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PREVENTION OF HOSPITAL AQUIRED INFECTION: FOCUS ON *Methicillin-resistant Staphylococcus aureus* (MRSA) AND *Vancomycin-resistant Enterococcus (*VRE)

Narrative Literature Review

LAHTI UNIVERSITY OF APPLIED SCIENCES
Degree Bachelor of Health Care
Degree programme in Nursing
Autumn 2018
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Abstract

Author(s)	Type of publication	Published
Aloysius Nkweze, Nkembeng Bernabe Nkwette, Forba Zemene Geogette	Bachelor's thesis	Autumn 2018
	Number of pages 39	

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Abstract

Hospital acquired infections (HAI) also known as nosocomial infections are infections that are acquired during care in the hospital and which are not present or incubating at the time of admission. Infections that occur more than 48 hours after patient`s admission are usually considered nosocomial. Proper hand washing before and after procedures in hospital environment remains the basic most effective way of preventing HAIs.

Student nurses are one of the major group of health workers responsible for the transmission of HAIs due to lack of knowledge and experience. Thus this study was conducted to provide health personnel with more knowledge on the prevention of hospital acquired infections more precisely MRSA and VRE in Finnish hospital and to find out the role of a nurse in the prevention of these hospital acquired infections.

A narrative literature review was conducted on the prevention of hospital acquired infections focusing on MRSA and VRE. Data was collected using online databases. Data collected were analysed using thematic analysis. Articles related to our studies in English or Finnish available in full text and free were selected for the study. From the findings, it resulted that SIRO is the organization responsible for the prevention of hospital acquired infections in Finland. There are however several methods in the prevention of Hospital acquired infection such as aseptic practices, isolation, use of protective equipment etc. All in all, hand washing and disinfection remains the most efficient method of prevention of hospital acquired infection. Nurses play a pivotal role in the prevention of hospital acquired infections. These roles involves promoting good hand hygiene, making best use of aseptic techniques, the use of universal precautionary practices, patients education, as well as proper cleaning and disinfecting practices.

Keywords

Hospital acquired infection, prevention, VRE, MRSA, Nurse

CONTENTS

1 INTRODUCTION

During our nursing degree pursuit and our multiple practical trainings, we noticed that many patients that were coming to the hospital for a disease or an infection were supposed to be treated in few days but ended up spending weeks in the hospital with a different infection that they probably contracted during their stay. After these, we started to find out what could be the possible reason for these patients staying longer time than normal and came across the term “hospital acquired infections” and decided to know more about it which led us to writing our thesis about it. We then decided to work under the research topic prevention of hospital acquired infection paying more attention to Methicillin-resistant Staphylococcus aureus (MRSA) and Vancomycin-Resistant Enterococci (VRE). Normally, the hospital is regarded as the safest environment for patients, but the interaction with the external society has proven that the hospital is a big reservoir for infections hence considered unsafe for patients and other health care officials. Our interest on finding out why hospitals are danger zones for patients has also poised our interest to carry out our thesis on this topic. As a result of this, we decided to explore in more details the hospital acquired infection and how it can be prevented. Prevention of hospital acquired infections will make the hospital environment in Finland a safe environment for patients, families, as well as health care professional.

Hospital acquired infection may be caused by different pathogens including bacterial virus, fungi, prions, viroid, and parasites. The infecting organism differ amongst different population groups of patients, different facilities, different health care settings, and different countries. However, in this thesis, to prevent the explosion of information, we limited the topic to focus on infections related to MRSA and VRE (these class of microorganisms belongs to bacteria). Bacteria are the most common hospital acquired infection pathogens. They have a greater virulence (microbe's ability to cause a disease to a host) and regardless of the status of the host, they can cause infections. Therefore, bacteria are common infectious agents all over the globe and have a high ability to cause countless numbers of infections to hospitals patients, families visiting the hospitals, and health care professionals.

2 THEORETICAL BACKGROUND

2.1 Hospital acquired infection

Hospitals acquired infections are those infections that occur for the first forty-eight hours or more after a patient has been admitted at the hospital (Horan & Gaynes 2004, 1659-1707). These infections can still be acquired within a month after discharged following in patient care. Horan and his associate's also defined hospital acquired infection as a systemic or localized condition that result from the reaction by an infectious agent or toxin (Horan et al. 2008, 36). The world health organization (WHO, 2002) defines hospital acquired infection as infection that occurs in patients under medical care in hospitals or other health care facilities which was not present at the time of admission of the patient (WHO, 2016). According to the Act on Infectious Disease, hospital acquired infection refers to an infection that has arose during or after treatment in the hospital (Anttila et al. 2010, 18). For that reason, medical treatment is nowadays increasingly being administered outside the hospital. That's the case of dialysis care that has been transferred to health centres and, many other care procedures are taken in many units outside hospitals. These infections can also occur during health care delivery and even after the discharge of patients (Hassan et al. 2017, 478-482). These hospital acquired infections occur all over the world, both in developed and developing countries. In developing and developed countries, these infections account for 10 % and 7% respectively (Raja & Annadurai 2014, 67). It is estimated that, in the United States of America (USA), hospital acquired infections occur in about 2 million patients per year with death toll of about 99000 and a cost of over 33 billion dollars each year (Klevens et al. 2007, 298). Different reasons have led to the alarming nature of hospital acquired infections in the twenty first century some of which include firstly, the increased number of patients admitted at the hospital who have weakened immune systems, increased in out treatment patients, movement of hospital staff from one patient to another which provides a way of spreading of pathogens, lack of sanitation etc. These infections get noticed only when they become epidemic, yet there is no institution or a country that may claim to have resolved this epidemic problem (Gupta et al. 2015, 4). It's worth noting that microbial growth times vary. For bacterial infections, the incubation time is about two days. As a result

some require treatment-related infection occurs only 48 or 72 hours after the start of the treatment period. The most commonly used CDC (Centres for Disease Control and Prevention, Atlanta, Georgia, USA) definition does not give any time limit about when the infection is related to treatment. (Anttila et al. 2010, 21).

