

Analysis of nosocomial outbreak caused by contaminated liquid hand soaps: A single-center study

Kontamine sıvı el sabunlarına bağlı hastane enfeksiyonu salgını analizi: Tek merkezli bir çalışma

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ABSTRACT

Objective: *P. aeruginosa* and *Klebsiella* spp. are the most common gram negative pathogens seen in the etiology of hospital acquired infection outbreaks. Inadequate hygiene and contaminated liquid hand soaps have important roles in the spread of bacteria. In this study, we identified the source and causes of nosocomial infection outbreak in a tertiary hospital.

Methods: CCulture samples were randomly obtained from soap dispensers filled with anionic liquid hand soap without antiseptic during the outbreak and from dispensers containing disposable liquid hand soap with antiseptic within the 5 years after the outbreak. The samples were cultivated in eosin methylene blue agar and blood agar mediums. In the identification of obtained samples, VITEK® 2 Compact automated system (bioMérieux, Marcy l'Etoile, France) was used.

Results: Among culture samples obtained from 18 patients with coronary by-pass during nosocomial outbreak in our hospital in 2011, *P. aeruginosa* (n=17) and *Klebsiella* spp. (n=8) were isolated. In culture samples of type A liquid hand soap group (anionic, antiseptic-free), *P. aeruginosa* (n=58) and *Klebsiella* spp. (n=15) were isolated during nosocomial infection

ÖZET

Amaç: *P. aeruginosa* ve *Klebsiella* spp. hastane enfeksiyonuna neden olan patojenik gram-negatif bakterilerden en sık karşılaşılan iki çeşiddir. Yetersiz hijyen ve bakteri ile kontamine olmuş sıvı el sabunları, söz konusu bakterilerin yayılmasında öne çıkan iki faktördür. Bu çalışmada üçüncü seviye bakım yapan bir hastanede hastane enfeksiyonu salgınının neden ve kaynaklarını belirledik.

Yöntem: Salgın esnasında antiseptik içermeyen anyonik sıvı sabun ile doldurulmuş sıvı sabunluklardan ve salgından sonraki beş yılda antiseptik sıvı sabun ile doldurulmuş sıvı sabunluklardan rastgele kültür örnekleri alınmıştır. Alınan örnekler eozin metilen mavi agar ve kanlı agar besiyerlerine ekildi ve elde edilen bakteri izolatlarının tanımlaması VITEK® 2 Compact otomatize sistemi (bioMérieux, Marcy l'Etoile, Fransa) kullanılarak gerçekleştirildi.

Bulgular: Hastanemizde 2011 yılında meydana gelen bir hastane enfeksiyonu salgını sırasında 18 koroner by-pass hastasından alınan kültür örneklerinde *P. aeruginosa* (n=17) ve *Klebsiella* spp. (n=8) izole edilmiştir. A tipi sıvı el sabununun (anyonik, antiseptik içermeyen) kültür örneklerinde salgın boyunca ve dezenfeksiyon sonrası

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Geliş Tarihi / Received : 07.04.2018
Kabul Tarihi / Accepted : 09.01.2019

DOI ID : 10.5505/TurkHijyen.2018.69862

Harman R, Dokur M. Analysis of nosocomial outbreak caused by contaminated liquid hand soaps: A single-center study. Turk Hij Den Biyol Derg, 2019; 76(3): 267-274

outbreak and in the early periods after disinfection. No further nosocomial outbreak infections were detected during the next 5-year period after use of Soap type B (antiseptic foam soap) and Soap type C (disposable antiseptic liquid soap). A few number of pathogens including *P. aeruginosa* (n=1) and *Klebsiella spp.* (n=2) were isolated in culture samples obtained from Soap type B dispensers. No bacteria were isolated in samples obtained from Soap type C dispensers.

Conclusion: The use of disposable liquid hand soap with antiseptic prohibits contamination and consequently, prevents nosocomial infection outbreaks.

Key Words: Liquid hand soaps, disposable, contamination, nosocomial outbreak

erken dönemlerde *P. aeruginosa* (n=58) ve *Klebsiella spp.* (n=15) izole edilmistir. Salgın sonrasındaki beş yıllık süreçte B (antiseptikli köpük sabun) ve C (antiseptikli sıvı sabun) tipi sabun kullanımlarında herhangi bir hastane salgınına rastlanmadı. Sadece B tipi sabunluklardan alınan örneklerde eser miktarda *P. aeruginosa* (n=1) ve *Klebsiella spp.* (n=2) gözlenmiştir. C tipi sabunluklardan alınan örneklerde herhangi bir bakteriye rastlanmadı.

