COMPARİSON OF EFFİCİENCY OF AİR AND SURFACE PURİFİCATİON DEVİCE WİTH CONVENTİONAL METHODS İN CANCER HOSPİTAL

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Introduction and Aim

Nosocomial Infection is a major health problem that causes morbidity and mortality. The length of hospital stay is longer and quality of life is worse in patients with hospital acquired infections, healthcare cost increases, labor loss and legal problems occur (1,2).

Patients are colonized with hospital flora within hours after hospitalization. Hospital environment and patient's flora are important sources of infections, especially in immunocompromised patients. Environmental disinfection must be provided for preventing nosocomial infections. After routine cleaning, disinfection of the area is carried out by cleaning staff by using high-middle or low level disinfectants according to the characteristics of the areas. The rooms of patients that are colonized or infected with resistant microorganisms should be cleaned more frequently for the health of the patient as well as the other patients and employees (3,4,5).

Microorganisms that cause serious infections like methicillin resistant *S. aureus (MRSA), vancomycin resistant Enterococcus (VRE), Acinetobacter spp, Clostridium difficile* and norovirus may live on surfaces for a long time. Microorganisms are carried by the hands of patients and health care workers and the may cause many infections like surgical field infection, pneumonia, sepsis, catheter related infection. Environmental hygiene is as important as hand hygiene In the prevention of these infections (6-9)

Environmental disinfection in the hospital is related to many factors and it is difficult to is do it appropriate all the time. There is need for infection control program,enough trained staff, suitable physical conditions for mechanical cleaning, appropriate disinfectants for surface cleaning for providing a good environmental hygiene. (5,10,11). Environmental disinfection can be in inadequate because of problems in organizational structure of the hospital or inappropriate staff behaviors. For this reason, many surface and air cleaning tools have been developed to provide good hygiene in the hospitals.

Puradigm® is an air and surface purification device that kills microorganisms by filtration, ionisation and oxidation . Microorganisms are destroyed by the effect of H2O2 and O3 (hydrogen peroxide and ozone). Positive H +,and negative O2 released from the atmosphere and electrons in the environment combine to form high energy clusters. This ionization also has an effect on the destruction of microorganisms. As the products that come up with this mechanism are non toxic, the device can be used when there is a patient in the room (12).

The aim of this study is to investigate the effect of Puradigm® on environmental and surface hygiene in the Infectious Diseases Ward at the Oncology Hospital where most of the patients have cancer and to compare this device with conventional cleaning methods.

Materials and Methods:

The study was conducted in Infectious Disease Ward, Ankara Oncology Training and Research Hospital.

3 different areas were used for the study.

- Area 1 and 2: Surface cultures were taken from two separate patient rooms with contact isolation before and after device insertion (bedheads, door handle, plug socket), and a nasal swab was taken from the patient in the room.One of the patients

had urinary tract infection caused by *VRE* and the other had an *Acinetobacter baumannii* infection.

- Area 3: Bacteria solutions including Acinetobacter baumannii, VRE and MRSA at 0.5 Mcfarland standard were prepared. 12 cm^2 of bacteria suspension was poured to 12 cm2 area in the surface of an empty room and let the surface to got dry. Cultures were taken by a swab from the floor at 0 hour before routine cleaning or switching on the device when. Then the device was switched on or cleaning with 5000 ppm NaOCl was performed. Cultures were repeated in the 12th and 24th hours when the room was supposed to be clean. Blood agar was used as culture media, colony forming units were counted after incubation for 24 hour at 37oC.

The results of area 1 and 2 are shown in Table 1 and Table 2. The results of area 3 is shown in Table 3. There was a significant decrease in the number of colony forming units or no growth in the media after 12-24 hours in the room that the device was used for purification . There was a decrease in the number of bacteria that were cultivated from the surface infected with Acinetobacter baumannii, VRE and MRSA after 12 hours of using the device and there was no growth of bacteria after 24 hours. The number of microorganisms was 10^2 after routine cleaning.