The presence of a foreign and detrimental species (pathogens) in a host is described as infection. Virus, bacterial, parasites, prions, viroid are called pathogens. Pathogenesis is the ability of a microorganism to cause a disease (Wilson 2000). Pathogens multiplies at the expenses of their host and affects their host normal functioning body system. However, hospital acquired infections are infections that are acquired when someone is hospitalized. It can also affect healthy people in the community, therefore indicating that not all infections are acquired during one's stay at the hospital. Hospital acquired infections that are caused by MRSA and VRE causes significant morbidity and mortality. MRSA and VRE, are multidrug resistant because they resist a large group of antibiotics and as a result, there can become an epidemic in hospital environment (Henderson 2006, 119). In different countries, while some have witnessed one epidemiology, others are living with these infections in their hospitals. Despite the different programs of infection controls over the past 30 years, the incidence of MRSA and VRE has continued to increase in most health care sectors (Burger et al. 2006, 34).

2.2 Mode of transmission and infection sites

HAI can be transmitted in many ways, but the 2 main routes of transmissions are airborne and contact. However, transmission can also be from the environment and from some stuff. Firstly, as airborne, organisms from the skin, mucous membrane of the throat and nose are dispersed in the air in droplets form through sneezing and coughing. The distance that the droplets may travel to infect a second person on the other location will depend on the size of the droplets and the movement and power of the air that disperses them. These will settle on a possible host and transmit the infection (Farida 1981). Secondly, through contact, the transmission can be from nurse to patient, from patient to patient or indirect contact i.e. through environmental and inanimate source of infections. Here, hands of the health care workers are the main source of transmission if poor hand hygiene is being practiced (Farida 1981).

Transmission from environment and stuffs is only as a result of the fact that, dirty environment acts as the best reservoir for pathogenic organisms to multiply. HAI can be transmitted to the patient through contaminated water, air and food. All the hospital environment ranging from the private area of the patient such as beds, baths, and toilets, walls of the hospital, floor and medical devices should be cleaned by professional cleaning agents. The hospital should also be well ventilated, and patient's admission in the same ward should take into account their health conditions. For example, a patient with infectious disease cannot be put in the same room with a patient who has been operated.

Infection control should be handled carefully by the hospital staff because infections can be transferred from the health care worker to the patient if the proper hygiene conditions are not used such as hand washing and the used of hand disinfectants, proper hygiene of the hospital staff by keeping nails short, and using proper prevention equipment when necessary such as gloves, masks, clean uniforms and aprons, head cover.

2.3 Epidemiology and prevalence of HAI: MRSA and VRE

For the first time in 1968, MRSA was first noticed at Boston city hospital in the USA (Herwaldt 1999, 106). In Europe it was noticed in 1961 (Michel & Gutman 1997, 349). Other countries in different years have noticed or identified hospital acquired infections, but however, there is a fact that they exist and cause significant problems in all health sectors. There is a greater negative impact in hospitals around the world in different countries caused as a result of the existence of MRSA. One of the major cause of hospital acquired infection in the world is MRSA, causing almost more than 50% of hospital acquired infections in different countries (Faria et al. 2004, 43). In the USA, MRSA accounts for 20-50 % of all hospital acquired infections (Kotilainen et al. 2003, 9). Also, according to Klevens, in the USA, MRSA infections mounts to 94360 yearly accounting for about 18000 deaths per year (Klevens et al. 2007, 298). In 2008, Europe had a strong presence of MRSA accounting for about 44% of hospital acquired infections (Kock et al. 2010, 15). The prevalence of MRSA has increased over the past 10 years. This is however associated with longer time spend at the hospital and an increased cost to the society. MRSA is very common in different healthcare sectors including

sport, clinics, and communities. However, those that are associated with the hospital are called hospital acquired MRSA and there are the most common cause of hospital acquired infections (Durai et al. 2010, 91). Some also are associated with the community and are termed community acquired MRSA (Deleo et al. 2010, 375). MRSA, causes skin and soft tissues infections like furuncles, impetigo, cellulitis, abscesses etc.

On the other hand, VRE was first discovered in England and France in 1986. Since then, it has become a major hospital acquired infection (Tristan & Christopher 2015, 8). VRE has a very high persistence ability in hospital environments, thereby increasing its transmission. In the world, North American records the highest rate of VRE (Tristan & Christopher 2015, 8). In the USA, VRE is recorded as the second highest common cause of hospital acquired infection. This was according to National health-care safety network (NHSN) from 2009 to 2010 which recorded a percentage of 35.5. By contrast, 6% of VRE prevalence was recorded in Canada from 2007 till 2011 (Zhanel et al. 2013, 68). It was recorded that, in Europe, the prevalence of VRE is less but however in the rise. According to the European antimicrobial resistance surveillance system (EARSS), 4% of VRE prevalence was recorded in Europe. This however varies amongst different countries. For example, 1% in France, Spain, Sweden, to higher than 20% in Greece, Ireland, United Kingdom, and Portugal (EARSS, 2015). It was reported to the center of disease control and prevention of hospital acquired infection surveillance system that, from 1989 through 1993, the percentage of nosocomial enterococci infections has increased from 0.3% to 7.9%. This was due to the increase of VRE infection in intensive care unit patients, even though there was also an increased noticed in non-intensive unit care patients (CDC, 1993). VRE is also a serious problem in long term care facilities. For example, it was found out that 47% of patients who were admitted in the hospital from long term care facilities were infected with VRE and also, the prevalence of VRE differs in different geographic areas among residents of long term care facilities (Boyce et al. 1997, 11). VRE varies in its virulence and it manifests clinically in intra-abdominal and pelvic infections, skin infections, urinary tract infections etc. There is resistance to antibiotics by displaying different mechanisms in their intrinsic and acquired resistance. They are efficiently attained and are able to transfer mobile resistance elements increasing dis-

semination of resistance genes, based on the genome plasticity which uses plasmids transposons and insertion sequences (Cattoir & Leclercq 2013, 68).

