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Prevention of nosocomial infections caused by the most common bacterial pathogens

A poster guide for nursing students

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Abstract

Prevention of the nosocomial infections caused by the most common bacterial pathogens
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The purpose of this thesis was to explore what kind of confidence nursing degree students obtain about prevention of hospital-acquired infections caused by bacterial pathogens. The objective of this study was to raise nursing degree students' awareness on self-protection and self-prevention of hospital-acquired infections during practical training and at work after graduation. The research question in this study was: what measures do nursing students need to take into account in regards to hospital-acquired infection prevention?

The knowledge base was included three precise principal data resources, such as THL, WHO, PMID, to build the theoretical framework. The method applied for this study was quantitative research method, following by the conduction of a survey. The survey was given to the certain group of students from Laurea.

The main results of this study were to evaluate Laurea UAS's nursing degree students' own knowledge and comprehensive understanding about the preventive measurement of hospital-acquired infections. Based on the results, the further outcome of this study was to provide a newest guide of self-prevention for nursing degree students. To be more specific, the guide was created as an informative and picturable poster, which contains all recommendations required for prevention of getting infection.

The analysis of the results demonstrated that approximately 80% of Laurea UAS's nursing degree students had been provided adequate knowledge about bacterial hospital-acquired infections during practice at healthcare facilities. More importantly, 50 out of 51 respondents have had the adequate level of confidence on performing hand hygiene appropriately equal or more than 50%. Besides that, there are some barriers that hinder students from performing hand hygiene and asepsis adequately. About half of nursing degree respondents had chosen 'they forget doing it' as their answers.

In conclusion, the figures from this study's findings generally showed that nursing degree students had deeply educated about the essentiality of infection prevention at Laurea UAS and at practice placement. Recommendations of this study are that it is strongly believed hand hygiene and asepsis play a vital role in healthcare professionals' career. For this reason, nursing degree students are necessarily provided information about hygiene-performing procedures promptly when they are freshmen. Additionally, authors' recommendation for further researches are that this study's topic-related and the poster about hand hygiene guideline will be made in Finnish in the future. Therefore, the results will be not only applied for nursing degree program in English but also in Finnish.

Keywords: nosocomial infections, hospital-acquired infections, bacterial pathogens, antibiotic resistance, hand hygiene, prevention of hospital-acquired infections, nursing students.

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1 Introduction

Hospital-acquired infection is the major public health problem in Finland (Jaakola, et al. 2016). According to THL (2017), the severe complications of getting hospital-acquired infection such as the high medical costs, prolonged hospilizations, and increased mortality are significantly necessary to be considered. As a matter of fact, the emergence of hospital-acquired infection leads to the emergence and spread of resistance to antimicrobial drugs. More severely, antibiotic resistance goes beyond hospitals, which finds it difficult in treating infections. For these reasons, it is highly important for instructing and educating nurses to prevent the spread of hospital-acquired infections.

WHO (2017) stated that there are a group of bacteria that threaten human health because they are resistant to antibiotics. These bacteria live and multiply in human body system in the presence of antibiotics. More importantly, they can be transmitted from contaminated people or equipment to other people by various ways. The National Institute For Health and Welfare (THL 2017) demonstrated that in Finland the most popular classification of the causative bacterial pathogens and their antimicrobial resistance infections includes MRSA (Methicillin-resistant Staphylococcus aureus), VRE (Vancomycin-Resistant Enterococci), ESBL (Extended spectrum beta lactamase), and CRE (Carbapenem-resistant Enterobacteriaceae).

According to WHO (2002), HAI stands for hospital-acquired infections. THL (2017) study showed that HAI is monitored in Finland under the Finnish Hospital Infection Program, named as SIRO. The programme has been ongoing since 1999 and involves all Finnish university hospitals and some other hospitals. The objective of SIRO monitoring is to prevent hospital-acquired infection. SIRO improves infection monitoring and gathers information about their occurrence in the participating hospitals. Additionally, there are many different methodological booklets containing information for health care professionals on the issue of prevention of hospital-acquired infection. However, this information does not seem to reach nursing students, especially those who are doing their first and second practices. (Tavolacci, et al. 2008.)

For these reasons, this study was done in an attempt to enhance nursing degree students' awareness of self-protection and self-prevention on getting hospital-acquired infections. To be more specific, a poster guide about hand hygiene and asepsis was provided for them.

2 Theoretical framework

2.1 Nosocomial infections

According to WHO (2002), nosocomial infection, or hospital-acquired infection, is any clinically disease of microbial origin that affects a patient as a result of his hospitalization, or occurs within 30 days after discharge from hospital. It can also develop in employees as a result of the work in the hospital. (WHO 2011.)

The importance of hospital-acquired infections can be evaluated from three angles: pathology, socio-economic consequences and ethical aspects. The first and most important, pathology, means the harm that these diseases cause to health and people's lives. This includes morbidity, mortality, lethality, disability, an increase in the duration of patients' stay in hospitals. Secondly, annual financial losses are estimated at approximately € 7 billion, including direct costs only. (THL 2017.) Thirdly, ethical aspects include deontological non-observance of the hand hygiene protocol and asepsis (WHO 2011).

In order any hospital acquired infection to exist, there must be the following components:

- source of infection (host, patient, health worker);
- pathogen (microorganism);
- transmission factors;
- receptive organism, whereas the sources in most cases are:
    - medical staff;
    - carriers of latent forms of infection;
    - patients with acute, erased or chronic form of infectious diseases, including wound infection;

Transmission factors include dust, water, food, equipment and medical instruments. (THL 2017.)

The leading routes of the infection are through contact, air-drop and air-dust. Parenteral route is also possible (typical for hepatitis B, C, D, etc.) (THL 2017).

In total there are more than 200 agents that can cause HAI; however, bacteria resistance to antibiotics plays an increasing role among all hospital-acquired infections recently. A multi-resistant bacterium means a microbe that has acquired resistance to the antimicrobials normally used in the treatment of infections caused by it. For this reason, this research work focus on the following infections: Staphylococcus aureus (MRSA), vancomycin-resistant Enterococcus faecalis or faecium (VRE), broadspectrum beta-lactamase enzymes (ESBL), carbapenememianti-enterobacter (CPE) producing bioactive enzymes. (THL 2017.)

2.2 Aetiology of the bacterial HAI

Many microorganisms cause HAI. The mentioned below figure illustrates the division of all microorganism by their ability to cause diseases.

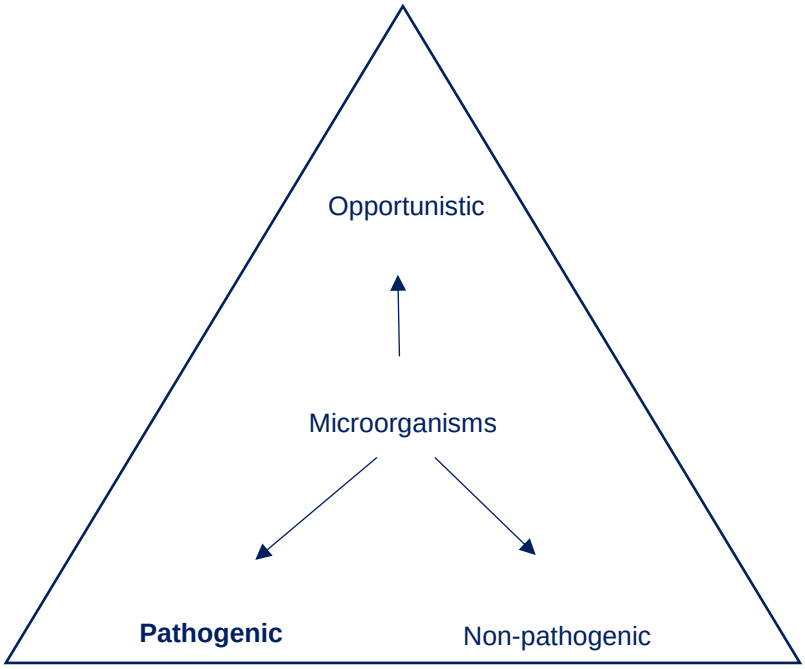

Figure 1. Division of all microorganisms

Pathogenic microorganisms are capable of causing disease; non-pathogenic are not capable of causing disease in humans. Whereas opportunistic microorganisms are those which cause disease only under certain circumstances. The most common pathogens of HAI are conditionally pathogenic microorganisms that surround humans in the everyday life constantly. (Fair & Tor 2014.)

