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# THE 3<sup>rd</sup> INTERNATIONAL CONFERENCE ON HEALTH SCIENCE 2016

"Optimizing the Mental Health under SDGs"

Poltekkes Kemenkes Yogyakarta

PROCEEDING  
BOOK

Inna Garuda Hotel Yogyakarta, Indonesia  
November, 6<sup>th</sup> 2016

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INNA GARUDA HOTEL YOGYAKARTA, INDONESIA  
November 6<sup>st</sup>, 2016



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### **“Optimizing theMental Health under SDGs”**

**INNA GARUDA HOTEL YOGYAKARTA, INDONESIA  
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## ANALYSIS OF Cl<sub>2</sub> GAS OBTAINED FROM SALT WATER ELECTROLYSIS AS DISINFECTANT IN THE DISINFECTION OF CARE-ROOMS IN HOSPITALS (A controlling effort for nosocomial infections)

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### ABSTRACT

Patients who were treated in hospitals after 48 hours can be infected by microorganisms. This condition is called as nosocomial infection. Nosocomial infection is a major cause of death among patients, i.e. amounting to 175,000 cases/year, and 10% of in-patients (1.4 million people) were estimated got nosocomial infection. In Indonesia, the in-patients who were exposed to nosocomial infection was as much as 9.4%. The impact of nosocomial infections increases the treatment days between 4-12 days, and also increases the treatment cost for about US \$ 600-40000/patient (± IDR 7,820,452-521,363,472). One of the prevention and control measures is by means of environments safety efforts with using air germ number standard which is set between 200-500 CFU/m<sup>3</sup>. Up to now, the efforts to sanitize the air in treatment rooms through disinfection is not effective, since the air germ number still exceeds the standard, i.e. 3,758 CFU/m<sup>3</sup>. As an alternative, air disinfection in treatment rooms can utilize Cl<sub>2</sub> gas derived from salt water electrolysis. Results of laboratory examination that using 1, 5, and 10 % salt concentration, show that those concentration were able to reduce the number of air germs, i.e. 15, 32, and 56 CFU/m<sup>3</sup>, respectively. The highest number of air germs was reduced by the application of 10 % concentration. Results of the analysis show that the Cl<sub>2</sub> gas obtained from the electrolysis can be used as a disinfectant to disinfect the treatment rooms in hospitals as nosocomial infection control efforts.

### INTRODUCTION

Other diseases which are emerged after patients were hospitalized for 48 hours and caused by microorganisms are called nosocomial infections. The sources of transmission of these infections are originated from medical equipments, humans (both the visitors and medical/paramedical personnel), and environment which are contaminated with disease agents, as well as patients who developed resistance to certain drugs. According to WHO (2011)<sup>1</sup>, nosocomial infection is one of major causes of the high global morbidity and mortality, i.e. 1.4 million deaths worldwide and 10% of hospitalized patients were experiencing nosocomial infection or about 175,000 cases/year. The average percentage of in-patient who got nosocomial infection in European and American countries is about 1%, meanwhile in Asian countries it is about 40%. In the USA, the incidence of nosocomial infection is 5-6 out of 100 in-patients, or in average, every year there are 2 million cases (Weinstein, 1998)<sup>2</sup>.

The prevalence of nosocomial infections in low and middle income countries is about 5.7 - 19.1%, or higher if compared with the prevalence in high income countries, i.e. 3.5 - 12% (Wikansari et al, 2012)<sup>3</sup>. Based on the research results of Panjaitan (2013)<sup>4</sup>, in Indonesia, 9.4% of in-patients in hospitals were contracted with nosocomial infection. According to Suwarni and Sutomo (2000)<sup>5</sup>, the incidence of nosocomial infections among public and private hospitals in Yogyakarta Province, in average was 4.26% cases.

According to WHO (2011)<sup>1</sup>, the impact of nosocomial infections can increase morbidity and mortality. The mortality due to these infections is as many as 1.4 million cases or 10% of the nosocomial infection affected patients. Nosocomial infections also increase mortality rate between 19-75% and causing longer hospitalization, i.e. between 4-12 days, thus increasing the cost for US \$ 600-40000/patient ( $\pm$  IDR 7.820.452-521.363.472).