Sonuç: Antiseptik içeren tek kullanımlık sıvı el sabunu kullanımı, bulaşmayı engelleyerek hastane enfeksiyonu salgını önler.

Anahtar Kelimeler: Sıvı el sabunları, tek kullanımlık, bulaş, hastane enfeksiyonu salgını

INTRODUCTION

Hospital outbreaks are important clinical issues that occur from time to time in hospitals' Intensive Care Units (ICU) and it can lead to mortal and morbid for risky patients and also healthcare providers. ICU of hospitals have suitable conditions for *P. aeruginosa* to live and reproduce. Other gram-negative bacteria strains (*Klebsiella spp.*, etc.) may also cause nosocomial infections (1,2). Hand hygiene is the most effective factor in preventing hospital infections and also interrupting faecal-hand contamination by washing (3). Soaps clean the dirt, organic matters and pathogenic bacteria on hands with their detergent feature. Some agents generally affects by killing bacteria on flora, even though they have minimal differences between each other (4). This study focuses on the examination of processes and solutions we followed on the verge of determining bacterial isolation in the soap samples collected to conduct a research on a nosocomial outbreak occurred in Cardiovascular Surgical ICU of

Sanko University Hospital in 2011.

MATERIAL and METHOD

Introducing setting

Sanko University Hospital is a third level health care institution with 600 patient beds capacity. We have four ICUs (general ICU, Cardiovascular Surgical ICU, neonatal ICU and coronary ICU) in our hospital. Number of patients admitted in ICU's are around 9000 per year. Alcohol-based soaps were widely used before the outbreak in 2011. Liquid hand soap dispensers group subject to our study that were used before the outbreak consisted of 476 liquid soap dispensers in all of the clinics of our hospital and they were filled with standard liquid hand soap commonly used in hospitals, manufactured only by the same company with a single type chemical formula including sodium hydroxide (NaOH) (anionic type) and without disinfectants (Soap

A). After the hospital outbreak, wall mounted soap dispensers filled with amphoteric, eco-labeled, liquid foam hand soap with betaine were preferred (Soap B). Another soap type (Soap C) was similar to Soap B with chemical formulation but it was used only in operating rooms, ICUs, laboratories and sterilization units.

Patients characteristics

We found total number of patients with nosocomial infections was 18 and 11 (61%) of the patients were female and 7 (39%) were male (Mean: 68.8±10.5 years (range:42-81). Mean of length of stay in hospital was 18.1±4.1 days (range:7-22). Meanwhile, total number of patients underwent coronary bypass surgery was 61 in the month of nosocomial outbreak. (Number of patients who underwent coronary by pass surgery was 221 in 2011). Furthermore the most frequent underlying diseases were hypertension and diabetes mellitus; number

of patients were 7 (38%) and 6 (33%) respectively. (Table 1).

Collection of samples and Bacterial isolates

Liquid hand soap isolates

Within the scope of activities of Infection Control Committee (ICT), environmental cultures were collected from Cardiovascular Surgical Service and ICU to conduct a research on the outbreak. Consequently *P. aeruginosa* and *Klebsiella* spp. reproduction in the liquid soap culture samples, new cultures were randomly collected from a total of 52 liquid hand soap dispensers in the hospital, especially in the risky areas. Thus, a more accurate bacterial culture sampling was obtained in this study.

Clinical isolates

Bacterial culture samples were obtained from liquid soap dispensers in our hospital by members

Table 1. Characteristics of patients with nosocomial infection (N=18)*

Parameters	Number of patients	Percent (%)
Age		
18-65 years	3	20
≥65 years	15	80
Mean: 68.8±10.5 years (range:42-81)		
Gender		
Male	7	39
Female	11	61
Underlying disease		
Diabetes Mellitus Type 2	6	33
Chronic obstructive pulmonary disease	2	11
Chronic renal failure	3	17
Hypertension	7	39
Length of stay in hospital		
5-15 days	4	22
≥15 days	14	78
Mean:18.1±4.1 days (range:7-22)		
Total	18	100

* Total the number of patients underwent coronary bypass surgery was 61 in the month of nosocomial outbreak and also the number of patients who underwent coronary by pass surgery was 221 in 2011.

of ICT. Then these samples were inoculated in eosin-methylene-blue and blood agar plates. The inoculated plates were then incubated aerobically at 37 °C for 24 hours.