The following figure gives visual idea of the different categories of HAI by the type of causative agent.

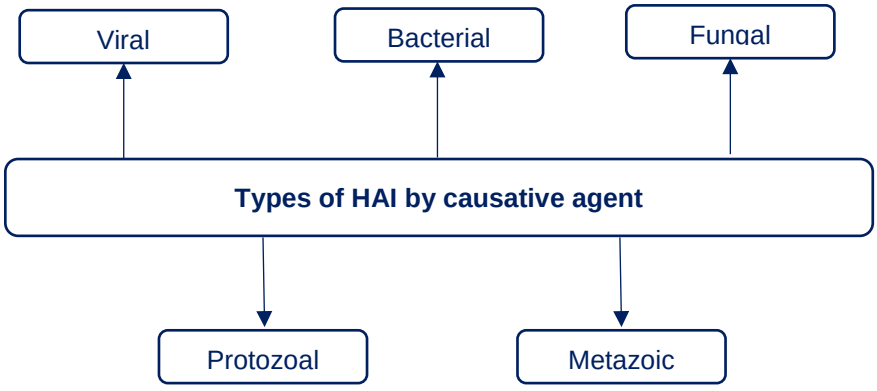

Figure 2. Classification of HAI by the type of causative agent

This manual examines the most common bacterial HAI.

2.3 MRSA

2.3.1 Definition

Staphylococcus aureus (MRSA), which is often called staphylococci, is a common bacterium found in healthy skin and nose mucosa. Some staphylococci have become resistant to standard staphylococcal antibiotics. Antibiotic resistant staphylococci are called methicillin resistant to Staphylococcus aureus, i.e. MRSA. (THL 2017.)

2.3.2 Causative agents

Most staphylococci-inflicted infections are mild, such as wet gilts, abscesses and other skin infections, and they improve without antibiotics. Staphylococcus can also cause serious infections, such as surgery wound infection, pneumonia, especially with patients in hospital. (THL 2017.)

Convolvement or colonization means the presence of staphylococcus on the skin or mucous membrane without causing the disease. At present, about 25 to 30 percent of people carry staphylococci bacteria with nasal mucosa. Infection means that staphylococci causes a symptomatic disease. If MRSA is up above the immune system, it makes it difficult to cure and leads to negative consequences. MRSA can cause pneumonia, boils, and abscesses. If it enters the bloodstream, it causes serious complications. (THL 2017.)

2.3.3 Signs and symptoms

MRSA infection can look exactly like ordinary infections of staphylococcus on the skin, for instance, small red cones, pimples or boils. Affected areas become red, painful, swollen. Pus or other liquid can leak from the wound. THL 2017).

MRSA infection in people who are in health care facilities tend to be severe. These infections may be in the bloodstream, heart, lungs or other organs, urine, or in the area of a recent surgery. Some symptoms of these severe infections may include chest pain, cough or shortness of breath, fatigue, fever and chills, general ill feeling, headache, rash, and wounds that do not heal. (CDC 2017.)

2.3.4 Prevalence

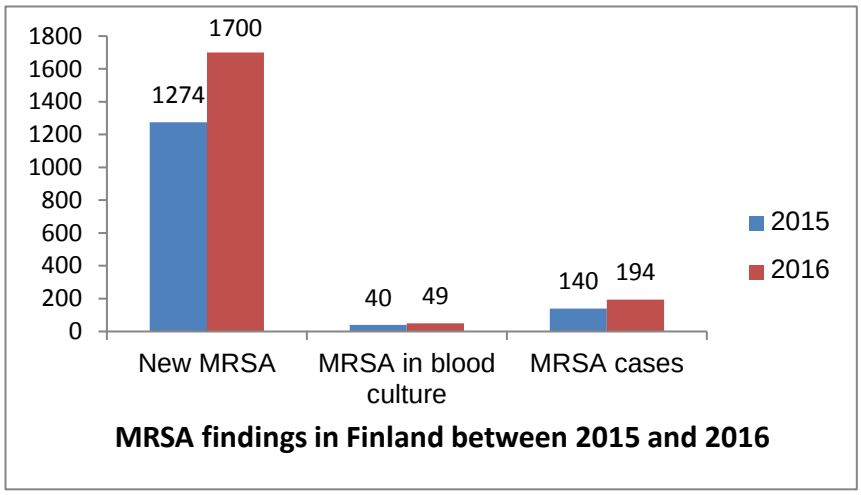

Figure 3. MRSA findings in Finland between 2015 and 2016 (THL 2017.)

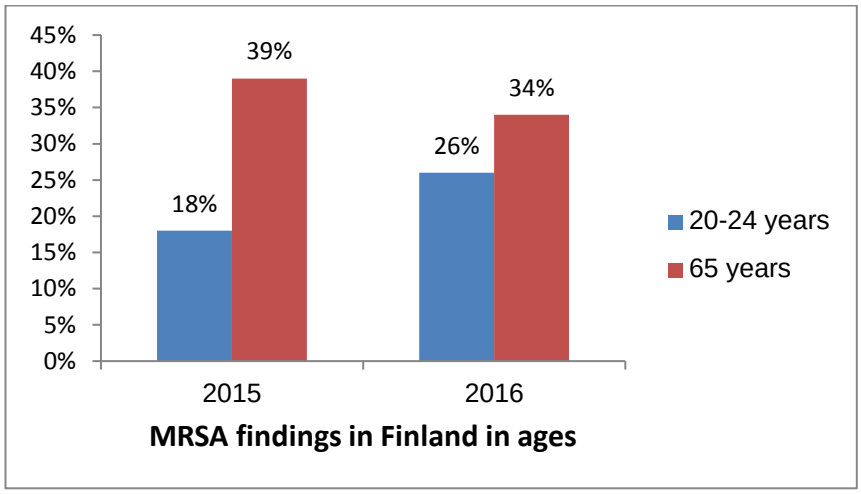

Figure 4. MRSA findings in Finland in ages (THL 2017.)

2.3.5 Ways of transmission and risk groups

The transmission happens by holding a MRSA bacterium from either of patients or the treatment environment to healthcare staff who delivers care to a patient, and adheres the bacteria to the next patient. (THL 2017.)

An increased risk of developing MRSA is found in people who have recently undergone surgery or have been hospitalized. Staphylococcus aureus is also often observed in elderly people living in nursing homes, and in people with a weakened immune system. The risk of infection with this persistent infection is increased in the presence of chronic diseases, such as diabetes, cancer or HIV. (CDC 2017.)

2.4 VRE

2.4.1 Definition

Enterococci was referred to the genus Streptococcus serogroup D. Enterococci are gram-positive strepto- or diplococci, are facultative anaerobes, grow in the temperature range of 10 to

45 °C. According to the physiological characteristics enterococci are very similar to streptococci, in connection with which, initially, until 1984, this type of bacteria was attributed to streptococcal infection. (Cetinkaya et al. 2000.)

Enteroccocci are bacteria that are normally located in the human intestines and in the female genital tract and are often found in the environment. Vancomycin is an antibiotic that is used to treat some drug-resistant infections caused by enterococci. When enterococci have become resistant to this drug and thus are called vancomycin-resistant enterococci (VRE). Most VRE infections occur in hospitals. (CDC 2011.)

