Deanship of Graduate Studies

Al-Quds University

Soap contamination by *Pseudomonas aeruginosa* in hospitals care units in Bethlehem and Hebron (West Bank, Palestine)

Shahd Raed Helmi AL-Qaisse

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Prepared by:

Shahd Raed Helmi AL-Qaisse

B. Sc: Biology / Medical laboratory science, Bethlehem University – Bethlehem

Supervisor: Dr. Gabi Abusadaa

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Thesis Approval

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Prepared by: Shahd Raed Helmi AL-Qaissi

Registration No: 22312406

Supervisor: Dr. Gabi Abusadaa

Master thesis submitted and accepted: 3/1/2026

The names and signatures of the examining committee members are as follows:

Head of Committee: Dr. Gabi Abusadaa

Internal Examiner: Dr. Hatem Eideh

External Examiner: Dr. Ghassan Handal

Jerusalem – Palestine

1447-2025

Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged, and that this study (or any part of the same) has not been submitted for a higher degree to any other university or institute.

Signed: 

Shahd Raed Helmi AL-Qaisse

Date: 3/1/2026

Dedication

I dedicate this research to my dear father, Raed, who has been the first one to encourage me on this journey. He has always been my biggest supporter in everything, standing by me through every challenge until I arrived where I am today.

To my beloved mother, whose unwavering prayers and affection have continually uplifted me.

And to my siblings: Bashar, Mariana, Rani, and Lourd, you are the most valuable people in my life.

To the spirit of my grandmother, may you rest in peace.

And finally, to my close ones, my friends, and all who have been there for me.

Shahd Raed Helmi AL-Qaissi

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Abstract

Background: Washing hands with contaminated soap can increase the exposure to opportunistic pathogens and may contribute to the transmission of bacteria in public environments. One of these pathogens is *Pseudomonas aeruginosa* a gram-negative environmental bacterium, that predominantly lives in humid environment. It is a major cause of nosocomial infections in hospitals and causes acute or chronic infections in immunocompromised individuals. In addition, *P. aeruginosa* has an inherent resistance to antimicrobial agents, which can be more aggressive and cause severe therapeutic problems. However, *P. aeruginosa* as an opportunistic pathogen can activate useful phenotypes under environmental stress and persist in harmful situations such as the presence of antibiotic or antiseptic substances.

Aim: To investigate the prevalence of *P. aeruginosa* contamination in soaps across hospital care units in Bethlehem and Hebron, Palestine.

Methods: Soaps samples (N=79) were collected from various sections including, Intensive care units, Internal medicine units, Cardiac care units, Pediatric Oncology Department, Dialysis units, Rehabilitation, Post-natal care, Delivery room, Postnatal unit and Surgery. All samples were cultured in cetrimide agar plates for the isolation of *P. aeruginosa* without prior dilution. Preliminary tests including Gram stain, oxidase and growth at 42°C, coupled with Biochemical Identification using API 20 NE, used as confirmation tests for *P. aeruginosa.*

Results: Out of 79 soap samples collected from different care units, 15 (18.98%) samples tested positively for *P. aeruginosa.* From Bethlehem hospitals, out of forty-five samples there are 6 (7.59%) positive samples were detected. However, thirty-four samples from Hebron hospitals, 9 (11.39%) were positive samples contaminated with *P. aeruginosa*. On the other hand, the results showed that among the samples collected, only 3/15 (20%) positive samples used by medical staff, while 12/15 (80%) positive samples were used by patients and their companions.

Conclusion and recommendations: All positive samples in this study were obtained from refilled soap dispensers; these findings support the notion that refillable soap dispensers are more susceptible to bacterial contamination likely due to accumulation of liquid in the pump head. Accordingly, positive samples in this study may be attributed to several factors including the presence of some soap bottles without a cover pump, unhygienic bathrooms, unclean sinks, or perhaps the contamination occurred in some way through tap water. In addition, the ability of *P. aeruginosa* to form biofilm may enhance its persistence, virulence and resist to antimicrobial agents. Antibiotic resistance represents a major and growing global public concern. Thus, reducing the transmission of bacterial pathogen among patients is essential to limit antibiotic use and slowing the antibiotic resistance.

Hence, it is important to ensure that effective hand hygiene is the most effective method mainly in healthcare settings, washing hands with proper and uncontaminated soap by medical staff or patients can help to reduce nosocomial infections. Consequently, hospitals are strongly encouraged to replace refillable soap dispenser with disposable, sealed nonrefillable system to ensure sterile and effective hand washing practices.

Keywords: *P. aeruginosa*, handwashing, refillable soap dispenser, soap contamination, hospital acquired infections (HAIs).

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List of Abbreviation

P. aeruginosa	*Pseudomonas aeruginosa*
WHO	The World Health Organization
API 20 NE	Analytical profile index 20 non-Enterobacteriaceae
HAIs	Hospital acquired infections
NIs	Nosocomial infection
CDC	Centers for Disease Control
CF	Cystic fibrosis
AMR	Antimicrobial resistance
MIC	Minimum inhibition concertation
AR	Antibiotic resistance
ESBL	Extended Spectrum Beta-Lactamase
AmpC	AmpC β-lactamase
EPS	Extracellular polymeric substances
LPS	Lipopolysaccharide
eDNA	Extracellular DNA
COVID-19	Coronavirus disease of 2019
AST	Antibiotic susceptibility test
BLI	β-lactamase inhibitors
MDR	Multi-drug resistance
XDR	Extensively-drug resistance
PDR	Pan-drug-resistant
CFU	Colony Forming Units
DLST	Double locus sequence typing
TSA	Tryptic soy agar
MAC	MacConkey agar
RAPD	Random amplification of polymorphic DNA
SMR	Small multidrug resistance
SMP	Small multidrug proteins

SUG	Suppressor of GroEL mutations
PSMR	Paired small multidrug resistance
QMRA	Quantitative microbial risk assessment
PCR	Polymerase chain reaction
pH	Hydrogen ion concentration
ARG	Antimicrobial resistance gene
IM	Internal medicine units
CCU	Cardiac care units
POD	Pediatric Oncology Department
PNC	Post-natal care
DR	Delivery room
TSI	Triple Sugar Iron
+ve	Positive
-ve	Negative
Pt	Patient

Chapter One

1.1 Introduction

Nowadays, the resistance of bacteria to antibiotics is increasing due to the random use of antibiotics. Therefore, it is possible for bacteria to survive and proliferate inside disinfectants and sterilizers, including *Pseudomonas aeruginosa*, which can live in medical environments and can be seen through blood, soap, and water (Gitter et al., 2024). *P. aeruginosa* is a gram-negative bacillus, thrives in aquatic environments and is an opportunistic bacterium that can colonize many living things, such as plants, animals, and humans. It interacts with host cell by flagella, pili and has a secretion system on outer membrane that provide it resistance to antimicrobial agents and it has the largest bacterial genome, which belongs to the ESKAPE group, that includes *Enterococcus faecium*, *Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii*, *P. aeruginosa*, and *Enterobacter* species (Botelho et al. 2019).

Their ability to "escape" the effects of antibiotics can underscore their impact on hospital infections. Moreover, *P. aeruginosa* is frequently responsible for emerging nosocomial infections (Sainz-Mejías et al., 2020). In fact, hospital-acquired infections (HAIs) is a globally significant problem and major concern because it contributes to increased morbidity and mortality rates. Nosocomial infection (NIs) is acquired within 48 hours of hospitalization (Aiesh et al., 2023). The US Centers for Disease Control and Prevention (CDC) reports that approximately 1.7 million hospital patients each year develop healthcare-associated infections while being treated for other health problems (Haque et al.,2018).

