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Research Article/Özgün Araştırma

Can public toilets in hospitals contribute to the spread of carbapenem resistant gram-negative microorganisms? Assessment with social handwashing observations

Hastane genel tuvaletlerinin karbapenem dirençli gram negatif mikroorganizmaların bulaşında katkısı olabilir mi? Sosyal el yıkama gözlemleri ile birlikte değerlendirme

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Abstract

Aim: The goal of our study is to investigate the role that public toilets in hospitals have in spreading and transmitting significant carbapenem resistant Gram negative microorganisms, and potentially compare them to the isolates present in our intensive care units.

Materials and Methods: In our study, student groups took samples from the toilets that were actively used, mostly by patient companions, in our hospital. In addition, social hand washing compliance and reliability was observed from the specified toilets.

Results: In 85 samples taken from fourteen toilets, Gram negative bacteria accounted for 26% of 115 bacterial growths. However, carbapenem-resistance, which is thought to have epidemiological significance, was not present in Gram negative isolates.

Conclusion: It was concluded that no major problem was associated with the transmission of Carbapenem-resistant Gram negative microorganisms from these areas through the hands and peripheral surfaces of patients and their companions.

Keywords: Carbapenem; Resistance; Social handwashing; Hospital toilets.

Öz

Amaç: Çalışmamızda birçok insanın ortak kullanım alanı olan hastane genel tuvaletlerinin epidemiyolojik açıdan önemli karbapenem dirençli Gram negatif mikroorganizmaların bulaşında, yayılmasında rollerinin araştırılması ve saptanması halinde yoğun bakımlarımızda etken olan izolatlar ile benzerliklerinin incelenmesi amaçlanmıştır.

Gereç ve Yöntem: Çalışmamızda, hastanemizde aktif kullanımda olan ve daha çok hasta yakınlarının kullandığı tuvaletlerden el hijyeni öğrenci grubu ile örnekler alındı. Ayrıca belirlenen tuvaletlerden sosyal el yıkama uyumu ve uygunluğu gözlemleri yapıldı.

Bulgular: On dört tuvaletten alınan 85 örnekte, 115 bakteri üremesi gözlendi. İzole edilen bakterilerden %26'sı gram negatifti. Ancak epidemiyolojik olarak önemli olduğu düşünülen karbapenem direnci varlığına Gram negatif izolatlarda rastlanmadı.

Sonuç: Hastaların ve hasta yakınlarının elleri ve çevresel yüzeyler yoluyla bu alanlardan karbapenem dirençli Gram negatif mikroorganizma bulaşının önemli bir sorun olmadığı kanaatine varıldı.

Anahtar Kelimeler: Karbapenem; Direnç; Sosyal El Yıkama; Hastane Tuvaletleri.

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Introduction

Hospital environments are the leading source of health care-associated infections. In the development of these infections, there is an interaction between the host, causative microorganism and environmental factors. Microorganisms within hospitals may reach patients through various means (hand contact, medical equipment, airway, etc).[1]

Isolates of *Klebsiella spp.* and *Acinetobacter spp* are a significant public health concern both in our country and worldwide. Due to the ability of these microorganisms to survive on various hospital surfaces, they may cause severe infections or even outbreaks in high risk hospital settings such as intensive care units (ICU).[2] In this study, we aimed to investigate the presence of carbapenem resistant agents carrying epidemiological significance in hospital toilets.

When evaluating hospital toilets in terms of their microbial contents; in a study conducted in our country, Cucen and colleagues identified various potentially pathogenic microorganisms, in addition to normal skin flora, on the surfaces of faucet handles and soap containers; these included *S.aureus*, *P.aeruginosa*, *Klebsiella spp*, *E.coli* and *Candida spp*.[3]

Social hand washing is a routine practice in which dirty/soiled hands are cleaned with soap and water throughout the day. Following toilet use, the hands should be washed with soap and water, rinsed thoroughly, and dried with a paper towel. The companions of patients, as well as hospital personnel, can help in preventing hospital-associated infections by practicing proper hand hygiene before and after contact with patients.[4] In a study investigating the role of the hands in transmitting *Klebsiella spp.*, hand washing was reported to evidently reduce the rates of colonization and infected patients ($p<0.001$).[5]

Our study aimed to investigate the role of the hospital public toilets (HPT), which is a shared area, in spreading and transmitting carbapenem resistant Gram negative bacteria of epidemiological significance, and potentially compare them to the isolates present in our intensive care units. Furthermore, we also aimed to observe the social hand washing compliance and reliability in the HPT, which are used by patients and their relatives, and when necessary, by healthcare professionals.