2.4.2 Causative agents

Enterococci are opportunistic bacteria, i.e. to harm the body requires a combination of several conditions, for example - an increased number of enterococci against a weakened immune system.

Enterococcal infection is carried out:

- When breast feeding the baby;
- With wounds, cuts;
- The use of infected and unwashed food;
- Eating food with unwashed hands, or contact of dirty hands with lips or mucous membranes of the mouth;
- Non-observance of the rules of personal hygiene, including care of the sexual organs.
- Health problems start against the background of the following factors:
- Infringement in an organism of metabolic processes;
- Disturbances in the balance of microflora (lacto- and bifidobacteria, which regulate the amount of enterococci in the digestive system) in the intestines, which is facilitated by the intake of antibacterial drugs;
- Hormonal imbalance;
- Decrease in reactivity of immunity: hypothermia, stress, the presence of various diseases (Rubenstein, E. & Keynan, Y. 2013.)

2.4.3 Signs and symptoms

Signs of enterococcal infection can be:

- Frequent urge to urinate;
- Difficulty with urination;
- Sharp pain when urinating in the urethra;
- Pain during defecation;
- Change of urine colour;
- Discharge from the urethra of a white-green hue;
- Lowering the potency, absence of sex drive to the opposite sex;

- General weakness, increased fatigue;
- Depression.

The first symptoms of infection are usually not easily observed, therefore, the most common problems are found with a scheduled physical examination. When the body is examined, enterococcus is detected in the smear, urine, excrement (faeces). (CDC 2011.)

2.4.4 Prevalence

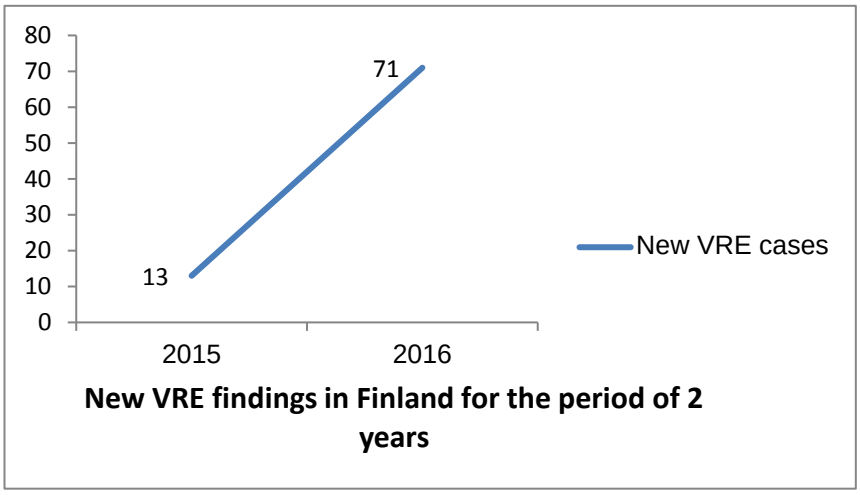

Figure 5. New VRE findings in Finland for the period of 2 years (THL 2017.)

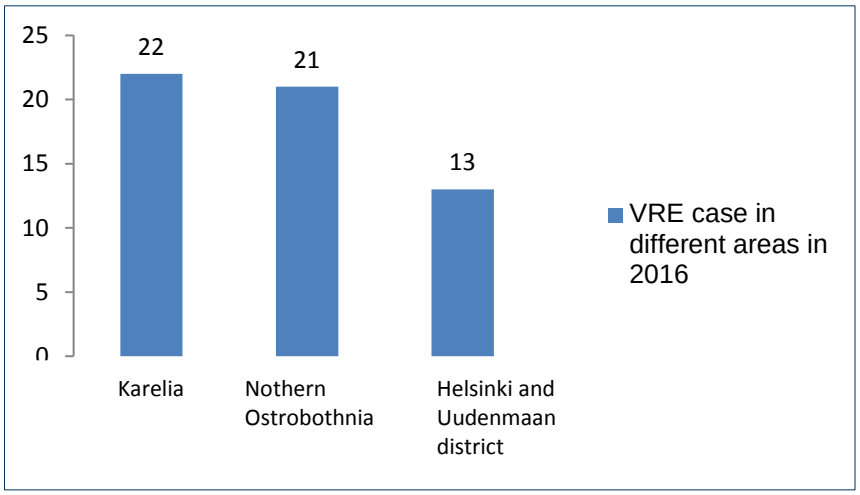

Figure 6. VRE cases in different areas in 2016 (THL 2017.)

2.4.5 Ways of transmission and risk factors

The risk factors for acquiring vancomycin-resistant enterococci by patients are not much different from any other multi-resistant pathogens of nosocomial infections. (Cetinkaya et al. 2000.)

The main habitat and multiplication of enterococci is the small intestine. In smaller quantities, they can be found in the large intestine, genitalia, spongy part of the urethra, and in some cases in the oral cavity. (Cetinkaya et al. 2000.)

Several studies have used case-control methods and multivariate analysis to examine the risk factors for VRE infection among hospitalized individuals. Among the risk factors that have emerged are longer duration of hospitalization, longer lengths of stay in ICU, the need for intrahospital transfer to another ward, the need for surgical reexploration following liver transplantation, and the use of enteral tube feedings. (Cetinkaya et al. 2000.)

2.5 ESBL

2.5.1 Definition

Extended spectrum beta-lactamases, known as ESBLs, are a type of enzyme or chemical produced by some bacteria. ESBL enzymes cause some antibiotics not to work for treating bacterial infections. (Jewell 2017.)

2.5.2 Causative agents

There are two common types of bacteria producing ESBL enzymes, which includes:

• Escherichia coli (E.coli) is known as harmless bacteria living mostly in the gut. These bacteria can cause some infections and food poison.

• Klebsiella is also a harmless group of bacteria living in the mouth, nose and gut. The most common infection causing by the group of bacteria is urinary tract infection in Finland. They also cause some other HAI. (THL 2015.)

When these bacteria manufacture ESBL, they become resistant to antibiotics.

2.5.3 Signs and symptoms

Infected patients have variable symptoms according to infections in different places. They might have reddened skin around skin site infection and fluid coming out from the sites when infection comes into the skin. If infections are in the gut, some symptoms relating to digestive system happen including the loss of appetite, stomach cramps, diarrhea, excessive gas bloating. Patients might feel disordered, fever, nausea and vomiting, difficulty in breathing when infections are spreaded in blood. Urinary tract infections are most commonly, which makes patients urinate more and feel burning during urination. (Jewell 2017.)

2.5.4 Prevalence

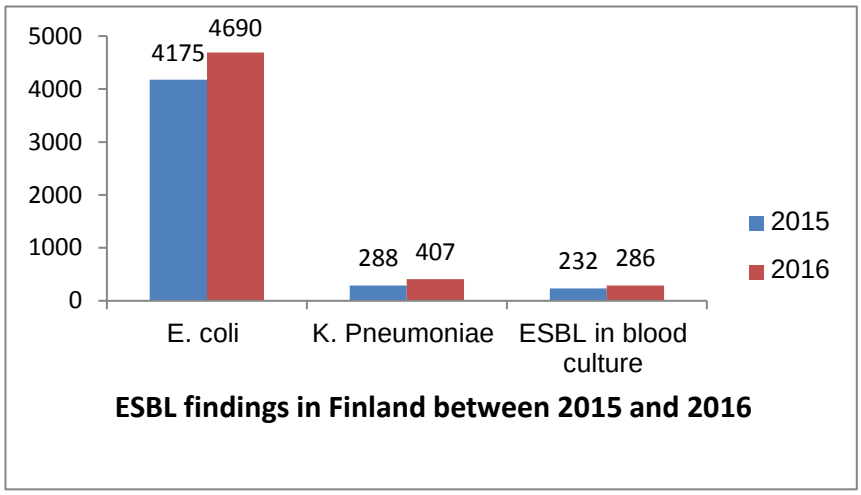

Figure 7. ESBL findings in Finland between 2015 and 2016 (THL 2017.)