In Palestine, the ability of *P. aeruginosa* to thrive in hospital environments with high resistance to antibiotics (Adwan et al.,2019). In intensive care units (ICUs), it plays a significant role in NIs and causes death of patients. In addition, there are several factors that contribute directly to developing nosocomial infections in patients who are in intensive wards within the hospital, including: advanced age, immunosuppression, urinary catheter, mechanical ventilation, and length of hospital stay (Qin et al.,2022). Furthermore, contaminated bedding, aerosols, tools, and equipment of healthcare workers and poor hand hygiene practices can also lead to increased risk of NIs.

Besides, patients in care units with suspected infection may not require antibiotics unless the infection is confirmed using microbiology tests, even if they are not in septic shock. Thereby, this way may decrease nosocomial infections and multi-drug resistance (Aiesh et al.,2023).

Interestingly, in the ICU, *P. aeruginosa* is responsible for a higher percentage of healthcare infections. (Reynolds & Kollef, 2021). Consequently, it can cause many serious diseases with acute and chronic life-threatening infections, including: endocarditis, bone and joint infections, ventilators associated pneumonia, urinary tract infections, digestive infections, meningitis, septicemia, and infection in patients with cystic fibrosis (CF) (Sharma et al., 2014). In addition, it can be found in low nutrients, as well as in rich nutrients habitat food such as wastewater and the human body (Mena & Gerba, 2009).

Many studies show that *P. aeruginosa* can resist the antiseptic agents, it is rapidly developing antimicrobial resistance (AMR), and showing increased tolerance to antiseptics such as chlorhexidine, cetylpyridinium chloride, povidone-iodine, triclosan, and hydrogen peroxide. Repeated exposure to these antiseptics increases the bacterial adaptation and their minimum inhibition concertation (MIC) (Karpiński et al., 2025). However, triclosan is a commonly used antiseptic in hospitals due to its broad antimicrobial activity.

In general, *P. aeruginosa* has a main remarkable mechanism that assists it to be more aggressive in antibiotic resistance (AR), and is classified into intrinsic, acquired, and adaptive resistance. Intrinsic resistance is a natural ability to resist by including low outer membrane permeability, expression of efflux pumps with various types, such as (MexAB-OprM, MexCD-OprJ, MexEF-OprN, and MexXY/OprM) that expel antibiotics out of the cell, and production of antibiotic-inactivating enzymes like Extended Spectrum Beta-Lactamase (ESBL) and AmpC β-lactamase (AmpC), which can break down the β-lactam ring in antibiotics, including penicillin, cephalosporins, and carbapenems (Botelho et al. 2019; Jacoby 2009).

The acquired resistance can be achieved by either mutations in genes or horizontal transfer of resistance genes (Pang et al., 2019). On the other hand, adaptive resistance is the ability of *P. aeruginosa* to survive despite some environmental conditions, such as anaerobiosis and the presence of antibiotics, and where it can form biofilms. This matrix structure allows *P. aeruginosa* to survive and persist in cystic fibrosis lung polymicrobial environments (Botelho et al. 2019).

Nevertheless, Liquid soap can become contaminated with bacteria and is a known health risk in healthcare settings especially the soap in the bulk-soap-refillable dispenser. Furthermore, several outbreaks associated with the use of contaminated soap in health care settings have been reported. Refillable bulk soap dispensers are the dominant type of dispenser in community settings, such as hospitals and public restrooms (Zapka et al., 2011). The pump mechanism allows *P. aeruginosa* to form biofilms, where bacteria can survive and resist the soap's preservatives, then transfer to the user's hands (Lucassen et al., 2023).

Significantly, contaminated hands of healthcare providers are an essential source of pathogens. On the other hand, suitable manual hygiene reduces the multiplication of microorganisms. Whereas handwashing practices in the patient care setting decreased pathogens responsible for nosocomial infections. According to the Centers for Disease Control and Prevention (CDC), manual hygiene is the most important practice in reducing the transmission of infection in health care settings (Toney-Butler et al., 2023).

Additionally, the overuse of disinfectants and soaps during the COVID-19 pandemic has driven bacteria to evolve new characteristics, enhancing their resistance and adaptability to diverse environments (Vadadoriya et al., 2024). Consequently, patient safety is a priority of any healthcare system. For this purpose, washing hands with soap and water is a universally accepted practice and the first line to reduce the transmission of microorganisms.

Five Moments for Hand Hygiene published by WHO, as follows: before touching a patient, before clean or aseptic procedure, after body fluid exposure risk, after touching a patient, and after touching patient surroundings (World Health Organization (WHO), 2023). If the health worker is present at these five moments, they can certainly reduce the hospital infection rate, and the treatment can be more effective. The ability of *P. aeruginosa* to live in soap in hospital settings, especially those with immunocompromised patients such as intensive care, dialysis, neonatal, and oncology therapy, makes them the most vulnerable groups to infection. Certain research has highlighted the significance of the humid environment as a reservoir of nosocomial *P. aeruginosa* strains; some of these reservoirs are difficult to avoid, like taps and siphons (Lombardi et al., 2025). This poses a serious risk to their lives due to the potential transmission of these resistant bacteria.

In view of these considerations, obtaining a culture and antibiotic susceptibility test (AST) prior to taking random antibiotics is very crucial. Thus, an appropriate culture obtained from a suitable site at the right time makes diagnosis of *P. aeruginosa* infection easier and more effective. For example, blood cultures should be taken before antibiotics are obtained, and the culture for CF should be taken immediately. Selective media for *P. aeruginosa* also make a difference in diagnosis, such as cetrimide medium is used for polymicrobial samples. *P. aeruginosa* can also be distinguished via critical testing, including its fruity odor, lactose, growth at 42 ° C, and positive oxidase reaction.

Currently, there are automated devices with kits for identification, AST, and measuring the MIC, such as Vitek 2. However, polymerase chain reaction (PCR) can help to detect the presence of *P. aeruginosa* accurately, therefore, assist in determining the treatment rapidly (Reynolds & Kollef, 2021), (Iglewski, 1996). On top of that, aminoglycosides (gentamicin, tobramycin, amikacin, netilmicin), carbapenems (imipenem, meropenem), cephalosporins (ceftazidime, cefepime), fluoroquinolones (ciprofloxacin, levofloxacin), penicillin with β-lactamase inhibitors (BLI) (ticarcillin and piperacillin in combination with clavulanic acid or tazobactam), monobactams (aztreonam), fosfomycin and polymyxins (colistin, polymyxin B). These 8 groups of antibiotics have been used to treat *P. aeruginosa* (Bassetti et al., 2018).

Otherwise, empirical treatment should be started as soon as cultures are collected, according to the status of patients and sites of infection. In the face of rising impedance of multi-drug resistance (MDR), extensively-drug resistance (XDR), and pan-drug-resistant (PDR) *P. aeruginosa*, combination therapy is often used, and the treatment options have to be prudent (Karruli et al., 2023).

