A Review of Risk Factors Associated with Patients' Development of Hospital Acquired Infections and Evidence Based Preventive Measures.

Name of Course: Integrative Learning Experience (capstone).

Name of Academic supervisor: Professor Manfred Green.

Name of student: Essabela Fewo

Program: I-MPH

Academic year: 2016-2017

Table of content pages

ABSTRACT

Introduction: Hospital acquired infection affects hundreds of millions of people worldwide posing a global health issue for patient safety. Understanding the potential risk factors in both the local and global context while evaluating to figure out the best evidence based preventive measures appropriate to the hospital setting and the available resources can help reduce the risk of acquiring most of the avoidable hospital acquired infection.

Objective: The main objective of this paper is to identify the risk factors in a variety of hospital settings associated with patient acquisition of hospital infection and to identify the most effective evidence based preventive measures.

Method: A literature review of peer review articles and guidelines was carried out to identify the risk factors associated with the acquisition of HAI and preventive measures that have proven effective in variety of hospital settings. Using the student Moodle portal entry into the University of Haifa library we search for peer review articles and in google for infection prevention guidelines.

Results: Of the 15 peer reviewed articles the risk factors included micro bacteria resistance, age extremes (neonates and elderly patients), underlying diseases, unclean and poorly designed hospital environment, frequent and prolonged use of medical devices for patient care. Preventive measures included appropriate hand hygiene, nursing care activities, hospital hygiene, less frequent use of medical devices or use of medical devices for shorter duration.

Conclusion: The risk factors identified in this review and the preventive measures will provide relevant information to decision makers, hospital administrators, health care workers and leaders working to improve patient safety in hospitals and other health care settings both in the developed and resource limited countries. The development of a continuous surveillance process to monitor other risk factors in the local context and evaluating the effectiveness of infection control activity is essential.

Key words: Hospital Acquired infections, Health care associated infection, risk factors, preventive measures.

INTRODUCTION

A hospital acquired infection (HAI) also known as Health Care Associated infection has been defined as an infection acquired in hospital by a patient who was admitted for a reason other than that infection, and he infection was not present or incubating at the time of admission, occurring more than 48 hours after admission or 72 hours after discharge (CDC 1998). It can take the form of an endogenous infection (auto-infection) or cross-infection (WHO 2002). HAI occur worldwide affecting both the developed and resource limited countries and account for a significant burden for the patient and for public health. Most research has been done on HAI identifying the most causative agents responsible for HAI; the prevalence of HAI ; the most common sites of the body prone to infections; the impact of HAI; the risk factors associated with the development of HAI and preventive measures,(Amy et al, 2014; Drakulovic et al, 1999; Ellen et al ,2016; Feng Wang et al, 2012; Koukou et al, 2015; Marta et al, 2016; Olivier et al, 2006; Sahu et al, 2017; Sohn et al, 2001; Singh et al, 2010 etc) . Therefore, there is an absolute need to review previous and current studies in different countries and settings to identify the risk factors associated with HAI and urge those concerned in preventing HAI to adopt the appropriate preventive measures.

A prevalence survey conducted under the auspices of World Health Organization (WHO) in 55 hospitals of 14 countries representing 4 WHO Regions (Europe, Eastern Mediterranean, South-East Asia and Western Pacific) showed that an average of 8.7% of hospital patients had HAI infections. It was found that at any time, over 1.4 million people worldwide suffer from infectious complications acquired in hospital (WHO 2002). Another international survey of the prevalence of hospital-acquired infections was conducted in 14 countries in different regions of the world between 1983 and 1985. The results of this survey showed a wide range of hospital acquired infections, with prevalence varying from 3% to 21% (mean 8.4%) in individual hospitals (WHO, 2002).

Despite the progress made in advancing public health and hospital care by many international organizations such as CDC, WHO, Joint Commission International etc and continuing concern of hospital managers with all attempts at improvement in care and to prevent the acquisition of hospital acquired infections, many health-care establishments are unable to achieve adequate levels of prevention particularly in developing countries and hospital acquired infections continue to develop among hospitalized patients with great impact on the population.

