# ประสิทธิภาพการล้างมือ ความรู้ ทัศนคติและพฤติกรรมที่เกี่ยวข้องในนิสิตทันตแพทย์ระดับปริญญาบัณฑิตและหลังปริญญา

นางสาวนันท์มนัส แย้มบุตร



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาศัลยศาสตร์ช่องปากและแม็กซิลโลเฟเชียล ภาควิชาศัลยศาสตร์
คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
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# EFFICIENCY OF HAND HYGIENE, RELATED KNOWLEDGE, ATTITUDE, AND BEHAVIOR AMONG UNDERGRADUATE AND POSTGRADUATE DENTAL STUDENTS

Miss Nanmanas Yaembut



A Thesis Submitted in Partial Fulfillment of the Requirements
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| By | Miss Nanmanas Yaembut |
| Field of Study | Oral and Maxillofacial Surgery |
| Thesis Advisor | Assistant Professor Keskanya Subbalekka, Ph.D. |
| Thesis Co-Advisor | Associate Professor Ruchanee Ampornaramveth, Ph.D. |

Accepted by the Faculty of Dentistry, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

.....Dean of the Faculty of Dentistry

(Assistant Professor Suchit Poolthong, Ph.D.)

THESIS COMMITTEE

.....Chairman

(Pagaporn Pantuwadee Pisarnturakit, Ph.D.)

.....Thesis Advisor

(Assistant Professor Keskanya Subbalekka, Ph.D.)

.....Thesis Co-Advisor

(Associate Professor Ruchanee Ampornaramveth, Ph.D.)

.....External Examiner

(Associate Professor Nirada Thanesuan, Ph.D.)

นันท์มนัส แย้มบุตร : ประสิทธิภาพการล้างมือ ความรู้ ทัศนคติและพฤติกรรมที่เกี่ยวข้องในนิสิตทันตแพทย์ระดับปริญญาบัณฑิตและหลังปริญญา. (EFFICIENCY OF HAND HYGIENE, RELATED KNOWLEDGE, ATTITUDE, AND BEHAVIOR AMONG UNDERGRADUATE AND POSTGRADUATE DENTAL STUDENTS) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ทพญ. ดร.เกศกัญญา สัพพะเลข, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: รศ. ทพญ. ดร.รัชนี อัมพรอร่ามเวทย์, 96 หน้า.

ที่มาของการศึกษา: การล้างมือช่วยลดความเสี่ยงในการแพร่กระจายเชื้อระหว่างผู้ป่วยและบุคลากรทางสาธารณสุข ในการทำงานทางศัลยกรรมช่องปาก ดังนั้นประสิทธิภาพการล้างมือก่อนทำงานศัลยกรรมจึงเป็นสิ่งที่ต้องคำนึงถึง การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาประสิทธิภาพการล้างมือสำหรับการทำงานศัลยกรรม รวมถึงความรู้ ทัศนคติ และพฤติกรรมของนิสิตทันตแพทย์ระดับปริญญาบัณฑิต และนิสิตทันตแพทย์หลังปริญญา

วิธีการศึกษา: แจกแบบสอบถามเพื่อประเมินความรู้ ทัศนคติ และพฤติกรรมการล้างมือแก่นิสิตทันตแพทย์ที่ปฏิบัติงานในคลินิกศัลยศาสตร์ทั้ง 4 กลุ่ม ได้แก่ นิสิตทันตแพทย์ระดับปริญญาบัณฑิตชั้นปีที่ 4, 5, 6 และนิสิตทันตแพทย์หลังปริญญา จากนั้นทำการเก็บตัวอย่างเชื้อแบคทีเรียบนมือของนิสิตก่อนและหลังล้างมือเพื่อทำหัตถการทางศัลยกรรม รวมทั้งหลังถอดถุงมือด้วย นำเชื้อแบคทีเรียไปเพาะเลี้ยง และนับจำนวนเชื้อแบคทีเรียที่เกิดขึ้น

ผลการศึกษา: จากผู้เข้าร่วมการศึกษาทั้งหมด 120 คน ประกอบด้วย นิสิตทันตแพทย์ระดับปริญญาบัณฑิตชั้นปีที่ 4 จำนวน 32 คน, ชั้นปีที่ 5 จำนวน 34 คน, ชั้นปีที่ 6 จำนวน 30 คน และนิสิตทันตแพทย์หลังปริญญาจำนวน 24 คน พบว่าจากกลุ่มนิสิตทันตแพทย์ทั้งหมด 4 กลุ่ม นิสิตทันตแพทย์ชั้นปีที่ 4 มีระดับคะแนนทัศนคติเกี่ยวกับการล้างมือสูงที่สุด และนิสิตทันตแพทย์หลังปริญญามีระดับคะแนนพฤติกรรมการล้างมือต่ำที่สุดอย่างมีนัยสำคัญ ภายหลังการล้างมือเพื่อทำหัตถการทางศัลยกรรม พบปริมาณเชื้อแบคทีเรียบนมือของนิสิตทันตแพทย์ระดับปริญญาบัณฑิตหลังการล้างมือน้อยกว่านิสิตทันตแพทย์หลังปริญญา นอกจากนี้พบปริมาณเชื้อแบคทีเรียเพิ่มขึ้นบนมือของนิสิตทุกคนหลังถอดถุงมือ โดยปริมาณเชื้อแบคทีเรียที่เพิ่มขึ้นหลังถิดถุงมือมีความสัมพันธ์กับระเวลาที่ทำหัตถการ

สรุปผลการศึกษา: นิสิตทันตแพทย์ระดับปริญญาบัณฑิตมีความรู้เกี่ยวกับการล้างมือไม่แตกต่างกันกับนิสิตทันตแพทย์หลังปริญญา แต่มีทัศนคติ พฤติกรรม และประสิทธิภาพการล้างมือมากกว่านิสิตทันตแพทย์หลังปริญญา

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# # 5575811932 : MAJOR ORAL AND MAXILLOFACIAL SURGERY
KEYWORDS: INFECTION CONTROL / ORAL SURGICAL CLINIC / DENTAL STUDENTS / HAND WASHING

NANMANAS YAEMBUT: EFFICIENCY OF HAND HYGIENE, RELATED KNOWLEDGE, ATTITUDE, AND BEHAVIOR AMONG UNDERGRADUATE AND POSTGRADUATE DENTAL STUDENTS. ADVISOR: ASST. PROF. KESKANYA SUBBALEKKA, Ph.D., CO-ADVISOR: ASSOC. PROF. RUCHANEE AMPORNARAMVETH, 96 pp.

Background: Hand washing is known to reduce a risk of transmission of the pathogen between patient and healthcare workers. Therefore, the effectiveness of hand washing before surgical operation should be concerned. This study aimed to investigate the effectiveness of surgical hand washing and related knowledge, attitude and behavior among undergraduate (UG) and postgraduate (PG) dental students.

Methods: The self-reported questionnaires measuring knowledge, attitude and behavior related to hand washing were handed out to four groups of 4$^{th}$, 5$^{th}$, 6$^{th}$-year UG and PG dental students attending oral surgery clinic. Sample of bacteria on participants' hands was collected by swab technique before, after surgical hand washing and after glove removal. After being cultured, the colony forming units (CFUs) were counted.

Results: One hundred and twenty dental students comprising thirty-two 4$^{th}$-year, thirty-four 5$^{th}$-year, thirty 6$^{th}$-year UG and twenty four PG dental students participated in this study. Among four groups of dental students, the 4$^{th}$- year UG dental students had the significantly highest attitude scores while PG dental students had the lowest behavior scores of hand washing. The UG dental students had significantly lower recoverable bacteria on hands after hand washing than PG dental students. Moreover, significantly bacterial regrowth were observed in all of students' hands after glove removal. The correlation between number of bacterial regrowth and duration of surgical procedure was also observed.

Conclusion: The UG dental students had positive attitude, better behavior and superior effectiveness of hand washing when compared with those of PG dental students

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| Department: | Oral and Maxillofacial Surgery | Student's Signature ..... |
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# CHAPTER I
# INTRODUCTION

## Background and Rationales

Hands are one of the most common sources of microbial transmission in patient care especially during surgical procedures. The infectious microorganisms can be transferred from either patients to patients or patients to surgical team members and vice versa. Total bacterial counts on hands of health care workers are range from 3.9x104 to 4.6 x106 CFU/$cm^2$ and may increase to as many as 4000-fold within an hour when the skin is covered with gloves(1, 2).

The organisms on surgical team members' hands may be transferred to the patient's mucous membranes or into the patient's blood stream via injection sites or open wound created during surgical procedures and eventually be the cause of surgical site infections (SSIs). SSIs is a common complication that can result in poor quality of life due to delayed wound healing, requiring longer hospitalization, re-admission to hospital or intensive care unit (ICU), increased use of antibiotic and other additional cost. Moreover, it also increased morbidity and mortality rate(3, 4). Therefore, prevention of cross infection is very important in every aspect including good knowledge and attitude related to hand hygiene, together with effective hand washing which has been proposed to be the first element of standard precaution.

Hand washing could reduce the transmission of health-care associated pathogens and the incidence of infection(5, 6). Despite availability and routine use of gloves for surgical procedure hand washing and gloving technique are still a serious concern. The surgical team members should be reminded that pathogens can gain access to surgical wound via an unnoticeable small defect in gloves. Among all surgical procedures, oral and maxillofacial surgery especially orthognathic surgery had the second highest prevalence of gloves perforations after gynecological surgery. This is undoubtedly due to the involvement of sharp instrument usage e.g. wire and

orthodontic tooth brackets(7). The most common site of glove perforation was reported to be the index finger of glove worn non-dominant hand(7-9).

Although hand washing is recognized as the key measure to prevent cross-transmission of pathogens and reduce the incidence of SSIs, the overall average health care workers' compliance is less than 40%(1). The reasons of non-compliance included timing pressure, lack of sinks and antiseptic agents, poor knowledge regarding clinical effectiveness of hand hygiene, bad attitude and negative influence of senior staffs considered the role models(10, 11). An adherence to hand washing before patient contact was highest among medical students (43.3%) and lowest among residents (0%)(12).

Multiple studies have been conducted to study the practice related to hand washing among nursing and medical students(13-15). A study in Greek nursing and medical students demonstrated that nursing students had greater hand washing practices, and considered hand hygiene was more important in their curriculum than medical students(14). Moreover, the student's hand hygiene knowledge and belief increase over time, particularly after start taking care of real patients(15). A survey of beliefs about hand washing in the first clinical year medical students revealed that only 21% of them knew the indications for hand hygiene. Moreover, most of them expected that the compliance about hand washing would be decreased in more experienced physicians(16). Disciplinary differences in hand hygiene education and assessment during undergraduate training may cause an impact on graduates' behavior upon entering the workforce(14).

Although hand washing practice are encouraged to be regularly performed in dental school, observation in the oral surgical clinic demonstrated that undergraduate dental students, especially those in their first year clinical training (4$^{th}$-year undergraduate dental students) had more compliance of hand washing that postgraduate dental students. This finding raised questions of the effectiveness of hand washing and related factors. Currently, no study has reported a hand hygiene practice among dental students. Thus, the aim of this study was to investigate the

effectiveness of hand washing and related knowledge, attitude, and behavior among undergraduate and postgraduate dental students.

**Research questions**

1. Do the effectiveness of hand washing differ between undergraduate and postgraduate dental students?

2. Do the knowledge, attitude and behavior of hand washing differ between undergraduate and postgraduate dental students?

**Objectives**

1. To observe amount of viable microorganisms on hand of undergraduate and postgraduate dental students before, after hand washing and after finish the surgical operation.

2. To determine the knowledge, attitude and behavior related to hand washing among undergraduate and postgraduate dental students.

**Hypothesis**

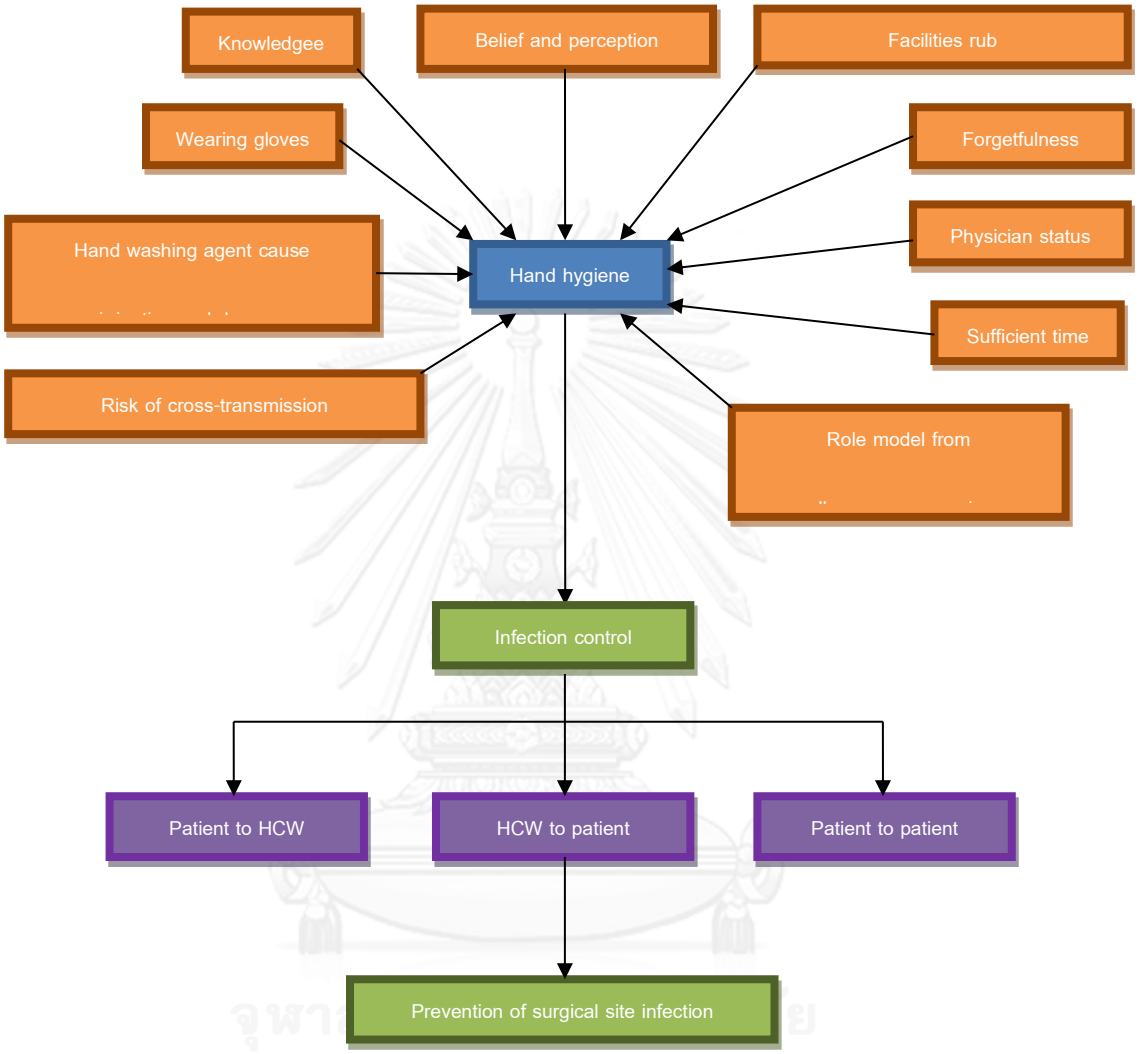
1. Effectiveness of hand washing among undergraduate dental students is different from postgraduate dental students.

2. Knowledge, attitude and behavior of hand washing among undergraduate dental students are different from postgraduate dental students.

**Expected benefits**

The results from this study may lead to improvement of hand washing practice in dental students.

## Conceptual framework



# CHAPTER II
# REVIEW AND RELATED LITERATURES

Health care-associated infection (HAI) is a major problem disturbing patient safety. The surveillance and prevention must be the first priority of concern. Although the risks of acquiring HAI is universal and pervades every health care system around the world, the global burden is unknown because of the difficulty of gathering reliable diagnostic data. Overall estimates indicate that more than 1.4 million patients worldwide are affected at any time. In developed countries, Europe reported the HAI incidence rate ranging from 4.6% to 9.3% and mortality due to HAI is estimated to be 1% (50,000 deaths per year). The estimate HAI incidence rate in the USA was 4.5% in 2002. The most frequent type of those is urinary tract infection (UTI, 36%), followed by surgical site infection (SSI, 20%)(1).