In Finland, the statistics on the prevalence of the MRSA and VRE from 2002-2016 has been clearly stated by the national institute for health and welfare (Table 1).

The prevalence of MRSA in Finland has been increasing from 2002 through 2008, even though it was almost constant in the year 2009 through 2015. However, 2016 has seen a large increase from 1274 cases in 2015 to 1700 cases in 2016. No data for VRE has been recorded until 2013 and from 2014 some cases were spotted out.

Table 1. Statistics from the National institute for health and welfare shows the following about the rate of MRSA and VRE from 1995-2016

Year	MRSA	VRE
2002	600	-
2003	859	-
2004	1479	-
2005	1374	-
2006	1331	-
2007	1254	-
2008	1728	-
2009	1266	-
2010	1267	-
2011	1328	-
2012	1287	-
2013	1282	-
2014	1342	32
2015	1274	13
2016	1700	71

In 2016 1700 new MRSA (Methicillin-resistant Staphylococcus aureus) cases were reported, which is significantly more than in the previous year (2015: 1274). Also, MRSA cases with blood culture were higher than in the previous year (2016: 49; 2015: 40). Of the MRSA outbreaks, 23 were in Helsinki and Uudenmaan sairaanhoitopiiri (1.4 / 100,000) and 6 in Pirkanmaa (1.1 / 100,000), in other hospital districts there were zero in two, 20. Most of the invasive cases occurred in men (30/49) and 65 and older (32/49), three were in children. The total cases were highest in Helsinki and Uusimaa hospital districts (604) and Pirkanmaa (291), with

the highest incidence in Pirkanmaa (55/100 000) and Päijät-Häme (51/100 000). (THL, 2016.)

In 2016, the number of new VRE (vancomycin resistant enterococci) cases increased from the previous year (2016: 71, 2015: 13). Most of the findings were hospital districts in Northern Karelia (22) and Northern Ostrobothnia (21), and Helsinki and Uudenmaan sairaanhoitopiiri (13).(THL, 2016.)

For the prevention of hospital acquired infection in Finland, a surveillance project was carried out in 1999-2000 in Finnish hospitals about nosocomial bloodstream infections (BSI) in which 4 hospitals volunteered to participate. 1477 cases BSIs were identified with a total rate of 0.8 BSI per 1000 patient per day (Table 2). The 1477 BSIs were identified in 1265 patients. The highest rate of BSIs was among patients in internal medicine, paediatrics, oncology, and general surgery. Surgical, neurological, and paediatric patients in intensive care unit had the highest proportion of infections (Lyytikainen et al. 2002)

Table 2: Number and percentage of bloodstream infections from different specialties in the intensive care unit

Specialty	Total number of bloodstream infections	Number of intensive care related blood stream infections	percentage
Gynecology and obstetrics	29	1	3
Oral surgery	1	1	100
Internal medicine	664	69	10
oncology	85	0	41
pediatrics	275	113	0
dermatology	1	1	100
Neurology	51	27	53
neurosurgery	19	16	84
General surgery	321	147	46
pulmonology	31	7	23
total	1477	382	26

A national survey was carried out in February-March 2005 in 30 hospitals by the national prevalence survey on healthcare associated infections(HAIs) in Finland and the results were as follow: the overall prevalence rate of HAI was 703 patients out of 8234 i.e. 8.5%. The most common HAI was surgical site infections 29% followed by urinary tract infections and clinical sepsis or primary bloodstream infection with percentages of 19% and 17% respectively. It also resulted from the study that males, advanced age and severity of underlining illness were high risk groups with high prevalence rate (Lyytikainen et al. 2005).

2.4 Risk factors associated to Hospital acquire infections

A surveillance project was carried out in 4 volunteered Finnish hospitals during 1999-2000: 2 tertiary care hospitals (both with 1600 beds), 1 central hospital (with 600 beds), and 1 district hospital (with 450 beds) (Lyytikainen et al. 2002). Data was collected during the projects about risk factors of bloodstream infections in those hospitals (Table 3).

Table 3: Underlying conditions and risk factors for nosocomial bloodstream infection (BSI) for patients with 1477 BSIs that were reported during 1999–2000.

Underlying condition or risk factors	Total number of cases	Number of bloodstream infections
surgery	374	26
Central venous catheter	703	61
Solid malignancy	212	15
Hematological malignancy	484	33
Stay in the intensive care unit	382	26
Newborn status	164	11
Hemodialysis	107	7
Admission for obstetric care	17	2
Organ transplantation	41	3

According to the Hospital District of Helsinki and Uusimaa (HUS), the infection risk with patients in intensive care is ten times higher than patients in normal or ordinary ward. The risk also is higher in complex illnesses. 5-15% admitted in the hospital will get a HAI that may be mild i.e. clear up without any treatment or severe depending on the patient's general health condition, the procedure he has went through and the hospital ward in which he is (HUS 2018).

3 AIMS AND RESEARCH QUESTIONS OF THE THESIS

This thesis was carried out in order to find out how to prevent hospital acquired infections with more emphasis on MRSA and VRE and also to provide more knowledge to nursing students and health care workers as well as the role of a nurse in the prevention of hospital acquired infections.

Nowadays, hospital acquired infections are becoming a serious threat to all health sector globally. As a result of this, this study was meant to provide some concrete evidence based on answers to the following questions:

1. How can hospital acquired infection be prevented particularly in Finland?
2. What is the role of a nurse in the prevention of hospital acquired infection?