HAI has been identified as one of the leading causes of death, high economic cost (due to increase length of stay in the hospital, increased use of drugs, and use of additional laboratory and diagnostic procedures) that has also added to the imbalance between allocation of resources for primary and secondary care. HAI becomes even more dangerous when uncontrolled cases (patients, staff, visitors) are potential risk for out breaks in the community (WHO 2002). The Center for disease control (CDC) has identified that HAIs account for an estimated 2 million infections and an estimated 99,000 deaths annually (CDC, 2007). An analysis by Amy et al ,(2014) identified that Medicare paid an additional $146 million per year due to six different types of hospital acquired condition episodes compared to what could have been paid without those hospital acquired conditions. These emphasize the importance of studying HAI as a global health problem.

Considering the fact that preventing patients from developing hospital acquired infection is an indicator of quality and safety of care in accordance with the International Patient Safety Goals by the Joint commission international (1994), the main objective of this paper is focus on patient safety goal number five which is to identify the risk factors associated with patient acquisition of hospital infection and to identify the most effective evidence based preventive measures. The results obtain will be use to provide relevant information to decision makers, hospital administrators and leaders working to improve patient safety in hospitals and other health care settings.

Chapter 1.

Epidemiology of Hospital Acquired Infection

1.1 Causes of hospital acquired infections:

According to the WHO 2002 guidelines for the prevention of hospital acquired infections, the infecting organisms vary among different patient populations, different health care settings, different facilities, and different countries.

1.1.1 Bacteria: These are the most common pathogens.

Commensal bacteria found in normal flora of healthy humans. Some commensal bacteria may cause infection if the natural host is compromised. For example, cutaneous coagulase negative staphylococci cause intravascular line infection and intestinal Escherichia coli is the most common cause of urinary tract infection.

Pathogenic bacteria have greater virulence, and cause infections regardless of host status. For example: Anaerobic Gram-positive rods (e.g. Clostridium) cause gangrene; Gram-positive bacteria such as Staphylococcus aureus (cutaneous bacteria that colonize the skin and nose of both hospital staff and patients) cause a wide variety of lung, bone, heart and bloodstream infections and are frequently resistant to antibiotics; beta-haemolytic streptococci are also important cause. Gram-negative bacteria such as Enterobacteriacae (e.g. Escherichia coli, Proteus, Klebsiella, Enterobacter, Serratia marcescens), may colonize sites when the host defenses are compromised (catheter insertion, bladder catheter, cannula insertion) and cause serious infections (e.g surgical site, lung, bacteremia, peritoneum infection etc). A surveillance of HAI by Singh, (2010) on the causes of device associated infections found out that the organisms isolated were Staphylococcus aureus, Enterococci, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Escherichia coli.

1.1.2 Viruses

There is the possibility of transmission of many viruses, including the hepatitis B and C viruses, respiratory syncytial virus (RSV), rotavirus, and enteroviruses. Other viruses such as cytomegalovirus, HIV, Ebola, influenza viruses, herpes simplex virus, and varicella-zoster virus, may also be transmitted within the hospital environment.

1.1.3 Parasites and fungi

Some parasites (e.g. Giardia lamblia) are transmitted easily among adults or children. Many fungi and other parasites such as Candida albicans, Aspergillus spp., Cryptococcus

neoformans, Cryptosporidium etc are opportunistic organisms and cause infections during extended antibiotic treatment and severe immunosuppression. Sarcoptes scabies (scabies) is an ectoparasite which has repeatedly caused outbreaks in health care facilities. Constance and Sarah, (2005) found out that Patients with prolonged and profound neutropenia are at risk for developing fungal infections in the hospital.

1.1.4 Flora from the health care environment .

Several types of microorganisms such as Pseudomonas, Acinetobacter, Mycobacterium etc survive well in the hospital environment: in water, damp areas, and occasionally in sterile products or disinfectants and may be found in items like linen, equipment and supplies used in care, in food, in fine dust and droplet nuclei generated by coughing and sneezing.