## I. Surgical site infection

The term “surgical site infection” (SSI) was introduced in 1992 to replace the previous term “surgical wound infection”(4). According to “Guideline for Prevention of Surgical Site Infection, 1999”, SSI is defined as infection occurring within 30 days after the operation or within 1 year if an implant is left in place after the procedure and affects either superficial or deep tissue at the operation site(17). Based on the CDC’s National Nosocomial Infections Surveillance (NNIS) system report, SSIs were the third frequently reported nosocomial infection, accounting for 14% to 16% of those among hospitalized patients and 38% among surgical patients(17). The risk for patients to confront SSI in developing countries is significantly higher than in developed countries(1). European data suggested that the incidence of SSIs may be as high as 20% depending on the procedure, the surveillance criteria used and the quality of data collection(4).

SSI result in poor quality of life as delayed wound healing, longer hospitalization, re-admission to hospital or intensive care unit (ICU) treatment,

increase use of antibiotic, additional cost, morbidity and mortality rates(3, 4). For example, in case-control study involving 255 matched pairs of patients with and without SSIs, the relative risk of death associated with SSI was 2.2 and those for re-admission within 30 days of discharge and ICU treatment were 5.5 and 1.6, respectively. The median of hospitalization duration in infected patients was 11 days, compared with 6 days in uninfected patients. The excess direct costs attributable to SSI were $3,089(3).

The level of bacterial burden is the most significant risk factor of SSI. An operative wound classification based on the degree of microbial contamination was developed by the US National Research Council group in 1964 including clean, clean-contaminated, contaminated and dirty wounds. The incidence of SSI of these classified wound is as follows ≤1-2%, 6-9%, 13-20% and 40%, respectively. This classification is widely used to predict the rate of infection after surgery(18).

The clinical diagnosis of SSI is defined as the simultaneous presence of all of the followings: pain at the surgical site, localized swelling and purulent discharge around the incision(19). If purulent drainage and/or mucocutaneous fistula develop within the first 30 postoperative days, it will be classified as a SSI of clean contaminated oral and maxillofacial surgical wound. Erythema, induration or tenderness around the suture line is not accepted as SSI. Infection can be confirmed by a wound culture of greater than $10^5$ organisms per gram of tissue(20). The frequently isolated pathogens in SSI included *Staphylococcus aureus*, coagulase-negative staphylococci, *Enterococcus* spp., and *Escherichia coli*. An increasing proportion of SSIs are caused by antimicrobial-resistant pathogens, such as *methicillin-resistant S. aureus* (MRSA), or by *Candida albicans*(20). The incidence of postoperative wound infection following oral and maxillofacial surgery vary between 0.2-37.8% depends on age of patient, type of surgery, difficulty and duration of operation, infection control compliance and the use and timing of prophylactic antibiotics(19, 21-27).

The incidence of infection after surgical removal of impacted third molars is the top three most common postoperative complications. This rate has been

reported to vary from 0.2-5.5%(19, 21, 22, 26). Surgical removal of bony impacted mandibular third molar carried a higher risk of postoperative infection than all other extractions. As Pell and Gregory classification, most of postsurgical wound infection was associated with a greater degree of impaction. Teeth classified as having class III and/or position C had more infection than teeth classified as having A or B impaction(22).

The orthognathic surgery related complication rate was 9.7%, of this 7.4% was related to postoperative infection. Most infection manifested three to four weeks postoperatively and the earliest infection was occurred within three days after operation with pus discharge. Concerning the location of infection, 51% occurred in maxilla and the remaining 49% occurred in mandible. The postoperative infection rate in bimaxillary osteotomy was significantly higher when compared with single-jaw osteotomy(23).

**II. Pathway of cross infection**

One of the causes of SSI is bacterial contamination during surgical procedure; particularly oral cavity which serves as the best source of microorganisms(28). In oral and maxillofacial surgery, both surgical team members and patients are regularly exposed to various infectious microorganisms through blood and oral secretion. The opportunities for cross infection between surgical procedures are patient to surgical team members, surgical team members to patient or even patient to patient(2).

*Patient to surgical team members*: This pathway is more difficult to control than the other two pathways. Direct contact (touching) with microorganisms from patient's saliva, blood, infectious mucosal lesion, spray, spatter or aerosols may be a route of microorganism transmission through non-intact skin resulting from cuts, abrasions or dermatitis especially around the fingernails. Indirect contact involves transfer of microorganisms from the source, such as patient's mouth, to an item or surface which subsequently contact with mucous membrane or broken skin of operators.

*Surgical team members to patient:* Spread of microorganisms from the surgical team members to patients is a rare event but could occur if members do not properly follow infection control procedures. If operator's hands contain lesions or other invisible non-intact skins, or acquired injury during procedure in the patient's mouth, blood-borne pathogens or other microorganisms could be transferred by direct contact. Adversely, the patient may contact indirectly with blood-borne pathogens if sharp instrument injury occur with dental team members during operation.

*Patient to patient:* Microorganisms might be transferred from patient to patient by indirect contact with improper sterile instruments, operatory surfaces and hands.

Transmission of the microorganisms from one patient to another via surgical team members' hands requires five sequential steps:

1. The organisms are present on the patient's skin, or have been shed onto objects surrounding the patients.
2. The organisms must be transferred to the hands of surgical team members.
3. The organisms must be surviving for at least several minutes on the hands of surgical team members.
4. Hand washing or hand antisepsis by the surgical team members must be inadequate or neglected, or the agent used for hand hygiene is inappropriate.
5. The contaminated hand of the surgical team members must come into direct contact with another patient or with an object that will come into direct contact with the patient.

As a result, surgical team members are required to use appropriate infection

Control procedures during operations and patient care to reduce, as much as possible, potential risks of disease transmission to patients and among themselves.

The infection control protocol that interrupt these pathways of cross infection are listed in table 1.

| Source of microorganism | Mode of disease spread | Mechanism or site of entry into body | Infection control procedure |
|---|---|---|---|
| Patient to surgical team member | | | |
| Patient's mouth | Direct contact | Through breaks in skin of surgical staff | - gloves/hand washing<br>- immunizations |
| | Droplet infection | Inhalation by surgical staff | - mask<br>- mouth rinsing |
| | | Through breaks in skin of surgical staff | - gloves/hand washing<br>- protecting clothing<br>- face shield<br>- mouth rinsing |
| | Indirect contact | Cuts, punctures or needle sticks in surgical staff | - needle safety and waste management<br>- heavy gloves for clean up<br>- ultrasonic cleaning rather than hand scrubbing<br>- instrument cassettes to reduce direct handling during cleaning |

| | | | |
|---|---|---|---|
| | | | - antimicrobial holding and cleaning solution |
| | | Through breaks in skin of surgical staff | - heavy gloves for cleanup<br>- protective clothing<br>- immunizations |
| Surgical team member to patient | | | |
| Surgical staff's hands (lesions or bleeding) | Direct contact | Through mucosal surfaces of patient | - gloves/hand washing<br>- care in handle sharp objects<br>- immunization |
| | Indirect contact | Bleeding on items used in patient's mouth | - gloves/hand washing<br>- instrument sterilization<br>- surface disinfection<br>- immunizations |
| Patient to patient | | | |
| Patient's mouth | Indirect contact<br>(instruments, surfaces, hands) | Through oral mucosal surfaces of patient | - instrument and hand piece sterilization<br>- sterilization monitoring |

| | | | |
|---|---|---|---|
| | | | - surface covers<br>- surface disinfection<br>- hand washing and proper gloving<br>- changing mask<br>clothing<br>- changing protective<br>clothing when needed<br>- use of sterile or clean supplies<br>- use of disposable items |

**Table 1:** Mechanisms of disease spread and prevention(2)

As shown in table above, hand washing and proper gloving are critical procedure to prevent cross infection in every aspects mentioned previously. Stiefel and colleagues reported that contaminated hands could be vehicles for the spread of bacteria. The type of bacteria acquired on hands is similar after contact with skin sites and environmental surfaces in the room of bacterial carriers(29). Surgical team members' hands become progressively colonized with commensal flora as well as potential pathogens during operation or patient care. Bacterial contamination increases linearly over time(1). The organisms on a surgical team member's hands may be transferred to the patient's mucous membranes or into the patient's blood stream via injection sites or open wound create during surgical procedures. Factors that influence the transfer of microorganisms from one person to another and affect cross-contamination rates are type of microorganisms, source and destination surface, moisture level and size of inoculums. In the absence of hand washing, the longer

the duration of care, the higher the degree of hand contamination will be observed(1). Several studies showed that hand antisepsis reduced the prevalence of HAI(5, 6).

**III. Types of microorganism on hands**

The microorganisms recovered from the hands could be divided into two categories, namely resident skin flora and transient skin flora. The resident skin flora consists of microorganisms that colonize on the several deep layers of skin and can never be removed totally, even with surgical hand washing, but their number can be reduced. If disrupted, for instance by hand washing, the resident skin flora can re-establish themselves at the same sites in the skin. *Staphylococcus epidermidis* is the dominant species of resident skin flora. Other resident bacteria include *Staphylococcus hominis*, and other coagulase-negative staphylococci, followed by coryneform bacteria (propionibacteria, corynebacteria, dermobacteria and micrococci). Among fungi, the most common genus of the resident skin flora is Pityrosporum (Malassezia) spp. Although the resident skin flora can cause infection when directly or indirectly spread to others, they are likely produce less severity in disease spread than the transient skin flora. The microorganisms of transient flora contaminate the hands during touching of or exposure to contaminated surfaces and then re-locate onto the outer layers of skin. They usually do not colonize and do not survive on the hands for long periods. This flora is frequently associated with HAIs, the severity in disease spreading depends on how the hands become contaminated. These microorganisms are able to infect the host by passing through dermal defects and also can contaminate dental instruments. Although they are more likely to be associated with an infection, the transient skin flora can be removed or simply reduce by proper hand washing. Typical transient skin flora includes *Staphylococcus aureus*, Gram-negative bacilli or yeasts, these microorganisms associate with isolated pathogens from SSI. Total bacterial counts on the hands of health care workers have been ranged from $3.9 \times 10^4$ to $4.6 \times 10^6$

CFU/$cm^2$(1). When the skin is covered with gloves, number of the resident skin flora and transient skin flora may be increased as fast as 4000-fold per hour(2).

**IV. Surgical glove perforation**

Despite the substantial effort to maintain asepsis during surgery, the risk of SSI remains. One possible causes of SSI include transfer pathogens on staffs' hands to patients in surgical settings. Meanwhile, protecting the surgeons from pathogens of the patients is at least as important as protecting the SSI. Many guidelines for prevention of SSI suggest all surgical team members wear sterile gloves as a protective barrier to prevent hand-to-wound contamination during operations(1, 17). The availability and routine use of gloves for surgical procedure raise questions about the relative importance of hand washing. The staffs should realize that the uses of gloves do not fully protect their hands or surgical wound from pathogen contamination. Pathogens can gain access to surgical wound via an unnoticeable small defect in gloves. Intact gloves act as a protective barrier against blood borne pathogens such as human immunodeficiency virus (HIV), hepatitis B virus and hepatitis C virus. However, breaches of gloves may expose operating surgical team members to the risk of viral infection, particularly if there are cuts or abrasion on the skin. Breached gloves not only indicate the potential for infection via the skin, but also bear witness to the possibility of needle injury and potential inoculation with viral particles(28). According to Palmer and Rickett, a surgeon risks more than one hepatitis infection per life-time and more than 1 in 1,500 surgeons is likely to be infected by HIV during the next 35 years because of damaged gloves(30). A recent trial demonstrated that punctured gloves double the risk of SSIs from 3.9% to 7.5% in surgical procedures, compared with intact gloves(31).

Gloves perforation occurred more often when gloves do not fit properly. During 18.3% of operations at least one glove was perforated. The individual glove perforation rate was 7.8% of all gloves used during surgery(9). A previous study indicated 2% of gloves were found to have a hole at the start of the operations and only 15% of surgical team members who breached their gloves were aware that the

glove was perforated(8). Although double gloving is recommended to decrease the risk of puncture during surgery, perforations are still observed in 86.52% after procedures and the inner glove of the double-gloving system was punctured in 6.82% of outer glove perforation(9).

In oral and maxillofacial surgery, the reported incidence of perforation of gloves used during variety of oral surgical procedures was ranged from 16.7%-91.1%. The highest rate was associated with orthognathic surgery (91.1%), followed by cleft lip and palate surgery (55.0%), excision of oral soft tumor (54.5%) and dental implantation (50.0%). The individual glove perforation rate was 10.45%(7). The incidence of perforation during the treatment of mandibular fracture is greater than 50% when a wiring technique is used, with over 84% of perforation were unnoticed at the time of surgery(32). Chrisropher and colleagues have examined the glove perforation rate associated with surgical extraction of wisdom teeth, the operative perforation rate was 8.6% and the individual glove perforation rate was 2.1% per operation(33).

The risk of gloves perforation increased with the duration of operating time. Significant increase of perforation was found when the operation time was longer than 2 hours, and increased 1.12 times in every 10 minutes of operating time(9). The most common factors favoring glove perforation include puncture by needles, spiked bone fragments or sharp surfaces on complex instruments. Particularly, in orthognathic surgery using additional wire and orthodontic tooth brackets are thought to have higher perforation risks compared with other operations(7). Glove perforation was more common for the surgeon than assistant(8, 32) and the most common site of perforation was the index finger of glove worn on non-dominant hand. Perhaps because the surgeon usually holds the sharp instrument in the dominant hand and holds the tissue with the non-dominant hand. Also, the needle-holder is usually in the right hand, and the needle may accidentally puncture the glove of the opposite hand(7-9).

## V. Hand Washing

The Center for Disease Control and Prevention (CDC) has stated: "It is well documented that one of the most important measures for preventing the spread of pathogens is effective hand washing". Appropriate hand washing provide protection for both patient and health care workers (HCWs) from the pathogens. Many of the infection control recommendations concerning dental staffs and patients risks are based on epidemiological, clinical and scientific knowledge obtained from medical research. In this regard, the practice of cleaning hands with an antiseptic agent probably began in the early $19^{th}$ century. In 2002 the CDC published the specific hand hygiene guidelines for infection control entitle "The 2002 Guideline for Hand Hygiene in Health-care Setting" (34) which propose that effective hand washing practice combined with the proper wearing of gloves is on of an essential element of infection control. Hand washing is categorized into two types as hand washing for nonsurgical and surgical dental procedures(28).

