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Effects of Nocospray Disinfection Device on the Reduction of Children's Hospital Acquired Infections

Mohammad Reza Mosaddegh [1], Ali Ghasemi [2], Zahra Sepehri [3], Mojgan Bahari [4], Mahdi Jahangiri [5], * Sara Jahangiri [6]

[1] Clinical Supervisor, Dr. Sheikh Children's Hospital, Mashhad University of Medical Sciences, Iran.

[2] Pediatric Hematology and Oncology Specialist, Assistant Professor, Department of Pediatrics, Dr. Sheikh Hospital, Mashhad University of Medical Sciences, Iran.

[3] Infection Control Supervisor, Dr. Sheikh Children's Hospital, Mashhad University of Medical Sciences, Iran.

[4] Nursing manager, Dr. Sheikh Children's Hospital, Mashhad University of Medical Sciences, Iran

[5] Internist, Medical school, Mashhad University of Medical Sciences, Iran.

[6] Master of Nursing, Dr. Sheikh Children's Hospital, Mashhad University of Medical Sciences, Iran.

Abstract

Background: Contamination of medical equipment and environmental surfaces with microorganisms plays a significant role in the transmission and spread of hospital infections. Considering the deaths and costs caused by hospital infections, it is necessary to take appropriate measures to prevent the spread of infection, such as cleaning and disinfection. The purpose of this study was determining the status of hospital infections before and after using the air and surface disinfectant device known as nocospray which applies dry mist technology and hydrogen peroxide solution.

Method: This cross-sectional study was conducted in two 6-month periods at Dr. Sheikh Children's Hospital, in Mashhad, between 2021 and 2022. All patients who were hospitalized for more than 48 hours and had a hospital infection were included in the study. In the second 6 months, a Nocospray disinfection device was used to disinfect surfaces and equipment. Nosocomial infection was determined according to clinical symptoms and blood, urine and tracheal tube cultures in both 6-month periods and the results of the two periods were compared.

Results: A total of 198 cases of nosocomial infections were observed, 121 cases (61%) of which were related to the first 6 months. The death rate in the second 6 months decreased by 1.65% compared to the first 6 months. Among children of different ages, the age range of 1 to 4 years accounted for the highest number of hospital infections. And the highest rate of infection was related to the intensive care unit.

Conclusion: This study showed the positive effect of surface and air disinfection devices (Nocospray) in reducing the incidence of hospital infections and mortality.

Key Words: Disinfection, Hospital acquired infection, Nocospray.

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Corresponding Author:

Sara Jahangiri, Master of Nursing, Dr. Sheikh Children's Hospital, Mashhad University of Medical Sciences, Iran. Email: sarajahangiri448@yahoo.com

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1- INTRODUCTION

Hospital acquired infections (HAIs) are one of the health problems in all societies (1). Nosocomial infections are associated with high costs for hospitalized patients and a significant increase in mortality (2, 3). These infections are not present on admission to the hospital and develop in the first 72 hours or more after admission (4). Recently, due to the deaths and losses caused by HAI, a lot of attention has been paid to them. According to the information provided by the World Health Organization, 1.7 million HAIs occur every year, and one out of every 20 people gets a hospital-acquired infection. These infections caused 99,000 deaths annually and cost about 26-32 million dollars. The rate of HAIs in Iran has been reported from at least 1.9% to more than 25%, which leads to an increase in the stay of patients in the hospital for up to 24 days. This is problematic not only for hospitalized patients and medical employees but also for the patients' families and other people; because patients are the cause of hospital infection transmission after discharge and create a vicious circle. Compared to other patients, people who get a hospital infection have a longer hospitalization period and a higher mortality rate, which is the most important side effect of treatment (5). Case-by-case examining the prevalence and incidence of hospital infections has confirmed the relationship between the poor environmental health condition of the hospital and transmission of microorganisms responsible for hospital infections. Microorganisms are widely transferred from environmental surfaces to patients through contact with surfaces. Environmental surfaces in hospitals and health care centers are divided into two categories: medical equipment surfaces (handles and buttons of dialysis machines, imaging devices, tool trolleys, medical and pharmaceutical devices, dental units, etc.) and building surfaces (walls, floors, windows, curtains, door handles, etc.). Epidemiological studies and experimental evidence show that environmental surfaces can be involved in the transmission and spread of respiratory and gastrointestinal hospital infections. The presence of pathogens on environmental surfaces near the patient, such as bedside tables, cupboards and handles, has been confirmed to be the most important cause of hospital infections. The surfaces of medical equipment such as blood pressure cuffs, stethoscopes, hemodialysis machines, and imaging devices may also be contaminated with infectious agents and accelerate and facilitate the transmission of these agents leading to the emergence and spread of disease (6). Contaminated surfaces, especially frequently touched surfaces, act as reservoirs for pathogens and contribute to disease transmission (7). The complete elimination of HAIs is currently not possible and appropriate measures must be done for their reduction. One of the necessary measures to control hospital infection is to plan and determine a policy regarding the disinfection and sterilization of equipment and devices in the hospital; because there is a possibility of infection transmission to patients due to contamination of equipment (8, 9). Therefore, considering that the transmission of infection from devices and the environment to patients takes place in a large way through contact (6), and considering the vulnerability of children, this study was conducted to determine the status of HAIs by the use of nocospray devices in a children’s hospital.