2.5.5 Ways of transmission and risk groups

ESBL-caused bacteria are found in air, water, dirt, such as human and animal fecal matter. Contact transmission is a common way of spreading ESBLs. Uninfected people can get infection by contacting with infected people or contaminated surface having bacteria. Airborne transmission is another mean, which infection spreads by breathing on someone. (Jewell 2017.)

ESBL occurs in hospitals and other healthcare facilities. Nurses are infected by either other patients or from healthcare environment. (THL 2015.)

2.6 CRE

2.6.1 Definition

CRE, which stands for carbapenem-resistant Enterobacteriaceae, are a family of germs that are difficult to treat because they have high levels of resistance to antibiotics. Klebsiella species and Escherichia coli (E. coli) are examples of Enterobacteriaceae, a normal part of the human gut bacteria that can become carbapenem-resistant. (CDC 2018.)

2.6.2 Causative agents

Enterobacteriaceae become resistant to carbapenem is due to production of Klebsiella pneumonia carbapenemase (KPC). KPC is an enzyme that is produced by some CRE that was first identified in the United States around 2001. KPC breaks down carbapenem making them ineffective. Both of these enzymes, as well as the enzyme VIM (Verona Integron-Mediated Metallo-ß-lactamase) have also been reported in Pseudomonas. (CDC 2015.)

2.6.3 Signs and symptoms

Symptoms of CRE infections include:

- urinary tract infection,
- cyanosis,

- sepsis,
- pneumonia, fever, septic shock, and low blood pressure. (Davis 2017).

2.6.4 Prevalence

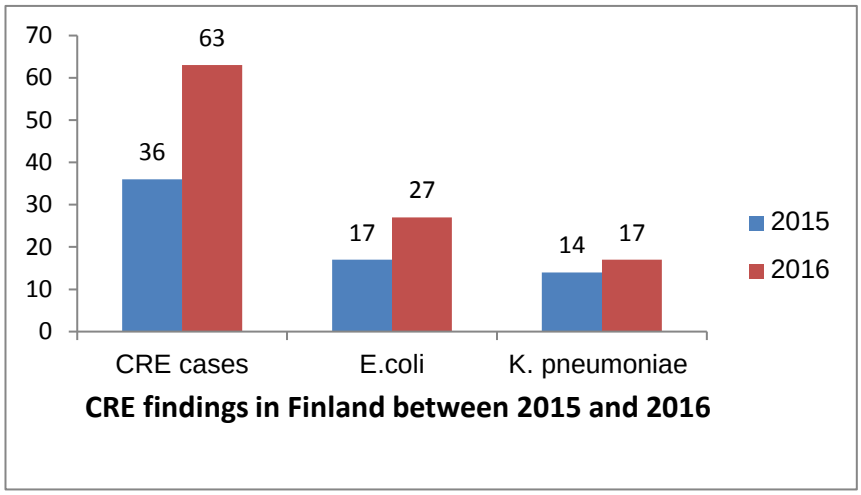

Figure 8. CRE findings in Finland between 2015 and 2016 (THL 2017.)

2.6.5 Ways of transmission and risk groups

CRE can be transmitted from infected or colonized people by contact. People can get infected by touching infected people or contaminated environmental surface. Contact transmission is the only way of spreading CREs infections. (CDC 2015.)

CRE primarily affect people in acute and long-term treatment in hospitals or healthcare institutions. (CDC 2015.)

2.7 Treatment and prevention of the nosocomial bacterial infections

The treatment of HAI is hampered by the absence of antimicrobial substitution options. Delaying the start of the right antimicrobial agent may degrade treatment results. Treatment alternatives may also be less effective than the antimicrobial used in the treatment of the infection caused by the microbe concerned or they may be completely absent. Colonization with multidrug resistance increases the risk of infection associated with treatment and thus the incidence of infections. (THL 2017.)

There are common precautions that are the basis for the prevention of infections caused by multi-resistant bacteria in health care facilities. These measures include hand hygiene and asepsis, patient and visitor control, using protection equipment, cleaning, disinfection or sterilization of equipment, care of the hospital environment and rooms. (THL 2017.)

Understanding hand hygiene practices is essential in planning interventions in health care. Some barriers including skin irritation caused by hand hygiene agents, inaccessible hand hygiene supplies, lack of knowledge of guidelines, insufficient time for hand hygiene, high workload and

understaffing, and lack of awareness on- the risk of cross-transmission of pathogens affect healthcare professionals not to perform hand hygiene properly. (WHO 2009.)

According to WHO (2007), there are some following vital policies that should be significantly considered by healthcare team and organization:

1	Promote optimal hand hygiene adherence.
2	The implementation of multidisciplinary, multimodal hand hygiene improvement strategies within health care facilities should be done adequately: • Access to a safe continuous water supply at all taps/faucets and the necessary facilities to perform hand hygiene. • Education of health-care workers on correct hand hygiene techniques. • Display of promotional hand hygiene reminders in the workplace. • Using posters by displaying at the most important points to educate the right techniques. • Measurement of hand hygiene compliance through observational monitoring and feedback of performance to health-care workers.
3	If alcohol-based hand rubs are not available or are too costly in some countries or areas or healthcare units, local production of hand rubs using the formula described in the WHO Recommended Hand Antisepsis Formulation: Guide to Local Production are importantly considered to be used.

2.8 The risk factors of bacterial HAI for healthcare professionals

2.8.1 Unhygienic environment

CDC (2003) report demonstrated that pathogens live and multiply in the unhygienic environment. Healthcare environment includes the condition and things around patients, staff and healthcare providers such as air, water, food, waste, surrounding subjects and areas. Thus, unfresh air can lead to a highly possible reservoir for pathogens growing faster. More dangerously, the increasing airborne bacterial contamination is a consequence if the healthcare filtered air system is not appropriately controlled. Water goes hand in hand with air. The lack of standard criteria for monitoring water in healthcare policies is considered as the contributing factors of HAI transmission. Food supplied for healthcare institutions are significantly necessary to handle carefully. Otherwise, food borne infection will be an outbreak or an initiation of severer HAI. Hospital waste is found to be hazardous and infectious waste, which contains a source of contamination. Both the improper restricted approach rule for waste storage and the

unseparated waste disposal play an important role in escalating the risk of HAI transmission. (CDC 2003.)

The uncleaning environmental surfaces and inadequately disinfected medical devices are potential reservoirs of bacterial pathogens. Walls, floors, windows, beds, baths and other surroundings would function as contaminated factors. Furthermore, disinfected measures for medical devices, which are not considerably taken into account, gradually increase the high possibility of transmitted bacterial HAI. (Khan et.al. 2017.)

2.8.2 Infected patients

Infected patients carry the flora of bacterial pathogens with them, which is incapable of transmitting to uninfected people, such as healthcare providers, staff, their families, and their surroundings. The causative bacterial HAIs by patients are categorized into two distinct classes. (Khan et.al. 2017.)

2.8.3 Microflora of patients

There is a link between the endogenous flora of bacterial pathogens in infected patients' body systems and the transmission to other people. To be more specific, the bacteria are transferred to tissue wounds or surgical sites, which can afterwards be transmitted to the healthcare professionals by direct contact. It is known as a common mean of transmission between caregivers and patients. Moreover, gram negative bacteria is a type of bacteria living in digestive system when it comes to post-operative abdominal phase. The bacteria possibly cause surgical-site infections and then in the health care environment grows a higher risk to be contaminated by healthcare professionals through direct contact with patients. (Khan et.al. 2017.)