### Hand washing for nonsurgical dental procedures

Several dental procedures can be defined as nonsurgical dental procedures include dental examination, restorative dentistry, endodontic treatment, prosthetic treatment and preventive procedure. The CDC guideline recommends that, at the beginning of working day, dental staffs should rub their hands with either plain soap or antimicrobial hand-wash agent and water for 15 seconds when visibly soiled are seen(34). Since pathogenic organisms have been found around bar soap during and after use, liquid preparations are preferable. Otherwise hand rubbing with alcohol-based hand rub is recommended for other opportunities for hand washing during patient care as it's faster and better tolerated by skin. The adequate amount of alcohol-based hand rub should be applied on the palm and rubbed thoroughly on both hands, covering all surfaces on the hands and fingers until the hands are dry. The manufacturer's recommendations regarding the volume of product to use should be followed. The potential problems should be considered when applying alcohol-based hand rub after using powdered gloves. Residual powder left on the hands by powdered gloves may not be removed as well and may interfere with the

antimicrobial action of the alcohol-based agent. Comparison of the pros and cons of traditional hand washing techniques with alcohol-based hand rub are illustrated in figure 1.

| Technique | Pros (+) | Cons (–) |
|---|---|---|
| Hand Washing | + Can use plain or antimicrobial soaps<br>+ Effective antimicrobial activity with antimicrobial soaps<br>+ Effectiveness only minimally affected by organic matter<br>+ Sinks readily available and accessible in most dental settings<br>+ Familiar technique<br>+ Allergic reactions to antimicrobial active ingredients are rare<br>+ Irritation dermatitis related to hand washing may be solved by relatively simple techniques or changes | – Frequent hand washing may cause skin dryness, chapping, and irritation<br>– Compliance with recommended hand-washing protocol is traditionally low<br>– Takes more time than antiseptic hand rubs<br>– Requires sink and water and paper towels or air dryers<br>– Personal habits and preferred products such as hand lotions may undermine professional training<br>– Strong fragrances and other ingredients may be poorly tolerated by sensitive people<br>– Water alone may be a skin irritant<br>– Time and technique are critical |
| Alcohol-Based (Antiseptic) Hand Rub | + Provides more effective antiseptic action on visibly clean hands than hand washing with plain or antimicrobial soaps<br>+ Faster protocol than hand washing<br>+ Reduced skin irritation and dryness compared to hand washing<br>+ May be used in absence of sinks and water, and during boil-water notices<br>+ Allergic reactions to alcohol or additives are rare<br>+ Reduces use of paper towels, waste | – Not indicated for use when hands are visibly dirty or contaminated<br>– Dispensing proper amount is critical<br>– Hands must be dry before agent is applied<br>– Frequent use may cause skin dryness or irritation if product lacks effective emollients/skin conditioners<br>– Agent may temporarily sting compromised skin<br>– Strong fragrances and other ingredients may be poorly tolerated by sensitive people<br>– Alcohol products are flammable, should be stored away from flames<br>– Residual powder may interfere with effectiveness or comfort of antiseptic rub<br>– Hand-washing stations must still be accessible for times when waterless sanitizers are inappropriate |

Adapted with permission from the Organization for Safety and Asepsis Procedures. From Policy to Practice: OSAP's Guide to the Guidelines. Washington, DC: OSAP, 2004:23.
*Hand washing performed according to recommended protocol, as outlined in this chapter.
†Antiseptic hand rubs meet recommended product selection criteria as defined in this chapter.

**Figure 1:** Comparison of the pros and cons of traditional hand-washing techniques with alcohol-based hand rub(28)



**Hand washing for surgical dental procedures**

Hand washing for this situation is defined as the antiseptic surgical hand scrubbing or antiseptic surgical hand rubbing performed before donning sterile glove preoperatively. The purpose of surgical hand washing is to eliminate transient skin flora and to reduce resident skin flora to the lowest level before donning glove. In case of an unnoticed puncture of the surgical glove, higher number of bacteria on the hands of surgeons can cause wound infections if contaminated into the operative field during surgery(35). Skin bacteria can multiply rapidly under surgical gloves if hands are washed with a non-antimicrobial soap. The bacterial growth occurs much slower if antiseptic agent was used for preoperative hand washing[2]. Since surgical procedures also tend to be longer than conventional dental

procedures, selection of an antimicrobial agent with residual activity rather than plain soap or alcohol-based hand rub alone is indicated(28). Persistent antimicrobial activity of detergent-based surgical scrub formulations is greatest for those containing 2% or 4% chlorhexidine gluconate, followed by hexachlorophene, triclosan, and iodophors(34). No agent is ideal for every situations, a decision depends on its acceptability by operating room personnel after repeated used. The current recommendation is to follow the manufacturer's instructions which usually include a 2- to 6-minute scrub(17).

Step-by-step procedures for nonsurgical and surgical hand washing are illustrated in figure 2.

| Methods | Agent | Purpose | Technique | Duration (minimum) | Indications |
|---|---|---|---|---|---|
| Routine Hand wash | Water and non-antimicrobial soap (i.e., plain soap)* | Remove soil and transient microorganisms | • Wet hands and wrists under cool running water<br>• Dispense hand-washing agent sufficient to cover hands and wrists<br>• Rub the agent into all areas, with particular emphasis around nails and between fingers<br>• Rinse thoroughly with cool water<br>• Dry hands completely with a disposable towel before donning gloves<br>• Use a towel to turn off the faucet if automatic controls are not available | 15 seconds | • Before and after treating each patient (e.g., before glove placement and after glove removal).<br>• After barehanded touching of inanimate objects likely to be contaminated by blood or saliva.<br>• Before leaving the dental operatory or the dental laboratory.<br>• When visibly soiled.†<br>• Before regloving after removing gloves that are torn, cut, or punctured. |
| Antiseptic Hand wash | Water and antimicrobial soap (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan) | Remove or destroy transient microorganisms and reduce resident flora (persistent activity) | | 15 seconds | |
| **Antiseptic Hand Rub** | Alcohol-based hand rub† | Remove or destroy transient microorganisms and reduce resident flora (persistent activity) | • Apply the product to palm of one hand<br>• Rub hands together, covering all surfaces of hands and fingers, until hands are dry†<br>• Allow hands to dry completely before donning gloves<br>• Follow manufacturer's recommendations regarding volume of product to use | Rub hands until the agent is dry† | |
| Surgical Antisepsis | Water and antimicrobial soap (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan) | Remove or destroy transient microorganisms and reduce resident flora (persistent activity) | • Remove rings, watches, and bracelets before beginning<br>• Remove debris from underneath fingernails using a nail cleaner under running water<br>• Wet hands and wrists under cool running water<br>• Using an antimicrobial agent scrub hands and forearms for the length of time recommended by the manufacturer's instructions before rinsing with cool water<br>• Dry hands completely (use of a sterile towel is ideal) before donning sterile surgeon's gloves | 2–6 minutes (longer scrub times are generally not indicated) | • Before donning sterile surgeon's gloves for oral surgical procedures |
| | Water and non-antimicrobial soap (i.e., plain soap)* followed by an alcohol-based surgical hand-scrub product with persistent activity | | • Prewash hands and forearms with non-antimicrobial (plain) soap* and water<br>• Thoroughly rinse and dry hands and forearms<br>• Follow the manufacturer's instructions for the surgical hand-scrub product with persistent activity<br>• Allow hands to dry completely before donning sterile surgeon's gloves | Follow manufacturer's instructions for surgical hand scrub product with persistent activity | |

**Figure 2:** Step-by-step procedures for nonsurgical and surgical hand hygiene(28)

For surgical hand disinfection, the use of antiseptic agent with 10-minute surgical hand scrubbing is the traditional technique. In 2002, the CDC stated that the use of a brush resulted in skin damage that increase bacteria shedding and discouraged staffs from performing hand washing. Furthermore, 2 to 6 minutes surgical hand rubbing with antiseptic agent can be reduced bacterial counts to

acceptable levels. Therefore, CDC considered a valid alternative surgical hand-rubbing to the conventional hand scrubbing protoco(34).

National Health Service (NHS) recommends technique for rubbing hands as “6 steps for hand hygiene” as the figure 3


Step 1: Rub palms together Step 2: Rub each palm over the back of the other hand Step 3: Rub between fingers on each hand


Step 4: Rub your hands fingers with the fingers together Step 5: Rub around each of the thumbs and wrists Step 6: Rub in circles on your palms

**Figure 3:** Six-steps for hand hygiene(1)

Although hand washing with antiseptic agent was performed before the surgical procedure, the microorganisms on hands could re-growth under the surgical gloves during the procedure. Herruzo et al reported 4% chlorhexidine gluconate is better than 7.5% povidone iodine in reducing the number of bacteria after hand

washing, but at the end of operation, bacterial count had increased to a higher number than just after hand disinfection(36).

**VI. Hand washing agents: chlorhexidine gluconate (CHG)**

The antimicrobial activity of CHG is attributable to attachment to, and subsequent disruption of cytoplasmic membranes. It has good activity against Gram-positive bacteria, rather less activity against Gram-negative bacteria and fungi, and minimal activity against mycobacteria. CHG is not sporicidal. *In vitro* activity demonstrated effectiveness against enveloped viruses, but significantly less activity against non-enveloped viruses such as retrovirus, adenovirus, and enteroviruses(34). The antimicrobial activity of CHG is not seriously affected by the presence of organic material, including blood. Its activity can be reduced by natural soaps, various inorganic anions, non-ionic surfactants, and hand creams containing anionic emulsifying agents. Preparation with 2% CHG is slightly less effective than those containing 4% CHG(1). A scrub agent based on 4% CHG was shown to be significantly more effective to reduce bacterial count than a 7.5% povidone iodine scrub agent(37). CHG has residual activity up to 6 hours. Addition of low concentrations (0.5–1%) of CHG to alcohol-based preparations results in significantly greater residual activity than alcohol alone. If attach to recommendation, CHG has a good safety record. Little, if any, absorption of the compound occurs through the skin. The frequency of skin irritation is concentration dependent, with products containing 4% are most likely to cause dermatitis when used frequently as antiseptic hand washing(1).

**VII. Indications for hand hygiene**

WHO proposed the recommendation “five moments for hand hygiene” as the figure 4.

| Moment | Endpoints of hand transmission | Prevented negative outcome |
|---|---|---|
| 1. Before touching a patient | Donor surface: any surface in the *health-care area*<br>Receptor surface: any surface in the *patient zone* | Patient colonization with health-care microorganisms; exceptionally, exogenous infection |
| 2. Before clean/ aseptic procedure | Donor surface: any other surface<br>Receptor surface: *critical site with infectious risk for the patient* or *critical site with combined infectious risk* | Patient endogenous infection; exceptionally exogenous infection |
| 3. After body fluid exposure risk | Donor surface: *critical site with body fluid exposure risk* or *critical site with combined infectious risk*<br>Receptor surface: any other surface | HCW infection |
| 4. After touching a patient | Donor surface: any surface in the *patient zone* with touching a patient<br>Receptor surface: any surface in the *health-care area* | HCW colonization; environment contamination |
| 5. After touching patient surroundings | Donor surface: any surface in the *patient zone* without touching the patient<br>Receptor surface: any surface in the *health-care area* | HCW cross-colonization; environment contamination |

**Figure 4:** The five moments for hand hygiene: explanations and link to evidence-based recommendation(1)

## VIII. Factors influencing adherence to hand washing practices

Although hand washing is the key control measure to prevent HAI, many studies reported that perception of knowledge about hand hygiene indications were less than 70%. Concerning about adherence to hand washing, overall averaged 40% of HCWs practiced hand washing during routine patient care(1). This low compliance may be due to different reasons included time pressure, lack of sinks and antiseptic agents, poor knowledge regarding clinical effectiveness of hand washing in reducing the spread of infection and negative influence of senior staffs as a role models(10, 11). Mona and Tariq evaluated the adherence to hand washing practice among HCWs in 5 medical and 5 surgical wards. They reported an overall frequency of hand washing was 6.7% before patient contact and 23.7% after patient contact. An adherence to hand washing was highest among medical students (70%), followed by interns (69.2%), residents (12.5%) and senior medical staffs (9.1%)(12). According to Pittet and colleagues' study, among the medical specialties, surgeons' adherence to hand washing was the second least frequent after anesthesiologist. The risk factors for noncompliance to hand hygiene guidelines are shown in the table 2.

| |
|---|
| **Material factors**<br>• Convenient and accessible hand washing facilities e.g. alcohol hand rub, soap, automated sink, paper towel<br>• Hand washing agents cause irritation and dryness |
| **Behavior and social factors**<br>• Lack of knowledge of guidelines/protocols<br>• Lack of scientific information of definitive impact of improved hand hygiene on health-care–associated infection rates<br>• Lack of awareness of impact on nosocomial infection<br>• Disagreement with the recommendations<br>• Not thinking about it/forgetfulness<br>• No role model from colleagues or superiors |
| **Factors in a health-care situation**<br>• Physician status<br>• Often too busy/insufficient time<br>• Patient needs take priority<br>• Low risk of acquiring infection from patients<br>• Wearing of gloves/beliefs that glove use obviates the need for hand hygiene<br>• Lack of active participation in hand hygiene promotion at individual or institutional level |

**Table 2:** The risk factors for noncompliance to hand hygiene guidelines(10, 11)

### IX. Hand washing practice among students

To improve hand hygiene behavior is a complex task involving many factors. The disciplinary differences in hand hygiene education and assessment during undergraduate training may impact on graduates' behavior upon entering the workforce(14), thereby ensuring "infection control" education of the students may improve knowledge, attitude and compliance for hand hygiene. In this regard, many

studies have been conducted to study the hand washing practice of medical and nursing students. The awareness and compliance of hand washing in students have been attributed to many factors. These factors comprise the following:

1. *Importance of hand hygiene in the under-graduate syllabus:* Students are prone to develop faulty hand washing practice if the curriculum was not enforced with hand hygiene concepts and skill(13). One study from a leading medical training center in Pakistan where only 17% of interns and postgraduate medical students were aware of WHO recommendation on hand washing and only 4.7% reported to observe correct washing before having direct patient contact(38). Basurrah and Madani's study reported an adherence to hand washing was highest among medical students (70%) and lowest among senior medical staff (9.1%). The authors stated in discussion regarding this apparently unusual result as in undergraduate education, the motivation of students on infection control issues was more intensive(12). In 2012, Al Kadi and Salati conduct a study to evaluate the awareness and compliance of hand washing among undergraduate medical students. They found that only 56% of medical students were able to remember positive indications for hand washing and the remaining 44% were either unaware or not sure about these moments. Only 29% of students were able to identify the five indications for hand hygiene in the questionnaire and compliance during clinical examination sessions was only 17%(13). Mortel et al conducted a cross-disciplinary study in 2010 to compare knowledge, beliefs, practices, education and assessment of undergraduate Greek nursing and medical students. They found that nursing students had greater hand hygiene knowledge, more positive beliefs and practices, and considered hand hygiene more important in their curriculum than medical students(14). Similarly, nursing students' scores of the hand hygiene knowledge, beliefs and practices of Italian nursing students are higher than medical students. Moreover, the authors also reported that students hand hygiene knowledge scores and self-reported compliance improved with increasing duration of practical course(15).

2. *Mentors or role models:* The role model change with each passing year of trainning from teachers to senior colleagues and if any of these role models are performing faulty hand hygiene, the students are likely to be less compliant. According to Lankford and colleagues' study, the students in a room with a senior medical staff person or peer who did not wash hands were significantly less likely to wash their own hands(39). Similarly to Alp et al's study, self- reported adherence to hand hygiene was associated with perceive good adherence by colleagues(40).

3. *Belief and attitude of students:* Stone had stated that hand hygiene compliance reflects the attitudes, behaviors, and beliefs of healthcare personnel(6). Many authors had addressed this issue in literature stressing the importance of correct hand hygiene behavior development at the early years of medical education(13, 14). At this course, students are made to understand effectively the outcomes of proper and improper hand hygiene. According to Mortel and colleagues' study, they found the nursing students' hand hygiene belief and self-reported practices to be significantly better than that of medical students(14). Additionally, Mortel and colleagues showed student's hand hygiene attitude and belief may increase over time, particularly after taking care of real patients(15). Graft et al studied the beliefs and attitudes of medical students when they were being promoted from the basic to the clinical phase and noticed a major lack of information about proper hand hygiene. The medical students believed that the hand hygiene compliance would be worse in more experienced physicians and senior consultants though they are often considered to be role models for medical students(16).

# CHAPTER III
# MATERIALS AND METHODS

## Sample selection

The data was collected from each thirty of 4th, 5th, 6th-year undergraduate (UG) and postgraduate (PG) dental students attending oral surgery clinic, Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Chulalongkorn University (Bangkok, Thailand).

## Inclusion criteria

The UG and PG dental students attending oral surgery clinic with no dermatologic condition or injury on hands and forearms

## Exclusion criteria

1. The UG and PG dental students who cannot read Thai language
2. The UG and PG dental students with a history of sensitivity to chlorhexidine gluconate
3. The UG and PG dental students who spend operating time less than 45 minutes or longer than 180 minutes
4. The UG and PG dental students who has perforating glove after surgical procedure
5. The UG and PG dental students who cannot cooperate throughout the data collecting process

Prior to the implementation, the study protocol was approved by the ethic committee, Faculty of Dentistry, Chulalongkorn University. Each of participants was informed about the detail of this study.