1.2 Source of Hospital acquired infection.

According to WHO 2002 guidelines for prevention of Hospital Acquired Infections, the sources of infection in a health care facility and of the preceding contamination may be the **patients**, the **inanimate environment** or the **personnel**.

1.2.1 .Patients: The source of most hospital epidemics are infected patients**,** i.e. patients contaminated with pathogenic microorganisms. Symptomless carriers might also carry other conventional pathogens. These microorganisms are often released into the environment in very high numbers, exceeding the minimal infective dose and contaminate other patients who subsequently develop hospital-acquired infections. A study by Koukou et al., (2015), found out that asymptomatic neonates were a source of Rotavirus Gastroenteritis in a Neonatal Unit of the Greek tertiary hospital.

1.2.2. The hospital environment: Pathogens may be present in the food and cause an outbreak of disease in the hospital. If the water distribution system breaks down, waterborne infections may develop.

1.2.3. Health workers: Infected or colonized (a carrier) health care worker might act as a source of HAI. A typical example is Staphylococcus aureus, which may be carried in the nasal passages of 30-60% of personnel. Contamination of patients by carriers can give rise to an outbreak of disease in the hospitalized patients because of their frequent contact with these patients. A study by Koukou et al (2005) identified that asymptomatic neonates, hospital personnel and environment (surfaces, medical tools) play a role as reservoir for hospital Rotavirus transmission which could lead to an outbreak in neonatal units.

1.3. The routes of transmission of HAIs. (WHO 2002).

1.3.1. Direct contact: Airborne transmission occurs only with microorganisms that are dispersed into the air and that are characterized by a low minimal infective dose. Only a few bacteria and viruses are present in expired air, and these are dispersed in large numbers only as a result of sneezing or coughing.

1.3.2 Indirect contact. This is the most frequent route of transmission. The infected patient or person touches and contaminates an object, an instrument, or a surface. Subsequent contact between that item and another patient is likely to contaminate the second individual who may then develop an infection. During general care and/or medical treatment, the hands of health-care workers often come into close contact with patients. The hands of the clinical personnel are thus the most frequent vehicles for transmission of HAI. A study by Olivier Gleizes et al , (2006) found out that Rota virus were found on the hands of 76–78% of health care workers taking care of the children infected with the rotavirus and on the hands of 20% of health care workers not taking care of children.

1.3.3 Vector-borne transmission is typical of countries in which insects, arthropods, and other parasites are widespread. These vectors become contaminated by contact with excreta or secretions from an infected patient and transmit the infective organisms mechanically to other patients.

1.4. Common body sites easily prone to HAI

The CDC's National Nosocomial Infections Surveillance System (NNIS) identified that the most common types of HAI are urinary tract infection, surgical site infection, pneumonia and blood stream infections (CDC 1998, CDC 2007,).

According to a point prevalence survey by the European Center for Disease prevention and control, 78.78% of the countries reported three types of HAI as their most common notably; pneumonia and lower respiratory tract infection, surgical site infection and urinary tract infection. These three HAI types accounted for more than half of the HAIs in all countries, except Sweden (48%). (ECDC Surveillance Report 2013). Another study by Sahu et al, (2017) identified that among a group of 100 neonates and infants who underwent an open heart surgery 47. 4% develop a lower respiratory tract infection, 31.1% develop a blood stream infection, 10% develop a urinary tract infection and 10.5 develop a surgical site infection.

Chapter 2

Risk factors associated with patient development of HAI

2.1 The microbial agent

Because the patient is exposed to a variety of microorganisms during hospitalization, the likelihood of exposure leading to infection depends partly on the characteristics of the microorganisms, including resistance to antimicrobial agents, intrinsic virulence, and amount (inoculum) of infective material.