2.8.4 Susceptibility of patients

Prolonged staying in hospitals, especially in ICU increases possibility of either being infected or spreading infections. Healthcare team working in ICU or isolation department has higher risk of getting infected than who are in other departments. (Khan et.al. 2015.)

2.8.5 Self-unawareness

When healthcare staff delivers care to patients, infection control measures are necessary to bear in mind. According to WHO (2009), hand hygiene is defined as a general term referring to any action of hand cleansing. The neglect of performing hand hygiene after being in contact with infected patients increases the risk of transmission to other people. Personal protective equipment, such as masks, gloves, head covers, uniform are vital to take into consideration for healthcare delivery. Improper injection procedure makes healthcare providers get infected in the blink of an eye. To be more specific, needle accidental stick or getting contact with patients' blood, body fluids during injection lead to the threat of being infected for healthcare professionals. (Khan et.al. 2017.)

3 Purpose, Aim & Research Questions

The purpose of this thesis was to explore what kind of confidence nursing students obtain about the prevention of hospital-acquired infection caused by bacterial pathogens.

The aim of the thesis was to produce an up-to-date guide for nursing degree students on self-prevention of hospital-acquired infection caused by bacterial pathogens. Hence, in the study it is necessary to identify and plan to focus on the following problem statement, objective and research question:

Problem: Students have low awareness of hospital-acquired infection prevention protocols before practical training or do not know the exact rules how to behave in the case of hospital-acquired infection outbreak caused by bacterial pathogens in the health care units.

Objective: The guide helps to enhance nursing students' knowledge on self-prevention of getting hospital-acquired infection and to provide nursing students self-awareness during practical training and at work afterwards.

Research question: What measures do nursing students need to take into account in regards to hospital-acquired infection prevention?

4 Research Methods

4.1 Quantitative research method

Quantitative research method was used in the thesis. The steps applied in the process of collecting data were a secondary data, which included search, screening, data extraction and primary data collection.

The following table illustrates what kind of patterns and methods were used in order to conduct the research.

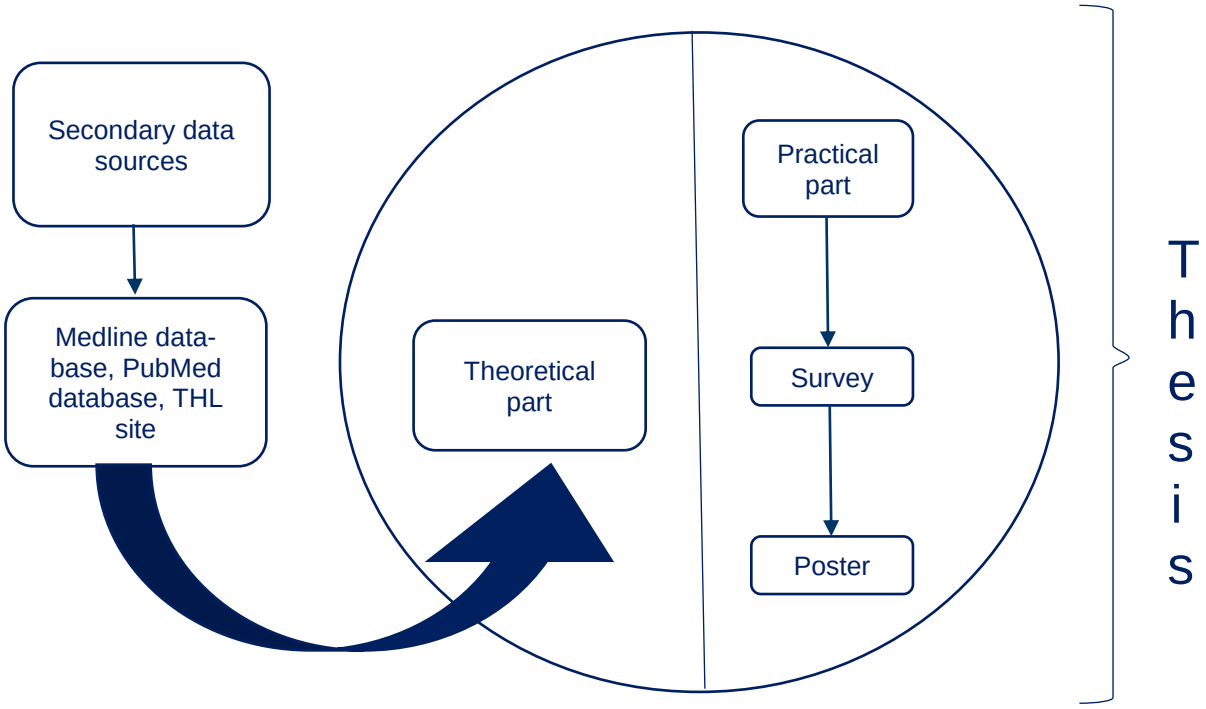

Figure 9. Description of the thesis writing patterns and methods

As seen from Figure 1, half of the thesis includes a theoretical part which was the internal approach of the phenomenon of hospital-acquired infections caused by bacterial pathogens. This part consisted of data collection from secondary data resources. Secondary data, according to Boslaugh (2007), is data collected by a researcher or a group of researchers for another purpose other than the specification or analysis under consideration. In this study, secondary information is used as theoretical background, which provides topic-related information and basic knowledge for readers. Additionally, secondary information was collected by using Boslaugh's (2007) guidelines for secondary data analysis from the Medline, PubMed and NCBI databases as recommended in the manual. Medline is a bibliographic database of life sciences and biomedical information. It includes bibliographic information for articles from academic journals covering medicine, nursing, pharmacy, dentistry, veterinary medicine, and health care. (Wikipedia 2018.) PubMed comprises more than 28 million citations for biomedical literature from MEDLINE, life science journals, and online books (PubMed n.d). Information from the National Institute for Health and Welfare, Finland (THL) was also recorded and used in the

theoretical part. NCBI is the National Center for Biotechnology Information that advances science and health by providing access to biomedical and genomic information.

Another purpose of using the quantitative research method was to conduct a survey for the respondent group. The survey was created in an attempt to find the answer for the research question and the understanding of nursing degree students about the topic. Quantitative research is used to quantify the problem by way of generating numerical data or data that can be transformed into usable statistics. It is used to quantify attitudes, opinions, behaviors, and other defined variables and generalize results from a larger sample population. Quantitative Research uses measurable data to formulate facts and uncover patterns in research. (DeFranzo 2011.) This technique promotes to effective collection of empirical data.

4.2 Survey

4.2.1 Data collection

The survey was created based on the fundamental materials consisting of National Institute for Health and Welfare's guidelines for the protection of multi-resistant microbial infections in 2017 (THL 2017), WHO's practical guide for the prevention of hospital-acquired infections published in 2002 (WHO 2002), and WHO Guidelines on Hand Hygiene in Health Care published in 2009 (WHO 2009).

The survey was designed for first, second and third-year nursing students in English degree program at Laurea UAS. The survey comprised of eleven closed questions. The survey was originally developed by thesis authors and was implemented in English. The aim of survey was to obtain information of nursing students` knowledge on nosocomial infections, which known as hospital-acquired infections, caused by the most common bacterial pathogens and the infection's guidelines, hand hygiene protocols, attitudes and confidence in knowledge on the guidelines and demographic background information.

In order to collect the data, paper-based questionnaires were created. The authors printed 86 copies and spread them during lessons to students from different groups. The survey was individual, which means that one person answered one questionnaire. The survey took place in April 2018, after the thesis plan was done and the research permission was granted in March 2018.

4.2.2 Data analysis

The respondents' answers were analysed in the middle of April 2018.