1.2 *P. aeruginosa* against disinfectants

Improper use of disinfectants plays a significant role in the spread of hospital-acquired infections. There are several factors contribute to the prevalence of disinfectant resistance, including misuse, inaccurate concentration, and inadequate training to prepare and storage of disinfectants in hospital settings. (Bakht et al., 2022). *P. aeruginosa* can develop resistance to disinfectants and antibacterial agents by several mechanisms including enzyme production suppression, biofilm formation, overexpression of efflux pumps, and outer membrane impermeability (Bakht et al., 2022) Moreover, the activity of small multidrug resistance (SMR) proteins known as resistance mechanisms of this pathogen. These proteins are located in the inner cytoplasmic membrane and are classified into the suppressor of GroEL mutations (SUG), small multidrug proteins (SMP), and paired small multidrug resistance (PSMR) subgroups, they cause resistance to various biocides. Furthermore, the genes qacE and qacEΔ1 are existed in the SMP subgroup, these genes are commonly carried on plasmids and integrons of multi gram-negative and gram-positive bacteria that are resistant to antimicrobial agents (Bakht et al., 2022; D'Arezzo et al., 2012).

However, the SMR family includes proton-dependent efflux pump. *P. aeruginosa* use efflux pumps as another mechanism to resist disinfectants. In *P. aeruginosa*, efflux pump systems play an important role in resistance by remove toxic compounds from the bacterial cell, including antibiotics, disinfectants such as chlorhexidine and other antimicrobial agents, thereby, promotes the bacterial survival (Bakht et al., 2022). Resistance to antibiotics and biocides is closely connected due to many antibiotic resistance genes are resides on class 1 integrons, which are mobile genetic elements. Consequently, incorrect disinfectant use poses a global concern of selecting for gram-negative bacteria resistant to antibiotics (Bakht et al., 2022).

1.3 Resistance of *P. aeruginosa* biofilms to disinfecting agents

In nature, biofilm is structured microbial communities adheres to either living or non-living surfaces and surrounded by a self-produced extracellular polymeric substance (EPS), that providing enhanced resistance to antimicrobial exposure. Furthermore, bacteria with biofilms formation can evade immune systems and resist antibacterial drugs up to 1000 times more than their planktonic counterparts. *P. aeruginosa* biofilm matrix contains lipopolysaccharide (LPS), extracellular DNA (eDNA), proteins, and lipids (Thi et al., 2020). It responds to nutrient-rich environment via attaches to accessible surfaces and undergoes cell division leading to the formation of mature biofilms, and within biofilms, *P. aeruginosa* demonstrates approximately 500 times increase in resistance to antibacterial agents than bacteria growing in suspension (Sagripanti & Bonifacino,2000).

However, the formation of bacterial biofilms develops complex processes, such as extensive changes in gene expression, primitive circulatory system, metabolic cooperation among cells, and the formation of microniches that support *P. aeruginosa* survival (Sagripanti & Bonifacino,2000). Moreover, several hospitals related environmental factors play an important role in influencing biofilm formation, including pH, surface characteristics, oxygen concentration, bacterial strain diversity and nutrient conditions (Abdallah et al., 2015).

1.4 Study Objectives

1. Investigate whether the *Pseudomonas aeruginosa* exist in soap in hospital settings in West Bank, Palestine (Bethlehem and Hebron).
2. To enhance the effectiveness of health care systems and reduce the risk of HAIs by washing hands.
3. To minimize *P. aeruginosa* transmission in healthcare facilities
4. Examine contamination rates in different hospital departments to identify high risk zones.

1.5Hypothesis

P. aeruginosa one of the most bacterial species associated with antibiotics resistance and nosocomial infections. It can colonize harsh environments such as soap. Healthcare workers and hospitalized patients who are washing their hands with soap dispenser contaminated with *P. aeruginosa* in hospitals or medical facilities can cause HAIs and serious illness.

Chapter Two

Literature Review

2.1 Soap contamination by *P. aeruginosa* in tertiary care hospitals

About (2 × 104 and 8 × 105 CFU/g) is the quantity of *P. aeruginosa* in the soap that was found in intensive care units; however, three patients were infected with a genotype found in the soap (Blanc et al., 2016). They isolate the soap by using inoculum of 0.1 g, and 10-1 serial dilutions were inoculated on to cetrimide agar and incubated at 37 °C for 48 h. After that, they used Double locus sequence typing (DLST) to analyze *P. aeruginosa* that was isolated. Further information by epidemiological investigations showing that the first patient was not exposed to the soap, the second could have been exposed, and the third was really exposed. Furthermore, the manual hygiene that was made with an alcohol-based solution for more than 15 years is the main cause; this contamination represents a supposed reservoir of pathogens that should be avoided in the hospital (Blanc et al., 2016).

2.2 Soap dispensers' contamination with gram-negative bacteria

Bacterial isolates of 140 liquid soap dispensers collected from hotel rooms across Germany, by using the Vitek 2 system to determine the microbial contamination of refillable standard pump dispensers and nonrefillable press-dispenser systems. Non-fastidious gram-negative bacteria were isolated; however, they found that the most contamination occurred in refillable soap dispensers, with a 70.2% contaminated rate. At the same time, they found nonrefillable soap dispensers with only a 10.6% concentration rate. One hundred µL of liquid samples were cultured on tryptic soy agar (TSA) and MacConkey agar (MAC) after being diluted from 10-1 to 10-4 in neutralizing solution. In this research, they focused on bacteria that have intrinsic resistance to multiple antibiotics, including *Acinetobacter baumannii*, *P. aeruginosa, Pluralibacter gergoviae*, *Stenotrophomonas maltophilia*, *Serratia marcescens,* and *Citrobacter*. Noteworthy, *P. aeruginosa* and *Pseudomonas putida* were detected in (25%). (Lucassen et al., 2023).

2.3 Molecular epidemiology of *Pseudomonas aeruginosa* hospital outbreak due to contaminated soap dispenser

Retrospective cohort study, prospective surveillance, auditing, extensive testing on healthcare workers and environmental studied by Lanini et al. (2011) that describes a fatal epidemic of *P. aeruginosa* that occurred in a hematology unit in Italy. To define relationships between *P. aeruginosa* isolates they used RAPD, macro restriction analyses and sequence typing. Additionally, they found a *P. aeruginosa* strain with the same genetic fingerprint and sequence type (ST175) as clinical isolates strain was isolated from a rich contaminated triclosan soap dispense. Generally, *P. aeruginosa* is inherently unaffecting by triclosan. Therefore, triclosan should be avoided in the health care settings specially in units that host immunocompromised patients at high risk of *P. aeruginosa* infection. The results in this study harmonic with the presumption that patients were infected indirectly Lanini et al. (2011).

2.4 Hand soap and eye drops contaminated by *P. aeruginosa* leads to eye infection risks

P. aeruginosa can cause a severe eye infection, research done by (Gitter et al., 2024) used two prospect exposure scenarios, the first one is about individuals using eye drops contaminated by bacteria, the second is about individuals washing their hands with contaminated liquid soap prior to placing their lens. This bacterium's severity can cause blindness if it reaches corneal tissue by contaminated fingers, lens and eye drops. Quantitative microbial risk assessment (QMRA) framework is an approach was used to predestine the likelihood of infection and diseases caused from exposure of *P. aeruginosa*. They demonstrated a precious result of infection risks by *P. aeruginosa* in both eyedrops and hand soap, the median risk of eye infection from a single exposure event was three degrees greater by volume for eye drop exposure (5.16×10^{-1}) compared to infection associated with a finger washed with hand soap touching the eye (2.52×10^{-4}). On the other hand, the estimated daily risk of infection for eye drops in one eye (9.45×10^{-1}) was three measures greater in volume than the average daily infection risk of hand soap exposure (5.04×10^{-4}), however the higher concentration of *P. aeruginosa* increases the higher risks. Furthermore, the research supports that pump heads in refillable liquid soap bottles can be the major entry pathway for bacterial biofilms.

