

EVALUATION OF NEBULIZED AERIAL DISINFECTANTS IN OPERATING ROOMS

Thesis

Submitted for Partial Fulfillment of M.Sc. Degree in
Clinical and Chemical Pathology

By

Maha Ahmad Anwar Hafez

M.B., B.Ch.

Faculty of Medicine, Ain Shams University

Supervised by

Professor/ Ghada Abd El-Wahed Ismail

*Professor of Clinical and Chemical Pathology,
Faculty of Medicine, Ain Shams University*

Doctor/ Sherin Ahmed Samy El Masry

*Lecturer of Clinical and Chemical Pathology,
Faculty of Medicine, Ain Shams University*

Doctor/ Samar Saad Rashad

*Lecturer of Clinical and Chemical Pathology,
Faculty of Medicine, Ain Shams University*

Faculty of Medicine,

Ain-Shams University

2011

تقييم إستخدام رذاذ مطهرات الهواء فى غرف العمليات

رسالة

توطئة للحصول علي درجة الماجستير فى
الباثولوجيا الاكلينيكية والكيميائية

مقدمة من

الطبيبة/ مها أحمد أنور حافظ

بكالوريوس الطب والجراحة العامة - كلية الطب - جامعة عين شمس

تحت إشراف

الأستاذ الدكتور/ غادة عبد الواحد إسماعيل

أستاذ الباثولوجيا الإكلينيكية والكيميائية

كلية الطب - جامعة عين شمس

الدكتور/ شيرين أحمد سامى المصرى

مدرس الباثولوجيا الإكلينيكية والكيميائية

كلية الطب - جامعة عين شمس

الدكتور/ سمر سعد رشاد

مدرس الباثولوجيا الاكلينيكية والكيميائية

كلية الطب - جامعة عين شمس

كلية الطب

جامعة عين شمس

٢٠١١

Contents

	Page
List of abbreviations	i
List of tables.....	
List of figures	
Introduction	1
Aim of the work	5
Review of literature	6
Chapter 1: Air Quality In Operating Rooms	6
Chapter 2: Evaluation Of Air Quality In Operating Rooms	 19
Chapter 3: CDC Guidelines For Disinfection In Operating Rooms	38
Chapter 4: Different Types Of Disinfectants Commonly Used In Hospitals	43
Materials and Methods	61
Results	69

Contents *(Cont..)*

	Page
Discussion	95
Summary	105
Conclusion	107
Recommendations	108
References	109
Appendices	126
Arabic summary	

List of Tables

<i>Table No.</i>	<i>Title</i>	<i>Page</i>
1	Selected microbiological cleanliness requirements for hospital rooms.....	17
2	ASPEC's guidelines for microbiological cleanliness (in CFU/plate) in operating theatres	18
3	Air sampling methods and examples of equipment	23
4	Levels of disinfection by type of micro-organism	41
5	Summary of decontamination agents.....	48
6	Antimicrobial activity of Hydrogen peroxide towards bacteria, yeast and viruses	50
7	Sporicidal activity of hydrogen peroxide towards spore forming bacteria and bacterial spores.....	51

List of Tables *(Cont..)*

<i>Table No.</i>	<i>Title</i>	<i>Page</i>
8	The difference between the mean levels of organisms isolated after routine terminal cleaning and disinfection and spraying of Bafry in the studied groups	79
9	The difference between the mean levels of organisms isolated after routine terminal cleaning and disinfection and spraying of Hawa-San in the studied groups....	81
10	The difference between the mean levels of organisms isolated after Nebulization of Bafry and spraying of Bafry in the studied groups	83
11	The difference between the mean levels of organisms isolated after Nebulization of Bafry and spraying of Bafry in the studied groups	85
12	The difference between the mean levels of organisms isolated from air and surfaces after Nebulization of Bafry in the studied groups.....	87

List of Tables *(Cont..)*

<i>Table No.</i>	<i>Title</i>	<i>Page</i>
13	The difference between the mean levels of organisms isolated from air and surfaces after spraying of Bafry in the studied groups.....	90
14	The difference between the mean levels of organisms isolated from air and surfaces after spraying of Hawa-San in the studied groups.....	93

List Of Figures

<i>Figure No.</i>	<i>Title</i>	<i>Page</i>
1	Source and routes of infection in the operating room	9
2	Side view of the air flow in the vertical lamina air flow	11
3	Top view of the air flow in the horizontal laminar air flow	11
4	Side view of the air flow in exponential laminar air flow ventilation	12
5	Air samplers acting by impaction	25
6	Air samplers acting by Centrifugal Acceleration	25
7	Air sampler acting by electrostatic precipitation	26
8	Automatic fogging disinfection unit	46
9	Neburotor Europa.....	65
10	Automist Sprayer	66

List Of Figures *(Cont..)*

<i>Figure No.</i>	<i>Title</i>	<i>Page</i>
11	Comparison between the mean concentrations of airborne organisms (CFU/m ³) isolated after routine terminal cleaning and disinfection, nebulization of Bafry, spraying of Bafry and spraying of Huwa-San among group 1, 2 and 3	72
12	Comparison between the mean concentration of organisms isolated from surfaces (CFU/plate) isolated after routine terminal cleaning and disinfection, nebulization of Bafry, spraying of Bafry and spraying of Huwa-San among group 1, 2 and 3.....	75
13	Comparison between the mean concentration of organisms isolated from the air and surfaces after nebulization of Bafry among group 1, 2 and 3	88