In this study, the results were analysed using the Microsoft Excel spreadsheet program. The respondents' answers were grouped according to the questions. The results were demonstrated with the help of tables. Based on the data collected, visual figures with the percentage division were created for each question.

The survey was presented to 51 English-speaking nursing students (overall the amount of nursing degree students is 86), including 12 first-year students, 23 second-year students and 16 third-year students. The respondents' rate was 59% in total. In the figural visualization of the results, the answer rates are presented in the percentage form, but in the explanation they are numerical. However, they are absolutely equal and can be used both ways.

5 Thesis findings

The collected results were combined into the analysis both for each year group of nursing degree students and for the whole group of students in English nursing degree program.

In the figure above are presented the answers with yes/no/no answer options to choose. The students were quite determined and mostly choose the options 'yes' or 'no'.

Questions of the survey	1st year students	2nd year students	3rd year students	All students
1. Have you ever obtained any information about bacterial hospital-acquired infections (e.g. MRSA) during practice?				
yes	5	23	14	42 (82%)
no	6	-	2	8 (16%)
no answer	1	-	-	1 (2%)
2. Have you ever read the National Institute for Health and Welfare's guidelines for the protection of multi-resistant microbial infections (2017) or WHO's practical guide for the prevention of hospital-acquired infections (2002)?				
yes	5	13	10	28 (55%)
no	7	10	6	23 (45%)
no answer	-	-	-	-
3. Do you know that antibiotic resistance is one of the most severe consequences of getting bacterial hospital-acquired infections?				
yes	10	17	13	40 (78%)
no	2	6	3	11 (22%)

Figure 10. Analysis of student's answers according to yes/no/no answer response

The next figure represents more subjective way to explore the students' knowledge and confidence regarding hand hygiene technique.

Scale used was 1-10 where 1 is least confident and 10 is most confident. The level of confidence of students according to each question was defined by which number from 1 to 10 they chose. If the answer is in the range of 1-2, it means the student has the least confidence in the content of these question. Similarly, the answer range of 3-4 means the student is fairly confident; the answer range of 5-8 means the student is quite confident; the answer range of 9-10 means the student is most confident.

Questions of the survey	least confident	fairly confident	quite confident	Most confident
1. How confident are you in your knowledge on hospital-acquired infections control protocols?				
1st year students	-	6	6	-
2nd year students	-	4	19	-
3rd year students	-	1	15	-
All students	-	11 (22%)	39 (78%)	-
2. How confident are you on your knowledge on performing hand hygiene properly?				
1st year students	-	-	12	-
2nd year students	-	1	22	-
3rd year students	-	-	16	-
All students	-	1 (2%)	50 (98%)	-
3. When do you follow hand hygiene guidelines: In every situation as demanded by the guidelines				
1st year students	1	-	-	11
2nd year students	1	-	-	22
3rd year students	-	2	-	14
All students	2 (4%)	2 (4%)	-	47 (92%)
4. When do you follow hand hygiene guidelines: When the amount of time is sufficient				
1st year students	-	2	-	10
2nd year students	-	2	-	21
3rd year students		4	-	12
All students	- -	8 (16%)	-	43 (84%)
5. When do you follow hand hygiene guidelines: When hands become visibly dirty				
1st year students	-	-	2	10
2nd year students	- -	3	-	20

3rd year students	-	-	4	12
All students		3 (6%)	6 (12%)	42 (84%)
6. When do you follow hand hygiene guidelines: In work situations where high infection risks exist.				
1st year students	-	-	2	10
2nd year students	-	-	1	22
3rd year students	-	-	1	15
All students	-	-	4 (8%)	47 (94%)

Figure 11. Analysis of the students' answers according to VAS scale

In the next questions the students were asked to assess how often they follow hand hygiene in different situations.

Questions of the survey	Always	At least 75%of the times	No less than 50% of the times	About 25% time	Never
1. Do you remember to use personal protective equipment (PPE) (e.g. gloves, masks, gowns, aprons.) when delivering care for a patient?					
1st year students	6	5	1	-	-
2nd year students	8	12	3	-	-
3rd year students	2	10	4	-	-
All students	16 (32%)	27 (54%)	8 (16%)	-	-
2. Do you remember to perform hand hygiene before contact with patient?					
1st year students	7	5	-	-	-
2nd year students	12	10	1	-	-
3rd year students	3	9	4	-	-
All students	22 (44%)	24 (48%)	5 (10%)	-	-
3. Do you remember to perform hand hygiene after contact with patient?					
1st year students	8	4	-	-	-
2nd year students	14	9	-	-	-

3rd year students	3	13	-	-	-
All students	25 (50%)	26 (54%)	-	-	-

Figure 12. Analysis of the students' answers according to the frequency of following hand hygiene

After that, the students were presented with different options to choose from in regards to reasons that prevent them from implementing hand hygiene in the care process.

The reasons made you not perform hand hygiene properly when you deliver care to patients	1st year students	2nd year students	3rd year students	All students
You forget.	6	18	10	34 (68%)
Hand hygiene products are not accessible.	1	15	4	20 (40%)
The work load and pressure hinder you from performing hand hygiene.	3	8	13	24 (48%)
Your supervisor tutors do not follow the technique.	4	10	6	20 (40%)
Lack of training	-	1	-	1 (2%)
Lack of motivation	-	-	-	-
Wearing gloves is safe enough to protect you from contamination.	2	9	7	18 (36%)
There are no severe consequences since the supervisor teachers do not criticize it.	-	4	-	4 (8%)
None of the above	4	2	2	8 (16%)

Figure 13. Analysis of the students' answers in regards to the reasons for not performing the hand hygiene

Last, but not least question was focusing on the prevalence of hand hygiene products among students. It turned out that the most popular way of disinfection is through soap and water (n=28, x=55%), then comes alcohol wall dispenser (that is placed on the wall; n=16, x=31%) and on the third place students prioritized portable hand dispenser (n=7, x=14%).

To sum up, it is important to note that the topic raised in the study work is a broad and global one. However, the questions presented in the survey and their analysis showed that the students are capable of the nosocomial bacterial infections and most of them are confident in hand hygiene protocols.

6 Discussion and thesis results

The number of respondents of survey was 51 over all 86 nursing degree students, which was 59% as the respondents' rate mentioned above. This figure clearly showed that students found the topic interesting and willingly cooperated during the questionnaire stage. Therefore, in general, this study had a good result. Whereas, particularly, around half of the third-year-student group responded.

It was comprehensibly seen that Laurea UAS's nursing degree students have highly acknowledged hospital-acquired infections and quite confident in performing hand hygiene properly, which was 82% and 98% of nursing degree students' answers in that order. It was more likely to be understood that most of them have had good medical knowledge and have been well-trained at Laurea UAS. Moreover, 44% and 50% of nursing students always remember to perform hand hygiene before and after contacting with patients, respectively.

Nevertheless, besides that, there are many other different answers with various reasons behind that. As a matter of fact, based on the thesis findings, freshmen were given slightly more ''no'' answers than other groups. This could be basically explained that freshmen, who have been educated at Laurea UAS for a short period of time, do not have sufficient nursing expertise. Therefore, it is a need for more lectures and training for them. Besides that, it was undeniable that in some questions, second-year and third-year students also responded inadequately. According to thesis findings given above, the mostly chosen reasons that hinder them from performing hand hygiene properly were ''you forget'', ''the work load and pressure hinder you from performing hand hygiene'', which was 68% and 48% of nursing degree students' answers in that order. Therefore, it is clearly shown that they did not get enough guidance from the practical placements, which was obviously seen by 40% of answers was for ''your supervisor tutors do not follow the technique''. More surprisingly, 40% of answers was shown that hand hygiene products are not accessible in there practice placements.