Materials and Methods

In our study, we observed social hand washing practices in the HPT that were actively used, mostly by patient companions, between March - May, 2019. Following toilet use, hand washing compliance, use of soap and duration of washing were evaluated. Student groups then took hand hygiene samples from the HPT. These swab samples were collected from the door handles in the toilets, tap heads in the sinks, flush handles and both automatic & manual release buttons of soap dispensers, and placed in a brain heart infusion broth culture medium. These culture samples were kept in a 37°C oven for 18-24 hours. They were subsequently plated on a medium with eosin methylene blue and 5% sheep blood agar. The isolated Gram negative microorganisms were identified by laser desorption / ionization time-of-flight mass spectrometry supported with matrix. During this process, a meropenem disc (Oxoid, USA) was placed on the mediums. After 24 hours of incubation at 37°C, the microorganisms growing around the meropenem discs were identified through conventional methods and Maldi-tof MS (BioMériux, France). The observations were recorded and saved on SPSS 22 (IBM Statistics). The study was approved by the I.U of Ethics Committee (protocol number:2018/16-4). Our study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

After 121 observations regarding hand washing compliance and reliability, it was determined that 31% of individuals did not wash their hands following toilet use, and 27% of individuals who washed them did so improperly. Table 1 displays the problems associated with improper hand washing. Of the 85 samples taken from fourteen toilets, 115 different microorganisms were observed; Gram negative microorganisms accounted for

26%. The distribution of these Gram negative microorganisms was as follows: 11 *Klebsiella pneumoniae*, 4 *Klebsiella oxytoca*, 7 *Escherichia coli*, 3 *Acinetobacter baumannii*, 2 *Enterobacter cloacae*, 1 *Enterobacter aerogenes*, 1 *Citrobacter* spp, and 1 *Proteus mirabilis*. Table 2 shows the distribution of the gram negative microorganisms according to the surface from where the sample was collected. Along with gram-negative growth, there was growth of gram positive cocci, bacilli, and yeast. However, the gram negative microorganisms did not demonstrate carbapenem resistance.

Table 1. Problems associated with improper hand washing.

	Improper Hand Washing Problems							
	No hand washing	No use of soap	Insufficient duration	Improper soap and duration conformity	Improper hand drying	Insufficient duration + improper hand drying	Insufficient duration & soap + improper drying	**Total**
Gender								
Female	37	11	6	3	21	23	9	**110**
Male	1	2	0	2	0	6	0	**11**
Total	**38**	**13**	**6**	**5**	**21**	**29**	**9**	**121**

Table 2. Distribution of Gram negative microorganisms according to sample surface

Surface of sample collection	Number (n)	Gr(-)growth (n)	Carbapenem resistance
Door handles	39	13	not detected
Tap heads	15	6	not detected
Flush handles	15	6	not detected
Manual soap release button	7	3	not detected
Electric soap release button	9	2	not detected
Total	85	30	not detected

Discussion

This study investigated if HPT contained carbapenem resistant Gram negative isolates that are significant in terms of health care-associated infections. Gram negative microorganisms develop carbapenem resistance through chromosomal mutations (porin loss, modification) and constitutive overexpression of ESBL/AmpC–β laktamaz. The spread and selection of carbapenem resistant isolates poses a significant threat to public health.[6] This situation makes treatment more difficult and infections progress with a high mortality rate, making it easily spread through horizontal transfer in the hospital environment.[7]

