

Bacterial Contamination on Electronic Surfaces in ICU

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ABSTRACT: Bacteria, especially Multidrug-resistant (MDR) isolates, can contaminate inanimate surfaces and equipment in intensive care unit (ICU) (such as bedrails, stethoscopes, medical charts, and ultrasound machines). Transmission of microbes from inanimate surfaces may play a major role in the colonization and infection of patients in ICUs. Healthcare worker hands and patient discharge both have the potential to spread germs, which can live for months on dry surfaces. (It was reported that the rate of environmental contamination is higher near infected individuals than it is near colonized patients, and that within the latter group, there is a link between the frequency of environmental contamination and culture-positive body locations) Incomprehensible sentence. In addition to acquiring germs from direct patient contact, healthcare personnel can pick them up through inanimate surfaces and equipment in the patient zone. Patient colonization or infection can occur if healthcare workers do not properly clean their hands before and after handling patients. Several pieces of equipment and frequently used objects in (ICU) include bacteria with antibiotic susceptibility profiles that are quite similar to those of germs isolated from patients. In light of the patient-zone concept and the potential consequences for bacterial pathogen cross-transmission to critically ill patients, this review aims to present up-to-date knowledge concerning the contamination of inanimate surfaces and equipment in ICUs.

Keywords: Bacteria, Gram-negative bacteria, electronics, contamination.

1. Introduction

Infections acquired in the intensive care unit (ICU) are a leading cause of death and disability [1]. Multidrug-resistant (MDR) bacterial infections are a serious public health issue and a constant challenge for clinicians caring for critically sick patients [6, 7]. Outbreaks [8, 2] and pathogen cross-transmission amongst critically sick patients [10, 11] have been linked to contamination of inanimate surfaces in the (ICU). Microorganisms can spread through healthcare staff' hands or be shed by patients themselves in the close vicinity of a patient's bed [12]. Surfaces, widely used medical equipment, and high-contact community surfaces (e.g., telephones, keyboards, medical charts) in the (ICU) was found to harbor multidrug-resistant bacteria [13–15]. It was found that both Gram-positive and Gram-negative bacteria might live on inanimate surfaces for up to a month, and even longer under humid and cooler temperatures [4]. It was suggested that the kind of organisms involved, the source and destination surfaces, the humidity level, and the size of the inoculum all have a role in the rates of cross-contamination [16, 17]. However, other factors such as hand hygiene compliance, nurse-staffing levels, frequency/ number of colonized or infected patients, (ICU) structural features (e.g., single-bed or multi-bed ICU rooms), and adoption of antibiotic stewardship programs [18, 19] may also play a role in the contamination and cross-transmission rate in the ICU. In the (ICU), where patients are already critically ill and have multiple risk factors for nosocomial infections [20], environmental contamination may present an even greater challenge because even the most stringent measures for infection prevention are not always possible. In addition, the area around (ICU) beds are densely packed with monitoring and support equipment, including a large number of hand-touch locations, necessitating complex and detailed cleaning procedures [5]. Infection control methods and the promotion of new therapies may benefit greatly by determining which areas are most frequently contaminated and what pollutants are

most typically found [17]. Fungal and viral contamination of the ICU environment was also reported [21, 22], particularly our assessment, however, we zeroed particularly on the threat posed by bacteria. Focusing on the most commonly isolated bacteria, the role of contamination for ICU-acquired colonization and infection, and the potential implications of care for ICU patients, this article aims to provide up-to-date evidence on the contamination of inanimate surfaces, equipment, and high-contact communal surfaces in ICU.

2. Literature Review

Electronics are widely used in the healthcare business to improve patient care while cutting expenses. Previous research has shown that microorganisms can colonize medical devices such as computers and cell phones in both hospital and non-hospital settings when samples were taken from frequently used keys with moistened sterile swabs, inoculated in liquid and solid media, and then incubated aerobically at 37°C for 24-48 hours. Standard microbiological techniques used to confirm the presence of growth. The Kirby-Bauer technique used to test pathogenic microorganisms for antibiotic resistance. Thus, all 80 samples (40 from each environment) showed signs of growth. *Staphylococcus aureus* found in both hospital and community settings (4 MRSA and 9 MSSA in hospitals vs. 6 MRSA and 11 MSSA in the community). The majority of hospital-isolated bacteria were Gram-negative bacilli (33%). Keyboard isolates from both environments exhibited statistically significant uniformity, with the exception of *Pseudomonas* [5].