The progress in the antibiotic treatment and the widespread use of antimicrobials for therapy or prophylaxis (including topical) is the major determinant of resistance. This problem is particularly critical in developing countries where more expensive second-line antibiotics may not be available or affordable (WHO 2002). A study by Virginia and Catherine (2013) found out that one of the risk factors associate with VAP (Ventilator Associated Pneumonia) was the previous use of antibiotics. Another study by Yallew et al, (2017) identified that patients who had previously received anti-microbial had 8.63 higher odds of developing HAI than those who did not receive anti-microbial.

2.2 Patient susceptibility

Patient factors that might influence the acquisition of infection include the patient's age, the immune status, underlying disease, nutritional status etc.

The extremes of life (infancy and old age) are associated with a decreased resistance to infection. A study by Sahu et al, (2017) in Indian on the Prevalence and outcome in infants undergoing open heart surgery identified the younger age group (neonates), lower body weight as risk factors for acquiring HAIs. Also the study by Sohn et al, (2001) found that neonates were at higher risk for HAI, while the study by Feng et al, (2012) indicated that old age was a risk factor for acquiring hospital acquired urinary tract infections.

Patients with chronic disease such as malignant tumours, leukaemia, diabetes mellitus, renal failure, or the acquired immunodeficiency syndrome (AIDS) have an increased susceptibility to infections with opportunistic pathogens. A study by Virginia and Catherine (2013) found that one of the risk factors for acquiring VAP in the pediatric unit were underlying respiratory disease and blood stream infections. Another study in the neurological intensive care unit found out that one of the risk factor for acquiring urinary tract infection was female gender

and patients with diabetes,(Feng et al, 2012). One other study by Yallew et al, (2017) identified that the odds of developing HAI among immune deficient patients were 2.4 times higher than their counterparts.

Mal nutrition has also been shown to be a risk factor for developing HAI because it lowers the body's immune system response to infections. A study in China found out that Serum pre-albumin levels were significantly lower in patients with evidence of infection during hospitalization compared with non-infected patients on days 6 and 9 after admission, Serum pre albumin levels in patients with poor outcomes at discharge were significantly lower compared with patients with good outcomes on days 3, 6, and 14–21 after admission ($P = 0.041$, $P = 0.02$, $P = 0.02$, respectively), (Shen-qi et al, 2017).

2.3 Hospital Environmental factors.

Health care settings are an environment where both infected persons and persons at increased risk of infection congregate. Patients with infections or carriers of pathogenic microorganisms admitted to hospital are potential sources of infection for other patients and staff. Patients who become infected in the hospital are a further source of infection, (WHO 2002)

Constance and Sarah. (2005), identified that the hospital environment was be a risk factor for acquiring invasive mycosis by neutropenic patients. Other studies by Koukou et al, (2015) ; Olivier et al, (2016) found out that the environment (surfaces, medical tools) play a role as reservoir for Rota virus that could lead to outbreaks in neonatal units. In the neurological intensive care unit Feng et al, (2012) found out that one of the risk factor for acquiring urinary tract infection was the duration of stay in the hospital environment; patients who stayed more than 7 days were more likely to develop urinary tract infection than those who stayed less than 7 days. Also Sahu et al, (2017) study on the prevalence and outcome in infants undergoing open heart surgery identified prolonged hospital stay and pre-operative interventions as risk factors for developing HAI.

2.4 Increased use of medical devices for diagnostic and therapeutic purposes

The highest prevalence of HAI has been found to occur mostly in the intensive care units, acute surgical and orthopedic wards where multiple manipulative medical procedures occur which may facilitate infection transmission.

Procedures such as biopsies, endoscopic examinations, catheterization, intubation/ventilation and suction and surgical procedures increase the risk of infection. Contaminated objects or substances may be introduced directly into tissues or normally sterile sites such as the urinary tract and the lower respiratory tract exposing these body sites of hospitalized patients to acquiring hospital associated infections (WHO 2002). A study by Sahu et al, (2017) identified that among a group of 100 neonates and infants who underwent an open heart surgery 47. 4% develop a lower respiratory tract infection, 31.1% develop a blood stream infection, 10% develop a urinary tract infection and 10.5 develop a surgical site infection.