Hand flora consists of the transient and resident flora. The amount of microorganisms found in the hands of healthcare workers is reported to be between 3.9 x 10^4 and 4.6 x 10^6.[8] While 80-90% of the resident flora is found on the superficial surface, 10-20% is found within the deep surface where it is unaffected by physical cleaning of the skin using soap-water. The resident flora consists of gram-positive microorganisms such as *Propionibacterium spp*., *Micrococcus spp*. and coagulase-negative staphylococcus (CNS), which are believed to have no link to health care-associated infections. However, microorganisms forming the transient flora are significant in terms of these infections.[9] In our study, we observed social hand washing practices in the HPT, which were primarily used by patients and their companions, and when necessary, by health care workers. After 121 observations regarding social hand washing compliance and reliability, we determined that 31% of individuals did not wash their hands, and 27% of individuals who washed them did so improperly. Hand washing is the most reliable way of preventing the contact and fecal-oral

transmission of potentially pathogenic microorganisms by the companions of patients. The results of our social hand washing compliance observations suggest that it may have an effect on the spread of carbapenem resistant Gram negative isolates, which carry significance in health care-associated infections. Therefore, we collected microbial samples from certain contact surfaces to determine the potential sources of contamination. It is reported that inanimate hospital environments such as taps and sinks may play an important role especially in epidemic health care-associated infections.[10] In a study conducted in Madagascar, Bonneault and colleagues investigated the means of transmission of ESBL-producing *Enterobacteriaceae* in neonatal intensive care units, and reported that transmission rates were >55% for family members and >75% for health care workers. In the same study, *K. pneumoniae* was reported to spread through contact with contaminated health care workers, while family members were not identified as a source of transmission.[11] The primary mechanisms involved in the development of carbapenem resistance are the gained expression of carbapenemases such as IMP, NDM and VIM-type enzymes, metallo-ß lactamases such as KPC-type-ß-lactamase, and OXA type and broad-spectrum ß-lactamases. OXA-48-like carbapenemases are among the most widespread mechanisms, especially in Europe, the Middle East and South America.[12] In a study conducted in our hospital, Duman and colleagues reported an epidemic in ICU patients involving *K. pneumonia* that expressed both NDM-1 and OXA-48 carbapenemases.[13] In the same study, the only reported risk factor was rectal colonization. Hand hygiene and avoiding close contact have been emphasized in the control of outbreaks. In our study, we evaluated HPT as a potential source of karbapenem resistant gram negative bacteria by collecting 85 samples from the door handles in the toilets, tap heads in the sinks, flush handles and both automatic & manual release buttons of soap dispensers, and found no presence. This result suggests that the companions of patients do not pose a significant threat when transmitting microbes from these areas through their hands and peripheral surfaces. In our previously conducted study; we determined that *K. pneumonia* isolates found in ICUs demonstrated a 5% carbapenem resistance in 2013, increasing to 36% by 2017.[14] Nonetheless, the rate of carbapenem resistance increases despite all measures, infections caused by carbapenem resistant microorganisms carry severe mortality rates of up to 44%.[15]

Contact transmission is the most significant means of spreading in hospital environments. Contact transmission is defined as the spread of an agent from one patient or health care worker to another through physical contact. It may also occur indirectly through mutual use of a contaminated tool. Health care workers and patient companions may spread the agent from its source through contact.[16]

Conclusion

It is important to identify carbapenem resistant microorganisms in hospital environments and take the necessary precautions at the source. We did not identify any carbapenem resistant Gram negative microorganisms in our hospital public toilets, and concluded that patients and their companions do not pose an important threat when transmitting microbes from these areas through their hands and peripheral surfaces. Nonetheless, it is evident that developing proper hand washing practices are crucial in reducing the future spread of these isolates in hospitals and the community.

Ethics Committee Approval

The study was approved by the I.U of Ethics Committee (protocol number:2018/16-4).

Informed Consent

Since this was a observational study no informed consent was received.

Authorship Contributions

Observations and Lab Practices: SAT, YD, YE, NP. Concept: SAT, YD, YE, NP. Design: YE, SAT. Data Collection or Processing: SAT, YD, YE, NP, Hand Hygiene Student

Group. Analysis or Interpretation: SAT, YD, YE. Literature Search: SAT, YD. Writing: SAT, YD

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Conflict of Interest

No conflict of interest was declared by the authors.

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Peer-review

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