**Study design**

The UG and PG dental students attending oral surgery clinic were selected. Prior to commence minor surgical operation, the participants were asked to complete self-administered questionnaires regarding knowledge, attitude and behavior toward hand washing. After completing the questionnaires, participants were asked to remove all accessories from hands and forearms. Before starting hand washing, the sample of bacteria on participants' dominant hands was collected by swab technique. Then the participants were let to perform surgical hand wash with 5 milliliters of 4% chlorhexidine gluconate (Ecoland®, Garforth, England) in their usual technique. Immediately after drying the hands with sterile towel, before donning gloves, sample of bacteria from participants' non-dominant hands was collected again with the same technique. The participants were then allowed to perform the minor oral surgery. As soon as participants finished the surgical operations, sample of bacteria on participants' dominant hands was collected again. All samples were transferred to lab for microbiological evaluation.

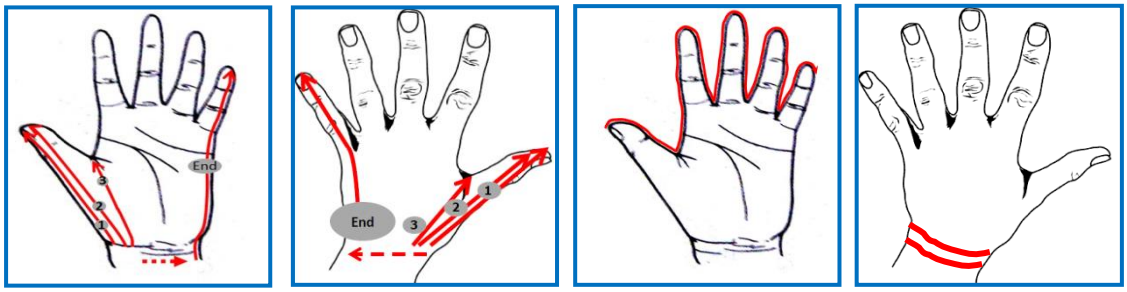
**Self-administered questionnaire**

On the basis of CDC 2002's concept, self-administered questionnaires was designed to measure knowledge, attitude and behavior factors related to hand hygiene. Knowledge of six-step hand hygiene according to WHO recommended guidelines and the hand hygiene indications was assessed by six questions using 3-point scale, the answer "yes" of all questions except question 3 and the answer "no" of question 3 were considered a correct answer. The variables of three questions related to attitude for hand hygiene comprised: perception on difficult to adhere, perception on hand hygiene for preventing infection and perceived subjective norm. All of these were assessed by 4-point scale. The scale was translated in to score ranging one to four. The score of each question was calculated into total attitude scores which had the maximum score of twelve. The variables of four questions related to hand hygiene behavior comprised: intention to adhere, duration of performing hand hygiene and possible reason for non-compliance of

hand hygiene. The questions were assessed by 4 and 2-point scale, respectively. The score of each question was calculated into total behavior scores which had the maximum score of six. The last question was assessed by selection the involved 9-choice. More than one choice could be selected by each participant. Age, sex, surgical experience of participants, type and duration of minor surgical operation were also recorded.

**Specimen collection**

Four sterile cotton swabs were used to collect bacteria from four areas of operator's hand by reproducible technique as follow: 1) Ran the first sterile cotton swab across the palm, starting from the wrist to the fingertip two times and one time from the wrist to inter-finger's area, repeated in the same action from thumb to little finger. 2) Ran the second sterile cotton swab across the back of the hand in the same action mentioned previously. 3) Ran the third sterile cotton swab across the border of each finger, starting from the tip of the thumb to little finger's tip. 4) Ran the fourth sterile cotton swab around the wrist 2 times. The steps of specimen collection are showed in figure 5. In order to remove as much as bacteria from hand, rubbing motion were used.




Step 1: Ran the first sterile cotton swab across the palm

Step 2: Ran the second sterile cotton swab across back of hand

Step 3: Ran the third cotton swab across border of finger

Step 4: Ran the fourth sterile around the wrist

**Figure** 5: The steps of specimen collection

The tip of cotton swab was cut by sterile scissors and then put into test tube containing 1 milliliter of sterile phosphate buffer saline (PBS). All test tubes were delivered to the Microbiology Department for culturing (Fig 6).

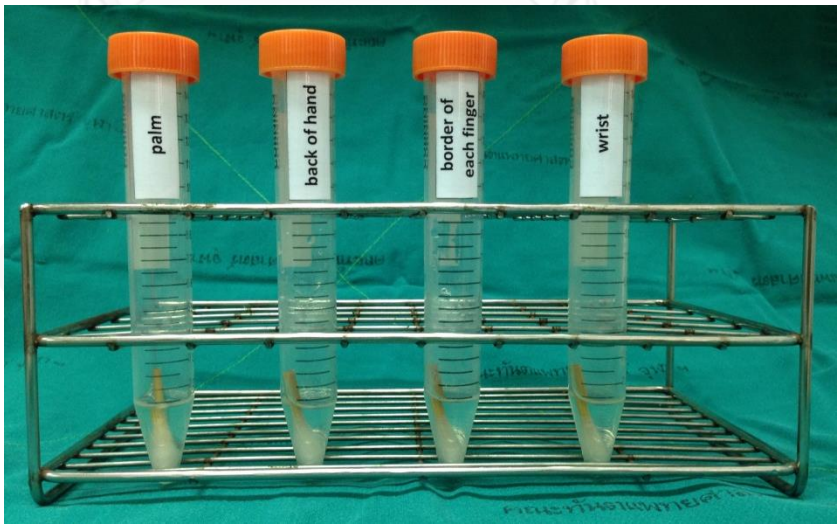



Figure 6: Test tubes carrying cotton swab tip. The tip of cotton swab was cut and placed in the test tube containing 1 ml of sterile PBS with labeling

**Bacterial culturing technique**

To recover bacteria from cotton swab, the test tubes containing cotton swab's tip were placed on shaker (Daihan Scientific®, Seoul, Korea) (Fig 7a) at 100 rpm for 10 minutes then vortexed vigorously on vortex mixer (Scientific Industries®, New York, USA) for 1 minute (Fig 7b). Serial 10-fold dilution of samples collected before hand hygiene needed to achieve countable colony. One hundred microliters of all samples was pipette and spread on Tryptic soy agar (TSA)(HiMedia laboratories Pvt.®, Mumbai, India) plate. The sterile glass balls (size 3 millimetres, Merck KGaA, Darmstadl, Germany) were used to spread the sample over the surface of agar plate. After 48 hours of incubation (Shel-Lab®, Cornius, USA) (Fig 7c) at 37 $^{\circ}$C in aerobic condition, numbers of colony were counted and calculated colony forming units (CFUs).


(a) (b) (c)



**Figure 7**: The machines for bacterial culturing process

(a) shaker (Daihan Scientific®, Seoul, Korea)

(b) vortex mixer (Scientific Industries®, New York, USA)

(c) incubator (Shel-lab, Cornelius, USA)

**Statistical analysis**

1. Data regarding knowledge, attitude and behavior of hand washing were analyzed with One-Way ANOVA.

2. Data regarding the difference of CFU counts on hand before, after hand washing, percent reduction of bacteria and bacteria regrowth were analyzed with One-Way ANOVA.

All data was analyzed with IBM SPSS software for Windows version 17.0. A p-value of $< 0.05$ is considered to be statistically significant.

# CHAPTER IV
# RESULTS

## Demographic data

One hundred and twenty dental students including thirty two of 4th-year, thirty four of 5th-year, thirty of 6th-year UG and twenty four PG dental students participated in this study. Minor oral surgical procedures which all participants performed were mainly extraction, impacted tooth removal and other surgical procedures. Due to the limited surgical skill, other surgical procedure performed by 4th-year UG dental students was only being assistance whereas a lot more complicated procedures were performed by PG dental students such as torectomy, implant placement and mini-screw removal. The mean ± SD of duration of surgical procedure were 69.38 ± 26.36, 75.00 ± 30.80, 84.50 ± 31.96 and 85.00 ± 32.24 minutes in 4th, 5th, 6th-year UG and PG dental students, respectively. The senior spent slightly longer surgical duration due to they had more difficult cases. However, the difference was not statistically significant among all groups. The number of all participants in each group, type and duration of surgical procedure were shown in Table 3.

| Grade | Type of surgical procedure | | | Mean ± SD of duration of surgical procedure (min.) |
|---|---|---|---|---|
| | Extraction | Impacted tooth removal | Others e.g. assistant, implant placement | |
| 4th- year UG dental students (n=32) | 17 | - | 15 | 69.38 ± 26.36 |
| 5th -year UG dental students (n=34) | 24 | 10 | - | 75.00 ± 30.80 |
| 6th -year UG dental students (n=30) | 8 | 22 | - | 84.50 ± 31.96 |
| PG dental students (n=24) | - | 16 | 8 | 85.00 ± 32.24 |

**Table 3**: The number of all participants in each group, type and duration of surgical procedure

**Knowledge of hand washing**

All of the 4th-year UG dental students (100 percent) claimed that they had knowledge about six-step hand hygiene according to WHO recommended guidelines. The number of dental students who confidently remembered this guideline was gradually decreased from 94.12, 96.67 and 80.33 percent in 5th, 6th-year UG and PG dental students, respectively. Number of dental students who were able to mark all of indications for hand washing correctly was only 31.25, 29.41, 26.67 and 25.00 percent in 4th, 5th, 6th-year UG and PG dental students, respectively. This percentage was gradually decreased in higher studying level as well. When we translate the question regarding the indications for hand washing into scores, the students acquired the average scores of 4.28 ± 0.58, 4.24 ± 0.65, 4.16 ± 0.59 and 4.04 ± 0.69 in 4th, 5th, 6th-year UG and PG dental students, respectively. These scores were not significantly different among groups (F (3, 116) = 0.745; p = 0.528) (Table 4).

| Knowledge | Number of participants | | | |
|---|---|---|---|---|
| | 4th-year UG n = 32 (%) | 5th-year UG n = 34 (%) | 6th-year UG n = 30 (%) | PG n = 24 (%) |
| Know the six-step hand hygiene according to WHO recommended guidelines | | | | |
| Yes | 32 (100) | 32 (94.12) | 29 (96.67) | 20 (80.33) |
| No | 0 | 0 | 1 (33.33) | 1 (4.17) |
| Probably | 0 | 2 (5.88) | 0 | 3 (12.50) |
| Able to tell about indications for hand washing correctly | | | | |
| All correct answers (score = 5) | 10 (31.25) | 10 (29.41) | 8 (26.67) | 6 (25.00) |
| Mean scores ± SD | 4.28 ± 0.58 | 4.24 ± 0.65 | 4.16 ± 0.59 | 4.04 ± 0.69 |
| *p*-value | 0.528 | | | |

**Table 4**: Knowledge of hand washing among dental students

These scores were not significantly different among groups

**Attitudes of hand washing**

As high as 93.75, 82.46, 83.33 and 79.17 percent of 4th, 5th, 6th-year UG and PG dental students had positive attitude on surgical hand washing compliance according WHO recommended guidelines. Moreover, all of the dental students believed that hand washing was useful for preventing infection. Considering a role model of hand washing in participants' opinion, all 4th-year UG dental students agreed that their colleagues or superiors were good role models for hand washing. In contrary, this argument was quite low in 6th-year UG and PG dental students, 66.67 and 75.00 percent respectively. Overall, total attitude scores ranged from seven to twelve demonstrated by mean ± SD were 11.06 ± 0.91, 10.09 ± 1.03, 10.00 ± 0.98 and 9.71 ± 1.20 in 4th, 5th, 6th-year UG and PG dental students, respectively. The significant difference of attitude scores was found among groups ($F(3, 116) = 9.838$; $p < 0.001$) (Table 5). The differences between pairs of group were observed between 4th and 5th-year UG dental students ($p = 0.003$), 4th and 6th-year UG dental students ($p = 0.001$), 4th-year and PG dental students ($p < 0.001$),

| Attitudes | Number of participants | | | |
|---|---|---|---|---|
| | 4th-year UG n = 32 (%) | 5th-year UG n = 34 (%) | 6th-year UG n = 30 (%) | PG n = 24 (%) |
| Attitude of compliance with surgical hand washing according to the WHO recommended guidelines | | | | |
| Very difficult | 0 | 0 | 0 | 0 |
| Quite difficult | 2 (6.25) | 6 (17.64) | 5 (16.67) | 5 (20.83) |
| Quite easy | 10 (31.25) | 15 (44.12) | 20 (66.67) | 13 (54.17) |
| Very easy | 20 (62.50) | 13 (38.34) | 5 (16.67) | 6 (25.00) |
| Attitude of hand washing for preventing infection | | | | |
| Very useless | 0 | 0 | 0 | 0 |
| Quite useless | 0 | 0 | 0 | 0 |
| Quite useful | 3 (9.38) | 10 (29.41) | 20 (66.67) | 6 (25.00) |
| Very useful | 29 (90.62) | 24 (70.59) | 10 (33.33) | 28 (75.00) |
| Attitude of being a good role model of hand washing by other colleagues or superiors | | | | |
| Strongly disagree | 0 | 0 | 0 | 0 |
| Disagree | 0 | 1 (2.94) | 1 (33.34) | 6 (25.00) |
| Agree | 13 (40.63) | 26 (74.47) | 19 (63.33) | 14 (58.33) |
| Strongly agree | 19 (59.37) | 7 (20.59) | 10 (33.33) | 4 (16.67) |
| Mean scores ± SD | 11.06 ± 0.91[a, b, c] | 10.09 ± 1.03[a] | 10.00 ± 0.98[b] | 9.71 ± 1.20[c] |
| *p*-value | | < 0.001 | | |

[a] indicated statistically significant difference at $p = 0.003$ compared between 4th-year and 5th-year UG dental students

[b] indicated statistically significant difference at $p = 0.001$ compared between 4th-year and 6th-year UG dental students

[c] indicated statistically significant difference at $p < 0.001$ compared between 4th-year UG and PG dental students

**Table** 5: Attitude of hand washing among dental students

Fourth year UG dental students had the highest attitude score. However, the significant difference of attitude scores was found among groups.

**Behaviors of hand washing**

The self-reported frequency of hand washing compliance was difference in each group. More than 80 percent of UG while only 41.67 percent of PG dental students reported that they always perform surgical hand wash prior to minor oral surgical procedures. All of other participants except one student reported that they usually perform surgical hand wash before starting the surgical procedure. The only one of the 4$^{th}$-year UG dental student (3.13 percent) reported that he/she seldom do it. Regarding the duration of surgical hand wash prior to the minor oral surgical procedure, the percentage of dental students who correctly spent the duration of surgical hand wash according to the WHO recommendation was lower when they were in higher educational level. As 78.12, 52.94, 36.67 and 12.50 percent of 4$^{th}$, 5$^{th}$, 6$^{th}$-year UG and PG dental students reported that they spent 2-6 minutes for surgical hand wash. The total behavior scores ranged from four to six demonstrated by mean ± SD were 5.66 ± 0.55, 5.44 ± 0.56, 5.17 ± 0.59 and 4.54 ± 0.66 in 4$^{th}$, 5$^{th}$, 6$^{th}$-year UG and PG dental students, respectively. We found that the significant difference of behavioral scores was found among groups ($F(3, 116) = 39.501$; $p < 0.001$) (Table 6). The differences between pairs of group were observed between PG and 4$^{th}$-year UG dental students ($p < 0.001$), PG and 5$^{th}$-year UG dental students ($p < 0.001$), PG and 6$^{th}$-year UG dental students ($p < 0.001$)

| Behaviors | Number of participants | | | |
|---|---|---|---|---|
| | 4th-year UG n = 32 (%) | 5th-year UG n = 34 (%) | 6th-year UG n = 30 (%) | PG n = 24 (%) |
| Behavior of the frequency of surgical hand wash prior to the minor oral surgical procedures | | | | |
| Never | 0 | 0 | 0 | 0 |
| Seldom | 1 (3.13) | 0 | 0 | 0 |
| Usually | 2 (6.35) | 3 (8.82) | 6 (20.00) | 14 (58.33) |
| Always | 29 (90.63) | 31 (91.18) | 24 (80.00) | 10 (41.67) |
| Duration of surgical hand wash prior to the minor oral surgical procedures | | | | |
| Less than 2 minutes | 7 (21.88) | 16 (47.06) | 19 (63.33) | 21 (87.50) |
| 2-6 minutes | 25 (78.12) | 18 (52.94) | 11 (36.67) | 3 (12.50) |
| Mean scores ± SD | 5.66 ± 0.55[a] | 5.44 ± 0.56[b] | 5.17 ± 0.59[c] | 4.54 ± 0.66[a, b, c] |
| *p*-value | < 0.001 | | | |

[a, b, c] indicated statistically significant difference at $p < 0.001$ compared between PG and 4th-year UG dental students, PG and 5th-year UG dental students, PG and 6th-year UG dental students, respectively

**Table** 6: Behavior hand washing among dental students

PG dental students had the highest behavioral scores. However, the significant difference of behavioral scores was found among groups.