4 METHODOLOGY

4.1 Literature review

In recent decades, using literature review has become established and more versatile in nursing research and health sciences (Kangasniemi et al. 2013, 291). A literature review is an objective, thorough summary and critical analysis of the relevant available research and non-research literature on the topic being studied (Hart 1998 cited in Cronin, Ryan and Coughlan 2008, 38). By reviewing literature, we seek or search for answers to a research question by exploring what is already known, telling what new knowledge the research has brought out and how important it is in the future nursing care. We distinguish two types of literature review among which a descriptive review, also known as traditional or narrative review and systematic review.

In this thesis, we decided to use the narrative literature review approach. This review was aimed to exhaustively describe the background theory pertaining to the selected topic, underlining other new studies on the topic, and bringing out inconsistencies and areas that lack relevant knowledge within a research which will further inspire research on areas that are lacking (Cronin, Frances, & Coughlan 2007). This method of literature review is also aimed at describing phenomenon since it is content driven and understanding by nature. (Kangasniemi et al 2012.) Therefore the idea of a literature review is to develop already existing theory and to build a new, which will be built on the existing theory. The literature review system aims to solve problems and makes it possible to describe the development of a theory based on history. (Salminen 2011). Based on data, narrative literature review gives qualitative and descriptive answers to chosen research questions. (Burns & Grove 2005, Polit & Beck 2012, Ahonen et.al 2013).

There are however potential pitfalls in narrative literature review because of its abstract and non-structured nature but positive in that, it enables researchers to focus on different areas that are of importance throughout the process. (Kangasniemi et al. 2012.). The narrative literature review however with its broad scope gives us more freedom and opportunities to review different areas on the prevention of hospital acquired infections. The process of narrative literature review in-

volves formation of research question, selection of data, constructing and observing the results. (Ahonen et al. 2013).

4.2 Content search and collection

In the process to collecting the articles needed to do this thesis, we started searching appropriate databases. The databases chosen among others were EBSCO CINAHL and PubMed. Moreover, in the literature, we searched from more than one database in order to get the most reliable publication and selected the most recent and evidenced based articles in English and Finnish languages. Finnish text books were also borrowed from the school library. The search of articles was limited to a specific time period from year 2000 till present, and articles were selected depending on the relevance and the evidenced based practices of the content. Filters used in the search consist of free full text (PubMed)/link full text (CINAHL), language: English, and references available (this was only for CINAHL since there is no such filter in PubMed).

The keywords that were used to search were Nosocomial, hospital, Infection, MRSA, VRE, risk factors, prevalence rate, epidemiology, and prevention. Articles that were from Finland and directed towards answering the research questions of our thesis topic were retained automatically for the study. However, the results were obtained taking into consideration the relevance of the articles. During the search, it resulted to large number of articles and as a result, once the authors found that the articles are not relevant to the study, it was immediately rejected as per the inclusion criteria that is; evidence based, peer review, in English or Finnish language, after the year 2000 and related to answering our research questions. However, it should be noted that articles that were used from database for the theoretical background were selected regardless of the origin or year of publication so far as it was related to the topic. The table below summarises the articles that were found and related to our research topic.

Table 4. Summary of databases and search word used, the number of article found, and the number of articles that were used in the literature review.

Search word used	Database used	Number of articles found	Number of articles used
Prevalence, Finland, 'hospital acquired infections'	EBSCO	71	2
	PubMed	0	0
Prevalence, MRSA, VRE, Finland	EBSCO	5	0
	PubMed	0	0
'Risk factors', 'hospital acquired infections', Finland	EBSCO	208	1
	PubMed	0	0
Prevention, 'hospital acquired infection', Finland	EBSCO	74	2
	PubMed	0	0

EBSCO and PubMed were used as search engines and 358 articles were relevant for the studies. However, from this search, 5 articles match our research questions taking into account our exclusion and inclusion criteria.

4.3 Content analysis

The goal for data analysis is to create comparison between the found information and to analyse the strengths and weaknesses of the already existing information as well as make conclusions based on data. (Ahonen et.al 2013) In this thesis the authors have chosen to use content analysis with themes for the data analysis. This method of analysis is the most common method for summarizing and synthesizing data of descriptive literature review. The focus of this analyzing method is mainly on the summary of the chosen literature rather than drawing new observations. Moreover, the aim of thematic analysis goes hand-in-hand with its focus, which is to 'identify themes from literature'. (Coughlan, Cronin & Ryan 2013, 96)

5 FINDINGS

5.1 Prevention of hospital acquired infection

Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another (World Health Organization, 2018). MRSA is contacted with one another by hand. In addition, infection can occur through common care management tools. Examples include, blood pressure monitors, stethoscopes, thermometers, shavers and other more difficult or less durable devices. Within the facilities, the importance of different contact surfaces and adhesion points for coming in contact with MRSA bacteria is paramount (Kurki & Pammo 2010, 16-17). The prevention of hospital acquired infection is centred on two main issues; prevention from person to person (hand hygiene, personal protective equipment, aseptic practices, and isolation) and preventing transmission from the environment.

In prevention from person to person, the following is taken into account; firstly, hand hygiene. Hand hygiene is the cornerstone of standard precautions. Alcoholic rubs is recommended in healthcare and should be applied or carefully rubbed into both hands including the finger tips. Unless you deem it necessary, that's if the hands are very dirty, else in hands decontamination, water and soap are not always necessary. According to Hedman et al, 2011. the use of protective equipment does not replace hands decontamination or alcoholic rubs. Hand disinfectant must be used after every patient contact and immediately after removing protective gloves. As a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with health care, the panel recommends that a national infection prevention and control (IPC) monitoring and evaluation program should be established to assess the extent to which standards are being met and activities are being performed according to the program’s goals and objectives. Hand hygiene monitoring with feedback should be considered as a key performance indicator at the national level. Hand hygiene monitoring plays a role in driving IPC standards and is a key performance indicator (WHO, 2017). The strong recommendation with moderate quality of evidence showed that, hand hygiene and audit data play an important role in improvement

of IPC by preventing the spread of resistant organisms. Another component specific to hand hygiene recommends that materials and equipment to perform appropriate hand hygiene should be readily available at the point of care. Due to the importance of hand hygiene, WHO recommends using alcoholic rubs in the following five situations: before contact with the patient, before aseptic measures, after touching body fluids, after contact with the patient and after contact with the patient's environment. (Anttila et al. 2010, 28.).