2- MATERIAL & METHOD

2-1. Design and population

This descriptive cross-sectional study was conducted in Dr. Sheikh Children's Hospital, Iran during one year from March 2021 to March 2022. The study population included patients admitted at ICU, emergency, general pediatric, PICU,

nephrology, emergency hematology, and hematology who were hospitalized for more than 48 hours and had a hospital-acquired infection according to the definition of hospital infection investigation system of the Ministry of Health, Treatment and Medical Education of Iran. According to the definition of the national hospital infection care system, nosocomial infection is an infection that is limited or widespread and is caused by pathogenic reactions related to the infectious agent itself or its toxins in the hospital.

2-2. Inclusion and exclusion criteria

The inclusion criteria were hospitalization and staying in the wards for more than 48 to 72 hours after the patient was admitted to the hospital, the absence of obvious symptoms of the relevant infection at the time of the patient's admission, the presence of criteria related to specific infections in hospitalized patients after 48-72 hours from admission, occurrence of symptoms and criteria related to clinical blood infection, laboratory proven blood infection, urinary tract infection and pneumonia in hospitalized patients. Outpatients were not considered in this study. The patients in the study population who had hospital infections such as blood, urine and pneumonia were recorded and investigated.

2-3. Procedure

The sample size was calculated by census. The positive result of culture and the presence of clinical symptoms indicating infection were the criteria for diagnosing nosocomial infection. Urinary frequency, burning sensation and discharge of purulent secretions indicated urinary infection. In the case of blood infection, fever was specifically considered. In the case of respiratory tract infection, symptoms of fever, presence of purulent secretions, pleural fluid infection and wheezing were considered. Due to the fact that surface culture is not usually done and is only desired in epidemic situations, in this study only blood, urine and tracheal tube samples were cultured. To investigate and confirm hospital infection in the first six months of the study, 12 urine culture samples, 7 tracheal tube culture samples, and 121 blood culture samples were taken from children hospitalized in the wards. After examining the samples by the laboratory and confirming the fungal and bacterial contamination of the collected samples and according to the clinical symptoms, the hospital infection of the patients was proved. Then, during the second six-month period of the study, an air and surface disinfection device known as nocospray was used.

The nocospray device used in this study was NOCOPERSIA 800 V model. The operation of the device is based on using dry mist technology, and the conversion of hydrogen peroxide solution (H_2O_2) into OH^- ions without creating any resistance, saturating the environment according to the volume determined using the diffusion law, connecting OH^- particles to the membrane of microorganisms inactivating and destructing them, as well as fully decomposing OH^- particles into oxygen and air humidity.

The features of the device for simultaneously disinfecting surfaces and the environment using dry mist technology are as follows: disinfecting inaccessible points and voids which is not possible with routine disinfection, the ability to quickly disinfect (50 cubic meters in 3 minutes) and being reused in the place within 30 minutes, the possibility of disinfecting the space up to 800 cubic meters with minimum time and consumption of solution, cost-effective so that only 1 milliliter of solution is used for each cubic meter, suitable substitute for formaldehyde tablets and UV lamps, the simplicity and speed of using the device without any need for a user, easy transportability, having a

quality control kit to ensure the absence of microorganisms, uniform and fast distribution of the solution to all points of the environment. Also, the solution used by this device has the following features: high antimicrobial spectrum with the ability to destroy all types of bacteria, fungi, viruses and spores, the ability to destroy biofilms, the ability to fully decompose the disinfectant solution, the lack of corrosive effect due to the working mechanism of the device, and the non-toxicity of the disinfectant solution. The results were analyzed with SPSS and values less than or equal to 0.05 were considered as significant.

3- RESULTS

In the one-year period of research, a total of 198 cases of hospital infection were observed. Of these, 56.06% were observed in boys and 43.93% were related to girls. The average duration of the patients' hospitalization was 19.3 days in the first six months of the study and in the second six months it was 16.2 days. **Tables 1** and **2** demonstrate the HAIs cases in detail.

Table-1: Type of infection by departments in the first six months

Department	Type of infection			Total
	PVAP-VAE*	UTI**	BSI***	
ICU & PICU	12	9	39	60
Emergency	0	0	2	2
General	0	0	11	11
Emergency Hematology	0	0	23	23
Nephrology	0	0	1	1
Hematology	0	2	22	24
Total	12	11	98	121

* Ventilator associated pneumonia-ventilator associated event

** Urinary tract infection

*** Bloodstream infection

Table-2: Type of infection by departments in the second six months

Department	Type of infection			Total
	PVAP-VAE *	UTI **	BSI ***	
ICU & PICU	12	7	16	35
Emergency	0	1	0	1
General	0	0	2	2
Emergency Hematology	0	3	19	22
Nephrology	0	0	3	3
Hematology	0	1	13	14
Total	12	12	53	77