2.5 *P. aeruginosa* contamination in various environments

Various possible environments sources of *P. aeruginosa* have been reported in healthcare units including, shower drains, aerosols and endoscopes (Cristina et al., 2021). *P. aeruginosa* can colonize in different condition and environments mainly in moist environments, it can transmit within hospitals units such as ICUs. Control and understand the strategy of this bacterium can be helpful to limit and decrease of its resistance and risk of transmission.

Patients contribute to spread of pathogen like bacteria, therefore personal hygiene and environmental cleanup is very important to reduce the nosocomial infections (Pham et al., 2019). Cross-contamination from a diversity of environmental reservoirs is one of the most reasons of *P. aeruginosa* transmission (Halstead et al., 2021). According to (Pham et al., 2019) they use the solely longitudinal surveillance data by evaluating the relative significant of *P. aeruginosa* transition ways via utilizing the hypothesis that various routes cause several models of variation in the spread. They use advanced mathematical patterns as environmental contamination, background transmission and cross-transmission. Moreover, this study was assessed to determine the bacterial capacity shed through ICU stay to cross-transmission and resolve the environmental contamination through and after patient's hospitalization. In France, in ICUs of the University hospital in Besançon, by collected important information about patients including, admission and discharge days, screening for results and days of patients in ICUs. They found that background and cross-transmission represent a considerable part in the transmission method. Nevertheless, the environmental contamination for post-discharge caused 1% of overall transmission. However, restricted influence related to the prevention of *P. aeruginosa* infection in ICUs occurred via enhancing post-discharge environmental cleaning. Furthermore, they assume by their model that patients can be part of environmental contamination as a result influence all patients in the department (Pham et al., 2019).

2.5.1 *P. aeruginosa* contamination in water system

P. aeruginosa found in natural waters like rivers, and due to their ability to colonize in hard condition with simple nutrition requirements, this bacterium can survive and colonize biofilms in water system manufactured by human. *P. aeruginosa* can persist in hospitals water system for a long time and cause HAIs by biofilm formation. Research by (Baghal Asghari et al., 2013) estimate the presence of *P. aeruginosa* of hospital tap waters. This study was conducted on 11 hospitals in Iran, where forty-four tap water samples were collected from different units, analyzed by nested polymerase chain reaction (PCR), via this technique they found that 9 hospitals and 32% of water system tested positively for *P. aeruginosa* (Baghal Asghari et al., 2013). In another study on a larger and more comprehensive scale conducted by (Cristina et al., 2021) from 17 healthcare departments in Northern Italy. They collect 4500 samples from tap water system, 93 samples of *P. aeruginosa* were found, most of them were from dental units and kitchens. Consequently, water contamination in *P. aeruginosa* can lead to its spread among patients and pose a risk to their lives. Moreover, *P. aeruginosa* is the most gram-negative bacteria can cause the perichondritis and it's associated with swimming in badly hygiene pool. However, it is can also transmitted through ear piercings, this microorganism led to the piercing related infection mostly in 2 to 4 weeks after piercing. This infection occurred across immediate touch of the piercing place to contaminated water or care products with *P. aeruginosa* (Brown et al., 2025).

2.5.2 *P. aeruginosa* contamination in personal care products

Products bacterial contamination can cause several moderate and severe diseases including, allergy, chemical burns, inflammation, skin rashes, swollen lips and keratitis (Bashir & Lambert, 2020). Some personal care products contain substances that some microorganisms need to grow. There is a possibility of the presence of bacteria or fungi inside care products such as skin and body care products, cosmetics, and eye lenses, maybe during industry process or the storge strategy. Personal care products are indispensable as they are used by most groups such as adults, children, and the elderly. There are many companies around the world that produce many personal care products, some of which are high quality and low quality. Most of these products are not sterile, but most consumers do not care whether they are safe or unsafe.

The possibility of contamination of such products with *P. aeruginosa* bacteria is possible because they can resist and live in an environment that contains several organic and inorganic components that are favorable for it especially if this component is not sterile. Its presence was proven through a work conducted in Saudi Arabia on several Cosmetics products of different qualities. It was found that most of the contamination was in lip care products, where *P. aeruginosa* has been a part of this contamination, in addition to other types of bacteria and fungi that cause this contamination (Alshehrei, 2023). *P. aeruginosa* is the most common microorganism found in contaminated cosmetics, according to (Lundov & Zachariae, 2008) they showed that the plurality of contamination occurred in creams, gels and shampoos in which high percentage of water was found. From 24 positive sample, the *P. aeruginosa* 40% was the most repeatedly found bacteria. Furthermore, care products contain preservative, it doesn't kill the bacterial spores but can minimize the bacterial contamination and dominate the vegetative stage of bacillus species. However, the presence of bacteria in preservative-based care products depends on several factors including, volatility of the preservative, acidity(pH), temperature and solubility. Therefore, to prevent contamination of cosmetic products with bacteria, they should not be present in raw materials, which means no soil or dust enters the product, clean environment with proper handling of cosmetics during production, water and equipment was used, and the storage process (Bashir & Lambert, 2020).

2.5.3 Hospital devices and equipment contaminated by *P. aeruginosa*

The tools and devices used in hospitals are diverse such as implanted medical devices, biopsy forceps, surgical instruments. Sterilizing them before and after use is very important to prevent the transmission of infection between patients, the use of non-sterile or inadequately sterilized instruments or devices during surgeries can lead to direct transmission of the pathogen, after that septicemia and death can occur. Thus, NIs cause high morbidity and mortality rates, and this significant event increase the burden on healthcare systems. According to (CDC) the proper sterilizing procedure can kill all microorganisms on the surface. Electronic devices are essential in hospitals to increase communication interaction, and heath care settings become more efficient (Habyarimana et al., 2020). Respiratory infections are one of the principle nosocomial infections and late-onset nosocomial pneumonia occur usually by *P. aeruginosa*, which is able to grow in distilled water (La Fauci et al., 2017). In environment full of microorganisms like hospital, there is a possibility for *P. aeruginosa* to contaminate instruments and transmit to patients. Moreover, respiratory devices can cause nosocomial infections. One of contamination reasons are related to improper maintenance of medical devices. Oxygen humidifiers play a critical source of bacterial contamination and HAIs. This concept was reported by (La Fauci et al., 2017). They collected water samples from reusable and disposable oxygen humidifiers used in different units. Accordingly, they found that *P. aeruginosa* was the main Gram-negative bacteria isolated in oxygen humidifiers. This may be related to its ability to survive and adapt in water environment. For this reason, a potential suggestion is to use disposable oxygen humidifiers (La Fauci et al., 2017).

2.5.4 *P. aeruginosa* contamination in food

In medical care, food and nutrition are very important for patient's healing. Generally, several health care settings, prepare the food in the kitchen and directly distributed to the patients. Consequently, food should be healthy, safe, sufficiently cooked and sterilized, in order to reduce the risk of contamination, but it is possible to transmit the infection from the food that the visitors bring to the patient if it is contaminated (Lund & O'Brien, 2009). Contamination of food with bacteria is common and easy to occur, as food contains elements and materials that are important for the continued survival of microorganisms. It can be found in vegetables, fruits, milk and meat. *Pseudomonas* species are widespread in food and the treatment for this bacterium with their antimicrobial resistance gene (ARG) become more difficult and complicated (Bloomfield et al., 2024). Their ability to secrete extracellular enzyme, form biofilms, considered as super-bug, rapid colonization, growth at low temperature and high ability to adaptation, so *P. aeruginosa* can be found in nutrient-rich foods. However, it is worth noting that food spoilage caused by *P. aeruginosa* should raise widespread concerns among consumers and the food control department (Li et al., 2023).