Bacterial identification and antibiotic susceptibility testing

Identification and antibiotic susceptibility tests on the bacteria isolated from cultures were completed by using VITEC 2® compact automated system (bioMérieux Industry, France). Antibiotic susceptibility tests were performed to detect antibiotic resistance of the bacterial isolates.

Ethical status

The research was conducted in full accord with the tenets of World Medical Association Declaration of Helsinki (ethical principles for medical research involving human subjects).

RESULTS

In this study, among the patients underwent coronary by-pass in our hospital's Cardiovascular Surgical ICU and inpatient clinic during nosocomial outbreak, 18 patients were diagnosed with surgical wound infection; *Klebsiella* spp. was 6 (33%) and *P. aeruginosa* was also 12 (67%). 7 patients were diagnosed with blood culture infection; *Klebsiella* spp. was 2 (29%) and *P. aeruginosa* was 5 (71%). Thus, total number of bacterial isolate was 25. (Table 2).

Bacterial culture samples (n=52) were obtained from liquid hand soap dispensers (Soap A) in Cardiovascular Surgical ICU of our hospital during nosocomial outbreak. The distributions of bacterial culture results were as follows: *P. aeruginosa* was 15 (29%) and of *Klebsiella* spp. was 34 (65%), and also in 3 (6%) bacterial culture samples there was no isolation. (Table 3)

After this, new bacterial culture samples were obtained from the soap barrel (primary soap distribution source). But, no bacterial isolation was detected. All contaminated liquid hand soaps dispensers were disinfected with 2% glutaraldehyde and refilled with Soap A by ICT of Sanko University Hospital. New culture samples were collected from contact points with external environment and the interior parts of the same liquid hand soap dispensers 15 (60%). in the total 25 bacterial culture isolates were *P. aeruginosa* and 0 (0%) were *Klebsiella* spp. and also in 10 (40%) bacterial culture samples there was no isolation after 2 days the first disinfection (Table 3).

Liquid hand soap dispensers were again collected and disinfected in the same way and refilled with Soap A. Two days after second disinfection, new culture samples were obtained from contact points with external environment of liquid hand soap dispensers. The number of isolated *P. aeruginosa* was 9 (36%) and 0 (0%) were *Klebsiella* spp. and also in 16 (64%) bacterial culture samples there was no isolation in total 25 bacterial culture samples.

Table 2. Liquid hand soap isolates and bacterial culture results (during nosocomial outbreak)

Isolate sources	Number of isolate	Bacterial culture results	
		<i>Klebsiella</i> spp.	<i>P.aeruginosa</i>
Wound/Pus culture	18	6 (33%)	12 (67%)
Blood culture	7	2 (29%)	5 (71%)
Total	25	8 (32%)	17 (68%)

Table 3. Distribution of bacterial culture results obtained from liquid hand soap dispenser during and after outbreaks (2011-2016)

Surveillance	Bacterial culture results				Total
	Soap	<i>Klebsiella spp.</i>	<i>P. aeruginosa</i>	No reproduction	
During the nosocomial outbreak	A	15 (29%)	34 (65%)	3 (6%)	52
After two days first disinfection	A	0 (0%)	15 (60%)	10 (40%)	25
After two days second disinfection	A	0 (0%)	9 (36%)	16 (64%)	25
1 year after the initial outbreak	B	0 (0%)	0 (0%)	23 (100%)	23
2 years after the initial outbreak	B	1 (5%)	0 (0%)	19 (95%)	20
3 years after the initial outbreak	B	0 (0%)	0 (0%)	22 (100%)	22
4 years after the initial outbreak	B	1 (3.8%)	1 (3.8%)	24 (92.4%)	26
5 years after the initial outbreak	B	0 (0%)	0 (0%)	26 (100%)	26
1 year after the initial outbreak	C	0 (0%)	0 (0%)	0 (0%)	0
2 years after the initial outbreak	C	0 (0%)	0 (0%)	0 (0%)	0
3 years after the initial outbreak	C	0 (0%)	0 (0%)	0 (0%)	0
4 years after the initial outbreak	C	0 (0%)	0 (0%)	0 (0%)	0
5 years after the initial outbreak	C	0 (0%)	0 (0%)	0 (0%)	0

Same bacterial isolates were also determined in the bacterial cultures obtained from the interior parts of the same liquid soap dispensers containing Soap A (Table 3).

Liquid hand soap dispensers were again collected and disinfected in the same way and refilled with liquid hand soap dispensers containing foam soap with antiseptic and eco-labeled (Soap B) to prevent contamination. After Soap B, almost no bacterial isolation was detected during the 5-year period (Table 3).