List Of Figures *(Cont..)*

<i>Figure No.</i>	<i>Title</i>	<i>Page</i>
14	Comparison between the mean concentrations of organisms isolated from the air and surfaces after spraying of Bafry among group 1, 2 and 3	91
15	Comparison between the mean concentrations of organisms isolated from the air and surfaces after spraying of Huwa-San among group 1, 2 and 3	94

INTRODUCTION

Operating rooms are a high risk area for both patients and medical staff; air-quality management is important so that such environments are ensured to be free of airborne infectious agents. Airborne bacteria have a considerable impact on infection during surgery. When the levels of airborne bacteria are reduced in operating rooms (OR), contamination of wounds is substantially reduced. The most frequently isolated microorganisms were methicillin resistant staphylococcus aureus (MRSA) and Acinetobacter baumannii, suggesting that airborne viable particles in operating theatres can be a significant risk factor for the development of nosocomial infections. In order to reduce bio-aerosol loads in indoor environments, certain control measures can be followed (*Padma et al., 2008*).

Environmental infection control and ventilation measures for OR include maintenance of positive-pressure ventilation with respect to corridors and adjacent areas, maintenance of ≥ 15 air change per hour (ACH), of which ≥ 3 ACH should be fresh air, filtration of all recirculated and fresh air through the appropriate filters, providing 90% efficiency (dust-spot testing) at a minimum, in rooms not engineered for horizontal laminar airflow, introduction of air at the ceiling

and exhaust air near the floor, not to use ultraviolet (UV) lights to prevent surgical-site infections and keeping operating room doors closed except for the passage of equipment, personnel, and patients and limitation of entry to essential personnel (*Sehulster and Raymond, 2003*).

There is an increasing body of evidence that cleaning or disinfection of the environment can reduce transmission of healthcare-associated pathogens. Because routine cleaning of equipment items and other high-touch surfaces does not always remove pathogens from contaminated surfaces, improved methods of disinfecting the hospital environment are needed (*Boyce, 2007*).

Unlike earlier fogging techniques that aerosolized relatively large particles of disinfectant, vapor decontamination methods deliver disinfectants in the form of a vapor (or gas) that is completely dispersed throughout the enclosed space. Formaldehyde and chlorine dioxide vapors are effective in eradicating microorganisms, but their use is associated with potentially toxic end products that require special disposal techniques. In contrast, vapor-phase hydrogen peroxide (i.e., hydrogen peroxide vapor) is catalytically converted to water and oxygen, leaving no harmful by-products (*Boyce, 2009*).

Gaseous chlorine dioxide is not mutagenic or carcinogenic in humans. They have a broad spectrum of antimicrobial activity, do not leave toxic residues, are unaffected by water hardness, are inexpensive and fast acting. The exact mechanism by which free chlorine destroys microorganisms has not been elucidated. Inactivation by chlorine can result from a number of factors: oxidation of sulfhydryl enzymes and amino acids; ring chlorination of amino acids; loss of intracellular contents; decreased uptake of nutrients; inhibition of protein synthesis; decreased oxygen uptake; oxidation of respiratory components; decreased adenosine triphosphate production; breaks in DNA and depressed DNA synthesis (*Rutala and Weber, 2008*).

Hydrogen peroxide vapor (HPV) is a sporicidal and mycobactericidal vapor-phase method for the decontamination of surfaces and medical equipment. HPV has been shown to inactivate several nosocomial pathogens in situ, but no in vitro efficacy data are available for common nosocomial pathogens (*Otter and French, 2009*). Hydrogen peroxide acts as an oxidant whose hydroxyl free radicals kill a wide range of microorganisms by attacking essential cell components, which include lipids, proteins, and DNA. This compound does have sporicidal activity at high concentrations and prolonged contact times and is widely used as a biocide. The value of stabilized hydrogen peroxide as an environmentally friendly cleaning agent

has been reported, although it can be corrosive to aluminum, copper, brass, or zinc (*Alfa and Jackson, 2001*).

Glutaraldehyde is a saturated dialdehyde that has gained wide acceptance as a high-level disinfectant and chemical sterilant. The biocidal activity of glutaraldehyde results from its alkylation of sulfhydryl, hydroxyl, carboxyl, and amino groups of microorganisms, which alters RNA, DNA, and protein synthesis. Vaporized Peracetic acid will inactivate gram-positive and gram-negative bacteria, fungi, and yeasts in <5min at <100ppm. Only limited information is available regarding the mechanism of action of peracetic acid, but it is thought to function as other oxidizing agents, i.e., it denatures proteins, disrupts cell wall permeability, and oxidizes sulfhydryl and sulfur bonds in proteins, enzymes, and other metabolites (*Rutala and Weber, 2008*).

AIM OF THE WORK

The aim of this work is to evaluate the most commercially used nebulized disinfectants available in the Egyptian market for their efficiency in OR environmental disinfection.