The prevention and control of nosocomial infections in hospitals is conducted through five main activities, namely; safety for patients, safety for health workers, safety for the institution, safety for the environment and safety for business (Nugraheni, 2012)<sup>6</sup>. Based on the decree of Minister of Health No.1204/Menkes/SK/X/2004, the environmental safety for preventing nosocomial infections consists of the condition that the air germ number in care-rooms should not exceeding the maximum threshold of 200-500 CFU/m<sup>3</sup> of air (Minister of Health, 2004)<sup>7</sup>.

The care-rooms sanitation techniques which are performed today is by ultra violet radiation and chemical disinfections (Boyce, 2011)<sup>8</sup> and (Ratula, 2010)<sup>9</sup>. However, the real condition of the results are still facing failure that the number of bacteria of the treatment rooms is still high. Based on the research results of Suwarni and Sutomo (2000)<sup>9</sup>, the examination of germ number in treatment rooms of public and private hospitals in Yogyakarta showed an average of 3,758 CFU/m<sup>3</sup>, or higher if compared to the standard 200-500 CFU/m<sup>3</sup>. Those prevention and control of nosocomial infections through room disinfection using ultraviolet light and chemicals need high investment cost. On the other hand, the incorrect use of chemical disinfectant can causing pollution in the environment and may lead to microorganism resistance (Kusnoputranto, 2005)<sup>10</sup>.

According to Saksono (2012)<sup>11</sup>, the control and prevention of nosocomial infections by means of treatment room disinfection can use Cl<sub>2</sub> gas as the disinfectant. Cl<sub>2</sub> gas can be obtained from the electrolysis of salt water. The electrolysis reaction of table salt (NaCl) solution with electrical current that produces 2Na in solid form and Cl<sub>2</sub> in gas form can be used as an alternative in the prevention and control of nosocomial infections.

Salt water solution is widely used for various activities as preservative substance (antimicrobial). Chlor (Cl) element as the active ingredient in salt has the characteristic of microbial killing. According to Giyanti (2004)<sup>12</sup>, the use of chlor in drinking water treatment, or called chlorination, is aimed to reduce and kill microorganisms. Chlor that available in markets is in the form of Chlorine. Electrolysis reaction is a process of the release of Cl element in salt that is functioned to damage the bond of NaCl becoming metallic sodium (Na) and chlor gas (Cl<sub>2</sub>).

Based on the laboratory tests, salt water solution with a concentration of 100g/liter can reduce the number of air germs from 70 CFU/m<sup>3</sup> to 56 CFU/m<sup>3</sup> (80% reduction). One of the advantages of Cl<sub>2</sub> gas electrolysis from salt water (NaCl) is it has low investment cost for the equipments and the materials are very cheap. The price of salt is very cheap and readily available and can always be found in every household.

## OBJECTIVE

To understand the results of theoretical study of the function of salt water, as the basis for laboratory testing, to determine its concentration variation in producing chlor gas (Cl<sub>2</sub>) as disinfectant for reducing the number of air germs in the treatment rooms of hospitals.

## METHOD

The methods used in this paper are literature review and fieldwork, by means of analyzing

the factors that affect the control and prevention of nosocomial infections. The factors comprise of: analysis of environmental factors, analysis of disinfection method for treatment room and force field analysis on the use of salt water as disinfectant in the disinfection of care-rooms in hospitals.

## ANALYSIS AND DISCUSSION

### 1. Factors affecting the control and prevention of nosocomial infections

The control and prevention of nosocomial infections is influenced by several factors, either from the sufferer patients themselves or from outside. Factors that were proved influencing the incidence of nosocomial infections are: the presence of microorganisms as disease agents (virus, bacteria and fungi); and resistance to drugs and equipments, including rooms which are contaminated with disease agents (Herpan, 2012)<sup>13</sup>. The propagation media of microorganisms in the treatment rooms, among others are via air, water, food, medical devices and humans who are related with the patients. In the transmission process of nosocomial infections, air is one of transmission media that has the greatest effect (Minister of Health, 2002)<sup>14</sup>.

According to Sutrisno (2002)<sup>15</sup>, the controlling technique of bacteria number in air can be conducted in various ways, e.g. air filtration system; self closing door; ultraviolet radiation; and disinfectant spraying.

#### c. Air filtration system

The air filtration is conducted by flowing air into the rooms through air filtration system. The infrastructures used may include central air conditioning, split air conditioning or buildings that are specially prepared for the air filtration. This system can work well if regular maintenance of the equipments used is applied. Air filter tools which are not maintained, by themselves play role as the breeding source of microorganisms.

