MICROBIAL ASSESSMENT OF DENTAL UNIT WATERLINE SYSTEM (DUWS)

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ABSTRACT

Introduction: Dental Unit Waterline System (DUWS) is an interconnected water network found inside a dental chair unit (DCU) that allows water to pass through and deliver to the patient's mouth during treatment. Many previous studies demonstrated the DUWS water was often heavily contaminated and might pose a risk of infection to the patients as well as dental personnel. ***Objective:*** To determine the sanitary level of output water from DCUs and assess the effectiveness of silver-coated tubing used in DCU in reducing microbial counts in DUWS water. ***Methods*:** Water from sources which include the air-water syringe, low speed handpiece, high speed handpiece and distilled water (control) were sampled from 13 DCUs. The temperature and pH of each sample were measured and the microbial counts of the total aerobic bacteria, total coliform, faecal coliform, *Escherichia coli*, faecal streptococci and *Pseudomonas aeruginosa* were determined using conventional microbiological procedures. Based on PCR products, the 16S rDNA gene sequence of bacteria isolated from the water samples were determined and used for identification. An *in vitro* model simulating the tubing of a DCU was setup in the laboratory using silver-coated and conventional polyurethane tubes. A microbial suspension comprising of similar bacteria earlier identified in the DUWS outgoing water was passed through the tubing in cycles of stagnation and flushing to mimic the routine operation of a DUWS. The effectiveness of the tubing in preventing biofilm formation was compared and assessed by the counts of adhering bacteria and observed under scanning electron microscope. ***Results:*** The average pH of the outgoing water was slightly acidic at pH 5.4-5.5 at an average temperature of 23°C. The outgoing water was

found free of pathogenic contaminant but highly loaded with four types of bacteria identified as *Sphingomonas rhizogenes* (17.9%), *Sphingomonas dokdonesis* (79.5%), *Sphingomonas mucosissima* (1.1%) and *Methylobacterium radiotolerans* (1.5%). The interior surface of both polyurethane and silver-coated tubes showed extensive biofilm formation and the outgoing water was heavy with bacterial counts. No significant difference in biofilm formation and bacterial contamination in the outgoing water were found in both types of tubing ($P>0.05$). ***Conclusion:*** The microbial load in the outgoing water from DUWS in the clinic under study was high and failed to meet the recommendation by American Dental Association. Silver-coated tubing was not effective in preventing biofilm formation nor reducing microbial load in DUWS water when compared with polyurethane tubings.

ABSTRAK

Pengenalan: Sistem Peraliran Unit Pergigian (SPUP) merupakan sistem saluran air yang didapati dalam unit kerusi pergigian (UKP) yang menyalurkan air melaluinya dan ke mulut pesakit semasa rawatan. Akan tetapi banyak penyelidikan yang telah dijalankan mendapati bahawa air dari SPUP adalah dicemarkan dan mungkin dapat menyebabkan jangkitan kepada pesakit dan staf pergigian. ***Objektif:*** Untuk menentukan paras kebersihan air dari UKP dan menyiasat kecekapan paip air yang telah dilapisi oleh logam perak bagi mengurangkan kontaminasi mikroorganisma dalam SPUP. ***Kaedah:*** Sumber air termasuk air dari tiga penyembur air, hanpis berkelajuan rendah, hanpis berkelajuan tinggi, dan air suling telah dikutip dari 13 unit kerusi pergigian. Suhu dan pH sampel air telah diukur and bilangan mikroorganisma bagi bakteria aerobik, kolifom, fekal kolifom, *Escherichia coli*, fekal streptokoki, dan *Pseudomonas aeruginosa* telah ditentukan dengan kaedah pengkulturan. Species bakteria yang mengkontaminasi sumber air SPUP telah dikenalpasti berdasarkan kepada turutan gen 16S rDNA. Selain itu, satu model *in vitro* yang menyerupai paip air unit kerusi pergigian telah disediakan dalam makmal dengan menggunakan paip air yang dilapisi dengan logam perak dan paip poliuretana seperti yang biasa didapati di unit kerusi pergigian. Species mikroorganisma yang didapati mengkontaminasi SPUP telah ditambah kepada sumber air disalurkan melalui model system paip tersebut bagi menyamai keadaan sebenar di klinik. Keupayaan paip air dalam mencegah pembentukkan biofilm turut dianalisa dan bakteria yang melekat pada permukaan paip diamati dengan menggunakan mikroskop elekton. ***Keputusan:*** pH purata sampel air adalah sedikit berasid, iaitu lebih kurang pH 5.4-5.5 dan suhu purata