Keyboards and other inanimate surfaces of electronic equipment in ICU are a common source of microbial contamination, which has been linked to ICU-acquired colonization and a wide range of nosocomial illnesses. The purpose of this study was to examine the frequency and species composition of bacterial contamination on keyboards and other inanimate surfaces of bedside equipment in ICU in hospitals affiliated with the Kashan University of Medical Sciences and Health Service. Seventy-five keyboards and other pieces of electronic equipment with static surfaces studied in descriptive cross-sectional research across five ICU in 2016 and 2017. Swabs dipped in normal saline used to gather samples from computer keyboards and other electronics. After being cultured from the samples and grown on Blood Agar (BA) and MacConkey Agar (MAC), the bacteria were identified by their morphology and biochemical traits. The majority, or 76%, of the electrical devices and computer keyboards tested positive for microbial contamination. Gram-positive bacteria were the most common source of contamination (70.7%), while coagulase-negative staphylococci were the most common kind of bacteria detected. Nurses' keyboards and other electronic devices had the greatest levels of contamination [19].

Before and after using disinfectant wipes containing chlorhexidine digluconate and triclosan, bacterial swabs were collected. It was determined what percentage of pollution eliminated by comparing the number and types of microbes identified before and after disinfection. Our findings corroborated a high prevalence of bacterial contamination of environmental surfaces, including some that pose a serious threat to human health. Before disinfection, most cases of illness from common skin commensal bacteria such as coagulase-negative staphylococci found on surfaces, mobile phones, and computer keyboards. The prevalence of *Bacillus* and *Enterobacteriaceae* species on the keyboards is unsurprising. *Staphylococcus aureus* was a representative of the possibly pathogenic species. Simple wiping with an antibacterial wet wipe significantly reduced microbial contamination of surfaces, with effects ranging from 36.8 to 100%, as determined by cultivation of swabs done 5 minutes after disinfection and subsequent computation of the decrease of contamination [4].

Bacteria, especially MDR isolates, can infect inanimate surfaces and equipment in ICUs (such as bedrails, stethoscopes, medical charts, and ultrasound machines). Transmission of microbes from inanimate surfaces may play a major role in the colonization and infection of patients in ICU [21].

Bacteria may live on dry surfaces for months; therefore, contamination can occur either through healthcare staff' hands or through direct patient shedding. There is a link between the frequency of environmental contamination and culture-positive body locations, and it has been reported that the environment is more contaminated surrounding infected individuals than colonized people are. In addition to acquiring germs from direct patient contact, healthcare personnel can pick them up through inanimate surfaces and equipment in the patient zone. Patient colonization or infection can occur if healthcare workers do not properly clean their hands before and after handling patients. Germs found on a variety of ICU furnishings and everyday objects, and their antibiotic resistance profiles often mirror those of germs obtained from patients. In light of the patient-zone concept and the potential consequences for bacterial pathogen cross-transmission to critically ill patients [18].

In order to assess the overall bacterial load and coliform count, swab samples obtained aseptically from each user interface (keyboard, mouse, ATM) and users' hands, and grown on nutrient and MacConkey agar. Significant differences ($p < 0.01$) discovered between the bacterial loads on keyboards, mice, and ATMs. From 313 randomly selected user interfaces 669 isolates obtained, representing 11 different bacterial species. Species such as *Aerococcus viridans* (9.4%), *Bacillus* spp. (8.4%), *Enterobacter aerogenes* (4.9%), *Gaffkya tetragena* (2.1%), *Klebsiella pneumoniae* (11.1%), *Micrococcus luteus* (10.9%), *Moraxella catarrhalis* (1.6%), *Proteus* spp. (10.6%), *Pseudomonas aeruginosa*. Every single contact tested has some sort of contamination. The level of contamination on interfaces in schools was equivalent to that in commercial centers but substantially lower than that in banks and cybercafés. Resistance to ciprofloxacin and ofloxacin was the least common, but resistance to amoxicillin, augmentin, nitrofurantoin, and ceftriaxone was widespread. Resistance to three antibiotics was the most common (31.9%), while 89.1% of bacterial isolates showed resistance to two or more medicines. Approximately 74% of plasmid-DNA analyzed antibiotic-resistant isolates were positive for the presence of one or more plasmids. We draw the conclusion that user interfaces harbor potentially harmful microorganisms that are resistant to several of the most widely used antibiotics. Therefore, these points of contact may serve as vectors for the dissemination of infections of clinical significance [3].

