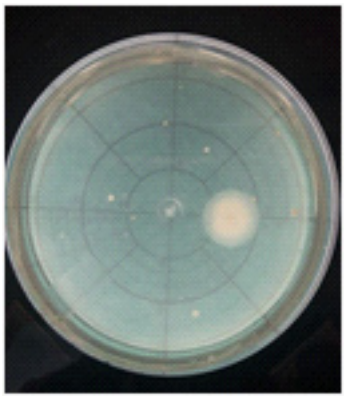
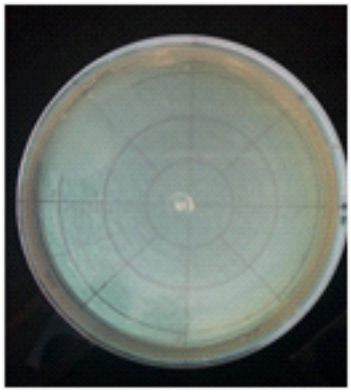
		
External handle sample plate after 24 hours of incubation	Left exit sample plate identification Six, with uniform bacterial and fungal colonies after 48 hours.	Sample sink conter plate, identification Thirteen, with few colonies of uniform bacterial and fungal colonies after 48 hours.
		
Sample plate from container three, identification twenty, with few colonies of uniform bacterial and fungal colonies after 48 hours.	High wall sample plate, identification twenty-three, with few colonies of uniform bacterial and fungal colonies after 48 hours.	

Table 1: Unit Format Colonies (UFC) by plate after 24 and 48 incubation hours.

Sampling	Number Identification Place	Replicate	Name Identification Place	Correction 24h	Correction 48h
				UFC/(m².h)	UFC/(m².h)
Petri plate	1	duplicate	Right entry	127,39	509,55
	2		Right entry	0,00	445,86
	3	duplicate	Left entry	0,00	382,17
	4		Left entry	63,69	445,86
	5	duplicate	Right exit	0,00	382,17
	6		Right exit	254,78	636,94
	7	duplicate	Left exit	0,00	382,17
	8		Left exit	0,00	318,47
	9	single plate	Handle door (inside)	0,00	63,69

Surfaces Swab	10	single plate	Handle door (outside)	12738,85	12738,85
	11	single plate	Handle door (inside)	0,00	0,00
Petri plate exposition	12	single plate	Sink surface	0,00	636,94
	13		Sink surface	0,00	191,08
	14		Waste Container 1	0,00	764,33
	15	triplicate	Waste Container 1	0,00	764,33
	16		Waste Container 1	0,00	382,17
	17			0,00	509,55
	18	triplicate	Waste Container 2	0,00	509,55
	19		Waste Container 2	0,00	509,55
	20			127,39	764,33
	21	triplicate	Waste Container 3	127,39	382,17
	22		Waste Container 3	63,69	509,55
	23	without replica	Superior wall	0,00	127,39
	24	without replica	Wall sink opposite	0,00	0,00
Swab and cultivation on nutriente agar	25	without replica	Wall inferior door trash 2	0,00	0,00
	26	without replica	Trolley handle	0,00	0,00

ND: not determined

Conclusion

Periodic monitoring of a hospital environment is necessary to control the quantification of existing microorganisms to prevent infections between the hospital staff and patients. The collection points direct the study to where the application of a product with antimicrobial action will be most effective.

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