A study in the neurological intensive care unit found out that one of the risk factor for acquiring urinary tract infection was the use of urinary catheters; UTI in catheterized group was 78% as compared to 11 % in non UTI group (Feng et al, 2012). The study done by Yallew et al, (2017) identified that patients who were administered central vascular catheter were 6.9 times more likely to develop HAI than those who did not. Also, Virgina and Catherine (2013) found out that one of the risk factors associated with ventilator associate pneumonia in children were the use of mechanical ventilator for more than 48 hours. Singh, (2010) during surveillance on HAI found out that the duration of indwelling devices such as urinary and intravenous catheters were major risk-factors for acquiring device associate infections.

2.5. Poor implementation of Hospital infection control practices.

Low adherence to recommended hand hygiene practices has been identified as a major factor in auto infections and cross infections in the hospital. Although the APIC and HICPAC (Infection Control Practices Advisory Committee) guidelines have been adopted by the majority of hospitals, adherence of health care workers to recommended handwashing practices has been shown to remained low, (Morbidity and Mortality Weekly Report 2002). WHO also has identified that poor implementation of standard precautions for the prevention of Hospital infection (for example inadequate use of personal protective equipment such as medical gloves, goggles, face shield etc), poor management of hospital waste and poor surveillance of hospital infection control practices exposed hospitalized patients to develop HAI.(WHO, 2002, Yallew et al, 2017).

Chapter 3

Prevention of patients from acquiring Hospital Acquired Infections

The WHO (2002) infection prevention guidelines emphasized that infection control programs can be effective provided they are comprehensive including surveillance, preventive activities, as well as staff training. The guidelines emphasize that there must also be an effective support at the national and regional levels.

3.1 National or regional programs.

The responsible health authority should develop a national (or regional) program to support hospitals in reducing the risk of HAI. Such programs need to:

-Develop and continually update guidelines for recommended health care surveillance, prevention, and practice;

-Develop a national system to monitor selected infections and assess the effectiveness of interventions;

-Harmonize initial and continuing training programs for health care professionals;

- Facilitate access to materials and products essential for hygiene and safety;

-Encourage health care establishments to monitor HAI, with feedback to the professionals concerned.

The health authority should designate an agency to oversee the program (a ministerial department, institution or other body), and plan national activities with the help of a national expert committee with both involvement of professional and academic organizations.

3.2 Hospital programs

The guidelines recommend that the major preventive efforts should be focused in hospitals and other health care facilities, and that risk prevention for patients and staff is a concern of everyone in the facility, and must be supported at the level of senior administration. A yearly work plan to assess and promote good health care, appropriate isolation, sterilization, and other practices, staff training, and epidemiological surveillance should be developed and that the hospitals must provide sufficient resources to support this program.

Two basic principles govern the main measures that should be taken in order to prevent the spread of hospital acquired infections in health-care facilities, that is, separating the infection source from the rest of the hospital and to cut off any route of transmission.

3.2.1 To separate the infection source from the rest of the hospital.

The first essential measure in preventing the spread of hospital infections is isolation of infected patients. Disease-specific precautions should include details of all the measures (private room, wearing of masks or gowns, etc.) to be taken in the case of a specific disease caused by a defined organism (See appendix 1 for disease-specific precaution). The symptoms of frank infection will make the potential of transmission apparent to the health worker and/or to managerial staff and infected personnel should be dismissed from patient care duties.

3.2.2. To cut off any route of infection transmission.

3.2.2.1 Hand hygiene.

Hand hygiene has been identified as the single most effective means of preventing the horizontal transmission of infections among hospital patients and health care personnel, (WHO, 2014) (See appendix 2 for hand hygiene guidelines). In 1995 and 1996, the Healthcare Infection Control Practices Advisory Committee (HICPAC) recommended that either antimicrobial soap or a waterless antiseptic agent be used for cleaning hands upon leaving the rooms of patients with multidrug-resistant pathogens (e.g., vancomycin-resistant enterococci (VRE) and methicillin-resistant Staphylococcus aureus (MRSA). In 2005, WHO launched a global hand hygiene campaign, it introduced the first Global Patient Safety Challenge “Clean Care is Safer Care as part of its world alliance for patient safety.