Secondly, the use of personal protective equipment. Protective equipment (protective clothing, aprons, mask and eye protection glasses should be worn by health care workers during procedures involving contact with patients' fluids (vomiting, stool, urine etc.). Health care workers should wear masks when working in the operating room or caring for immuno-compromised patients. In addition to these, health care workers must wear masks when caring for patients with airborne infections, or when performing bronchoscopies or similar examination (WHO, 2002, chapter 4.). Gloves are used in several situation of care: 1) Patient protection: staff wear sterile gloves for surgery, care for immunocompromised patients, invasive procedures which enter body cavities. Non-sterile gloves should be worn for all patient contacts where hands are likely to be contaminated, or for any mucous membrane contact. 2) Staff protection: staff wear non-sterile gloves to care for patients with communicable disease transmitted by contact, to perform bronchoscopies or similar examinations. Hands must be washed when gloves are removed or changed. Disposable gloves should not be reused. Latex or polyvinylchloride are the materials most frequently used for gloves. Quality, i.e. absence of porosity or holes and duration of use vary considerably from one glove type to another. Sensitivity to latex may occur, and the occupational health program must have policies to evaluate and manage this problem. (WHO 2002.).

Thirdly, aseptic practices, in which all staff must maintain good personal hygiene. Nails must be clean and kept short. False nails should not be worn. Hair must be worn short or pinned up. Beard and moustaches must be kept trimmed short and clean. Staff can normally wear a personal uniform, or street clothes covered by a white coat. In special areas such as burn or intensive care units, uniform trousers and a short-sleeved gown are required for men and women. In other units, women

may wear a shirtsleeves dress. The working outfit must be made of a material easy to wash and decontaminate. If possible, a clean outfit should be worn each day. The outfit must be changed after exposure to blood or if it becomes wet through excessive sweating or other fluid exposure. In aseptic units and in operating rooms, staff must wear dedicated shoes, which must be easy to clean. In aseptic units, operating rooms, or performing selected invasive procedures, staff must wear caps or hoods which completely cover the hair. (World health organization, 2002, chapter 4.). The prevention of infections transmission between patients can be through the elimination of unnecessary injections. The use of disposable and sterile syringes and needle is recommended. We should avoid medications contamination and, also make sure we place used needles and other instruments in a safe disposal box.

Lastly, isolation. In hospitals and nursing establishments, infections are prevented by hand disinfection and proper cleaning of equipment and care environment. Sometimes, these actions are not enough, but nursing staff uses protective gloves and other protective clothing for longer periods of time in the treatment and patient rooms. To prevent the spread, the patient can be placed in a single room, which is referred to as contact isolation. (Terveyden ja hyvinvoinnin laitos 2016.) There are proper guidelines that must be followed in the patient isolation and the decision to stop the MRSA patient isolation must be made by hygienic nurse, the staff responsible for the prevention of hospital infections. Generally, the isolation lasts throughout the treatment period. During this period, the patient is placed in a single room or room with other MRSA patients. If a patient leaves the patient room to go to a treatment, examination/research or rehabilitation he must follow the instructions given by the staff. Patients are provided with their own bathroom and toilet. Unless it is possible, he or she must use the space only after or on a different day after the others. It is also good that MRSA patients have their own personal detergents and shampoos unless there is a dispensing pack. (Kurki & Pammo 2010, 19). When dealing with a patient's room, staff normally wear protective gloves, remove them when leaving the room and disinfecting their hands with an alcoholic solution. Visitors disinfect their hands before entering and leaving the room. If visitors help in treating a patient, they should be protected as nursing staff. (Kurki & Pammo 2010, 18) Visitors may also be asked to wear protective

gloves, especially if they help with the patient's treatment or if they are likely to be in contact with the skin, blood, urine, wounds or other secretions of the patient. Visitors should always disinfect their hands with an alcoholic solution when leaving the patient room. This will ensure that the MRSA does not come from outside the room.

Another important point is preventing transmission from the environment. The hospital environment refers to all spaces, surfaces, furniture, instruments and substances, even animals that are inside the hospital (excluding people), often known as non-living environment. In fact, the environment always contains plenty of microbes when there is moisture and little organic matter. (Anttila et al. 2010, 121.) To minimize the transmission of microorganisms from equipment and the environment, adequate methods for cleaning, disinfecting and sterilizing must be in place. Written policies and procedures which are updated on a regular basis must be developed for each facility. (World health organization, 2002, chapter 4.) Prevention of infections transmission from the environment includes among others cleaning of hospital environment. Routine cleaning is necessary to ensure a hospital environment which is visibly clean, and free from dust and soil. Ninety per cent of microorganisms are present within “visible dirt”, and the purpose of routine cleaning is to eliminate this dirt. Neither soap nor detergents have antimicrobial activity, and the cleaning process depends essentially on mechanical action. There must be policies specifying the frequency of cleaning and cleaning agents used for walls, floors, windows, beds, curtains, screens, fixtures, furniture, baths and toilets, and all reused medical devices. Methods must be appropriate for the likelihood of contamination, and necessary level of asepsis. This may be achieved by classifying areas into one of four hospital zones. (WHO 2002, 4). The destruction of microorganisms also known as sterilization. It is operational and can decrease microorganisms by 10(-6). This cleaning method includes thermal and chemical sterilization. During thermal sterilization, exposure to steam saturated with water is 121 °C for 30 minutes, or 134 °C for 13 minutes in an autoclave for wet sterilization and 160 °C for 120 minutes, or 170 °C for 60 minutes in case of dry sterilization. Chemical sterilization is another method of cleaning the hospital environment. It is a mechanism consisting of total destroy of bacteria and microorganisms in hospital setting. Sterilization results are mostly sure and can be tested by the indicator on