	Puradigm®			**Mechanical cleaning**		
Number of Microorganism (cfu/cm^2)	Before use	12^{th} hour	**24^{th} hour**	Before cleaning	12^{th} hour	**24^{th} hour**
Bedside	10^2	5	**0**	10^2	10^2	**15**
Shelf	10^2	4	**0**	10^2	10^2	**30**
Door handle,	10^2	1	**0**	10^2	10^2	**20**
Plug socket	10	1	**0**	10	10	**10**
Nasal mucosa of the patient	10^3	10^2	**10**	10^2	10^2	10^2

Table 1. Culture of infected patient's room with Vancomycin resistant Enterococcci

	Puradigm®			**Mechanical cleaning**		
Number of Microorganism (cfu/cm^2)	Before use	12^{th} hour	**24^{th} hour**	Before cleaning	12^{th} hour	**24^{th} hour**
Bedside	10^2	5	**0**	10^2	10	**20**
Shelf	10^2	4	**0**	10^2	30	**30**
Door handle,	10^2	3	**0**	10^2	20	**20**
Plug socket	10	1	**0**	10	10	**10**
Nasal mucosa of the patient	10^3	40	**10**	10^2	60	10^2

Tablo 2. Culture of infected patient's room with Acinetobacter baumanni

	Puradigm®			**Mechanical cleaning**		
Number of Microorganism	Before use	12th hour	**24** th hour	Before cleaning	12th hour	**24** th hour
Acinetobacter suspension (cfu/cm^2)	>10^5 cfu/ml	1 cfu/ml	**0**	>10^5 cfu/ml	10^2	10
VRE suspension (cfu/cm^2)	>10^5 cfu/ml	2 cfu/ml	**0**	>10^5 cfu/ml	10^2	10^2
MRSA suspension (cfu/cm^2)	>10^5 cfu/ml		**0**	>10^5 cfu/ml	10^3	10^3

Table 3. Culture of bacteria solutions

Culture of room before and after cleaning with device are shown in Figure 1 and Figure 2.

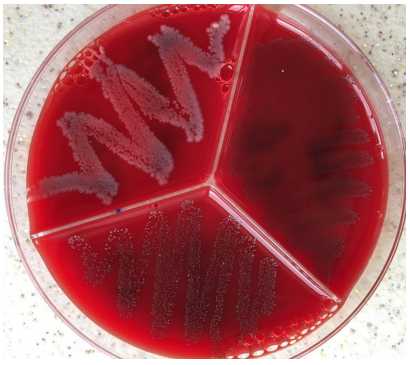

Figure 1: Before

Figure 2: After

Discussion

Hospital acquired infection is a health care problem that causes high morbidity and mortality if not prevented. As the causative microorganism are usually resistant to most of the antimicrobials, treatment is difficult and cost is high. Environmental hygiene is important in preventing hospital infections (13).

In this study, we showed that the air and environment purification device can be used as an adjunct to routine cleaning to ensure the environmental hygiene to prevent hospital infections. The device was more effective than conventional cleaning methods in providing hygiene of the surfaces. This kind of devices that makes purification with ozone can be used to provide environmental hygiene in the special areas that need frequent cleaning in the hospitals.
Patients are colonized by hospital flora within hours of days after hospitalisation. Hospital flora is a major source of infection. Resistant microorganisms that are present at the surface of the hospital can infect patients and / or health workers, leading to serious infections (3,4). Microorganisms such as MRSA, VRE, *Acinetobacter species, Clostridium difficile* and norovirus continue to survive on surfaces for a long time. These microorganisms can cause hospital infections with cross contamination through hands, if they are not killed by physical cleaning and disinfectants. It was shown that VRE colonisation continued on the surfaces that were not cleaned well (6,14,15).

In this study, cultures were taken before and after physical cleaning and device usage on the surfaces contaminated with VRE, MRSA and *Acinetobacter,* that are among the most

common microorganisms causing nosocomial infections. While all of the microorganisms were killed after the use of the device, the microorganisms continued to grow after the physical cleaning.