Overall, the level of confidence more than 50 % in hospital-acquired infections control protocols of Laurea UAS's nursing students constituted for the high proportion.

Despite of the fact that many of the questions were not objective in a way that most of them included the respondent's own view and evaluation, the analysis did not show any ideal answers. The students adequately measured their abilities to cope in the healthcare environment by pointing out only options that fitted their real situations, trying to avoid the race for the right answers. This gives a thought that students do realize the severity of the situation and

this can be justified by the high percentage of confidentiality when to follow hand hygiene guidelines.

7 Guidance for nursing students

Hand hygiene is considered to be the most important procedure to protect nursing students from getting infection. In this way, the thesis result is to provide nursing students consensus recommendations for keeping clean and asepsis. WHO (2009) stated a wide range of recommendations for healthcare workers in WHO Guidelines on Hand Hygiene in Health Care report. However, the most necessary and suitable hand hygiene-related recommendations for nursing students are chosen based on the thesis research results, which includes indications for hand hygiene, hand hygiene technique, uses of gloves and skin care.

According to the analysis of the survey implemented during the study research and fundamental materials used as theoretical framework it was designed a list of recommendations for nursing students that were reflected in the poster. The recommendations include indications for hand hygiene, hand hygiene technique, use of personal protective equipment, skin care

1. Indications for hand hygiene:

• Avoid wearing wristwatch, rings, or other hand jewellery; no artificial/gel nails.
• Remember to disinfect your hands:
1) Before or after patient contact or action;
2) Before wearing and removing protective gloves or other protective equipment;
3) Before going to and leaving the treatment environment.
• Remember to wash your hands with soap and water:
1) When your hands are visibly dirty or feel dirty
2) When there is a risk of being infected by bacterial infections (note: already suspecting before diagnosis is confirmed).

2. Hand hygiene technique

• Apply a palmful of alcohol-based hand rub and cover all surfaces of the hands.
Rub hands until dry.
• When washing hands with soap and water, wet hands with water and apply the amount of product necessary to cover all surfaces.
Rinse hands with water and dry thoroughly with a single-use towel.
Use clean, running water whenever possible. Avoid using hot water, as repeated exposure to hot water may increase the risk of dermatitis.
Use towel to turn off tap/faucet.
Dry hands thoroughly using a method that does not decontaminate hands.
Make sure, towels are not used multiple times or by multiple people.

• Liquid, bar, leaf or powdered forms of soap are acceptable. When bar soap is used, small bars of soap in racks that facilitate drainage should be used to allow the bars to dry.

3. Use of personal protective equipment

• Gloves - when dealing with blood, secretions, ulcers, lice, mucous membranes or contaminated areas or instruments;
• Gown and protective sleeves - when there is a risk of blood or other infections transmitted via direct contact;
• Mask - when there is a risk of blood or other nosocomial infections;
• Protective glasses - when there is a risk of blood, for example, in the oral care unit.

4. Skin care

• Care for your skin condition properly.
• Use alternative hand hygiene products with confirmed allergies or adverse reactions.
• Use hand lotions or creams to minimize the occurrence of irritant contact dermatitis associated with hand antisepsis or hand washing.
• When alcohol-based hand rub is available in the health-care facility for hygienic hand antisepsis, the use of antimicrobial soap is not recommended.
• Soap and alcohol-based hand rub should not be used concomitantly.
• Handle your hand hoards properly, if necessary, contact occupational health-care facilities.

8 Ethics and study limitation

8.1 Ethics

There is a list of premises for the responsible conduct of research ethics and reliability that the thesis authors take into account and reflect in the thesis topic. In the study work, the first step for following the ethics of conduct and research is to ask the research permission from the Laurea's authorities. In order to fulfil this intension, the project plan was created following the ethical considerations. In addition, integrity, meticulousness, and accuracy are strictly complied for researching theoretical studies, collecting data from groups of Laurea UAS's nursing students, analysing data and evaluating the research results. The particular example is making references for all sources of studies, articles for the thesis from various means such as books, textbooks, and webpages. In order to make the data collection precisely, all chosen questionnaires base on the background of scientific criteria and knowledge in a variety of articles. Moreover, research misconduct including fabrication, falsification (misrepresentation), plagiarism, misappropriation is strongly inhibited in researching and writing the thesis. Avoiding disregard for the responsible conduct of research is taken into consideration surely by the thesis authors. Additionally, the preliminary ethical review is carried out carefully, which means the thesis objective does not cause any harm or violence. Besides that, personal information of respondents for the thesis's survey is kept confidentially. Finally, a pair of authors agree on the

rule that the rights, obligations, responsibilities are considerably taken with respective attitudes, perspectives and behaviours. (TENK 2012.)

8.2 Study limitation

While the theoretical research and data analysis have been formulated academically, challenges and limitations are unavoidable. During the thesis research and data analysis stages, there were two main disadvantages that suppressed the achievement of the research purpose. First, in terms of the thesis research, antimicrobial infection is such a broad topic that contains a huge various source of information. However, the precise and reliable materials, which are able to be used and provided for the research, are narrowly restricted. For that reason, theoretical background was officially supported by three principal resources provided by THL, WHO organizations and PMID, a place in which most medical research studies are published. Second, data collection was constricted by the lack of amount of respondents from three nursing degree groups, which was specifically 12 out of 23 the first-year, 23 out of 28 the second-year, and 16 out of 35 the third-year nursing degree students done the survey. Nevertheless, data analysis have been demonstrated adequately, based on a range of quality surveys. Moreover, the schedules of three nursing degree groups are different. It made it hard to collect sufficient answers from all nursing degree students.

9 Conclusion and recommendation

9.1 Conclusion

It is evident that the bacterial infections are surrounding our livings, especially in the health care settings. We face with the issue of the increase of diseases and illnesses nowadays. Basing on the result of data collection, there are variety of reasons for not performing hand hygiene and asepsis properly, which includes lack of appropriate accessible equipment, high staff-to-patient ratios, allergies to handwashing products, insufficient knowledge of staff about risks and procedures, too long a duration recommended for washing, and the time required (WHO 2002). However, WHO (2002) showed the importance of hands in the transmission of hospital infections has been well demonstrated, and can be minimized with appropriate hand hygiene. It is strongly believed that hand hygiene is merely the most effective way to decrease the risk of infection.

The survey implemented in the study work helped in deriving main aspects of nursing students' awareness of bacterial nosocomial infections and helped in creating recommendational poster oriented for the respondents. All in all, according to the findings, hand hygiene technique and indications, use of personal protective equipment and skin care recommendations were reflected in the poster. Hence, the appliance of the poster would be effective for both nursing students and the teachers.

9.2 Recommendation

Hospital-acquired infection was considered as a must-to-know and broad topic. In this study, authors had been researched some parts of the topic. Beyond that, authors of this study highly recommend that other topic-related aspects should be done in further studies in either English or Finnish.

The poster designed throughout the research study work and oriented for nursing students considered to be vital and bringing the necessary information in a nutshell. It was easy to understand with knowledgeable demonstration and was beautifully designed with colourful pictures. Authors suggest that it should be implemented in some lectures, trainings, or workshops to provide this knowledge for nursing degree students. Before putting in use, the poster should be evaluated to update to the current state-of-the-art version in order to ensure the suitability of the poster for students.

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Appendices

Appendix 1: Survey

Dear respondent! You are invited to be part of our thesis research for the 'Prevention of nosocomial infections caused by the most common bacterial pathogens'.
Please, fill in the following questions, based on the National Institute for Health and Welfare's guidelines for the protection of multi-resistant microbial infections (2017), WHO's practical guide for the prevention of hospital-acquired infections (2002), and WHO Guidelines on Hand Hygiene in Health Care (2009). The survey is kept in secret and all the information will be deleted after its analysis.
Your participation is highly important as it gives the fundament for the authors to create a guideline for nursing students on prevention of nosocomial infections, which known as hospital-acquired infections, caused by the most common bacterial pathogens.