the sterilized package. The use of green, blue, red and yellow colors can also indicate the way things are used and handled. The sterile product has no germs or spores at all. The color of the clean and disinfected product is blue and dirty red in color. Yellow color is used as a sign of infection risk. (Karhumäki, Jonsson & Saros 2016, 80-81.). A high degree of environmental contamination in patients with MRSA, VRE or symptomatic Clostridium difficile infection has been reported in several studies (Anttila et al. 2010, 124). In addition to direct contamination via person to person contact, contact with contaminated equipment, many other factors are good to be taken into consideration. The patient may be infected with the structures of the hospital through ventilation ducts, refrigeration appliances, moisture damage, contaminated water supply systems or building dust related to renovation and new construction. The level of ventilation is determined by the number of people in the same space and the space itself. Water and moisture can promote infection spread. So, for the control of infections it is important that in all parts of the water supply system and management, cold water remains at the temperature of -20°C and hot water over 50°C (Anttila et al. 2010,143).

5.2 WHO universal precautions

According to the World Health Organization, they are standard precautions meant to reduce the risk of transmission of bloodborne and other pathogens from both recognized and unrecognized sources. They are the basic level of infection control precautions which are to be used in the care of all patients. Amongst which includes hand hygiene, personal protective equipment (PPE) and, respiratory hygiene and cough etiquette. Many vulnerable people seeking care develop a health care-associated infection (HAI) resulting in harm and sometimes even death, especially in low- and middle-income countries (LMICs). This could be prevented through simple, low-cost infection prevention and control (IPC) interventions performed at critical moments, such as hand hygiene (world health organization, 2002). A total absence of or inadequate hand hygiene practices in healthcare is one aspect of infection prevention and control considered to be a critical example of defects in the quality of care. According to an extract from the systematic literature reviews undertaken as the background for the WHO Guidelines on Core Components of Infection Prevention and Control Programs at the National and Acute

Health Care Facility Level, they are core component recommendations specific to hand hygiene. The reduction of nosocomial infections transmission can occur at two different levels that consists of: firstly, to reduce transmission from one person to another and secondly preventing transmission from the environment to humans.

5.3 Knowledge and practices regarding universal precautions in Finland

Treatment-related infections are monitored nationwide in Finland by a hospital infection program within SIRO. The program has been in operation since 1999 and is currently participating in all Finnish university hospitals and some other hospitals. SIRO monitors some of the most typical treatment-related infections that have a significant public health significance.

The goal of SIRO monitoring is to help hospitals combat treatment-related infections. SIRO develops monitoring of infections and collects information about their presence in participating hospitals. Hospitals participating in the program can compare their own prevalence rates with those of other hospitals. In participating hospitals program, hospitals are involved in the prevention work of persons representing different occupational groups: hygienic nurses, infectious doctors, clinical microbiologists, hospital microbiologists and surgeons (National Institute of Health and Welfare, 2017.) Patient isolation and precautions taken during treatment of a patient are aimed to prevent infectious microbes (MRSA, VRE) to move from infected or colonized patients to other patients or workers by infectious agents.

The following can be used as precaution methods: hand disinfection (basic technic to fight against infections), operational methods or practices (rules of procedure, handling of needle sharp tools, cleaning and disinfection etc.), protective clothing, a barrier nursing such as gloves, instruments, eye protection and gloves to prevent infection, space isolation (a different room, part of a room or a different department), ventilation arrangements prevent airborne infiltration from the isolation room to staff working there or other facilities in the hospital. Usual precautions are recommended to be followed by each patient regardless of whether the patient has an infection or if his or her resistance is impaired (Hedman et al. 2011). These are good practice and are the basis for isolation in some special situations.

In Finland, each healthcare professional is personally responsible for maintaining his or her professional qualifications. The development of forms of care requires constant updating of own field of expertise. The new therapeutic approach is always reflected on both the doctors' and nurses' daily lives. (Anttila et al. 2010, 29-30).

Good hand hygiene reduces the number of care associated infections. The operational model devised for the evaluation and development of hand hygiene practices is based on evidence on the effect of hand hygiene on patients' outcomes. The aim of the KhYHKÄ operational model is to strengthen patient safety in social and health care organizations by means of influencing hand hygiene practices (Finnish Nursing Research Foundation, 2018.) The model contents three stages that give guides and evidence- based structure in practice:

1. Systematic and constant monitoring of practices
2. A Rapid provision of feedback
3. Possible changes in practices.

The premise of the model is that the unit's infection prevention liaison, who is going to observe hand hygiene, has the competencies needed for observing and providing feedback. If the organization does not have an infection prevention liaison network, it is recommended to make sure that each of the units has a person with sufficient knowledge about the meaning of good hand hygiene. She or he should also have competence to implement the operational model. In addition to common theoretical education it is important for infection prevention liaisons to have training related to observing and providing feedback. (Finnish Nursing Research Foundation, 2018.) The development of staff's hand hygiene is insured by an up-to- date competences in practices. That simply means that, staff must be educated, the education should not only focus on theoretical education but more on hand hygiene practices. For example, it is possible to combine training given by the Infection Control Unit staff with a "blue-light box". This combination can be used to demonstrate success in performance. Similarly, effective are interventions consisting of guidance at bedside, reminders and posters combined with other methods. (Finnish Nursing Research Foundation, 2018.) In conclusion, the effect-

iveness of the operational model requires the combination of the above-mentioned structure among others a systematic and constant monitoring of practices, a rapid provision of feedback, a possible changing in practices. The more the treatment given to the patient disrupts the normal defence system, the more important it is that the ignorance of health care personnel do not expose patients to treatment-related infections. Therefore, the quality of education in the prevention of infections must be given greater attention in healthcare. At the same time, it must be decided who in the social and health care institution is entitled and adequately qualified to provide such training (Anttila et al. 2010, 33-34).