Areas are classified according to purpose of use in the hospital (A, B, C, D). İnfected patients are that have to be isolated are in category C. The cleaning equipment should be separated from the ones used for other rooms. In category D, there are the areas that special patients are taken care like operating theatres, intensive care units, premature infant units, hemodialysis units and transplantation units. Cleaning of these areas is done with separate equipment, using disinfectant at least once a day (16,17)

In the physical cleaning of the patient rooms, it is necessary to use separate cloths for each area, to select appropriate disinfectant, to have suitable space for cleaning the used equipment, to make good mechanical cleaning and clean as soon as it gets dirty. However, all this depends on many factors, such as the physical condition of the hospital, the infection control procedures of the hospital, the availability of enough cleaning staff, and the training of cleaning staff. The areas like windows or walls of the room can be cleaned when a patient is discharged but the areas that are more frequently contaminated like bedheads, door handles, plug sockets etc. should be cleaned everyday (6,18). It is more difficult to ensure effective physical cleaning in units that require frequent cleaning. Therefore, alternative methods are needed.

In this study, we searched for the effectiveness of a method that could be used at the same time physical cleaning to obtain better environment hygiene.We took cultures from bedheads, door handles, plug sockets and shelves of the two patients' rooms infected with VRE and *Acinetobacte*r,before and after physical cleaning. The number of microorganisms was reduced or did not changed after cleaning compared to the cultures taken before cleaning. After use of the device, no microorganism was seen on all surfaces at 12th hour or 24th hour.

Infections can be transmitted by hospital environment and surfaces, the patient's own flora, or the hands of health care workers. Especially immunosuppressive patients' flora can cause hospital infection. It has been shown that nasal carriage of *S. aureus or Streptocococcus pyogenes* of the health care workers may cause nosocomial infections (especially surgical site infection) by contact or airway route. Patients may be colonized with Gram positive, gram negative bacteria and yeasts within 1 week after hospitalisation (19,20). Several potential health-care-associated pathogens (eg, Staphylococcus aureus and Staphylococcus epidermidis) and drug-resistant organisms have also been recovered from adjacent to the surgical field (21)

In this study, nasal swab was taken from two patients infected with VRE or Acinetobacter. After using the device, the number of microorganisms that grow in the media was decreased, but it did not completely disappear. This result suggests that the device can be used to decrease the number of microorganisms in a part of body that could be an infection source, such as nasal mucosa. But there is a need for more detailed work in this subject.

Different methods and devices can be used besides physical cleaning in environmental disinfection. Some of these can not be used in areas where the patients or health care workers are present due to the toxic or harmful side effects of the method. The patients are discharged from the room during the disinfection and this makes disruption in health care service Puradigm® is safe and can be used wherever the patient and staff are present because

it is not toxic or harmful. In this study, we continued to use the device until the patient was discharged. No toxic side effects were observed.

Conclusion

An equipment that kills microorganisms with ionization and oxidation can be used in addition to physically cleaning to obtain better environmental hygiene in hospitals. It was seen that the device was useful in cleaning the areas that are difficult to reach with mechanical cleaning. It is important to prevent cross contamination and the spreading hospital infections, especially in special units like operating theatres, intensive care units, organ/bone marrow transplantation units, where frequent cleaning is required. Environment and surface cleanliness is as important as hand hygiene in preventing cross contamination. In this study, it was found that it this device can be useful for disinfection of areas that should be frequently cleaned and mechanical cleaning could not be done well. It was observed that the device could be used while the patient was in the room, and there was negative or toxic effect to the patient.

It has been shown that the device kills microorganisms that cause serious infections like *Acinetobacter* and VRE in 12-24 hours, which is more effective than mechanical cleaning.

The effectiveness of the device, known to be harmless to human health, was tested on patient flora. Colonized microorganisms in the nasal mucosa were found to decrease after use of the device. Puradigm® can be used especially in the prevention of colonization with resistant microorganisms, especially MRSA. We think that there is need for more experimental work is this area.

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Figure Legends

Table 1. Culture of infected patient's room with Vancomycin resistant Enterococcci
Table 2. Culture of infected patient's room with Acinetobacter baumanni
Table 3. Culture of bacteria solutions
Figure 1. Culture of room before cleaning with device
Figure 2. Culture of room after 24th hours from cleaning