From the dentistry clinic, 40 electronic gadgets chosen. The gadgets separated into three categories at random. Disinfectants used to treat Group A were isopropyl alcohol and Group B was a glutaraldehyde solution. The instruments disinfected before the initial sample taken. The dentist office left as a repository for the samples. The second sample taken from each unit 7 hours later. Microscopically analysis of the bacterial count. Bacterial colonies were clearly visible in-group A, according to the results. In addition, 2% glutaraldehyde shown to be an efficient disinfecting agent, with significantly fewer or no bacterial colonies, compared to the standard alcohol-based disinfecting agent [4].

3. Methodology

3.1. Electronics inside ICU

Bedside monitors and ventilators are two examples of the highly specialized equipment utilized in (ICU). The patient's condition monitored and treated with the use of ICU. When it comes to intensive care, NET brand ICU equipment has raised the bar. We provide a wide variety of critical care equipment, such as ventilators, patient monitors, CPAP machines, BPAP machines, etc., for use in intensive care units, as shown in Table 1.

Table 1. Equipment's used in ICU

Equipment	Usage
NET Ventilator	The patient's breathing parameters monitored and displayed via an electrically and pneumatically operated NET Ventilator. Used to save the lives of those who are unable to breathe on their own (both children and adults). Only medical professionals should use it.
CPAP System	The CPAP machine used to save the lives of patients (including children and adults) who are unable to breathe adequately on their own.
BPAP System	NET BPAP is not a life-support device and instead used to treat obstructive sleep apnea-hypopnea syndrome (OSAHS).
Infusion Pumps	A spirometer is a device used to measure the volume and velocity of exhaled air to evaluate lung function. Asthma, COPD, and other lung diseases are among those for which it utilized as a diagnostic tool.

3.2. Staphylococcus

In order to meet the clinical necessity to distinguish between *Staphylococcus aureus* and those staphylococci previously categorized as being less or nonpathogenic, the definition of the heterogeneous group of coagulase-negative staphylococci (CoNS) continues to be dependent on diagnostic techniques. CoNS are currently one of the main nosocomial infections as a result of patient- and procedure-related alterations, with *S. epidermidis* and *S. haemolyticus* being the most important species [16, 17]. They contribute significantly to infections caused by foreign bodies and infections in premature babies. While *S. saprophyticus* linked to acute urethritis, *S. lugdunensis* is a special case that shares certain characteristics with *S. aureus* in its ability to infect the heart. Many additional CoNS species, as shown in (Figure 1) in addition to those recognized as food-associated saprophytes colonize the skin and mucous membranes of people and animals. These species less usually linked with clinically apparent diseases [17].

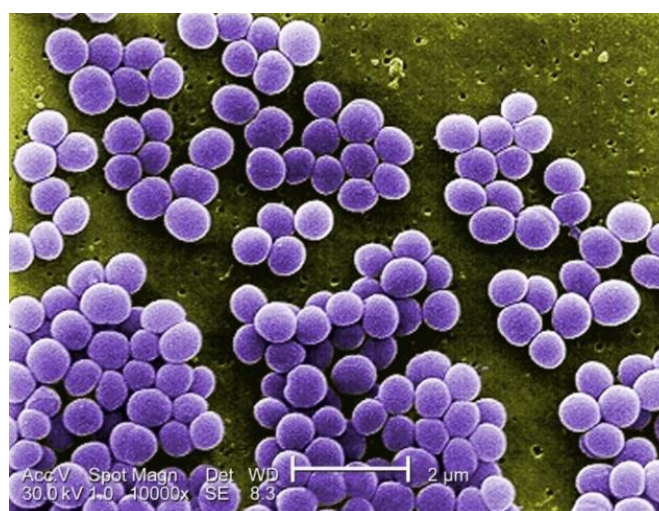


Figure 1. *Staphylococcus*. From Bacteriology and cancers: towards new therapeutic strategies. (2nd ed., p. 355), by A. Quentin, 2017.

As more strains develop antibiotic resistance, it is getting harder and harder to provide treatments meant to eradicate illnesses. Hospital departments claim that these strains account for 20 to 50 percent of all strains [17, 18].

3.3. Gram-Negative Bacteria

Gram-Negative Bacteria Infections caused by gram-negative bacteria include meningitis, pneumonia, bloodstream infections, wound infections, and infections at surgical sites. Gram-negative bacteria are growing resistant to the majority of existing antibiotics and to a variety of other medications [18, 19]. These bacteria can pass on genetic information that enables other bacteria to develop drug resistance, and they have the innate ability to discover novel methods to be resistant. Gram-negative bacteria (GNB) are among the most serious public health issues in the world because of their high level of antibiotic resistance [18].