WHO recommends that Hand washing with (non-medicated) soap is essential when hands are dirty and should be routine after physical contact with a patient. Hands washing should be followed by hands disinfected with alcohol when an infected tissue or body fluid is touched without gloves. During a surgical intervention, Hands should therefore be disinfected with a long-acting disinfectant before gloves are put on, (WHO 2014). For this purpose, hands should be washed for 10-15 minutes with an antibacterial detergent containing chlorhexidine or an iodophore, or rubbed twice for 2 minutes with an alcoholic solution of one of these antiseptics. Studies have proven these practices to be effective in preventing HAI. A group of researcher found out that an educational program directed at respiratory care practitioners and ICU nurses on appropriate hand hygiene dramatically decreased the incidence of Ventilator associated pneumonia highlighting the role of hand hygiene in preventing VAP (Drakulovic et al, 1999).

The study by Constance and Sarah (2005) found out that hand hygiene by health personnel and patients was one of the principle preventive measures to protect hospitalized neutropenia from acquiring mycosis from the hospital environment. Olivier et al, (2006) also indicated that hand washing was an essential practice to reduce the transmission of Rota virus in children younger than 5 years of age in the major European countries.

3.2.2. 2.Effective nursing care practices:

There are specific nursing activities that have been identified to be effective in the prevention of HAI. Some studies found out that education of the health care staff on regular use of antiseptic oral care , use of non-invasive ventilation when possible and placing patients in an semi-recumbent position reduced ventilator associated pneumonia, (Virginia and Catherine ,2013; Drakulovic , 1999). A study by Strouse ,(2015) revealed that bacteria contamination of the bath basin was common and that plain wipes bathing resulted in a lower incidence of catheter associated urinary tract infection . Also, Olivier et al, (2006) found out that nursing practices such as diapering could reduce Rota viral infections in the hospital.

3.2.2.3. Hygiene of the hospital environment.

3.2.2.3.1 Cleaning of the Hospital environment .

The principal aim of cleaning is to remove visible dirt. Soaps and detergents act as solubility promoting agents where bacteria and other microorganisms are suspended in the cleaning fluid and removed from the surface. Cleaning needs therefore to be carried out in a standardized manner or, better, by automated means that will guarantee an adequate level of cleanliness. A study by Constance and Sarah, (2005) identified that invasive mycosis in hospitalized neutropenia could be prevented by hospital air filtration and reduction of dust in the hospital environment. Also Olivier et al, (2006) found out that preventing humidity in the hospital environment could reduce the spread of Rota virus.

3.2. 2.3.2Management of health-care waste.

Management of health care waste is an integral part of hospital hygiene and infection control program. When infectious medical waste (such as discarded blood, blood-soaked bandages, sharps waste, surgical waste, animal or human tissue, used bandages and dressings, discarded gloves, human or body parts, cultures, swabs, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste etc) are well managed or disposed of, it can reduce the risk of acquiring hospital infection. Each state has comprehensive rules for the management of infectious waste, including requirements for storage, transport,

disposal, licensing, and processing are necessary to prevent HAI. A study by Yallew et al, (2017) identified that patients who were admitted in wards with the presence of medical waste container in the room had 82% less chance of developing HAI .

3.3.2.4. The effective implementation of decontamination processes;

All objects that come in contact with patients should be considered as potentially contaminated. If an object is reusable, transmission of infective agents must be prevented by cleaning, disinfection, or sterilization.

3.3.2.4.1 Sterilization.

The process of sterilization is intended to render an object free of micro-organism, but most often it reduces the microorganisms by a factor of more than 106 (i.e. more than 99.9999% are killed). Standard reference works, such as pharmacopoeias, often state that no more than one out of 1000000 sterilized items may still bear microorganisms. This is done by sterilizing only objects that are clean (free of visible dirt) and applying the principles of good manufacturing practice, (CDC 1998).