Furthermore, food handlers play a major part in food safety via proper food handling practices and simple hygiene steps like hand washing. This procedure can prevent food contamination (Mallah et al., 2023). In a study conducted by (Kominos et al., 1972), they isolated *P. aeruginosa* from different vegetables, most of it was found in tomatos, acquired from hospital kitchen. The source of this contamination was from kitchen workers' hands, used knives and cutting boards contaminated with *P. aeruginosa*. However, they also found identical strains of P. *aeruginosa* in patients and those isolated from vegetables. Thus, kitchen utensils and vegetables can be a source of nosocomial infection (Kominos et al., 1972). Accordingly, it is necessary to wash hands thoroughly and ensure that the equipment used in hospital kitchens are clean and sterilized properly before cutting food on them. It is important to wash vegetables and make sure that they are clean before use in order to reduce infections and transmission of microorganisms to patients.

Chapter Three

Materials and Methods

3.1 Study design & Place of study

I tested the presence of *P. aeruginosa* in hand soap used in hospitals. The study conducted across five hospitals located in Bethlehem and Hebron, Palestine. In Hebron the study conducted in one government hospital and another private. In Bethlehem, two private and one government hospitals were included. Furthermore, samples were collected between May to October 2025.

3.2 Ethical consideration

This research did not include data from patients. Nevertheless, permission from government and private hospitals were obtained to carry out the study. Moreover, the names of hospitals are not mentioned in order to protect their privacy.

3.3 Samples selection

Samples were collected based on: Soap used by patients and their companions and Soap used by the medical staff, nurses and physicians. All liquid soap samples from different departments of the hospitals with immunocompromised patients including: Intensive care units (ICU), Internal medicine units (IM), Cardiac care units (CCU), Pediatric Oncology Department (POD), Dialysis units, Rehabilitation, Post natal care (PNC), Delivery room (DR), Postnatal unit (PN) and Surgery.

Total samples (n= 79), collected in sterile containers from refillable-pump soap dispenser. All samples were sent in an ice box, as quickly as possible to the Microbiology Laboratory at Al-Quds University, Palestine.

3.4 Culture and identification of *P. aeruginosa*

All collected samples were cultured without dilution by application 100ul of soap spread by spreader on the surface of cetrimide (cetyltrimethylammonium bromide) agar medium, a selective and differential medium for *P. aeruginosa*. To obtain isolated colonies, cetrimide agar then incubated aerobically for 24–48h at 30-35°C. A greenish coloration (pyocyanin pigment) which fluoresces under ultraviolet radiation (Razooki et al., 2009) was obtained, indicating the growth of *P. aeruginosa*, as shown in **Fig 4.1**. After growth, for confirmatory identification to obtain pure colonies, subculture done onto Tryptic Soy Agar (TSA) and incubated at 30-35°C for 18-24h.

P. aeruginosa exposed to the standard bacteriological strategies including; it is shiny and greenish; fruity or grape like odor, Gram -negative rod shaped under microscope, catalase positive test for *P. aeruginosa*, oxidase test positive with rapid change to dark purple color, its ability to grow at 42°C and Triple Sugar Iron (TSI) test to differentiate between *P. aeruginosa* and another *Pseudomonas* species). Furthermore, recognized later as *P. aeruginosa* by API 20NE multi-test (Amato et al., 1980). This bio-typing technique is a normalized framework for the identification of bacteria not belonging to the Enterobacteriaceae family, non-fastidious, and Gram-negative rods, constitute eight conventional tests which include potassium nitrate (NO_3), l-tryptophane (TRP), d-glucose (GLU), l-arginine (ADH), urea (URE), esculin ferric citrate (ESC), gelatin (GEL) and 4-nitrophenyl-β-D-galactopyranoside (PNPG) and furthermore assimilation of 12 mixtures, which incorporate d-glucose (GLU), L-arabinose (ARA), d-mannose (MNE), D-mannitol (MAN), N-acetyl-glucosamine (NAG), d-maltose (MAL), potassium gluconate (GNT), capric corrosive (CAP), adipic acid (ADI), malic acid (MLT), trisodium citrate (CIT) and phenylacetic acid (PAC). Wells of biochemical test will be inoculated with 0.5 McFarland bacterial suspension and incubated for 48 h (at 37 °C). The outcomes were read after adding appropriate reagents, as 7-digit number that were distinguished by API 20NE logical record.

3.5 Data analysis

Data were presented in tables and marked with (+ve) for positive soap samples contaminated by *P. aeruginosa*, or with (-ve) when no growth for *P. aeruginosa*. Tables contain the sample's number from certain departments in hospitals used by patients or medical staff.

3.6 Cetrimide media

In the current study, cetrimide agar plates were prepared by dissolving 46.5 g of cetrimide medium powder (Merck) with 4 g of glucose and sterilized by autoclaving for 15 minutes at 121 °C (Bonnet et al., 2019).

Cetrimide agar is selective and differential medium used for the isolation of *P. aeruginosa*. This medium contains several important components that shows its activity, including: Cetyltrimethylammonium bromide which is a detergent that inhibits most of bacterial species by damaging their cell membranes except *P. aeruginosa.* This action led to release of nitrogen and phosphorus which prevent the growth of other bacteria, also it has compounds like potassium sulfate and magnesium chloride that promote the production of pyocyanin and pyoverdine fluorescent pigments. Additionally, *P. aeruginosa* produces pyocyanin when cultured on cetrimide agar (Robin & Janda, 1984). Pyocyanin is a green to blue water-soluble pigment which has a powerful characteristic such as antibacterial, antioxidant, and anticancer, and is produced by 90–95% of *P. aeruginosa.* It is also used in several fields including, medical engineering, aquaculture, biotechnology, medicine and agriculture. Moreover, the strains that produce pyocyanin can be more resistant to antibiotics, and it contributes to genes controlling in efflux pumps which provide the metal's resistant (Abdelaziz et al., 2022).

Chapter Four

Results

In total, seventy-nine soap samples were collected in liquid phase, and none were in bars or solid form. Results showed that 15 samples tested positively for *P. aeruginosa*. A total of forty-five samples obtained from Bethlehem hospitals, 6 (7.59%) tested positive for *P. aeruginosa*. On the other hand, out of thirty-four samples collected from Hebron hospitals, 9 (11.39%) were positive for *P. aeruginosa*.

Twenty samples were collected from various units at the Government hospital in Bethlehem. Of these, 2 (10%) samples from the Oncology ward tested positive. These samples had been used by both patients (Pt) and staff. **(Table 4.1)**

Notably, two shampoo samples (12, 7) were collected from this hospital.

Table 4.1a: *P. aeruginosa* analysis in different liquid soap dispensers used in government hospital in Bethlehem.

Samples No	Ward	Positive	Negative	User Pt/Staff
1	ICU		-ve	Staff
2	ICU		-ve	Staff
3	ICU		-ve	Pt
4	Oncology		-ve	Pt
5	Oncology		-ve	Pt
6	Oncology		-ve	Pt
7	Oncology		-ve	Pt
8	Oncology	+ve		Pt
9	Oncology		-ve	Pt
10	Oncology		-ve	Pt
11	Oncology	+ve		Staff
12	Dialysis		-ve	Staff
13	CCU		-ve	Pt
14	POD		-ve	Pt
15	POD		-ve	Pt
16	POD		-ve	Staff

Table 4.1b: *P. aeruginosa* analysis in different liquid soap dispensers used in government hospital in Bethlehem.