ialah 23 °C. Air keluaran dari unit kerusi pergigian didapati bebas dari mikrorganisma penjangkit penyakit tetapi telah dicemari dengan empat species bakteria, iaitu *Sphingomonas rhizogenes* (17.9%), *Sphingomonas dokdonesis* (79.5%), *Sphingomonas mucosissima* (1.1%) dan *Methylobacterium radiotolerans* (1.5%). Kedua-dua jenis paip air menunjukkan pembentukkan biofilm yang banyak dan hasilan air keluaran juga didapati sangat tercemar. Tiada perbezaan yang nyata dari segi pembentukkan biofilm dan pencemaran bakteria dalam air keluaran di antara kedua-dua jenis paip air ($P > 0.05$). ***Kesimpulan:*** Bilangan bakteria dalam air keluaran dari unit kerusi pergigian in klinik adalah sangat tinggi dan gagal mencapai cadangan oleh Persatuan Pergigian Amerika. Oleh itu, paip air yang telah dilapisi oleh logamperak tidak berkesan untuk mencegah pembentukkan biofilm bagi mengurangkan kontaminasi bakteria dalam air keluaran apabila dibandingkan dengan poliuretana paip.

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CONTENTS **Page**

ABSTRACT ii

ACKNOWLEDGEMENT vi

CONTENTS viii

LIST OF FIGURES xii

LIST OF TABLES xiv

LIST OF SYMBOLS AND ABBREVIATIONS xvi

CHAPTER ONE: INTRODUCTION AND OBJECTIVES 1

1.1 INTRODUCTION 2

1.2 OBJECTIVES 4

CHAPTER TWO: LITERATURE REVIEW 5

2.1 DENTAL UNIT WATERLINE SYSTEM AND BIOFILM FORMATION 6

2.1.1 Dental Unit Waterline System (DUWS) 6

2.1.2 Biofilm Formation 6

2.2 MICROBIAL CONTAMINATION AND HEALTH RISKS 8

2.2.1 Exposure to Endotoxin 10

2.2.2 Exposure to *Pseudomonas aeruginosa* 11

2.2.3 Exposure to Legionellae 12

2.2.4 Exposure to Non-tuberculous Mycobacteria (NTM) 14

2.3 TREATMENTS FOR MICROBIAL CONTAMINATION 15

2.3.1 Anti-retraction Valves and Retrograde Aspiration of Oral Fluids 15

2.3.2 Flushing 16

2.3.3 Filtration 16

2.3.4 Independent Clean Water System 17

2.3.5 Chemical Treatment 18

2.3.5.1 Side Effects and Limitations 18

2.3.5.2 Common Chemical Treatments 20

2.3.6 DUWS Cleaning and Disinfection System 25

2.3.7 Modification of tubing 27

2.4 GUIDELINES AND RECOMMENDATIONS ON DUWS 27

2.5 METHODS OF DETECT CONTAMINATION 28

CHAPTER THREE: MATERIALS AND METHODS 31

3.1 RESEARCH DESIGN 32

3.2 MEDIA, DILUENT, AND APPARATUS 34

3.3 SAMPLES COLLECTION 34

3.3.1 Dental Chair Unit (DCU) 34

3.3.2 Collection of Water Samples 36

3.4 LABORATORY PROCESSING OF WATER SAMPLES 38

3.4.1 pH and Temperature Measurement 38

3.4.2 Heterotrophic Plate Count 38

3.4.3 Total Coliforms Plate Count 39

3.4.4 Faecal Coliforms Plate Count 41

3.4.5 *Escherichia coli* Plate Count 41

3.4.6 Faecal Streptococci Plate Count 42

3.4.7 *Pseudomonas aeruginosa* Plate Count 42

3.4.8 Statistical Analysis 43

3.4.9 Control Cultures for Laboratory Processing 43

3.5 IDENTIFICATION OF BACTERIAL ISOLATES 44

3.5.1 Gram Staining 45

3.5.2 Observation under Scanning Electron Microscope 45

3.5.3 Identification of Bacterial Genomic DNA 46

3.5.3.1 Genomic DNA Purification of Gram-Negative Bacteria 46

3.5.3.2 Polymerase Chain Reaction (PCR) 47

3.5.3.3 PCR Product Purification 48