Moreover, the SENIC research or study has revealed that the number of infections control professionals is so low for effective result. Although the number of patients according to the SENIC study, urinary tract infections, bacteraemia, and post-operative respiratory tract infections could be effectively reduced if there were one hygienist nurse in the hospital per 250 patients (Anttila et al. 2010, 33). A significant part of the injuries in the health care sector still remains unaccounted for, employees have not been sufficiently aware of the consequences of accidents (Anttila et al. 2010, 29).

5.4 Role of nurse in prevention of hospital acquired infection

Nurse play a central role as far as the prevention of hospital acquired infection is concerned (Özkal et al. 2014, 4). This is achieved not only as a result of using evidence based in their nursing practice but also research in nursing as well as educating patients. The agency for health care research and quality supported an evidence based report that suggests that the level of education of nurses is directly proportional to the rate of error that occurs in patients and points out the importance of nurses having enough scientific knowledge and skills as well as being able to put these skills and knowledge into practice (Korkmaz 2009). Nurses are in a great position to cause change in improving the care standards of patients. There are many tools that can be used by a nurse to form a safe area or environment for patients. However, the universal precautions are important to create and infection free zone (CDC, 2010). Based on these precautions, it is highly recommended that nurses have to wear protective equipment when dealing with body fluids.

One great role that a nurse plays in the prevention of infections is doing proper hand washing. This is also however the most important nursing intervention in the prevention of infections. Antimicrobial soaps and water is an effective hand washing method as well as the use of disinfectants for robbing of the hands. There are several ways in which nurses can prevent hospital acquired infections. These involve avoiding unnecessarily urinary catheterization, good hand washing and aseptic techniques when inserting and caring of urinary catheter, appropriate dressing of wounds, etc. Nurses using barrier precautions like sterile fields, caps, masks, gloves, gowns etc. makes a great contribution in fighting against hospital acquired infections. Putting aside nurse interventions in bedsides, a safe environment can be created by nurses by reporting all errors and near misses which helps in the improvement of organizations thereby reducing future errors. Nurses can also use leadership skills in infection prevention. This is achieved by safe infection procedures, use of knowledge, skills, and practice to keep the patient safe.

In a nut shell, nurses play the following roles in the prevention of infections. Firstly, through the promotion of hand hygiene as per the WHO guidelines (WHO, 2002) which states that handwashing should be done before and after each patient contact, after contact with environmental equipment, before putting on gloves and after removing gloves without which will lead to an increase in infections (Emily, Sydnor & Trish, 2011). Secondly, nurses should make the best use of aseptic techniques which give a great protection to patients from infections. Thirdly, the use of universal precautionary practices which involve the cleaning up of spills, appropriate waste handling, handling sharp objects with care as well as proper hand washing (Yatin et al. 2014, 18). In addition to this, patient education is highly important as it empowers the patients to actively take part in their care which will help reduce the risk of hospital acquired infections. Patient education is important in the prevention of MRSA. He must be told to carefully wash his hands with soap and water as soon as they get dirty, disinfect his hands always before eating and after a bath, avoid touching possible harbouring sites such as catheters, drains or wounds. Lastly, cleaning and disinfecting practices in which nurses should be responsible for cleaning up all medical devices after use either after or between each patient.

6 DISCUSSION

In this thesis, the authors aim was to investigate how to prevent hospital acquired infections in Finland, laying more emphasis on MRSA and VRE. More emphasis was also laid on the provision of more knowledge to nursing students on clinical trainings, the healthy society, patient's family members, and health care professionals as well as the role nurses play on the prevention of hospital acquired infections. Hospital acquired infection are associated with great deal of morbidity, mortality, as well as increase in financial burden. According to the European centre for disease prevention and control, in the European Union, approximately 25,000 patients die yearly from hospital acquired infections (ECDC, 2009). This is however in great contrast to the United State of America, where there are 1.7 million cases, resulting to 99,000 deaths per year (Ruth et al. 2014, 44). In Finland however, it is estimated that there are 40000 to 50000 cases of hospital acquired infections every year resulting in 700 to 800 deaths. In EU the ratio of death due to hospital acquired infection is 25000 per 508 million inhabitants and 700-800 per 5.5 million in Finland (Jukka 2018). This shows a very high death rate in Finland compared to the EU rate therefore preventive methods used in Finland are not effective compared to the EU recommendations. As a result, more emphasis should be put on the prevention of these hospital acquired infections.

There are potential pitfalls in the prevention of hospital acquired infections and as a result, the study efficacy of nosocomial infection control (SENIC) demonstrated that one third of hospital acquired infections might be prevented with appropriate infection control measures. This involves surveillance methods, prevention strategies and treatment programs. In Finland, hospital staff are required to follow the infection control procedures. These staff are also specialized in providing instructions and training on the prevention and control of the infection. There are also commitments from the hospital management to infection safety follow-up and improvement. The hospital management also have the full responsibility for ensuring the execution of these policies (HUS, 2018). There is however a similar procedure in the United Kingdom regarding infection prevention and control.

In the prevalence of hospital acquired infection in Finland, it is shown that the infection risk is higher in complex illnesses. Patients in intensive care are ten times more likely to develop hospital acquired infection than patients on normal hospital wards. It is also shown that in Finland about 5-15 % of sick people develop hospital acquired infection. In the process of preventing hospital acquired infection in Finland, the Finnish Hospital Infection program (SIRO) does the monitoring. This monitoring tries to gather information about the occurrence of hospital acquired infections in different hospitals, and hospitals can always compare their findings and figures with other hospitals.