Samples No	Ward	Positive	Negative	User Pt/Staff
17	Surgery		-ve	Pt
18	Surgery		-ve	Pt
19	Surgery		-ve	Pt
20	Surgery		-ve	Staff

In addition, 10 soap samples from a refilled-pump dispenser were obtained from a private hospital in Bethlehem. However, one sample was positive, collected from the patient's surgery section. **(Table 4.2)**.

Table 4.2: Culture results of *P. aeruginosa* analysis in multi liquid soap dispensers used in private hospital in Bethlehem.

Samples No	Ward	Positive	Negative	User Pt/Staff
1	ICU		-ve	Staff/Pt
2	Surgery		-ve	Staff
3	Surgery	+ve		Pt
4	Surgery		-ve	Pt
5	Rehabilitation		-ve	Pt
6	Rehabilitation		-ve	Staff
7	Rehabilitation		-ve	Pt
8	IM		-ve	Staff
9	IM		-ve	Pt
10	IM		-ve	Pt

The second private hospital specialized in maternity in Bethlehem, out of 15 samples gathered, 3 (20%) tested positive from the postnatal, surgery, and emergency units. (**Table 4.3**).

Table 4.3: Results of *P. aeruginosa* analysis in different liquid soap dispensers used in second private hospital in Bethlehem.

Samples No	Ward	Positive	Negative	User Pt/Staff
1	PN		-ve	Staff
2	PN		-ve	Staff
3	PN	+ve		Pt
4	PN		-ve	Pt
5	Surgery	+ve		Pt
6	Surgery		-ve	Staff
7	Emergency		-ve	Staff
8	Emergency	+ve		Staff
9	NICU		-ve	Pt
10	NICU		-ve	Pt
11	DR		-ve	Pt
12	DR		-ve	Staff
13	Out clinics		-ve	Staff
14	Out clinics		-ve	Staff
15	Hospital lab		-ve	Staff

The results obtained through the analysis of 17 liquid soap sample from the soap dispenser used at Government hospital in Hebron, 4 (23.52%) samples were positive (**Table 4.4).**

Table 4.4: Results of *P. aeruginosa* analysis in different liquid soap dispensers used in government hospital in Hebron.

Samples No	Ward	Positive	Negative	User Pt/Staff
1	ICU		-ve	Staff
2	ICU		-ve	Pt
3	ICU	+ve		Pt
4	ICU		-ve	Pt
5	IM	+ve		Staff
6	IM		-ve	Staff
7	CCU		-ve	Staff
8	CCU		-ve	Pt
9	Surgery	+ve		Pt
10	Surgery		-ve	Pt
11	Surgery	+ve		Pt
12	Surgery		-ve	Staff
13	Surgery		-ve	Pt
14	Surgery		-ve	Pt
15	Dialysis		-ve	Pt
16	Dialysis		-ve	Staff
17	Dialysis		-ve	Pt/Staff

At the private hospital in Hebron, *P. aeruginosa* was detected in 5 (29.41%) refilled soap bottles of 17 samples collected from various sections **(Table 4.5).**

Table 4.5a: Results of *P. aeruginosa* analysis in different liquid soap dispensers used in private hospital in Hebron.

Samples No	Ward	Positive	Negative	User Pt/Staff
1	IM	+ve		Pt
2	IM	+ve		Pt
3	IM		-ve	Pt
4	IM		-ve	Pt
5	IM		-ve	Staff
6	IM		-ve	Staff
7	IM		-ve	Pt
8	CCU	+ve		Pt
9	CCU		-ve	Staff

Table 4.5b: Results of *P. aeruginosa* analysis in different liquid soap dispensers used in private hospital in Hebron.

Samples No	Ward	Positive	Negative	User Pt/Staff
10	CCU	+ve		Pt
11	Surgery		-ve	Pt
12	Surgery		-ve	Staff
13	Surgery		-ve	Pt
14	Surgery		-ve	Pt
15	Surgery		-ve	Pt
16	Surgery	+ve	-ve	Pt
17	Surgery		-ve	Pt

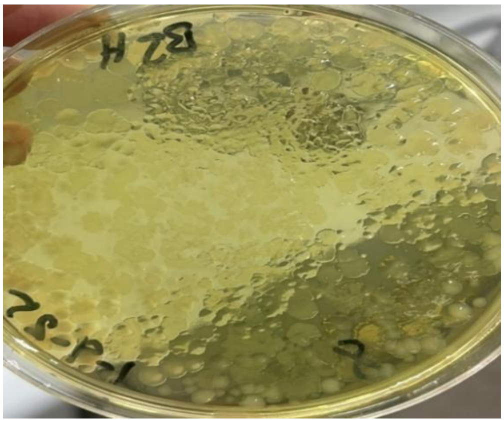

Fig 4.1: *P. aeruginosa* growth at 35°C in cetrimide agar from soap sample.

P. aeruginosa is characterized by its greenish color on cetrimide media, it was observed greenish coloration (pyocyanin pigment).

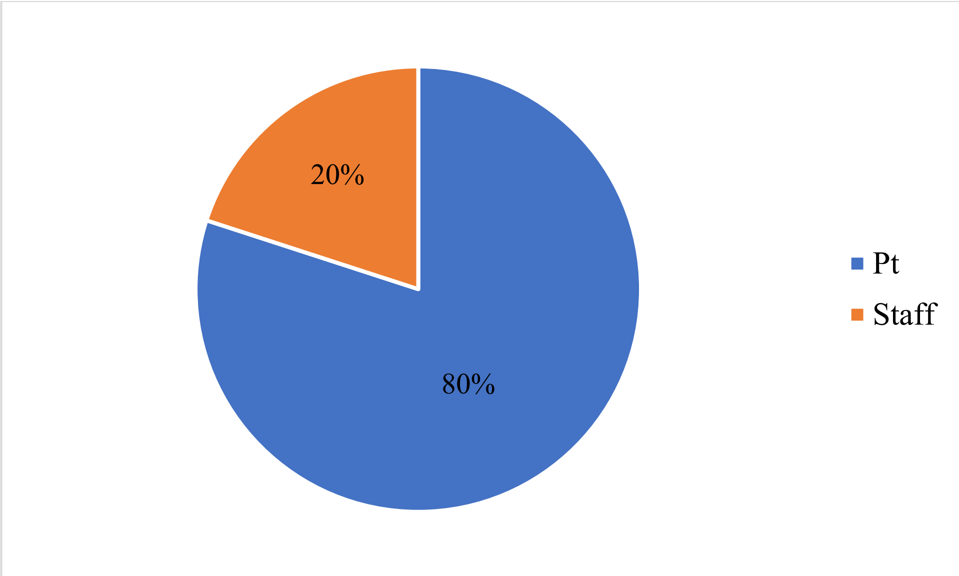

Fig 4.2: *P. aeruginosa* contaminated soap samples used by staff and Patients

Pie chart shows the rate of soap samples were collected from hospitals contaminated with *P. aeruginosa* used by both, staff and patients. A total of 15 positive samples, there are three (20%) contaminated soap samples used by staff observed in orange color. In the other hand, the blue color shows the rate of 12 (80%) contaminated soap samples were used by patients.

Chapter Five

Discussion

This study focused on the contamination of soap by *P. aeruginosa*, which is known for its intrinsic resistance to antiseptics and disinfectants. Previous studies have reported that *P. aeruginosa* can resist soap disinfectants. For instance, (D'Arezzo et al., 2012) determined that *P. aeruginosa* can resist the triclosan, which is one of the disinfectants used in soap.