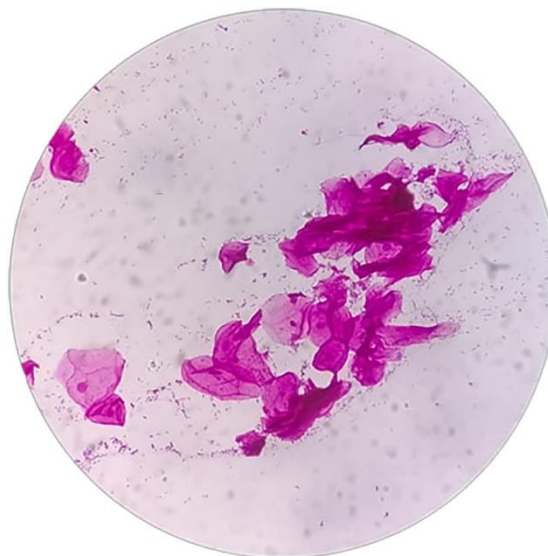


Figure 2. Gram Negative Bacteria. From How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. (6th ed. P. 134), by A. Kramer, M. Benson, and A. Junger, 2006.

Due to the frequent need for patients to be in (ICU) and the high risk of morbidity and death, these bacteria have a substantial clinical value in hospitals. The majority of clinical isolates come from two big families, Enterobacteriaceae and the non-fermenters; however, there are additional gram-negative organisms that are clinically relevant, such as Neisseria, Haemophilus species, Helicobacter pylori, and Chlamydia trachomatis [12]. This exercise examines the interprofessional team's involvement in treating patients with gram-negative bacteria and the assessment of gram-negative bacteria [5, 20].

3.4. Escherichia coli

Escherichia coli is a kind of bacterium that found in the environment, food, and the intestines of both humans and animals. A sizable and varied group of bacteria is E. coli. While the majority of E. coli strains are not harmful, some of them can make you sick. Some strains of E. coli can cause diarrhea, while others can cause pneumonia, lung diseases, and urinary tract infections, among other disorders [21].

Poly (dimethylsiloxane) line patterns 5 m tall used to study the bacterial response to surface topography during biofilm development (PDMS). Escherichia coli cells attached atop protruding line patterns shown to align more perpendicularly to the orientation of the lines as the pattern shrank [22]. Cell cluster formation per unit area was reduced by 14-fold on 5 m broad line patterns compared to flat PDMS. Cells connected on narrow patterns, in contrast to the decreased colony formation, were longer and had greater transcriptional activity, indicating that such unfavorable topography may put attached cells under stress. Results from mutant tests suggest that flagella mobility contributes to the observed preference for narrow patterns in cell orientation [23.24]. This confirmed by variations in cell rotation

pattern before settling on various surface topographies. With the use of 10 m tall hexagonal patterns, a new set of design principles for antifouling topographies developed and verified [25].

Table 2. Items reported contaminating bacteria in ICU.

Item	Microorganism
ECG Leads	VRE Coagulase-negative Staphylococci, <i>P. aeruginosa</i>
Blood Pressure cuffs	<i>S. aureus</i>
Ventilator	<i>S. aureus</i>
Suction system switches	<i>S. aureus</i>
Medical charts	Coagulase-negative staphylococci, <i>A. baumannii</i> <i>K. pneumoniae</i>
Portable radiograph equipment	<i>S. aureus</i> (MRSA) VRE <i>A. baumannii</i> <i>K. pneumoniae</i> <i>P. aeruginosa</i>
Ultrasound machine	<i>S. aureus</i> (MRSA, MSSA) Coagulase-negative staphylococci <i>P. aeruginosa</i> <i>A. baumannii</i> <i>Corinenebacterium</i> spp. <i>Bacillus</i> spp.

4. Conclusion

As a conclusion Bacteria, especially MDR species, are prevalent on inanimate surfaces and equipment in the ICU. Additional research is required to determine the extent to which bacterial contamination contributes to ICU-acquired colonization or infection. Knowing the potential for pathogen cross-transmission from inanimate surfaces is important for clinicians and researchers to implement effective infection control methods. These bacteria are Escherichia coli, Gram-Negative Bacteria, and Staphylococcus. As we can see that, these bacteria contaminated on electronic surfaces at Intensive Care Unit such as ECG, Ventilator et. devices.

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