Overall, top three reasons that made participants incapable of hand washing were forgetfulness or laziness (n=71), followed by insufficient time to perform hand washing (n = 46) and confident on glove usage (n= 46), respectively. The other reasons of the non-compliance to hand washing were insufficient facilities, hand washing agent cause irritation and dryness, lack of knowledge on guidelines, no role model and lack of scientific information of definitive impact of improved hand hygiene on HAI rates. One of the 6th-year UG dental students disagreed with the WHO recommended guidelines (Fig 8).

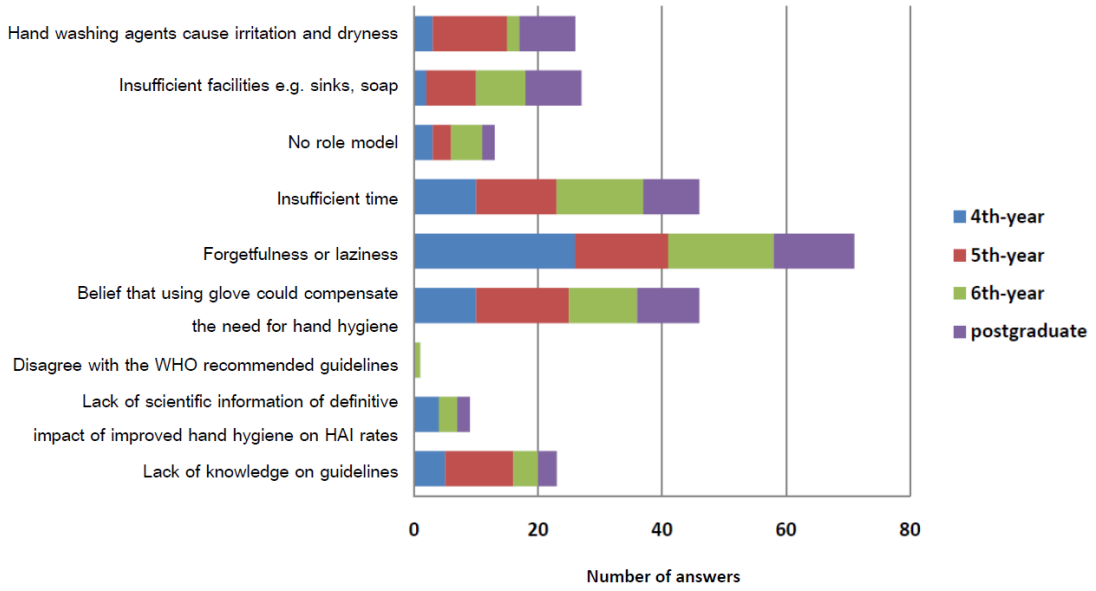



**Figure 8**: Reasons for non-compliance to perform hand washing

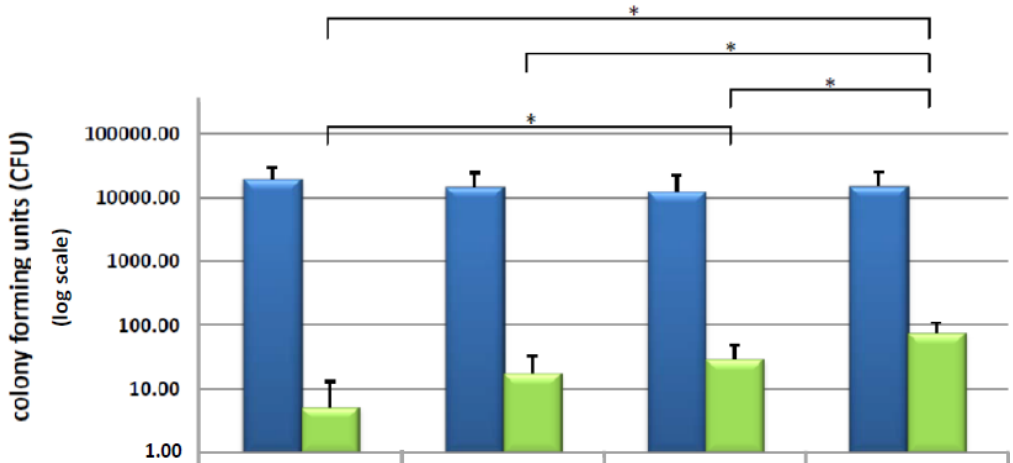
The top three reasons that made participants incapable of hand washing were forgetfulness or laziness, insufficient time to perform hand washing and confident on glove usage. More than one choice could be selected.

## Total number of bacteria on hand before and after hand washing among dental students

Bacterial load on hand prior to hand washing was calculated from the sum of all bacteria from four regions of hand. The mean ± SD of CFU counts on hands before hand washing were 1,974.06 ± 1,0081.50, 1,5034.71 ± 9473.18, 1,2709.00 ± 9516.53 and 1,5369.17 ± 9,752.28 in 4$^{th}$, 5$^{th}$, 6$^{th}$-year UG and PG dental students, respectively. The 4$^{th}$-year UG dental students seem to have the highest number of bacterial on their hands, followed by PG, 5$^{th}$ and 6$^{th}$-year UG dental students, respectively. However, no significant difference in total number of bacteria on hand was observed among all groups (Fig 9).

Surgical hand wash performed by UG and PG dental students resulted in a substantial reduction of total number of bacteria on hand. The mean ± SD of CFU counts on hands after hand washing were 5.31 ± 8.03, 17.94 ± 16.10, 30.00 ± 19.48 and 77.50 ± 34.04 in 4$^{th}$, 5$^{th}$, 6$^{th}$-year UG and PG dental students, respectively. Notably, PG dental students had significantly higher number of bacteria left on their

hands after hand washing compared to all groups of UG dental students. Moreover, the significant difference was also found between 4th and 6th-year UG dental students ($F(3, 116) = 63.024$; $p < 0.001$) (Fig 9).




| | | 4th-year | 5th-year | 6th-year | postgraduate |
|---|---|---|---|---|---|
| Before hand hygiene | mean | 19474.06 | 15034.71 | 12709.00 | 15369.17 |
| | SD | 10081.50 | 9473.18 | 9516.53 | 9752.28 |
| | minimum | 2900 | 3700 | 2330 | 2540 |
| | maximum | 43300 | 39900 | 53100 | 40400 |
| | median | 17050 | 14945 | 10745 | 13700 |
| After hand hygiene | mean | 5.31 | 17.94 | 30.00 | 77.50 |
| | SD | 8.03 | 16.10 | 19.48 | 34.04 |
| | minimum | 0 | 0 | 0 | 30 |
| | maximum | 20 | 50 | 70 | 180 |
| | median | 0 | 20 | 20 | 70 |



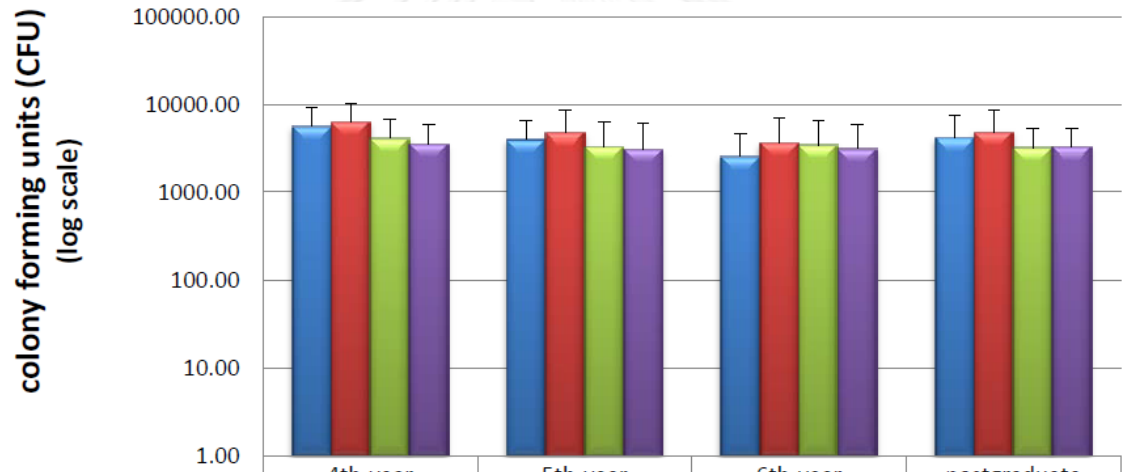
* indicated statistically significant difference at $p < 0.001$

**Figure 9**: Numbers of bacteria on hand before and after hand washing

Surgical hand wash resulted in a substantial reduction of total number of bacteria on hand. The differences were statistically significant between PG and all groups of UG, and between 4th and 6th-year UG dental students.

**Number of bacteria in each part of hand before and after hand washing among dental students**

Generally, the back of hand had the highest bacterial accumulation, followed by palm, border of each finger and wrist, respectively. However, palms of 6th-year UG dental students were the site where bacteria least accumulated and PG dental students had a little bit more bacterial load around their wrist than on the border of each finger. The average numbers of bacteria in each part of hand of dental students before hand washing were shown in Figure 10.

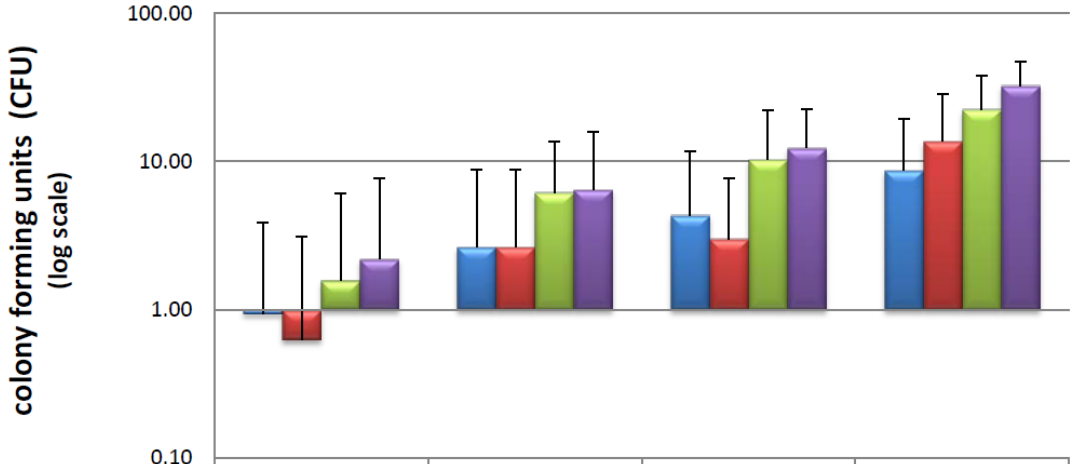



| | 4th-year | 5th-year | 6th-year | postgraduate |
|---|---|---|---|---|
| palm | 5591.25 | 3984.12 | 2532.33 | 4120.42 |
| back of hand | 6270.31 | 4734.71 | 3627.33 | 4806.25 |
| border of each fingers | 4105.00 | 3285.29 | 3437.67 | 3195.83 |
| wrist | 3507.50 | 3030.59 | 3111.67 | 3246.67 |

**Figure 10:** Average numbers of bacteria in each part of hand before hand washing

The highest number of bacteria was found on back of the hand, followed by palm, border of each fingers and wrist, respectively.

After hand washing, the highest number of bacteria was found at the wrist and border of each finger while palm and back of hand was the cleanest site determined by the lowest number of bacteria left after performed hand washing. The average numbers of bacteria in each part of hand of dental students after hand washing were shown in Figure 11.




| | 4th-year | 5th-year | 6th-year | postgraduate |
|---|---|---|---|---|
| palm | 0.94 | 2.65 | 4.33 | 8.75 |
| back of hand | 0.63 | 2.65 | 3.00 | 13.75 |
| border of each fingers | 1.56 | 6.18 | 10.33 | 22.50 |
| wrist | 2.19 | 6.47 | 12.33 | 32.50 |

**Figure 11**: Average numbers of bacteria in each part of hand after hand washing

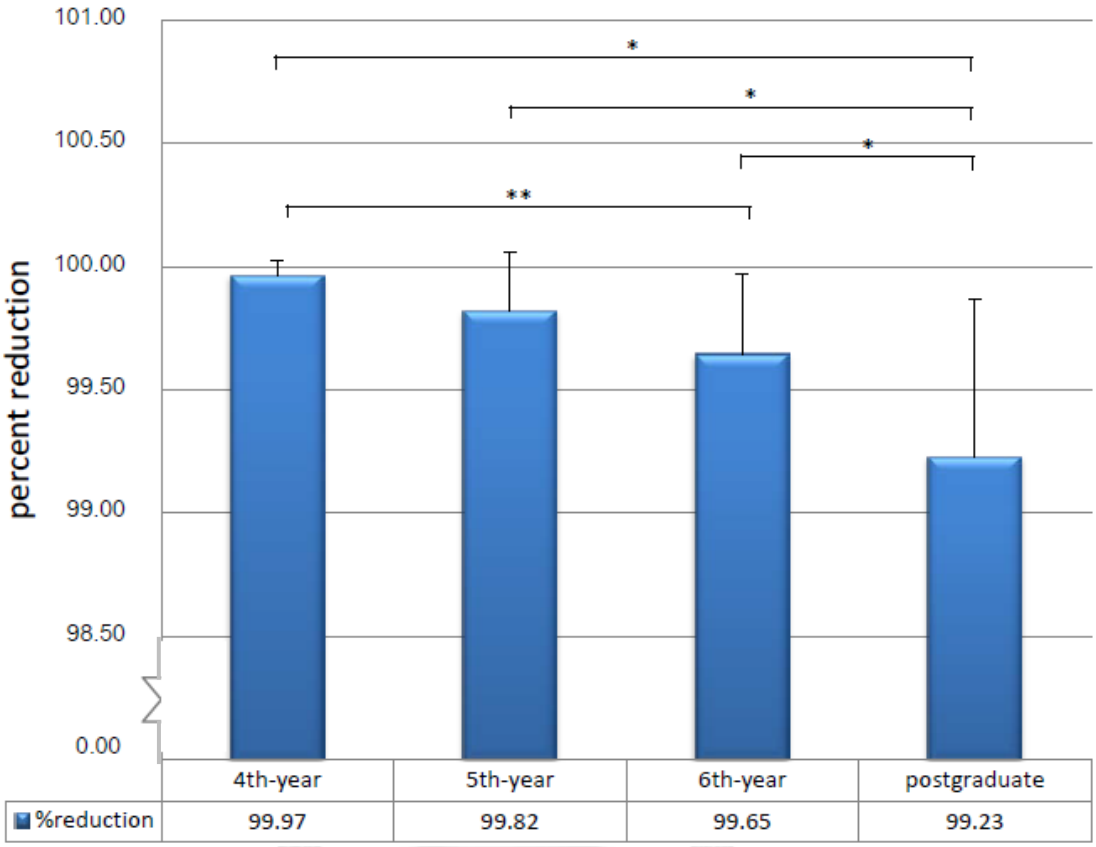
Wrist was the site where dental students had the highest number of bacterial left, followed by border of each finger. PG dental students had higher number of bacterial left after hand washing when compared with UG dental students.



### Efficiency of hand washing

After surgical hand wash, all dental students participating in this study were able to wash their hands effectively as demonstrated by more than 99 percent of bacteria on hand were eliminated. The mean ± SD of percent reductions of bacteria were 99.97 ± 0.06, 99.82 ± 0.24, 99.65 ± 0.32 and 99.23 ± 0.64 in $4^{th}$, $5^{th}$, $6^{th}$ -year UG and PG dental students, respectively. Despite the minimal difference of percent reduction, statistically significant differences were found between PG and all grades of UG dental students, and between $4^{th}$ and $6^{th}$-year UG dental students ($F(3, 116) =$

21.734; $p < 0.001$) (Fig 12). This result was consistent with total number of bacteria on hand after hand washing.