As a result of 15 (18.9%) soap samples testing positive for *P. aeruginosa* contamination, all positive samples were collected from refilled soap dispensers that were located on sinks in patients' bathrooms and medical staff rooms. In this study, no significant growth was observed in diluted liquid soap. This may be attributed to decrease in bacterial concentration after dilution, when the bacterial load in the soap is initially low. Presence of *P. aeruginosa* within biofilms with dilution further reduces their isolation because of the activity of soap preservatives or disinfectants (Schaffner et al., 2018; Lorenz et al., 2012). The soap contamination by *P. aeruginosa* in hospitals was studied in several previous studies (Blanc et al., 2016), which have also been found *P. aeruginosa* in the soap that was tested in ICUs.

Significantly, there are other species of Gram-negative bacteria also can be found in soaps and it is supported by previous field studies (Lucassen et al., 2023) that have demonstrated the ability of gram-negative bacteria such as *P. aeruginosa*, *Pseudomonas putida, S.marcescens, Klebsiella oxytoca*, and *Pasteurella testudines* to be present in refillable and non-refillable soaps. However, soap contaminated by several types of bacteria such as *S. marcescens, Klebsiella pneumoniae, Citrobacter freundii, Citrobacter youngae, Providencia rettgeri, Providencia stuartii, P. aeruginosa, Pseudomonas fluorescens, and Serratia rubidaea*, could be transmitted to other surfaces after washing hands (Zapka et al. 2011). On the other hand, as Gram-negative bacteria are the major source of liquid soap contamination from pump dispensers, yeast and molds, such as *Candida* spp. and *Aspergillus fumigatus*, can also be contaminants of soaps (Lucassen et al., 2023).

In greater detail, (Table 4.1) has the results of two positive soap samples (2.53%) located in the oncology section and used by patients. These positive results may be due to the presence of soap bottles without a cover pump, unhygienic bathrooms, unclean sinks, or contaminated tap water, since it was not covered as proven in many previous studies. This environment in the hospital absolutely contributes to increasing the biofilms of bacteria and nosocomial infections. Furthermore, in (Table 4.2), only one sample was positive (1.26%); it is better than other hospitals, but also raises concern that this soap may act as a reservoir of *P. aeruginosa* infections. On the other hand, in (Table 4.3), despite the cleanliness of this hospital environment, three samples (3.39%) showed the presence of *P. aeruginosa* bacteria. However, these samples were taken from refillable soap dispensers.

At the same time, samples were taken from non-refillable soap dispensers containing disinfectants, which are used only by medical staff, and did not show any growth on the cetrimide agar plates. These results support the notion that refillable soap dispensers are more prone to bacterial contamination via accumulation of liquid in the pump head. This is due to several factors, including the possibility of biofilms forming on the head of the pump when soap dispensers are repeatedly placed in environments that are conclusive to bacterial growth, such as bathrooms.

As a result, bacteria will be transferred from the soap to the hands via aspiration of biofilms through the press release of the pump head. Furthermore, soap contamination with *P. aeruginosa* in samples from hospitals in Hebron (Table 4.4), (Table 4.5a, b) were relatively higher than in samples from Bethlehem. There are several possible reasons for this, including the fact that Hebron is geographically larger than Bethlehem, therefore has a larger population, meaning that more people are likely to be hospitalized, and the likelihood of contamination is higher. Apart from the fact that the bathrooms were in very poor conditions, and it could contribute to increased contamination and the spread of infection. The sight of uncovered soap dispensers was a recurring one in both hospitals in Hebron, as well as in government hospital in Bethlehem as mentioned before. Some of the positive samples in (Table 4.5) were taken from soap brought by patients, rather than from the hospital itself but found in the patients' bathroom. These results confirm the idea that refillable soap dispenser may be easily contaminated.

The main goal of hand washing is to remove dirt and reduce the transmission of infections within hospitals. While the step of hand washing may seem simple, it is very important, especially for the medical staff before and after dealing with patients, as well as patients and their companions. However, in this study, as shown in Fig 4.2 only two 3/15 (20%) positive samples were used by medical staff, while 12/15 (80%) positive samples were used by patients and their companions. The use of contaminated soap from both is life-threatening because of the potential for the transmission of *P. aeruginosa* bacteria to them. Currently, with the increasing resistance of bacteria to antibiotics and disinfectants, this will make treatment more difficult, especially for those with weakened immunity.

Having these people in an environment full of resistant bacteria, such as a hospital environment, will make them more susceptible to hospital-acquired infections. Therefore, washing hands with clean soap and water will help reduce the possibility of transmitting the infection. Soap is usually considered a safe environment and is the first choice for washing hands to reduce and inhibit the growth of microorganisms such as bacteria, in terms of risks and infection, some strains of bacteria such as *Clostridium difficile* which live on people's skin without symptoms for healthy people. It can be prevented by washing hands with soap and water (Kiersnowska et al., 2021).

This present study highlighted on soap found in hospitals, especially in facilities with immunocompromised patients. *P. aeruginosa* is one of the most opportunistic, prevalent and resistant bacteria in hospitals environment. Their presence in soap represents a risk to their lives if transferred to them. This may be determined by several factors, the most important of which are biofilms that are used as an adaptation to adverse environmental conditions and act as a weapon for survival and resistance. However, there are other factors that may contribute to the transmission of infection, including the condition of the skin, the size of the hands, hand washing practices, the quality of water and drying paper tissues (Zapka et al., 2011). There is also a possibility of contamination of soap during its manufacture. In addition, there are many reservoirs other than soap that may be the cause of the transmission of *P. aeruginosa* to patients such as food or devices, and this should not be allowed in a place like a hospital.

Chapter Six

6.1 Conclusion

To conclude, it is essential to ensure that hand washing with soap and water is the most effective method mainly in the healthcare settings, this action can contribute to control and decrease the incidence of nosocomial infections. *P. aeruginosa* can be present in liquid soap especially in refillable soap dispenser. This bacterium can cause severe infection principally to immunocompromised patients. Moreover, antibiotic resistance is a global public issue and is increasing. Thus, decreasing the spread of bacterial strains of infection among patients will help control antibiotic consumption and resistance. Despite the seriousness of this matter, sometimes the consumption of antibiotics among individuals may be done individually and not by consulting a doctor.

The study results showed the presence of *P. aeruginosa* bacteria in some refillable soap dispenser used in hospitals. In Palestine, the health research system faces significant challenges due to many circumstances (AlKhaldi et al., 2020). Therefore, the rapid spread of infection among patients will be possible. Conducting a study like this will draw attention to the quality of hand washing with clean soaps. Hand washing in the health sector is a very important step to reduce the spread of infections. Additionally, hand washing should be applied every time the hands are dirty or after using the bathroom, especially if there is a sick person or someone with a weak immune system.

6.2 Limitations and Recommendations

The study has a number of significant limitations that should be taken into consideration. First of all, the sample size was comparatively small due to the fact that not all patient rooms and hospital facilities had soap, and this applies to all hospitals in which the study was conducted. Also, the closure of north of West bank by the Israeli military forces which prevented us from taking samples from Nablus, Jenin, Qalqilyah and Tulkarm. Another limitation is in some departments such as dialysis, CCU, and internal medicine where only one bathroom for all patients is available, and there was not enough soap in it and there is no list of ingredients on most soap bottles. So, they are not classified as to whether they contain sterilizers or not. However, some hospitals did not allow soap samples to be taken from some of their departments.