3.5.3.4 Agarose Gel Electrophoresis 48

3.5.3.5 DNA Concentration, Yield and Purity Determination 49

3.5.3.6 Sequencing of the 16S rDNA Gene and Bacterial Identification 50

3.6 THE ANTIBIOFILM PROPERTIES OF SILVER-COATED TUBING 50

3.6.1 *In Vitro* Dental Unit Waterline System (DUWS) Biofilm Model 50

3.6.2 Assessment of Antibiofilm Properties of Tubing 52

3.6.2.1 Determination of Number of Adhering Bacteria 53

3.6.2.2 Determination of Number of Planktonic Bacteria 53

3.6.2.3 Observation under Scanning Electron Microscope (SEM) 53

3.6.3 Statistical Analysis 54

CHAPTER FOUR: RESULTS 55

4.1 LABORATORY PROCESSING OF WATER SAMPLES 56

4.1.1 pH and Temperature Measurement 56

4.1.2 Heterotrophic Plate Count 57

4.1.3 Microbiological Tests (Total Coliforms Count, Faecal Coliforms Count, *Escherichia coli* Count, Faecal Streptococci Count and *Pseudomonas aeruginosa* Count) 62

4.2 IDENTIFICATION OF BACTERIAL ISOLATES 68

4.2.1 Colony, Cells and Ultrastructural Characteristics 68

4.2.2 Gel Electrophoresis Visualisation 73

4.2.3 Nucleotide Sequence Comparison with GenBank Database and Microbial Abundance Percentage 74

4.3 THE ANTIBIOFILM PROPERTIES OF SILVER-COATED TUBING 75

4.3.1 Determination of the Number of Adhering Bacteria 75

4.3.2 Determination of the Number of Planktonic Bacteria 79

4.3.3 Gradual Changes in the Number of Bacteria over Period of Trial 81

CHAPTER FIVE: DISCUSSION 83

5.1 LABORATORY PROCESSING OF WATER SAMPLES 84

5.2 IDENTIFICATION OF BACTERIAL ISOLATES 91

5.3 THE ANTIBIOFILM PROPERTIES OF SILVER-COATED TUBING 93

CHAPTER SIX: CONCLUSION 96

6.1 CONCLUSION 97

6.2 FUTURE RECOMMENDATIONS 97

CHAPTER SEVEN: REFERENCES 98

APPENDIX 111

Appendix 1: List of Equipments 112

Appendix 2: Preparation of Media, Diluent and Appratus 113

Appendix 3: Quantitation of Bacterial Cells 121

Appendix 4: Dental Unit Water Lines, Biofilm and Water Quality 122

LIST OF FIGURES **Page**

Figure 3.1	Flow chart of the design of the study	33
Figure 3.2	An overview of a dental chair unit in a dental teaching clinic	34
Figure 3.3	The filter unit used to filter municipal water source prior to distillation	35
Figure 3.4	The water distilled placed in the clinic	35
Figure 3.5	Distilled water collected from the distiller and was stored in 20 L plastic container	36
Figure 3.6	The tip points of each handpieces were wiped with alcohol prior to sampling	37
Figure 3.7	Water inlet to dental chair	38
Figure 3.8	A filtration apparatus consisting of glass funnel, filter base and vacuum beaker was assembled correctly and connected to an electronic vacuum pump	40
Figure 3.9	A piece of sterile gridded cellulose nitrate membrane filter with 0.45 µm pore size and 47 mm diameter was aseptically placed on to the filter base	40
Figure 3.10:	*In vitro* model for DUWS biofilm formation	51
Figure 3.11:	Schematic diagram of *in vitro* model for DUWS biofilm formation	52
Figure 4.1	A bar chart showing that the pH of water collected from four different water sources	56
Figure 4.2	A bar chart showing that the temperature of water collected from	57