Please, choose your group:

SNV215SN	SNV216SN	SNV217SN
☐	☐	☐

Please, choose your gender:

Male	Female	Other
☐	☐	☐

Part 1. Knowledge testing

The following five questions are based on the National Institute for Health and Welfare's guidelines for the protection of multi-resistant microbial infections (2017) and WHO's practical guide for the prevention of hospital-acquired infections (2002).

1. Have you ever obtained any information about bacterial hospital-acquired infections (e.g. MRSA) during practice?

Yes	No	No answer
☐	☐	☐

2. Have you ever read through the National Institute for Health and Welfare's guidelines for the protection of multi-resistant microbial infections (2017) or WHO's practical guide for the prevention of hospital-acquired infections (2002)?

Yes	No	No answer
☐	☐	☐

3. How confident are you in your knowledge on hospital-acquired infections control protocols?

Least confident	1	2	3	4	5	6	7	8	9	10	Most confident
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

4. Do you remember to use personal protective equipment (PPE) (e.g. gloves, masks, gowns, aprons.) when delivering care for a patient?

Always	At least 75% of the times	No less than 50% of the times	About 25% of the times	Never
☐	☐	☐	☐	☐

5. Do you know that antibiotic resistance is one of the most severe consequences of getting bacterial hospital-acquired infections?

Yes	No
☐	☐

Part 2. Preventive measures accessing.
The next five questions are based on the WHO Guidelines on Hand Hygiene in Health Care (2009).
6. How confident are you on your knowledge on performing hand hygiene properly?

Least confident	1	2	3	4	5	6	7	8	9	10	Most confident
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

7. Do you remember to perform hand hygiene **before** contact with patient?

Always	At least 75% of the times	No less than 50% of the times	About 25% of the times	Never
☐	☐	☐	☐	☐

8. Do you remember to perform hand hygiene **after** contact with patient?

Always	At least 75% of the times	No less than 50% of the times	About 25% of the times	Never
☐	☐	☐	☐	☐

9. The reasons made you **not** perform hand hygiene properly when you deliver care to patients. (**You can choose <u>several options</u>**):

You forget.	☐
Hand hygiene products are not accessible.	☐
The work load and pressure hinder you from performing hand hygiene.	☐
Your supervisor tutors do not follow the technique.	☐
Lack of training	☐
Lack of motivation	☐
Wearing gloves is safe enough to protect you from contamination.	☐
There are no severe consequences since the supervisor teachers do not criticize it.	☐
None of the above	☐

10. Please prioritize the use of the following components according to your preference (1 – most preferable, 2 – less preferable, 3 – least preferable)

- Soap and Water ☐
- Alcohol hand disinfectant (portable/table) ☐
- Alcohol hand disinfectant (wall dispenser) ☐

11. When do you follow hand hygiene guidelines?

1) In every situation as demanded by the guidelines:

Very Unlikely	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐	Very likely

2) When the amount of time is sufficient:

Very unlikely	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐	Very likely

3) When hands become visibly dirty:

Very unlikely	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐	Very likely

4) In work situations where high infection risks exist.

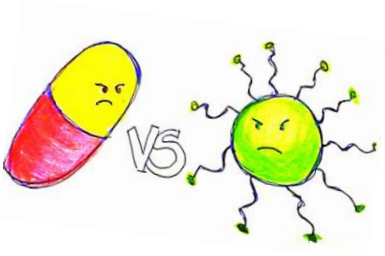
Very Unlikely	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	8 ☐	9 ☐	10 ☐	Very likely

<u>Thank you for your time and cooperation!</u>

Appendix 2: Poster

GUIDE FOR PREVENTION OF THE MOST COMMON BACTERIAL INFECTIONS

The most common bacterial infections in Finland include MRSA, ESBL, VRE, and CRE. Their multi-resistant microbial strains are adapted to the acquisition of resistance mechanisms; as a result, they are often resistant to the medicines of other antimicrobials.



Important to know

The staff rarely acts as a source of infection with the MDR if the skin of the hands is in the right hands and there are no foreign factors such as jewellery, nail art, etc.

Recommendations for nursing students

Indications for hand hygiene

- Avoid wearing wristwatch, rings, or other hand jewellery; no artificial/gel nails.
- Remember to disinfect your hands:
  before or after patient contact or action
  before wearing and removing protective gloves or other protective equipment
  before going to and leaving the treatment environment
- Remember to wash your hands with soap and water:
  when your hands are visibly dirty or feel dirty
  when there is a risk of being infected by bacterial infections (note: already suspecting before diagnosis is confirmed)

Hand hygiene technique

- Apply a palmful of alcohol-based hand rub and cover all surfaces of the hands. Rub hands until dry.
- When washing hands with soap and water, wet hands with water and apply the amount of product necessary to cover all surfaces.
  Rinse hands with water and dry thoroughly with a single-use towel.
  Use clean, running water whenever possible. Avoid using hot water, as repeated exposure to hot water may increase the risk of dermatitis.
  Use towel to turn off tap/faucet.
  Dry hands thoroughly using a method that does not decontaminate hands.
  Make sure, towels are not used multiple times or by multiple people.
- Liquid, bar, leaf or powdered forms of soap are acceptable. When bar soap is used, small bars of soap in racks that facilitate drainage should be used to allow the bars to dry.

Use of PPE

- *Gloves* - when dealing with blood, secretions, ulcers, lice, mucous membranes or contaminated areas or instruments
- *Gown and protective sleeves* - when there is a risk of blood or getting an infectious disease transmitted via direct contact
- *Mask* - when there is a risk of blood or nosocomial infections
- *Protective glasses* - when there is a risk of blood, for example in the oral care unit

Skin care

- Care for your skin condition properly.
- Use alternative hand hygiene products with confirmed allergies or adverse reactions.
- Use hand lotions or creams to minimize the occurrence of irritant contact dermatitis associated with hand antisepsis or hand washing.
- When alcohol-based hand rub is available in the health-care facility for hygienic hand antisepsis, the use of antimicrobial soap is not recommended.
- Soap and alcohol-based hand rub should not be used concomitantly.
- Handle your hand hoards properly, if necessary, contact occupational health-care facilities.

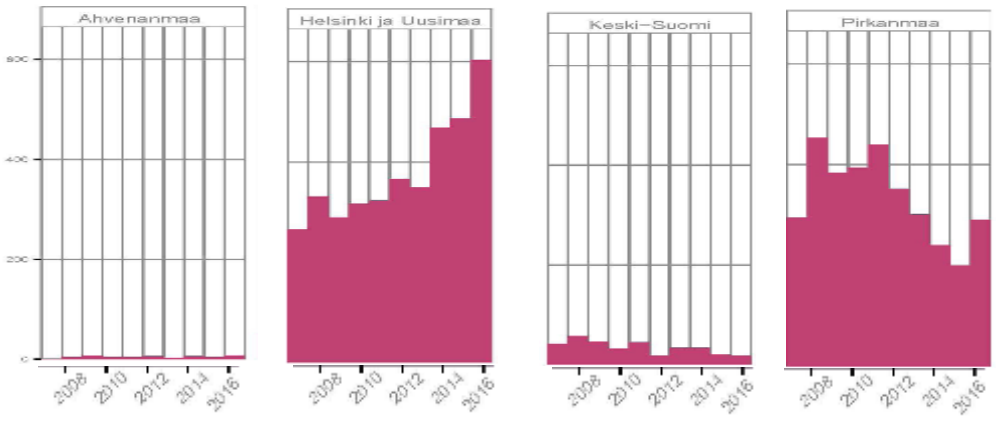


Fig. 1 MRSA-cases in different areas of Finland, 2007-2016

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