* indicated statistically significant difference at $p < 0.001$

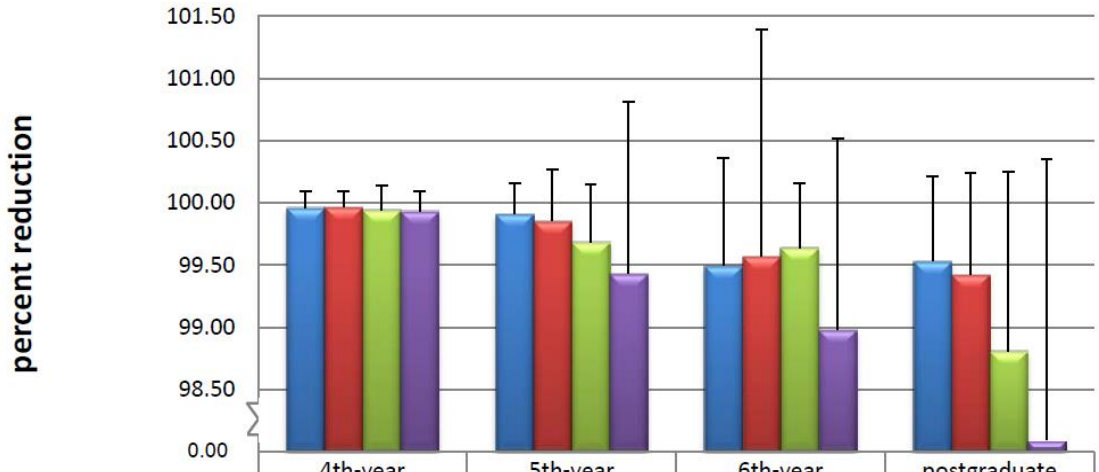
** indicated statistically significant difference at $p = 0.008$

**Figure 12**: Percent reductions of bacteria after hand washing

All UG and PG dental students could eliminate more than 99% of bacterial on their hands by surgical hand wash. However, the statistically significant differences were found between PG and all groups of UG, and between 4th-year and 6th-year UG dental students.

### Efficiency of hand washing in each part of hand

The percent reductions of bacteria on each part of hand of 4th-year UG dental students were comparable. However, the ignorance on wrist and border of each finger were observed in seniors (Fig 13).




| | 4th-year | 5th-year | 6th-year | postgraduate |
|---|---|---|---|---|
| palm | 99.96 | 99.91 | 99.50 | 99.53 |
| back of hand | 99.97 | 99.86 | 99.57 | 99.43 |
| border of each fingers | 99.94 | 99.69 | 99.64 | 98.81 |
| wrist | 99.93 | 99.43 | 98.98 | 98.09 |

**Figure 13**: Percent reductions of recoverable bacteria in each part of hand after surgical hand wash

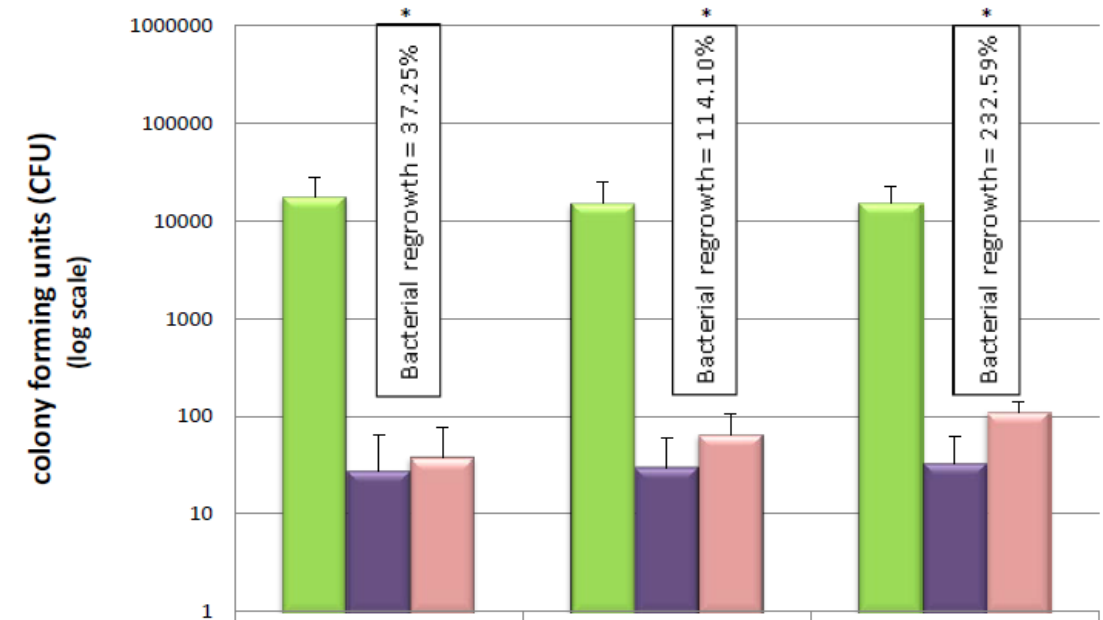
The percent reduction of bacteria was lowest at wrist followed by border of each finger in all groups.



### Number of bacterial regrowth on hand after glove removal

Over all duration of surgical procedures ranging from 45-160 minutes were categorized into 3 periods; <1, 1-2 and > 2 hours. Total numbers of bacteria on hand was substantially reduced after surgical hand wash and re-grown after glove removal at the end of operation. The mean ± SD of CFU counts on hands after glove removal were 37.84 ± 38.35, 63.93 ± 42.34 and 109.29 ± 32.40 when the duration of glove wearing were <1, 1-2 and > 2 hours, respectively. By comparing to number of bacteria after hand washing, percentages of bacterial regrowth were 37.25, 114.10 and 232.59 after donning gloves for <1, 1-2 and > 2 hours, respectively. The number

of bacterial regrowth significantly increased with the longer duration of surgical procedure (F (2, 117) = 42.955; $p < 0.001$). Comparison of total numbers of bacteria on hand before and after hand washing, after glove removal and percentage of bacterial regrowth were shown in Figure 14.




| | <1 hour | 1-2 hours | >2 hours |
|---|---|---|---|
| before hand hygiene | 17462.16 | 14901.59 | 15012.14 |
| after hand hygiene | 27.57 | 29.86 | 32.86 |
| after remove glove | 37.84 | 63.93 | 109.29 |

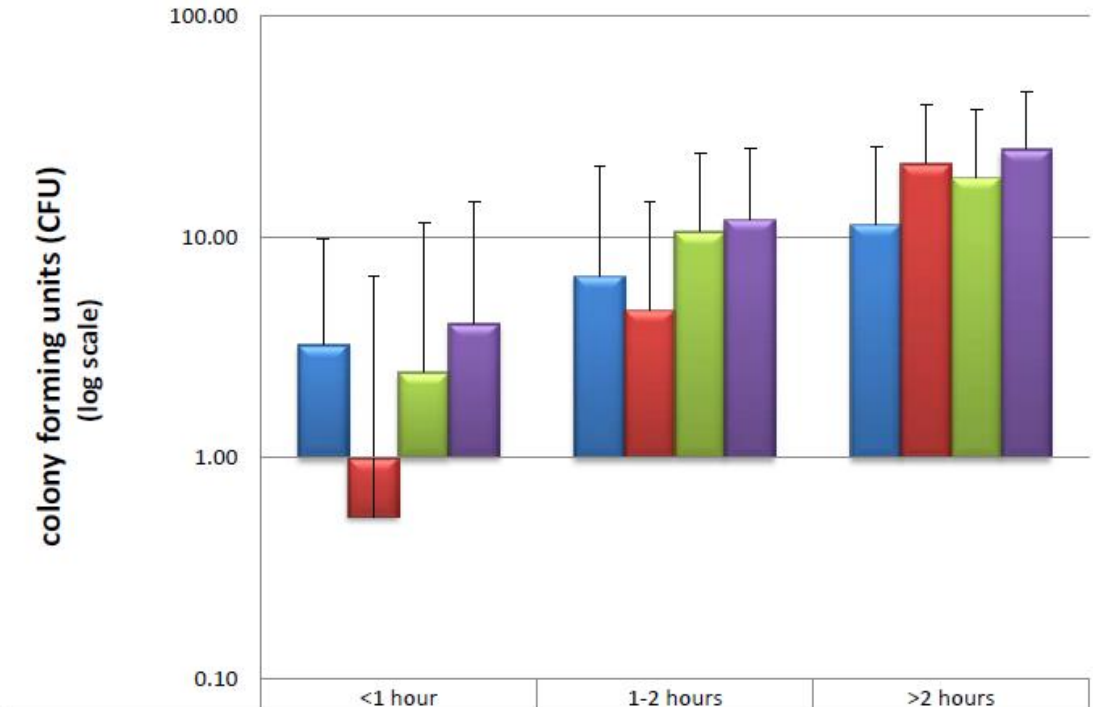
* indicated statistically significant difference at $p < 0.001$

**Figure** 14: The total numbers of bacteria on hand before, after hand hygiene, after glove removal

Total numbers of bacteria on hand was substantial reduction after surgical hand wash and increase after glove removal. Rapid bacterial regrowth was increased according to the duration of surgical procedures.

**Number of bacterial regrowth in each part of hand after glove removal**

Regardless of the duration of surgical procedures, wrist was the part where the highest bacterial regrowth was found as determined by the highest number of recoverable bacteria after glove removal. The back of hand was the site where the lowest bacterial regrowth was found when the duration of surgical procedures was not longer than 2 hours. The average numbers of bacterial regrowth determined by numbers of bacteria in each part of hand after glove removal according the duration of surgical procedure was shown in Figure 15.




| | <1 hour | 1-2 hours | >2 hours |
|---|---|---|---|
| palm | 3.24 | 6.67 | 11.43 |
| back of hand | 0.54 | 4.65 | 21.43 |
| border of each fingers | 2.43 | 10.58 | 18.57 |
| wrist | 4.05 | 12.03 | 25.00 |

**Figure 15**: Average numbers of bacteria in each part of hand after glove removal

Regardless of the duration of surgical procedures, wrist was the part of hand where the highest bacterial regrowth was found. The back of hand was the site of the lowest bacterial regrowth when the duration of surgical procedures was not longer than 2 hours.

# CHAPTER V
# DISCUSSION AND CONCLUSION

The present study was conducted to investigate the effectiveness of hand hygiene, related knowledge, attitude and behavior among dental students. The participants in our study included 4th-year undergraduate dental students who represented the least experienced group enrolled in first year clinical training program, 5th and 6th-year undergraduate dental students, who had more clinical experience, and postgraduate dental students who represented over 5-year experienced dental practitioners. Because of a limited number of students enrolling in postgraduate program, the number of postgraduate dental students was lower than in the other groups.

The efficiency of hand washing in our study was determined by the percent reduction of bacteria after surgical hand wash. For sample collection and quantification, we chose a swab technique and culturing on agar plates instead of hand imprint and glove juice technique(41, 42). This technique allowed us to recover the microorganism burden from the whole hand more efficiently and be capable of collecting the bacterial flora colonized on the groove of the hand that provides a more precise measurement of bacterial contamination in each region of the hand. Microbial species identification was not performed because we primarily focused on a quantitative rather than a qualitative assessment. We collected bacterial samples from the participants' dominant hands prior to hand hygiene because people usually use the dominant hand for daily life activities. Therefore, this data would appropriately represent the average number of bacteria found on people's hands. After hand washing, we could not collect bacterial samples bacteria from the participants' dominant hands again because most of the bacteria were previously removed by the swab. Thus, the bacteria sample remaining after hand hygiene was collected from the participants' non-dominant hands. After glove removal, we collected the bacteria sample from the participants' dominant hand again because

we assumed that there might be more sweat on the dominant hand while performing oral surgical procedures, which may promote bacterial regrowth.

From self-reported questionnaire, although most of dental students indicated that they had knowledge about six-step hand hygiene according to WHO recommended guidelines, only 25-30% of them were able to identify all indications of hand washing correctly. This result is similar to the studies of Graf et al(16), and Kadi and Salati(13), which 21% and 29% of medical students could do so. Our finding reveals a lack of knowledge about the indication for hand washing among dental students even this knowledge is taught in preclinical curriculum. Most of dental students missed at least one correct indication of hand washing, therefore their scores were not significantly different among all groups even they had the different clinical experience. This result differs from the finding of Mortel et al which demonstrated that students' hand hygiene knowledge scores improved over the duration of educated level, particularly with increasing experience of real patient care(15).

Despite the similarity in knowledge of hand washing among postgraduate and all groups of undergraduate dental students, the attitude and behavior of hand washing decreased with increasing educated level. The 4th-year undergraduate dental students had the highest attitude scores and postgraduate dental students had the lowest behavior scores of hand washing. These results reveal that attitude and behavior of hand washing did not correlate with the knowledge of hand washing, but they inversely correlated with the clinical experience. Our finding is supported by previous studies demonstrating that attitude and compliance to hand washing decreased in more experienced clinicians. For example, a study conducted in the university of Saudi Arabia demonstrated that an adherence to hand washing before patient contact was highest among medical students (70%) and lowest among senior medical staffs (9.1%)[12]. Graf et al used a survey sheet to study the beliefs of hand hygiene among medical students in their first clinical year. They found that hand washing compliance would be worse in more experienced physician and senior consultants though they are often considered to be the role models for medical students(16). On contrary, Patarakul et al demonstrated that residents or fellows had

a higher adherence to hand hygiene (16.9%) compared with medical students (3.8%)(10).

From our finding, although the dirtiest part of hand was the back of hand, the highest number of bacterial left after surgical hand wash was at the wrist. This result suggested that wrist was the most neglected site after dental students performed surgical hand wash. Currently, there is no available data regarding the threshold of bacterial contamination on operators' hands that would be critical for surgical site infections. Moreover, we found that hand washing in dental students seems to be effective as more than 99% reduction of bacteria were observed. However, the effectiveness of hand washing decreased with increasing clinical experience as the 4$^{th}$-year undergraduate dental students had the highest percent reduction of bacteria while postgraduate dental students had the lowest percent reduction of bacteria after surgical hand wash. This result was consistent with self-reported attitude and behavior of hand washing. For particular reasons, in this study, during 6-year undergraduate dental curriculum of Chulalongkorn University, infection control class is in the 2$^{nd}$-year and the practice of hand hygiene is in the 4$^{th}$-year just before attending clinical course. This might have a positive influence on the adherence of hand hygiene in 4$^{th}$-year UG dental students enrolling first year clinical training. Since hand hygiene is considered a basic knowledge, it is anticipated that every dental student recognized instinctively without emphasis. Conversely, our result suggested that the hand hygiene should be re-emphasized in higher level of dental students.

Even though chlorhexidine gluconate has residual activity on skin up to 6 hours, rapid microbial regrowth still occur in moist environment under the surgical glove. Particularly, Thailand locates in tropical zone which cause more sweat during doing activity, thus the number of bacterial regrowth on hand in this study was higher than the study of Faoagali et al in the same situation. Interestingly, the number of bacterial regrowth on palm did not increase as high as other parts of the hand when the operation was longer. Still the number of bacterial regrowth after glove removal was not exceeding those amounts founded before hand washing. However, the unnoticeable contamination may be occurred through invisible glove leakage thus hand washing after glove removal should be performed habitually.

To our knowledge, this study is the first report of the effectiveness of hand washing among dental students. It provides the important information on the effectiveness of hand washing related to the clinical experience, which may benefit in improving dental curriculum. Although our dental students practicing in oral surgery clinic had effective hand washing, we found that the more estranging from the emphasis of infection control lesson, the more neglecting to practice hand washing. Thus, infection control program and hand washing practice should be more emphatic and revised every year even in postgraduate dental course.

This study was conducted in a minor oral surgery clinic where the convenient and accessibility to hand washing facilities such as antiseptic hand washing solution, tap water with sink, sterile towel were provided. In this study chlorhexidine gluconate hand washing solution produced from the same manufacturer was dispensed to each participant in the same amount. The participants were allowed to practice hand washing without observing, to let them performed their regular technique, which may vary in technique and length of time depending on each individual. The sample of bacteria on participant's hand was collected by the only one examiner; therefore error from technical variation was less likely to occur.