6.1 Limitation and ethical considerations

During this thesis, articles were systematically reviewed from academic databases. These articles are peer reviewed and evidenced based by professionals and therefore can be considered reliable. These articles were full text and free to access and read. Articles were selected toward answering our research questions. Limited articles fulfilling our inclusion and exclusion criteria could be found. Limitations were clearly outlined. For example, only few hospitals were selected or named in the articles which was not totally representative of the target of the study. Nursing is evolving all the time and for this reason, articles over the year 2000 were used to ensure they are evidenced based and not outdated.

7 CONCLUSION

MRSA and VRE pose problems to the health sectors due to their ability to spread among the patients and healthcare workers. Despite various studies or research on HCAI prevention, the World Health Organization emphasizes on practice regarding universal precautions, the annual infection rate is still growing for many numerous reasons. Governance and stewardship, availability of resources, safety culture, monitoring and surveillance systems, and inappropriate prescription of antibiotics are the main barriers in combating health care–associated infections and mitigating their consequences (Allegranzi et al. 2011).

Bacteraemia caused by methicillin-resistant S. aureus (MRSA) is associated with increased mortality and morbidity, leading to high healthcare expenditures. Patients with health weakened by the disease such as blood cancer are more vulnerable due to the deficiencies of defence system. Moreover, studies have demonstrated that, colonized patients can 22 times develop an infection by MRSA more than those who are not identified as carriers. According to a matched historical cohort study and cost analysis in a single hospital in Israel for the years 2005-2011, the cost of prevention was calculated as the sum of the cost of microbiology tests, single-use equipment used for patients in isolation, and infection control personnel. As results, an average of 20,000 patients were screened yearly. The cost of prevention was $208,100 per year, with the major contributor being laboratory cost. It was calculated that interventions averted 34 cases of bacteraemia yearly: 17 presenting on admission and 17 acquired in the hospital. The average cost of a case admitted with bacteraemia was $14,500, and the net cost attributable to nosocomial bacteraemia was $9,400. Antibiotics contributed only 0.4% of the total disease management cost. When the annual cost of averted cases of bacteraemia and that of prevention were compared, the intervention resulted in annual cost savings of $199,600. (Chowers et al. 2015, 10-9)

The above results simply highlight the importance of adequate resources in an effective prevention of bacteraemia in hospital. However, strengthening of reporting and surveillance systems for HAIs coupled with proper governance and steward-

ship are crucial in order to improve the health and safety of patients (Esfandiari et al. 2018, 7).

Nurses and healthcare facility are responsible for the prevention of hospital acquired infection. Healthcare staff and hospitals should follow the guidelines recommended for sterilization and disinfection. The European prevalence of infection in intensive care study has shown that there are several factors responsible for patients contacting hospital acquired infection (Horan et al. 2008, 36). In taking all measure steps to prevent hospital acquired infection can decrease the risk of contracting them by 70% or even more. However, due to the present nature of hospitals and health care settings, a 100% elimination of hospital acquired infection is impossible to achieve. Therefore some general measures for the control of hospital acquired infection may include; screening the intensive care unit so see if there is need for isolation of people with hospital acquired infections. Identification of the type of isolation could also help reduce the chances for further infection. Also, poor hand hygiene is responsible for 40% of infections transmission in hospitals. Surveys and studies have shown that the improvement of hand washing reduces nosocomial infection. Hand hygiene must therefore be taken into consideration which deals with the washing of hands before and after touching people in the hospital. In addition to this, putting on appropriate gear which includes gloves, gowns, and even face protection is also highly needed. Furthermore, proper cleaning of surfaces and well ventilated rooms is important.

The control of infections can be highly cost-effective. About one third of hospital acquired infections can be prevented. In order to achieve this, several strategies should also be simultaneously pursued (Scheckler et al. 1998, 19). Firstly, more data is required by continued improvement of national surveillance of hospital acquired infection. Systems for surveillance of hospital acquired infections that occurs out of hospitals, where much health care is now given has to be developed. Secondly, it has to be ensured that the use of the surveillance is valid. Thirdly, the improvement of the design of invasive device is important in controlling hospital acquired infection for example, non-invasive monitoring devices and minimally invasive surgical techniques that avoid high risk associated with bypassing normal host defence barriers that are the skin and the mucous membranes. Lastly, antibi-

otic control programs are important. In the future, controlling colonization using immunization or flora competing may help reduce the risk for antibiotic-resistant strains. In combating antimicrobial resistance problems and investigating outbreaks of multidrug-resistant pathogens, the epidemiologic tool used as a routine technique is the pulsed-field gel electrophoresis (Tenover et al. 1997, 18).

ACKNOWLEDGEMENTS

This bachelor's thesis was principally suggested by one of the writers, a nursing student Forba Bernabe Nkwette second by Nkembeng Aloysius Nkweze who found it interesting and supported the idea.

I would like to thank our supervisors, Brita kunelius-määttä for giving us the great opportunity to work with her on this thesis and her great contributions towards the realisation of this work.

One of the authors Nkembeng Aloysius Nkweze will want to thank my parents and brothers more especially Lekraka Fombin and Deugubuh Forbin who gave me all the financial support towards the pursuit for further education. Great thanks to all friends Chief Moteka, Richard, Nadine, Sade, Papi Monga, and others not mentioned for all their material, morals and financial support throughout my studies.

I wish to dedicate this work to my lovely and God gift wife Nkembeng Patience Ewelisane and our lovely son Nkweze Esunge Ryan Nkembeng for all their lovely and emotional support throughout this studies. My greatest thanks goes to my father in heaven God almighty for giving me anointing and grace throughout this work.

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