#### d. Self Closing Door

In this system, mats which are soaked in advance into disinfectant solution are provided and placed in front of the door inside the room. Microorganisms that will be disinfected are only those that contact with the mat, whereas other microorganisms existing in the surrounding air still can enter the rooms.

#### e. Ultra Violet (UV) Radiation

Ultra violet irradiation system uses a moveable instrument that its angle can be adjusted. The ultra violet lamp is mounted on wall or ceiling of the room. The weakness of this system is even though the microorganisms that are exposed to ultraviolet light will die, those that are not affected will remain alive. Ultra violet disinfection is costly regarding to the procurement of the specific lamps.

#### f. Disinfectant Spraying

Disinfectant spraying system uses devices, such as sprayer, mister or fogger, to produce air spray which is mixed with disinfectant solution in low pressure and in the form of large enough sized droplet. The use of chemical disinfectants which are not appropriate in the dose and timing of exposure can causing environment pollution due to the presence of the chemicals' residue and resistance to the target microorganisms may occur.

2. Analysis of Factors Influencing Nosocomial Infection Prevention

c. Salt Water as Disinfectant for Treatment Rooms in Hospitals

Electrolysis of salt water is a destruction reaction of NaCl (table salt) bonds in water. Salt water consists of table salt (NaCl) which are dissolved into water with certain concentration. The bond of NaCl in electrolysis will be broken into sodium ( $2\text{Na}^+$ ) in solid form and  $\text{Cl}_2$  in gas form. Electrolysis is an electrochemical cell which causes redox (reduction and oxidation) reaction. Reduction and oxidation reactions occur in Sodium (Na) element, meanwhile oxidation reaction occurs in Chlorine element ([http://www.ut.ac.id/html/suplemen/peki4310/sel\\_elektrolisis.htm](http://www.ut.ac.id/html/suplemen/peki4310/sel_elektrolisis.htm))<sup>16</sup>.

The  $\text{Cl}_2$  gas obtained from the electrolysis of salt water is released into the air, and therefore kill the existing microorganisms. The results of tests conducted at the laboratory of Polytechnic of Health of Yogyakarta at June 25 th, 2013 showed that table salt concentration of 100g/liter in 10 minutes exposure is able to reduce 80 % of bacteria number. In the market, chlorine is known under the trade name of Chlorine, and commonly used as disinfectant in drinking water treatment.

$\text{Cl}_2$  gas from the electrolysis of salt water can be used for controlling and prevention of nosocomial infections in hospitals. This disinfection of treatment rooms in hospitals by using the  $\text{Cl}_2$  gas can reduce the air germs number in those rooms. Therefore, theoretically, that reduction of bacteria number can prevent nosocomial infection among in-patients in hospitals. Electrolysis of table salt (NaCl) water can be applied at the treatment rooms in public hospitals as the efforts to control and prevent the occurrence of nosocomial infections.

d. Analysis of Nosocomial Infection Causing Factors

Analysis of factors for the occurrence of nosocomial infections is needed to determine the factors associated with the control and prevention efforts of nosocomial infections. The analysis is described in detail in Table 1, as follows.

**Table 1.**  
**Analysis of Nosocomial Infection Causing Factors**

No	Items	Factors			
		Taking Medication	Human	Equipment	Environment
1	Risk of Transmission	Small	Big	Small	Big
2	Target	Patients	Doctors, Paramedics, Patients and Visitors	Paramedics	Sanitation Officers
3	Characteristic	Curative	Preventive and Promotive	Preventive	Preventive and Promotive
4	Transmission	Small	Big	Big	Big
5	Cost	Expensive	Expensive	Cheap	Cheap
6	Easiness	Difficult	Difficult	Easy	Easy
7	Technology	Not available	Not available	Available	Available
8	Special Officer	Needed	Needed	Needed	Not Needed

9	Sustainability	Not Exist	Exist	Exist	Exist
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Based on the analysis of the factors influencing the occurrence of nosocomial infection among in-patients, human and environment are considered as the factors that contribute great influence on the incidence of this infection. Since human factors are very difficult to control, in this paper the control of environmental factors is more emphasized in the prevention of nosocomial infections.

e. Analysis of Environmental Factors as the Cause of Nosocomial Infection

Environmental factors consist of water, soil and air. The incidence of nosocomial infections among in-patients in hospitals is via air due to pathogenic microorganisms present in the air. Analysis of environmental factors was conducted to determine the dominant factors which are affecting, and to find the ways of controlling and preventing nosocomial infection as appropriate measure (Tinambunan, 2008)<sup>17</sup>.