This study had several limitations. First, an awareness of subjects being a participant, therefore the answers to the questionnaire and hand hygiene performance may not correspond with their usual practice. Second, this study was conducted in Chulalongkorn University only, so it may not be representative of the entire dental students.

To improve effectiveness of hand washing, the influence of different attitude and behavior of dental students should be considered in further study, including role model, using alcohol-based hand rub alternative, educational interventions. Since the attitude and behavior of hand washing were significantly worsen in postgraduate dental students who represented over 5-year experienced dental practitioners, the factors affecting the clinical experience should be concerned.

In conclusion, hand hygiene in dental students seems to be effective. The undergraduate dental students had knowledge of hand washing similar to that of

postgraduate dental students, but they had positive attitude, better behavior and superior effectiveness of hand washing when compared with those of postgraduate dental students.

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# APPENDIX A

Informed Consent Sheet for All Participants (in Thai)

Consent Formed for All Participants (in Thai)

Withdrawal Form in Case Drop-out is Demand (in Thai)

**เอกสารข้อมูลคำอธิบายสำหรับอาสาสมัครที่เข้าร่วมในการวิจัย**

**(Patient/Participant Information Sheet)**

1. โครงการเรื่อง ประสิทธิภาพการล้างมือ, ความรู้, ทัศนคติและพฤติกรรมที่เกี่ยวข้องในนิสิตทันตแพทย์ระดับปริญญาบัณฑิตและหลังหลังปริญญา

2. ชื่อผู้วิจัยหลัก น.ส.นันท์มนัส..แย้มบุตร สถาบันที่สังกัด ภาควิชาศัลยศาสตร์

แหล่งทุนวิจัย 1. The Special Task force for Activating Research (STAR) และ

2. DRU on Oral Microbiology

3. วัตถุประสงค์ของโครงการ เพื่อประเมินความรู้ ทัศนคติ พฤติกรรมและประสิทธิภาพการล้างมือของนิสิตทันตแพทย์ระดับปริญญาและหลังปริญญา

4. สถานที่ดำเนินการวิจัย ภาควิชาศัลยศาสตร์ คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

5. วิธีการที่เกี่ยวข้องกับการวิจัย โดยสรุป

อาสาสมัครจะถูกเก็บตัวอย่างเชื้อจุลชีพบนมือ 3 ช่วงเวลา ได้แก่ ก่อนล้างมือเพื่อทำหัตถการทางศัลยศาสตร์หลังล้างมือเพื่อทำหัตถการทางศัลยศาสตร์ และหลังเสร็จสิ้นหัตถการทางศัลยศาสตร์ โดยการเก็บตัวอย่างเชื้อจะใช้ไม้พันสำลีถูบริเวณหน้ามือ หลังมือ ง่ามนิ้วมือ และข้อมือของอาสาสมัคร จากนั้นจะนำตัวอย่างเชื้อไปทำการเพาะเลี้ยงในห้องปฏิบัติการ ภายหลังการเก็บตัวอย่างเชื้อบนมือจากนั้นอาสาสมัครต้องตอบแบบสอบถามในการประเมินความรู้ ทัศนคติ และพฤติกรรมที่เกี่ยวข้องกับการล้างมือ

6. เหตุผลที่เชิญเข้าร่วมเป็นอาสาสมัครในโครงการ (เช่น "เนื่องจากท่านเป็นผู้ป่วยโรค....." หรือ "เนื่องจากคาดว่าท่านเป็นอาสาสมัครที่มีสุขภาพดี")..

เนื่องจากท่านเป็นนิสิตผู้ทำหัตถการทางศัลยศาสตร์ช่องปากที่คาดว่าต้องใช้เวลานานตั้งแต่ 45 นาทีขึ้นไป

7. ความรับผิดชอบของอาสาสมัคร (ให้ระบุว่า " ขอให้ท่านปฏิบัติตามที่ผู้วิจัยแนะนำ")และ ระยะเวลาที่อาสาสมัครจะอยู่ในโครงการ

ขอให้ท่านปฏิบัติตามที่ผู้วิจัยแนะนำ โดยมีระยะเวลาเข้าร่วมโครงการประมาณ 3 ชั่วโมง

8. ประโยชน์ของการวิจัยที่อาสาสมัครและ/หรือผู้อื่นที่อาจได้รับ

ท่านจะไม่ได้รับประโยชน์โดยตรง ในการร่วมการวิจัยครั้งนี้ แต่ผลการวิจัยที่ได้จะนำไปพัฒนาการเรียนการสอนระบบควบคุมการติดเชื้อในคณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

9. ความเสี่ยงหรือความไม่สะดวกที่อาจจะเกิดขึ้นแก่อาสาสมัคร และในบางกรณีแก่ทารกในครรภ์หรือทารกที่ดื่มนมมารดา

การเข้าร่วมโครงการวิจัยนี้ไม่มีความเสี่ยงใดๆต่ออาสาสมัคร

10. ค่าใช้จ่ายที่อาสาสมัครจะต้องจ่าย หรืออาจจะต้องจ่าย (ขอให้ระบุว่า อาสาสมัครต้องออกค่าใช้จ่ายอะไรบ้างในการรักษาตามปกติ แต่หากขบวนการวิจัยนั้นมีการรักษาหรือตรวจมากเกินกว่ามาตรฐาน ผู้วิจัยและผู้สนับสนุนการวิจัยต้องออกค่าใช้จ่ายส่วนเกินทั้งหมด)

ไม่มี

11. การชดเชยใดๆ และการรักษาที่จะจัดให้แก่อาสาสมัครในกรณีที่ได้รับอันตรายซึ่งเกี่ยวข้องกับการวิจัย

หากท่านได้รับอันตรายจากการทำวิจัย ผู้วิจัยจะดำเนินการให้ท่านได้รับการรักษาโดยผู้วิจัยและผู้สนับสนุนการวิจัยจะเป็นผู้รับผิดชอบค่าใช้จ่ายของการรักษา

12. การจ่ายค่าเดินทาง ค่าเสียเวลา (ถ้ามี) ซึ่งต้องกำหนดไว้เป็นรายครั้ง แก่อาสาสมัครที่เข้าร่วมในการวิจัย (ทั้งนี้ ต้องไม่มีข้อแม้หรือเงื่อนไขใดๆ ทั้งสิ้นในการจ่ายเงิน)

ไม่มี

13. เหตุการณ์ที่อาจจะเกิดขึ้น หรือเหตุผลซึ่งผู้วิจัยจะต้องยกเลิกการเข้าร่วมในโครงการวิจัยของอาสาสมัคร

อาสาสมัครที่ทำหัตถการทางศัลยศาสตร์ช่องปากสิ้นสุดและถอดถุงมือก่อนครบกำหนดเวลา 45 นาที

14. มีการเก็บชิ้นตัวอย่างที่ได้มาจากอาสาสมัครเอาไว้ใช้ในโครงการวิจัยในอนาคตหรือไม่ เก็บจำนวนเท่าไหร่ อย่างไร และที่ไหน

ไม่มี

15. การกำกับดูแลและควบคุมการดำเนินโครงการ

ผู้กำกับดูแลการวิจัย ผู้ตรวจสอบ คณะกรรมการพิจารณาจริยธรรม และคณะกรรมการที่เกี่ยวข้อง สามารถเข้าไปตรวจสอบการดำเนินโครงการ รวมทั้ง ตรวจสอบบันทึกข้อมูลของอาสาสมัคร เพื่อเป็นการยืนยันถึงขั้นตอนในการวิจัยทางคลินิกและข้อมูลอื่นๆ โดยไม่ล่วงละเมิดเอกสิทธิ์ในการปิดบังข้อมูลของอาสาสมัคร ตามกรอบที่กฎหมายและกฎระเบียบได้อนุญาตไว้ นอกจากนี้โดยการลงนามให้ความยินยอม อาสาสมัครหรือผู้แทนตามกฎหมายจะมีสิทธิตรวจสอบและมีสิทธิที่จะได้รับข้อมูลด้วยเช่นกัน

16. จริยธรรมการวิจัย

การดำเนินการโครงการวิจัยนี้ ผู้วิจัยคำนึงถึงหลักจริยธรรมการวิจัย ดังนี้

1. หลักความเคารพในบุคคล (Respect for person) โดยการให้ข้อมูลจนอาสาสมัครเข้าใจเป็นอย่างดี และตัดสินใจอย่างอิสระในการให้ความยินยอมเข้าร่วมในการวิจัย รวมทั้งการเก็บรักษาความลับของอาสาสมัคร

2. หลักการให้ประโยชน์ไม่ก่อให้เกิดอันตราย (Beneficence/Non-Maleficence) ซึ่งได้ระบุในข้อ 8 และ 9 ว่าจะมีประโยชน์หรือความเสี่ยงกับอาสาสมัครหรือไม่

3. หลักความยุติธรรม (Justice) คือมีเกณฑ์คัดเข้าและคัดออกชัดเจน มีการกระจายความเสี่ยงและผลประโยชน์อย่างเท่าเทียมกัน โดยวิธีสุ่มเข้ากลุ่มศึกษา

17. ข้อมูลที่อาจนำไปสู่การเปิดเผยตัวของอาสาสมัครจะได้รับการปกปิด ยกเว้นว่าได้รับคำยินยอมไว้โดยกฎระเบียบและกฎหมายที่เกี่ยวข้องเท่านั้น จึงจะเปิดเผยข้อมูลแก่สาธารณชนได้ ในกรณีที่ผลการวิจัยได้รับการตีพิมพ์ ชื่อและที่อยู่ของอาสาสมัครจะต้องได้รับการปกปิดอยู่เสมอ และอาสาสมัครหรือผู้แทนตามกฎหมายจะได้รับแจ้งโดยทันท่วงที ในกรณีที่มีข้อมูลใหม่ซึ่งอาจใช้ประกอบการตัดสินใจของอาสาสมัครว่าจะยังคงเข้าร่วมในโครงการวิจัยต่อไปได้หรือไม่

18. หากท่านมีข้อสงสัยต้องการสอบถามเกี่ยวกับสิทธิของท่านหรือผู้วิจัยไม่ปฏิบัติตามที่เขียนไว้ในเอกสารข้อมูลคำอธิบายสำหรับผู้เข้าร่วมในการวิจัย ท่านสามารถติดต่อหรือร้องเรียนได้ที่

ฝ่ายวิจัย คณะทันตแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

ตึกสมเด็จย่า 93 ชั้น 10 หรือที่หมายเลขโทรศัพท์ 0-2218-8816 ในเวลาทำการ

19. หากท่านต้องการยกเลิกการเข้าร่วมเป็นอาสาสมัครในโครงการนี้ ให้ท่านกรอกและส่งเอกสารขอยกเลิกมาที่

น.ส.นันท์มนัส แย้มบุตร

240/5 หมู่ 7 ถ.กาญจนาภิเษก แขวงฉิมพลี เขตตลิ่งชัน กรุงเทพฯ 10170

20. อาสาสมัครสามารถติดต่อผู้วิจัยได้ตลอด 24 ชั่วโมง ที่:

น.ส.นันท์มนัส แย้มบุตร 081-4850402

.....

(ทญ.นันท์มนัส แย้มบุตร)

ผู้วิจัยหลัก

วันที่...../...../.....

**เอกสารยินยอมเข้าร่วมการวิจัย (Consent Form)**

การวิจัยเรื่อง ประสิทธิภาพการล้างมือ, ความรู้, ทัศนคติและพฤติกรรมที่เกี่ยวข้องในนิสิตทันตแพทย์ระดับปริญญาบัณฑิตและหลังหลังปริญญา

“ข้าพเจ้า (นาย, นาง, นางสาว, เด็กชาย, เด็กหญิง).....

อยู่บ้านเลขที่.....ถนน.....ตำบล/แขวง.....

อำเภอ/เขต.....จังหวัด.....รหัสไปรษณีย์.... .....

ก่อนที่จะลงนามในใบยินยอมให้ทำการวิจัยนี้ ข้าพเจ้าได้รับเอกสารข้อมูลคำอธิบายสำหรับอาสาสมัครที่เข้าร่วมในการวิจัยแล้ว 1 ฉบับ รวมทั้งได้รับการอธิบายจากผู้วิจัยถึงวัตถุประสงค์ของการวิจัย วิธีการทำวิจัย อันตรายหรืออาการที่อาจเกิดขึ้นจากการทำวิจัยหรือจากยาที่ใช้ รวมทั้งประโยชน์ที่จะเกิดขึ้นจากการวิจัยอย่างละเอียด และมีความเข้าใจดีแล้ว

ผู้วิจัยรับรองว่าจะตอบคำถามต่าง ๆ ที่ข้าพเจ้าสงสัยด้วยความเต็มใจไม่ปิดบังซ่อนเร้นจนข้าพเจ้าพอใจ

ข้าพเจ้าเข้าร่วมโครงการวิจัยนี้โดยสมัครใจ ข้าพเจ้ามีสิทธิที่จะบอกเลิกการเข้าร่วมในโครงการวิจัยนี้เมื่อใดก็ได้และการบอกเลิกการเข้าร่วมการวิจัยนี้จะไม่มีผลต่อการรักษาโรคที่ข้าพเจ้าจะพึงได้รับต่อไป

ผู้วิจัยรับรองว่าจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่าง ๆ ที่เกี่ยวข้องกระทำได้เฉพาะกรณีจำเป็น ด้วยเหตุผลทางวิชาการเท่านั้น และผู้วิจัยรับรองว่าหากเกิดอันตรายใด ๆ จากการวิจัยดังกล่าว ข้าพเจ้าจะได้รับการรักษาพยาบาลโดยไม่คิดมูลค่า

ข้าพเจ้าได้อ่านเอกสารและข้อความข้างต้นแล้ว มีความเข้าใจดีทุกประการ และได้ลงนามในใบยินยอมนี้ด้วยความเต็มใจ

ข้าพเจ้าได้รับสำเนาเอกสารใบยินยอมที่ข้าพเจ้าลงนามและลงวันที่ และเอกสารยกเลิกการเข้าร่วมวิจัย อย่างละ 1 ฉบับ เป็นที่เรียบร้อยแล้ว

ลงนาม.....ผู้ยินยอม

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....พยาน

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....ผู้วิจัยหลัก

(ทญ.นันท์มนัส แย้มบุตร)

วันที่.....เดือน.....พ.ศ.....

ข้าพเจ้าไม่สามารถอ่านหนังสือได้ แต่ผู้วิจัยได้อ่านข้อความในใบยินยอมนี้ให้แก่ข้าพเจ้าฟังจนเข้าใจดีแล้ว ข้าพเจ้าจึงลงนาม หรือประทับลายนิ้วหัวแม่มือขวาของข้าพเจ้าในใบยินยอมนี้ด้วยความเต็มใจ



ลงนาม.....ผู้ยินยอม

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....พยาน

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....ผู้วิจัยหลัก

(ทญ.นันท์มนัส แย้มบุตร)

วันที่.....เดือน.....พ.ศ.....

ในกรณีที่ผู้ถูกทดลองยังไม่บรรลุนิติภาวะ จะต้องได้รับการยินยอมจากผู้ปกครองหรือผู้อุปการะโดยชอบด้วยกฎหมาย

ลงนาม.....ผู้ปกครอง

(.....)

วันที่.....เดือน.....พ.ศ.....



ลงนาม.....พยาน

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....ผู้วิจัยหลัก

(ทญ.นันท์มนัส แย้มบุตร)

วันที่.....เดือน.....พ.ศ.....

**เอกสารยกเลิกการเข้าร่วมวิจัย (Withdrawal Form)**

การวิจัยเรื่อง ประสิทธิภาพการล้างมือ, ความรู้, ทัศนคติและพฤติกรรมที่เกี่ยวข้องในนิสิตทันตแพทย์ระดับปริญญาบัณฑิตและหลังหลังปริญญา

“ข้าพเจ้า (นาย, นาง, นางสาว, เด็กชาย, เด็กหญิง).....

อยู่บ้านเลขที่.....ถนน.....ตำบล/แขวง.....

อำเภอ/เขต.....จังหวัด.....รหัสไปรษณีย์.....

