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The role of the intensive care unit environment and health-care workers in the transmission of bacteria associated with hospital acquired infections

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Summary The goal of this study was to attempt to determine the rate of contamination of health-care workers' (HCWs) hands and environmental surfaces in intensive care units (ICU) by the main bacteria associated with hospital acquired infections (HAIs) in Tehran, Iran. A total of 605 and 762 swab samples were obtained from six ICU environments and HCWs' hands. Identification of the bacterial isolates was performed according to standard biochemical methods, and their antimicrobial susceptibility was determined based on the guidelines recommended by clinical and laboratory standards institute (CLSI). The homology of the resistance patterns was assessed by the NTSYSsp software. The most frequent

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bacteria on the HCWs' hands and in the environmental samples were *Acinetobacter baumannii* (1.4% and 16.5%, respectively), *Staphylococcus aureus* (5.9% and 8.1%, respectively), *S. epidermidis* (20.9% and 18.7%, respectively), and *Enterococcus* spp. (1% and 1.3%, respectively). Patients' oxygen masks, ventilators, and bed linens were the most contaminated sites. Nurses' aides and housekeepers were the most contaminated staff. Imipenem resistant *A. baumannii* (94% and 54.5%), methicillin-resistant *S. aureus* (MRSAs, 59.6% and 67.3%), and vancomycin resistant Enterococci (VREs, 0% and 25%) were detected on the hands of ICU staff and the environmental samples, respectively. Different isolates of *S. aureus* and *Enterococcus* spp. showed significant homology in these samples. These results showed contamination of the ICU environments and HCWs with important bacterial pathogens that are the main risk factors for HAIs in the studied hospitals.

Introduction

HAIs, such as bacteremia, pneumonia, urinary tract and skin or soft tissue infections, are among the most frequent complications that occur in hospitalized patients in intensive care units (ICUs) [1,2]. Patients in ICUs are at the highest risk for HAIs because of invasive medical procedures during their hospitalizations. The ICU staff and physicians can serve as vehicles for the spread of resident pathogens from different hospital wards to ICUs [2]. Accordingly, the hands of HCWs and ICU personnel require the greatest hygiene standards. Contamination of the ICU environment also plays an important role in the acquisition of nosocomial pathogens by both patients and HCWs. Investigation of the rate of bacterial contamination of the hands of HCWs and the ICU environmental surfaces could provide recommendations for preventing transmission of pathogenic bacteria to patients and personnel in health-care settings [3].

Bacterial strains from patients, the hands of HCWs, and the ICU environment have been demonstrated to be associated with hospital-acquired outbreaks by several studies [4—7]. Although most enteric Gram-negative bacilli cannot remain viable on the dry surfaces of medical equipment or in the ICU environment and are sensitive to common disinfectants, biofilm-forming bacteria, such as *Pseudomonas aeruginosa* and *Acinetobacter baumannii*, are highly resistant to such harsh conditions and are strongly associated with HAIs through contaminated medical devices and other environmental equipment in hospitals [4]. HCWs and ICU staff can serve as major reservoirs of common bacterial pathogens, such as vancomycin resistant *Enterococci* (VRE) [5] and other members of the *Enterobacteriaceae* and multi drug resistant (MDR) Gram-positive and Gram-negative bacteria, which are responsible for HAIs [6]. Colonization and transmission of these hyper resistant bacterial pathogens are generally considered to be a major problem in infection control programs in ICUs. The role of the ICU staff and environment in HAIs should be considered when devising strategies to prevent or reduce the occurrence of these infections among the highly sensitive patients. There are some reports that showed poor hand hygiene compliance among different hospital staff in Iran [7—9]. However, few data exist on the microbial contamination of HCWs' hands and the hospital environment in the studied hospitals. This study was designed to investigate the frequency and resistance patterns of the main bacterial agents responsible for HAIs on the hands of HCWs and the ICU environments in six ICUs in Tehran, Iran.

Methods

Design and setting

The study was conducted in medical hospitals of Shahid Beheshti University of Medical Sciences in Tehran, Iran, from August 2010 through September 2012. Samples of ICU HCWs aged 25—40 years old, including nurses (79, 426 samples), physicians (6, 26 samples), housekeepers (23, 155 samples), secretaries (4, 32 samples), and nurses' aides (16, 123 samples), were taken randomly after hand hygiene and before any contact with patients, respectively. The ICU environmental surfaces and devices, which were in contact with the hospitalized patients, were also randomly selected for sampling during routine daily patient care in six ICUs in different hospitals (Table 1). All of the HCWs and equipment were sampled several times during the study period. Accordingly, based on the