Based on Table 2, environmental factors that influence the occurrence of nosocomial infections is the surrounding air. The air contain causal microorganisms of nosocomial infection which are originated from human, including the patients who do activities in the hospitals. Water and soil factors have small contribution to nosocomial infection cases. The provision of water in hospitals has passed adequate treatment and is tailored to existing standards. Soil factors also have small contribution in these infections since patients are not in direct contact with it. The incidence of nosocomial infections has very small possibility to occur via soil transmission.

**Table 2. Analysis of Environmental Factors Causing Nosocomial Infections**

Items	Environment		
	Water	Soil	Air
Risk of transmission	Small	Small	Big
Transmission source	Yes	No	Yes
Technology	Available	Not Available	Available
Effort	Preventive	Not Applicable	Preventive
Public Participation	Not Exist	Not Exist	Exist
Failure	Not Exist	Not Exist	Exist
Cost	Not Applicable	Not Applicable	Present

f. Analysis of Room Disinfection Methods

Based on the analysis, the method of room disinfection by using Cl<sub>2</sub> gas is considered as the best method or superior when compared with the existing methods. Room disinfection method with using Cl<sub>2</sub> gas can be manufactured with appropriate technology, has low cost and can be made by general people.

**Table 3. Analysis of Room Disinfection Methods**

Items	Factors		
	Sunlight/Ultra Violet	Chemical substance	Cl <sub>2</sub> Gas
Technology	Available	Available	Available
Cost	Expensive	Expensive	Cheap
Pollution Impact	Possible in form of waste of UV lamp	Possible in form of chemical residues and microorganism resistance	Not Present
Government involvement	Exist	Exist	Not Exist
Special Officer	Needed	Needed	Not Needed
Operational of Tools	By Special Officer	By Special Officer	By Any Officer
Operational Guidance of Tools	Exist	Exist	Exist

g. Force Field Analysis of Cl<sub>2</sub> Gas as Disinfectant of Care-Rooms in Hospitals

Force Field Analysis (FFA) is an analysis about the factors existed in real condition that strengthen the use of a certain method of being more excellent.

**Table 4. Force Analysis Factor of Cl<sub>2</sub> Gas Utilization Obtained from Salt Water Electrolysis as Disinfectant for Care-Rooms in Hospitals**

No	UV and chemicals	Value	Salt Water Electrolysis	Value
1.	Cost	-	Cost	+
2.	Appropriate technology	-	Appropriate technology	+
3.	Design	+	Design	+
4.	Ease of manufacture	-	Ease of manufacture	+
5.	Ease of use	+	Ease of use	+
6.	Availability of materials in manufacturing	-	Availability of materials in manufacturing	+
7.	Need no expert in the manufacturing	-	Need no expert in the manufacturing	+
8.	Ease of maintenance	-	Ease of maintenance	+
9.	Benefit	+	Benefit	+
10.	Possibility of environmental pollution	-	Possibility of environmental pollution	+
11.	Management Acceptance	+	Management Acceptance	+
12.	Occupational Accident	-	Occupational Accident	+
13.	Length of Application Time	-	Length of Application Time	+
14.	Procurement of Equipment and Materials	-	Procurement of Equipment and Materials	+
Sum+		4	Sum+	14

Based on the results of Force Field Analysis, electrolysis method for salt water is an appropriate technology that can be applied to disinfect treatment rooms in hospitals, therefore the control and prevention of nosocomial infections can be conducted. The operation and maintenance of the device (electrolizer) is very easy to do, and the ingredient (table salt) is also

easy to obtain and cheap. The electrolyzer is also easy to manufacture and its procedure of handling is very simple.

## CONCLUSIONS AND RECOMMENDATIONS

### 1. Conclusions

- a. Theoretically, salt water produces chlor gas ( $\text{Cl}_2$ ) which can be used as a disinfectant for treatment room disinfection in hospitals.
- b. Salt water electrolysis method is more superior to other chemicals such as Virkon and Mikrosit as disinfectant for treatment room disinfection in hospitals.

### 2. Recommendations

It is needed to conduct laboratory examinations for concentration variations of salt water in producing chlor gas ( $\text{Cl}_2$ ) as disinfectant for care-room disinfection in hospitals.

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