* Ventilator associated pneumonia-ventilator associated event

** Urinary tract infection

*** Bloodstream infection

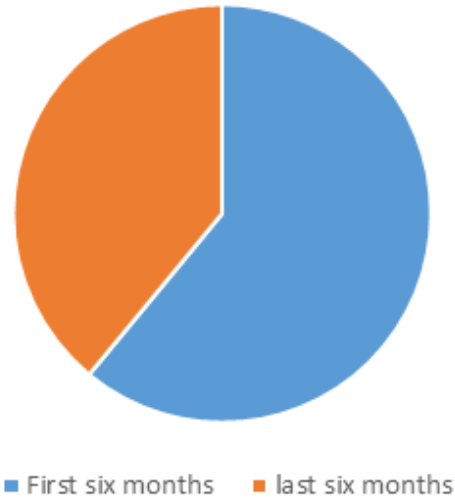

Fig. 1: Hospital infection rate in every 6 months compared to the whole year

Also, the average duration of hospitalization until the onset of infection was 8.6 days in the first six months and 7.1 days in the second six months (**Table 3**).

The death rate due to HAIs was 10.74% in the first six months and 9.09% in the second six months.

Table-3: Average time interval between hospitalization and infection

Department		Type of infection			Total
		PVAP-VAE *	UTI **	BSI ***	
First six months	Number of infections	12	11	98	121
	Mean duration (days)	13.9	9	7.8	8.6
	SD	15.3	11.8	13.6	13.6
Second six months	Number of infections	12	12	53	77
	Mean duration (days)	16.5	3	5.8	7.1
	SD	16.2	3	9.1	10.6

* Ventilator associated pneumonia-ventilator associated event

**Urinary tract infection

*** Bloodstream infection

In terms of age, the highest rate of HAIs in the first six months and the second six months of the study was related to the age group of 0-4 years, and was obtained to be 60.33% and 50.64%, respectively. While the lowest rate of HAIs was related to the age group above 15 years and was 8.26% and 6.49%, respectively. The results related to HAIs based on age groups are presented in **Tables 4** and **5.**

4- DISCUSSION

The results of this research revealed that in the second six months of the study, when the nocospray device was used to disinfect surfaces and equipment, the number of HAIs were 44 cases less compared to the first six months. Therefore, a 36.36% reduction in the incidence of HAIs in the second six months compared to the first six months

was achieved. As in the present study, researchers at Rajaee Heart Hospital in Tehran used a nocospray device to disinfect surfaces instead of the previous method of using formaldehyde. They also used 2% peracetic acid solution through a microjet device for disinfection and compared its performance with 6% hydrogen peroxide solution used by nocospray devices. In this study, it was found that the use of hydrogen peroxide through nocospray was significantly better than peracetic acid (10).

Table-4: HAIs based on age groups in the first six months

Age group	Type of infection			Total
	PVAP-VAE *	UTI **	BSI ***	
1-4	8	8	57	73
5-14	4	3	31	38
15-18	0	0	10	10
Total	12	11	98	121

* Ventilator associated pneumonia-ventilator associated event

** Urinary tract infection

*** Bloodstream infection

Table-5: HAIs based on age groups in the second six months

Age group	Type of infection			Total
	PVAP-VAE *	UTI **	BSI ***	
1-4	4	10	25	39
5-14	7	2	24	33
15-18	1	0	4	5
Total	12	12	53	77

* Ventilator associated pneumonia-ventilator associated event

** Urinary tract infection

*** Bloodstream infection

The highest rate of HAIs in the first and last six months of the study were 60 and 35 cases in the ICU department, respectively. In the study by Heidari et al., (11) ICU was reported as the most contaminated area, which is consistent with our study results. In the intensive care unit, due to the general weakness caused by the disease, the weakening of the body's defense mechanisms, and the length of hospitalization, patients are very vulnerable to the placement of devices and especially the insertion of a tracheal tube and breathing with an artificial ventilation device (12). In a study conducted by Barzegari et al., to investigate the bacterial contamination of different hospital departments, out of 1758 samples, 542 cases (30.8%) had bacterial contamination, and the highest contamination was related to medical equipment at the rate of 69.3% (13). This was a considerable level of contamination in different surfaces in the hospital. The high percentage of bacterial contamination of different hospital surfaces and departments can be caused by the type of disinfectant used, the lack of correct and principled methods of using

them by employees and those in charge of disinfection, the lack of supervision on different departments by the control committee, and the lack of sufficient training (14). Moreover, the cleanliness of the surface in terms of observational monitoring is not a proof of the cleanliness of the surface in terms of microbial contamination. The presence of factors that pollute the environment, such as improper cleaning and overcrowding in the hospital, can be considered as the reasons for the high level of contamination in the present study. Therefore, in this study, an attempt was made to minimize the incidence of infection by systematic planning and the use of appropriate and preventive methods such as the use of a nocospray device.

5- CONCLUSION

As it was found in this research, the use of the nocospray device reduced the incidence of hospital infection in patients and, as a result, long-term hospitalization, following the reduction of infectious complications during hospitalization.

6- ACKNOWLEDGMENTS

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7- CONFLICT OF INTEREST

None.

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