ขอยกเลิกการเข้าร่วมโครงการวิจัยนี้ โดยมีเหตุผลในการยกเลิกการเข้าร่วมวิจัยคือ

- ❑ ย้ายภูมิลำเนา
- ❑ ไม่สะดวกในการเดินทาง
- ❑ เหตุผลอื่น.....

ลงนาม.....ผู้ยกเลิก

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....พยาน

(.....)

วันที่.....เดือน.....พ.ศ.....

ลงนาม.....ผู้วิจัยหลัก

(น.ส.นันท์มนัส แย้มบุตร)

วันที่.....เดือน.....พ.ศ.....

**ที่อยู่สำหรับส่งเอกสาร** ชื่อ น.ส.นันท์มนัส..แย้มบุตร

บ้านเลขที่ 240/5 ถนนกาญจนาภิเษก ตำบล/แขวงฉิมพลี อำเภอ/เขตตลิ่งชัน กรุงเทพฯ 10170

# APPENDIX B

## Statistic Output

**Table 1:** Descriptive analysis in the knowledge of hand washing among dental students

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| total score of knowledge | 120 | 3 | 5 | 4.19 | .626 |
| Valid N (listwise) | 120 | | | | |

**Table 2-4:** Comparison in the knowledge of hand washing among dental students

**ANOVA**

total score of knowledge

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .880 | 3 | .293 | .745 | .528 |
| Within Groups | 45.711 | 116 | .394 | | |
| Total | 46.592 | 119 | | | |

**Multiple Comparisons**

total score of knowledge

Scheffe

| (I) grade | (J) grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| grade 4 | grade 5 | .046 | .155 | .993 | -.39 | .48 |
| | grade 6 | .115 | .160 | .915 | -.34 | .57 |
| | postgrad. | .240 | .170 | .575 | -.24 | .72 |
| grade 5 | grade 4 | -.046 | .155 | .993 | -.48 | .39 |
| | grade 6 | .069 | .157 | .979 | -.38 | .51 |
| | postgrad. | .194 | .167 | .720 | -.28 | .67 |
| grade 6 | grade 4 | -.115 | .160 | .915 | -.57 | .34 |
| | grade 5 | -.069 | .157 | .979 | -.51 | .38 |
| | postgrad. | .125 | .172 | .912 | -.36 | .61 |
| postgrad. | grade 4 | -.240 | .170 | .575 | -.72 | .24 |
| | grade 5 | -.194 | .167 | .720 | -.67 | .28 |
| | grade 6 | -.125 | .172 | .912 | -.61 | .36 |

**total score of knowledge**

Scheffe[a,b]

| grade | N | Subset for alpha = 0.05 |
|---|---|---|
| | | 1 |
| postgrad. | 24 | 4.04 |
| grade 6 | 30 | 4.17 |
| grade 5 | 34 | 4.24 |
| grade 4 | 32 | 4.28 |
| Sig. | | .544 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

**Table 5:** Descriptive analysis in the attitudes of hand washing among dental students

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| total score of attitude | 120 | 7 | 12 | 10.25 | 1.132 |
| Valid N (listwise) | 120 | | | | |

**Table 6-8:** Comparison in the attitudes of hand washing among dental students

**ANOVA**

total score of attitude

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 30.931 | 3 | 10.310 | 9.838 | .000 |
| Within Groups | 121.569 | 116 | 1.048 | | |
| Total | 152.500 | 119 | | | |

**Multiple Comparisons**

total score of attitude

Scheffe

| (I) grade | (J) grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| grade 4 | grade 5 | .974* | .252 | .003 | .26 | 1.69 |
| | grade 6 | 1.063* | .260 | .001 | .32 | 1.80 |
| | postgrad. | 1.354* | .276 | .000 | .57 | 2.14 |
| grade 5 | grade 4 | -.974* | .252 | .003 | -1.69 | -.26 |
| | grade 6 | .088 | .256 | .989 | -.64 | .82 |
| | postgrad. | .380 | .273 | .587 | -.39 | 1.15 |
| grade 6 | grade 4 | -1.063* | .260 | .001 | -1.80 | -.32 |
| | grade 5 | -.088 | .256 | .989 | -.82 | .64 |
| | postgrad. | .292 | .280 | .781 | -.50 | 1.09 |
| postgrad. | grade 4 | -1.354* | .276 | .000 | -2.14 | -.57 |
| | grade 5 | -.380 | .273 | .587 | -1.15 | .39 |
| | grade 6 | -.292 | .280 | .781 | -1.09 | .50 |

*. The mean difference is significant at the 0.05 level.

**total score of attitude**

Scheffe[a,b]

| grade | N | Subset for alpha = 0.05 | |
|---|---|---|---|
| | | 1 | 2 |
| postgrad. | 24 | 9.71 | |
| grade 6 | 30 | 10.00 | |
| grade 5 | 34 | 10.09 | |
| grade 4 | 32 | | 11.06 |
| Sig. | | .568 | 1.000 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

**Table 9:** Descriptive analysis in the behaviors of hand washing among dental students

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| total score of behavior | 120 | 1 | 5 | 2.34 | .865 |
| Valid N (listwise) | 120 | | | | |

**Table 10-12:** Comparison in the behaviors of hand washing among dental students

**ANOVA**

total score of behavior

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 44.971 | 3 | 14.990 | 39.501 | .000 |
| Within Groups | 44.021 | 116 | .379 | | |
| Total | 88.992 | 119 | | | |

**Multiple Comparisons**

total score of behavior

Scheffe

| (I) grade | (J) grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| grade 4 | grade 5 | .132 | .152 | .859 | -.30 | .56 |
| | grade 6 | .183 | .157 | .713 | -.26 | .63 |
| | postgrad. | 1.625* | .166 | .000 | 1.15 | 2.10 |
| grade 5 | grade 4 | -.132 | .152 | .859 | -.56 | .30 |
| | grade 6 | .051 | .154 | .991 | -.39 | .49 |
| | postgrad. | 1.493* | .164 | .000 | 1.03 | 1.96 |
| grade 6 | grade 4 | -.183 | .157 | .713 | -.63 | .26 |
| | grade 5 | -.051 | .154 | .991 | -.49 | .39 |
| | postgrad. | 1.442* | .169 | .000 | .96 | 1.92 |
| postgrad. | grade 4 | -1.625* | .166 | .000 | -2.10 | -1.15 |
| | grade 5 | -1.493* | .164 | .000 | -1.96 | -1.03 |
| | grade 6 | -1.442* | .169 | .000 | -1.92 | -.96 |

*. The mean difference is significant at the 0.05 level.

**total score of behavior**

Scheffe[a,b]

| grade | N | Subset for alpha = 0.05 | |
|---|---|---|---|
| | | 1 | 2 |
| postgrad. | 24 | 1.13 | |
| grade 6 | 30 | | 2.57 |
| grade 5 | 34 | | 2.62 |
| grade 4 | 32 | | 2.75 |
| Sig. | | 1.000 | .728 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

**Table 13:** Descriptive analysis in the number of bacteria on hand before hand washing among dental students

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| BH remaining CFU on hand | 120 | 2230 | 53100 | 15704.00 | 9901.986 |
| Valid N (listwise) | 120 | | | | |

**Table 14-16:** Comparison in the number of bacteria on hand before hand washing among dental students

**ANOVA**

BH remaining CFU on hand

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 7.418E8 | 3 | 2.473E8 | 2.625 | .054 |
| Within Groups | 1.093E10 | 116 | 94189836.830 | | |
| Total | 1.167E10 | 119 | | | |

**Multiple Comparisons**

BH remaining CFU on hand

Scheffe

| (I) grade | (J) grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| grade 4 | grade 5 | 4439.357 | 2390.339 | .332 | -2341.98 | 11220.69 |
| | grade 6 | 6765.063 | 2466.393 | .062 | -232.03 | 13762.16 |
| | postgraduate | 4104.896 | 2620.689 | .487 | -3329.93 | 11539.72 |
| grade 5 | grade 4 | -4439.357 | 2390.339 | .332 | -11220.69 | 2341.98 |
| | grade 6 | 2325.706 | 2431.039 | .822 | -4571.09 | 9222.50 |
| | postgraduate | -334.461 | 2587.444 | .999 | -7674.97 | 7006.05 |
| grade 6 | grade 4 | -6765.063 | 2466.393 | .062 | -13762.16 | 232.03 |
| | grade 5 | -2325.706 | 2431.039 | .822 | -9222.50 | 4571.09 |
| | postgraduate | -2660.167 | 2657.863 | .801 | -10200.46 | 4880.13 |
| postgraduate | grade 4 | -4104.896 | 2620.689 | .487 | -11539.72 | 3329.93 |
| | grade 5 | 334.461 | 2587.444 | .999 | -7006.05 | 7674.97 |
| | grade 6 | 2660.167 | 2657.863 | .801 | -4880.13 | 10200.46 |

**BH remaining CFU on hand**

Scheffe[a,b]

| grade | N | Subset for alpha = 0.05 |
|---|---|---|
| | | 1 |
| grade 6 | 30 | 12709.00 |
| grade 5 | 34 | 15034.71 |
| postgraduate | 24 | 15369.17 |
| grade 4 | 32 | 19474.06 |
| Sig. | | .073 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.



**Table 17:** Descriptive analysis in the number of bacteria on hand after hand washing among dental students

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| AH remaining CFU on hand | 120 | 0 | 180 | 29.50 | 32.639 |
| Valid N (listwise) | 120 | | | | |

**Table 18-20:** Comparison in the number of bacteria on hand before hand washing among dental students

**ANOVA**

AH remaining CFU on hand

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 78567.243 | 3 | 26189.081 | 63.024 | .000 |
| Within Groups | 48202.757 | 116 | 415.541 | | |
| Total | 126770.000 | 119 | | | |

**Multiple Comparisons**

AH remaining CFU on hand

Scheffe

| (I) grade | (J) grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| grade 4 | grade 5 | -12.629 | 5.021 | .103 | -26.87 | 1.61 |
| | grade 6 | -24.688* | 5.180 | .000 | -39.38 | -9.99 |
| | postgraduate | -72.188* | 5.505 | .000 | -87.80 | -56.57 |
| grade 5 | grade 4 | 12.629 | 5.021 | .103 | -1.61 | 26.87 |
| | grade 6 | -12.059 | 5.106 | .140 | -26.54 | 2.43 |
| | postgraduate | -59.559* | 5.435 | .000 | -74.98 | -44.14 |
| grade 6 | grade 4 | 24.688* | 5.180 | .000 | 9.99 | 39.38 |
| | grade 5 | 12.059 | 5.106 | .140 | -2.43 | 26.54 |
| | postgraduate | -47.500* | 5.583 | .000 | -63.34 | -31.66 |
| postgraduate | grade 4 | 72.188* | 5.505 | .000 | 56.57 | 87.80 |
| | grade 5 | 59.559* | 5.435 | .000 | 44.14 | 74.98 |
| | grade 6 | 47.500* | 5.583 | .000 | 31.66 | 63.34 |

*. The mean difference is significant at the 0.05 level.

**AH remaining CFU on hand**

Scheffe[a,b]

| grade | N | Subset for alpha = 0.05 | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| grade 4 | 32 | 5.31 | | |
| grade 5 | 34 | 17.94 | 17.94 | |
| grade 6 | 30 | | 30.00 | |
| postgraduate | 24 | | | 77.50 |
| Sig. | | .136 | .167 | 1.000 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

**Table 21:** Descriptive analysis in the percent reduction of bacteria on hand after hand washing among dental students

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| PR remaining CFU on hand | 120 | 97.24 | 100.00 | 99.6976 | .43600 |
| Valid N (listwise) | 120 | | | | |

**Table 22-24:** Comparison in the percent reduction of bacteria on hand after hand washing among dental students

**ANOVA**

PR remaining CFU on hand

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 8.140 | 3 | 2.713 | 21.734 | .000 |
| Within Groups | 14.482 | 116 | .125 | | |
| Total | 22.622 | 119 | | | |

**Multiple Comparisons**

PR remaining CFU on hand

Scheffe

| (I) grade | (J) grade | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| grade 4 | grade 5 | .14471 | .08702 | .433 | -.1022 | .3916 |
| | grade 6 | .31700* | .08979 | .008 | .0623 | .5717 |
| | postgraduate | .73583* | .09541 | .000 | .4652 | 1.0065 |
| grade 5 | grade 4 | -.14471 | .08702 | .433 | -.3916 | .1022 |
| | grade 6 | .17229 | .08851 | .290 | -.0788 | .4234 |
| | postgraduate | .59113* | .09420 | .000 | .3239 | .8584 |
| grade 6 | grade 4 | -.31700* | .08979 | .008 | -.5717 | -.0623 |
| | grade 5 | -.17229 | .08851 | .290 | -.4234 | .0788 |
| | postgraduate | .41883* | .09676 | .001 | .1443 | .6933 |
| postgraduate | grade 4 | -.73583* | .09541 | .000 | -1.0065 | -.4652 |
| | grade 5 | -.59113* | .09420 | .000 | -.8584 | -.3239 |
| | grade 6 | -.41883* | .09676 | .001 | -.6933 | -.1443 |

*. The mean difference is significant at the 0.05 level.

**PR remaining CFU on hand**

Scheffe[a,b]

| grade | N | Subset for alpha = 0.05 | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| postgraduate | 24 | 99.2292 | | |
| grade 6 | 30 | | 99.6480 | |
| grade 5 | 34 | | 99.8203 | 99.8203 |
| grade 4 | 32 | | | 99.9650 |
| Sig. | | 1.000 | .325 | .483 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 29.485.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

**Table 25:** Descriptive analysis in the number of bacteria regrowth on hand after glove removal

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| total number of bacterial regrowth on hand | 120 | -10 | 140 | 31.67 | 30.015 |
| Valid N (listwise) | 120 | | | | |

**Table 26-28:** Comparison in the number of bacteria regrowth on hand after glove removal

**ANOVA**

total number of bacterial regrowth on hand

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 45388.961 | 2 | 22694.481 | 42.955 | .000 |
| Within Groups | 61815.364 | 117 | 528.336 | | |
| Total | 107204.325 | 119 | | | |

**Multiple Comparisons**

total number of bacterial regrowth on hand

Scheffe

| (I) duration | (J) duration | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| less than 1 hour | 1 to 2 hours | -23.802* | 4.684 | .000 | -35.41 | -12.19 |
| | more than 2 hours | -66.158* | 7.212 | .000 | -84.04 | -48.28 |
| 1 to 2 hours | less than 1 hour | 23.802* | 4.684 | .000 | 12.19 | 35.41 |
| | more than 2 hours | -42.356* | 6.738 | .000 | -59.06 | -25.65 |
| more than 2 hours | less than 1 hour | 66.158* | 7.212 | .000 | 48.28 | 84.04 |
| | 1 to 2 hours | 42.356* | 6.738 | .000 | 25.65 | 59.06 |

*. The mean difference is significant at the 0.05 level.

**total number of bacterial regrowth on hand**

Scheffe[a,b]

| duration | N | Subset for alpha = 0.05 | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| less than 1 hour | 37 | 10.27 | | |
| 1 to 2 hours | 69 | | 34.07 | |
| more than 2 hours | 14 | | | 76.43 |
| Sig. | | 1.000 | 1.000 | 1.000 |

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 26.561.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

**Table 29:** The correlation between number of bacterial regrowth on hand after glove removal and duration of surgical operation

**Correlations**

| | | total number of bacterial regrowth on hand | duration |
|---|---|---|---|
| total number of bacterial regrowth on hand | Pearson Correlation | 1 | .635** |
| | Sig. (2-tailed) | | .000 |
| | N | 120 | 120 |
| duration | Pearson Correlation | .635** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 120 | 120 |

**Correlations**

| | | total number of bacterial regrowth on hand | duration |
|---|---|---|---|
| total number of bacterial regrowth on hand | Pearson Correlation | 1 | .635** |
| | Sig. (2-tailed) | | .000 |
| | N | 120 | 120 |
| duration | Pearson Correlation | .635** | 1 |
| | Sig. (2-tailed) | .000 | |
| | N | 120 | 120 |

**. Correlation is significant at the 0.01 level (2-tailed).

# VITA

Nanmanas Yaembut (นันท์มนัส แย้มบุตร)

Student, Master of Science Program in Oral and Maxillofacial Surgery, Faculty of Dentistry, Chulalongkorn University