Based on the results, there are some substantial recommendations that should be taken into consideration regarding to the safety of personal care products in hospitals including liquid soap against microbial contamination like *P. aeruginosa*. Refillable soap dispenser can become more contaminated than un- refillable soap dispenser. Thus, to avoid contamination, the following statement is very important to be applied. Pump head of the soap bottle should be changed constantly or put a new soap bottle and not refill the old ones to use it again, put soap with a certain percentage of disinfectants other than triclosan or put an alcohol-based sterilizer in patients' rooms to be used after washing hands, check and test the soap available in the hospital to ensure that it is not contaminated before using it.

Larger multi-purpose studies are recommended to validate these findings across different hospitals. Future studies should consider using other faster and newer techniques to link the strain of *P. aeruginosa* bacteria that might be found in soap to those infected by hospital patients. It can also be seen if it is resistant to antibiotics by performing an antibiotic sensitivity test and can examine the biofilms in the soap bottles. Even though the priority of hand washing by good quality soap in hospitals is of greatest importance. There is a lack of published study on the soap contamination and hand washing practices in Palestinian hospitals. Besides, they could be more precise and broader on the importance of washing and sterilizing hands before medical staff and visitors interact with patients. This can improve the quality of service and ensure that the equipment used in hospitals' sections are sterilized to reduce transmission of microorganisms to patients.

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تلوُّث الصَّابون ببكتيريا الزَّائفة الزّنجاريَّة في وحدات الرّعاية بمستشفيات بيت لحم والخليل (الضَّفة الغربيَّة، فلسطين)

اعداد: شهد رائد القيسي

اشراف: د. جابي أبو سعدى

الملخص بالعربي

خلفيَّة الدّراسة: غسل اليدين بالصَّابون الملوّث يمكن أن يزيد من عدد مسبّبات الأمراض الانتهازيَّة على اليدين، وقد يؤدّي دورًا في انتقال البكتيريا في الأماكن العامَّة. وتعتبر بكتيريا الزائفة الزنجارية أحد هذه المسبّبات، وهي بكتيريا بيئيَّة سلبيَّة الجرام، إذ ينتج عنها التهابات حادَّة ومزمنة لدى الأفراد الَّذين يعانون من نقص المناعة، يضاف إلى ذلك أنَّها مسبب رئيسي للعدوى المكتسبة في المستشفيات لدى مرضى وحدات العناية المركّزة. وبناءً على ذلك، وبسبب مقاومتها الطَّبيعيَّة للمضادّات الحيويَّة وقدرتها على تكوين أغشية حيويَّة، فمن الممكن أن تسببّ الإصابة بهذه البكتيريا مشاكل علاجيَّة خطيرة. ومع ذلك، فإنَّ أهمّيَّة بكتيريا الزَّائفة الزّنجاريَّة كمرض انتهازي تعتمد على قدرتها على تنشيط أنماط ظاهريَّة مفيدة في ظل الضُّغوط البيئيَّة والاستمرار في المواقف الضَّارَّة، مثل: وجود مضادّات حيويَّة، أو مواد مُطهّرة. ومن جانب آخر فإنَّ المستودع الرّئيس لبكتيريا الزَّائفة الزّنجاريَّة هو البيئات الرَّطبة.

هدف الدّراسة: هدفت الدّراسة إلى التَّحقُّق من وجود بكتيريا الزّائفة الزّنجاريَّة في الصَّابون في وحدات الرّعاية الصّحيَّة في مستشفيات مدينتي بيت لحم والخليل.

منهجيَّة البحث: لأجراء هذه الدّراسة، تمّ جمع 79 عينة صابون من أقسام مختلفة بما في ذلك وحدات العناية المركّزة، والطّب الباطني، والعناية القلبيَّة، وقسم طب أورام الأطفال، وغسيل الكلى، وإعادة التَّأهيل، والرّعاية بعد الولادة، وغرفة الولادة، ووحدة ما بعد الولادة، إضافة إلى قسم الجراحة. وتمّت زراعة جميع العينات دون تخفيف لفحص وجود بكتيريا الزّائفة الزّنجارية على صحون (ستريمايد). بعد ذلك تم استخدام الاختبارات الأوَّليَّة، بما في ذلك تلطيخ (جرام الاكسوديز والنمو) عند 42 درجة مئويَّة، إلى جانب التَّحديد الكيميائي الحيوي كاختبارات تأكيد لبكتيريا الزّائفة الزّنجاريّة.

نتائج الدّراسة: من بين 79 من عينات الصَّابون الّتي جمعت من وحدات رعاية مختلفة، تمّ اختبار 15 عينة إيجابيَّة لبكتيريا الزّائفة الزّنجاريّة، إذ تمّ اكتشاف 6 عينات إيجابيَّة من مستشفيات بيت لحم (7.59٪). في المقابل تمّ العثور على 9 عينات إيجابية (11.39٪) ملوثة بالزّائفة الزّنجاريّة في مستشفيات الخليل. وقد أظهرت نتائج العيّنات الّتي تمّ جمعها أنَّ الطَّاقم الطّبّي استخدم 3 عيّنات إيجابيَّة، أي ما نسبته (20%) من العيّنات الإيجابيَّة من أصل 15، في حين استخدم المرضى ومرافقوهم 12 عيّنة إيجابيَّة بما نسبته (80%).

التَّوصيات: تمّ جمع العيّنات الإيجابيَّة من علب صابون معاد تعبئتها؛ حيث إنَّ النتائج الَّتي توصّلت إليها الدّراسة تدعم فكرة أن موزّعات الصَّابون القابلة لإعادة التعبئة أكثر عرضة للتَّلوّث البكتيري حيث يتراكم السَّائل في رأس المضخّة. ومن الممكن أن تكون العيّنات الإيجابيّة في هذه الدّراسة ملوثة بسبب وجود بعض زجاجات الصَّابون الَّتي تفتقر إلى مضخَّة تغطية، وكذلك الحمَّامات غير النَّظيفة، والأحواض غير النَّظيفة، ربَّما حدث التَّلوّث بطريقة ما عبر ماء الصُّنبور. يضاف إلى ذلك أنَّ تكوين الأغشية الحيوية يمكن أن يساعد بكتيريا الزّائفة الزّنجاريّة على أن تكون أكثر عدوانيَّة ومقاومة للعوامل المضادّة للبكتيريا.

وبشكل عام، فإنَّ مقاومة المضادّات الحيوية تعتبر قضيَّة عامة عالمية، وتزداد بشكل مستمرّ؛ لذا فإنَّ تقليل انتشار السلالات البكتيرية بين المرضى يتمّ عن طريق السيّطرة على استهلاك المضادّات الحيوية ومقاومتها. ومن الأهمّيَّة بمكان التَّأكّد من أن غسل اليدين هو الطَّريقة الأكثر فعالية في بيئات الرّعاية الصّحيّة، حيث يمكن أن يساعد غسل اليدين بصابون سليم وغير ملوث من قبل الطاقم الطّبي أو المرضى في تقليل حدَّة العدوى. ولذا؛ يتوجَّب على المستشفيات التَّحكُّم في استخدام موزّع صابون قابل للتّخلّص، أو غير قابل لإعادة التَّعبئة لضمان غسل اليدين بشكل مُعقَّم وصحيح.

الكلمات المفتاحية: الزّائفة الزّنجاريَّة، غسل اليدين، موزّع الصَّابون القابل لإعادة التَّعبئة، تلوّث الصَّابون، العدوى المكتسبة من المستشفيات.

Appendices

Photos taken during the collection of samples show the condition of some soap bottles found in certain hospital departments.


Lina
SHAMPOO
شامبو
لينا


Rose


FLORIS
Septadine
Tarhitz
ספטדין
תרחיץ
Chlorhexidine gluconate 4%
500