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Original Article

Spread of *Staphylococcus aureus* between medical staff and high-frequency contact surfaces in a large metropolitan hospital

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ABSTRACT

Objective: To examine whether bacteria are transferred between the hands of medical staff and high-frequency contact surfaces within and between departments of a major metropolitan hospital, and to further analyze the patterns of cross-transmission.
Methods: Microbiological samples were collected from the hands of 112 hospital employees as well as from 120 high-frequency contact surfaces in four hospital departments. Samples were collected on agar plates, analyzed for the presence of *Staphylococcus aureus* or methicillin-resistant *S. aureus* (MRSA) by standard microbiology testing, and partially genotyped using pulsed-field gel electrophoresis.
Results: Genetically identical MRSA was identified on the surface of an electrocardiography device in the medical intensive care unit and on the same type of device in the neurosurgical unit. Genetically similar *S. aureus* was identified on an infusion pump in the medical intensive care unit and on the hands of several doctors in a different department who regularly use that pump. Genetically identical *S. aureus* was also identified on bedside rail restraint in the medical intensive care unit and on the hands of the nurse in the neurosurgical unit. Finally, genetically similar MRSA was identified both on the surface of an electrocardiography device and on the suction apparatus in the medical intensive care unit.
Conclusion: Cross-contamination of *S. aureus* or MRSA on medical workers' hands and contact surfaces was demonstrated within and between departments of a large metropolitan hospital. Improvements are needed in medical staff hygiene habits and in the cleaning of high-frequency contact surfaces to help prevent and control nosocomial infections.

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1. Introduction

Hospital-acquired infections are a serious global health issue and pose risks to medical staff, patients, and the broader community [1,2]. In fact, hospital-acquired infections are the fourth most frequent cause of death in the United States behind heart disease, cancer, and stroke [3]. In China, 25–33% of patients admitted to the hospital acquire nosocomial infections [4]. These infections place a substantial economic burden in countries worldwide [5–8].

Contamination of medical workers' hands and contact surfaces in the hospital are key sources of hospital-acquired infections [9–11]. Contact surfaces near patient areas have been classified as low-, medium-, or high-frequency contact surfaces [12]. High-frequency contact surfaces include nurses' work computers, multi-parameter electrocardiography (ECG) monitors, glucose meters, suction catheters, infusion pumps, worktables, bedside rail restraints, and door handles. Few studies have compared these different surfaces to determine their respective contributions to hospital-acquired infections. Given that high-frequency contact surfaces are more likely to be contaminated, we focused on them in the present work. Many pathogenic bacteria have been shown to live on these surfaces, including coagulase-negative *Staphylococcus, Enterococcus, Staphylococcus aureus,* and methicillin-resistant *S. aureus* (MRSA). As nosocomial infection caused by MRSA is very difficult to treat, MRSA has attracted much more public attention than any other bacteria [13]. Much of the literature on hospital-acquired nosocomial infections has focused on identifying which microorganisms and which surfaces are involved, while few studies have examined how microorganisms travel from one surface to another or between surfaces and medical workers. Some studies have documented cross-contamination of *S. aureus, Enterococcus sp.,* and *Acinetobacter sp.* between medical workers' hands and their mobile phones [14,15].

To our knowledge, no studies directly examine bacterial transmission between hospital contact surfaces and medical staff. We therefore sought to examine how bacteria is transmitted between the hands of medical personnel and high-frequency contact surfaces in multiple departments of a major metropolitan hospital in China.

2. Materials and methods

2.1. Ethical considerations

This study was approved by the Ethics Committee of China–Japan Friendship Hospital prior to data collection. Informed consent was obtained from all medical workers who participated.

2.2. Subjects and locations of samplings

Microbiological sampling was performed in a 1500-bed tertiary care hospital providing service to a large area in Beijing, China on February 20–21, 2014. Samples were collected on Replicate Organism Detection And Counting (RODAC) plates (Becton, Dickinson and Company, Japan).

A total of 112 samples were collected from medical workers via cluster sampling, including 112 samples from the self-reported dominant hand of 30 medical workers from the medical intensive care unit, 30 from the surgical intensive care unit, 22 from the urology department, and 30 from the neurosurgical department (Table 1). Medical workers included doctors, nurses, nursing assistants, and cleaners. Nursing assistants and cleaners were classified as "other personnel." Workers were excluded if they had recently washed their hands or if their hands showed obvious signs contamination with patient body fluids such as blood.

Table 1 – Numbers of hospital workers and high-frequency contact surfaces sampled for *S. aureus* and MRSA in a large metropolitan hospital, by worker type and department.

Sample	Department				Total
	Surgical intensive care unit	Medical intensive care unit	Urology	Neurosurgery	
Hand					
Doctor	13	16	8	8	45
Nurse	14	14	10	17	55
Others	3	0	4	5	12
Total	**30**	**30**	**22**	**30**	**112**
Contact surface					
Worktable	3	2	3	3	11
Bedside rail restraint	7	3	6	6	22
Door handle	5	4	4	5	18
Work computer	4	4	4	4	16
Multi-parameter ECG monitor	7	3	7	6	23
Glucose meter	2	2	2	2	8
Joint of sputum suction tube and suction apparatus	4	3	0	0	7
Infusion pump	4	3	1	1	9
Fixed-line telephone	0	0	2	2	4
Beeper	0	0	1	1	2
Total	**36**	**24**	**30**	**30**	**120**