four different water sources

Figure 4.3 The mean of microbial load from different water sources 58

Figure 4.4 Images of heterotrophic plate counts 61

Figure 4.5 Images of total coliforms counts 63

Figure 4.6 Images of faecal coliforms counts 64

Figure 4.7 Images of *Escherichia coli* counts 65

Figure 4.8 Images of faecal streptococci counts 66

Figure 4.9 Images of *Pseudomonas aeruginosa* counts 67

Figure 4.10 Images of isolate A 69

Figure 4.11 Images of isolate B 70

Figure 4.12 Images of isolate C 71

Figure 4.13: Images of isolate D 72

Figure 4.14: Image of gel electrophoresis 73

Figure 4.15: The number of adhering bacteria (cfu/cm^2) to the inner surface of silver-coated tubing compared to the conventional polyurethane tubing. 75

Figure 4.16: Electron micrograph showing the gradual increase in the bacterial colonisation population to the inner surface of polyurethane tubing 77

Figure 4.17: Electron micrograph showing the gradual increase in the bacterial colonisation population to the inner surface of silver-coated tubing 78

Figure 4.18: The number of bacteria found in water samples collected from silver-coated tubing compared to that of the conventional polyurethane tubing 79

LIST OF TABLES **Page**

Table 2.1	Types of organisms isolated from dental unit waterline system	9
Table 2.2:	List of proposed disinfectant and their respective efficiency	20
Table 3.1	Cultures used as positive and negative controls in the laboratory processing	44
Table 4.1	Comparison of heterotrophic plate count from different water sources to the standard recommended by ADA	59
Table 4.2	Comparison of heterotrophic plate count between output water from the air-water syringe, low and high speed handpieces to that of distilled water source	60
Table 4.3	Microbiological tests of distilled water, air-water syringe, low speed handpiece and high speed handpiece	62
Table 4.4	Colony characteristics of isolates recovered from water samples	68
Table 4.5:	Identity of common bacteria isolated from water samples as determined by comparing their 16S rDNA gene sequences with that of GenBank database	74
Table 4.6:	The number of adhering bacteria (cfu/cm) to the inner surface of silver-coated tubing compared to the conventional polyurethane tubing.	76
Table 4.7:	The number of planktonic bacteria found in water samples collected from silver-coated tubing compared to that of the conventional polyurethane tubing	80
Table 4.8:	The number of adhering bacteria and planktonic bacteria from	81

polyurethane tubing was compared over the period of trial

Table 4.9: The number of adhering bacteria and planktonic bacteria from silver-coated tubing was compared over the period of trial. 82

LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviation	Description
et al.	And others
bp	Base pairs
cm	Centimeter
cfu/mL	Colony forming units per mililitre
cfu/cm^2	Colony forming units per centrimetre square
°C	Degree celsius
DNA	Deoxyribonucleic acid
EU/mL	Endotoxin units per mililitre
g	Gravity
g	Gram
g/ml	Gram per millilitre
g/L	Gram per litre
hr	Hours
kPa	kilo Pascal
L	Litre
mL	Millilitre
mL/min	Mililitre per minute
µg/mL	Microgram per mililitre
µL	Microlitre
µm	Micromolar
µmole/ml	Micromoles per milliliter
mg	Miligram

mg/mL	Miligram per mililitre
mm	Milimetre
mM	Milimolar
min	Minute
M	Molar
MW	Molecular weight
nm	Nanometer
P	Probrability
pp.	Pages
rDNA	Ribosomal Deoxynucleic Acid
rRNA	Ribosomal Ribonucleic Acid
%	Percent
sec	Seconds
spp.	Species
i.e.	That is
U/ml	Unit per milliliter
V	Voltage
w/v	Weights per volume