In order to get a better result, we went to a step further and tried to use another soap type (Soap C). Soap C had similar chemical formulation with Soap B, but it was completely disposable and it was used in operating rooms, ICUs, laboratories and sterilization units.

A total of 164 bacterial culture samples were

obtained from new liquid hand soap dispensers after the use of Soap B and Soap C (total number of sample were 124 and 40 respectively) during the 5-years-long surveillance period. The number of total bacterial isolates was 117 after this period. But, the number of bacterial isolates obtained from Soap B dispensers was only 3. (*Klebsiella spp.*, n=2 and *P. aeruginosa*, n=1). Unlike not any bacterial isolation in soap cultures were obtained from Soap C dispensers. Therefore, no new outbreak caused by Soap B and Soap C was determined in our hospital during the 5-years-long surveillance period (Table 3).

DISCUSSION

It is widely known that soaps can colonize with gram-negative microorganisms during nosocomial outbreaks. *P. aeruginosa* and *Klebsiella spp.* are two

of the most commonly colonizing microorganisms (5,6). It is important to always keep in mind that these microorganisms, that are also an important factor in hospital outbreaks, can easily colonize in soaps and disinfectants and cause infections (7). In order to prevent such infections, all soap dispensers, washed thoroughly and dried by draining, and new soap dispensers mounted during this process. However, it should be taken into consideration that this process does not work as expected due to lack of attention of medical staff.

In an etiologic study conducted by Blanc et al. (8), as pathogenic bacteria *P. aeruginosa* (n=776) was isolated from 358 patients out of 382 patients with nosocomial infection (93.7%) treated in a tertiary care university hospital. We determined that only 3 (0.8%) of the patients with nosocomial infection were due to contaminated liquid hand soaps. In the findings Blanc et al. concluded, it is especially remarkable that the most frequent contamination element in nosocomial infections is *P. aeruginosa* even though the most frequent contamination route is not soap dispensers. The findings of our study about the most common isolate being *P. aeruginosa* matches with the study Blanc et al.

Although the importance of hand washing is considered an important factor in the prevention of nosocomial infections, there is always a resistance to it. This resistance was tried to be balanced with disinfectants.

The accessibility of hand disinfectants the ease of use with a very little amount of time required increased the adaptation to hand hygiene. Intense and increased work-loads may affect nurses negatively in following the rules about hygiene (9). Consequently, latest guides suggest utilization of hand disinfectants as long as there isn't any visible dirt on hands or a contamination with sporophyte microorganisms (10). Conformity with hand hygiene does not surpass 50% in many hospitals. Hospital infection rate around the globe is around 7-10% and the treatments of these

infections are quite costly. In 20-40% of the cases of carrying and spreading microorganisms that shows high virulence and multiple treatment resistance between patients are caused by dirty hands of healthcare personnel. At least 50% of this problem could simply be solved with hand (3,4). Effectiveness of washing hands depends on length and technique. Length usually needs to be short in hospitals due to work load. Effective washing length is generally 8 to 20 seconds. However, when we add before and after procedures such as going to the washbasin and coming back, this period increases to 40 to 80 seconds. One minute-long hand washing session causes a significant decrease in microorganism number (11,12). Hands must be rinsed well after washing, dried with single-use paper towel and the sink must be turned off with paper towel or knee. A lotion must be used to protect hands after washing (3).

In order to increase the adaptation of patients and healthcare professionals to hygienic rules, it is important to have adequate number of wash-hand basins in the work area, with sinks that can be easily controlled with knees or arms, and provide easy access to liquid hand soap, lotion and paper towels. Containers used to refill liquid soaps must be cleaned and disinfected; preferably, hand soaps contained in soft, disposable containers that does not create a negative pressure during pumping must be used. In order to reduce the risk of contamination, liquid hand soap dispenser, which can be controllable by the elbows, is preferred. (2,3,13,14). It is noteworthy that after the use of Soap B and Soap C, there is no nosocomial outbreak in inpatient clinics of our university hospital.

CONCLUSION

Disposable liquid hand soap completely prevents contamination. This can be an effective solution to the prevention of nosocomial infections. Hence, along with hygiene precautions disposable liquid hand soap dispensers must be used especially in risky areas

such as operating rooms, ICUs, hematology/oncology units, burn units, disinfection and sterilization units and labs, and in all units of hospitals if possible.

ACKNOWLEDGMENT

We thank members of ICT and technical staff of Sanko University Hospital for assistance.

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