Sterilization can be achieved by both physical and chemical means. Physical methods are based on the action of heat (autoclaving, dry thermal or wet thermal sterilization) or on mechanical separation by filtration. Chemical means include gas sterilization with ethylene oxide or other gases, and immersion in a disinfectant solution with sterilizing properties such as glutaraldehyde (CDC 1998)

3.3.2.4.2. Disinfection

According to the guidelines of the Centers for Disease Control (1998), high-level disinfection can be expected to destroy all microorganisms, with the exception of large numbers of bacterial spores. Intermediate disinfection inactivates Mycobacterium tuberculosis, vegetative bacteria, most viruses, and most fungi but does not necessarily kill bacterial spores. Low-level disinfection can kill most bacteria, some viruses, and some fungi but cannot be relied on to kill resistant microorganisms such as tubercle bacilli or bacterial spores.

3.2.3. Surveillance of HAI:

The development of a surveillance process to monitor the rate of HAI is an essential first step to identify local problems and priorities, and evaluate the effectiveness of infection control activity. Surveillance, by itself is an effective process to decrease the frequency of hospital-acquired infections.

3.2.3.1 Specific objectives of a surveillance program for the prevention of HAI

-To improve awareness of clinical staff and other hospital workers (including administrators) about HAI and antimicrobial resistance so they appreciate the need for preventive action.

-To monitor trends; incidence, prevalence and distribution of HAI and where possible risk-adjusted incidence for intra- and inter-hospital comparisons.

-To identify the need for new or intensified prevention programs, and evaluate the impact of prevention measures.

-To identify possible areas for improvement in patient care, and for further epidemiological studies (i.e. risk factor analysis)

3.2.3.2. Types of surveillance for HAI,

3.2.3.2.1 Site-oriented surveillance in which priorities is to monitor frequent infections with significant impact in mortality, morbidity, costs and which may be avoidable. Common priority areas are: ventilator-associated pneumonia; surgical site infections; primary bloodstream infections; multiple-drug resistant bacteria

3.2.3.2 .2 Unit-oriented surveillance: In this area, efforts are focus on high-risk units such as intensive care units, surgical units, oncology/ hematology, burn units, neonatology, etc.

3.2.3.2.3 Priority-oriented surveillance: This is surveillance undertaken for a specific issue of concern to the facility for example urinary tract infections in patients with urinary catheters in long-term care facilities.

While surveillance is focused in high-risk sectors, some surveillance activity should occur for the rest of the hospital. This may be most efficiently performed on a rotating basis (laboratory-based or repeated prevalence studies). One study had demonstrated the need for surveillance of HAI, for example during a device-associated infection (DAI) surveillance by Singh et al, (2010) in a teaching hospital in rural Gujarat in India , it was stated that the surveillance program helps in determining the infection rates, risk factors, and in planning the preventive strategies to ensure a quality healthcare in any hospital.

Chapter 4

Method

At the start beginning of this project writing, after choosing the title for the capstone that was confirmed by my academic supervisor, we meet to discuss on the methodology and the presentation of materials. To get material used for this literature review I search in google search engine for guidelines used for the prevention of hospital acquired infections and found 3 guidelines of interest: the WHO guideline of prevention of HAI, CDC guidelines and the Hospital Infection Control Practices Advisory Committee (HICPAC) guidelines.

In addition, I used the student moodle portal entry into the University of Haifa library. In the library search I used the key words; Hospital acquired infections, hospital associated infections, risk factors, preventive measures. I found 838 articles. When I limited it to full text, scholarly Journal, it resulted to 762 articles. Finally when I further limited them from the period of 1997 to 2017 and free accessibility through the university library they all resulted to 14 articles. Finally, I got one more articles through google search which I could not get through the University library free of charge. I tried getting some more articles from other data based sources such as Pubmed, but because I found difficulty accessing them, I finally used only those that I could get through the university library free access.

Included articles: I included a total of 15 peer review articles that were written in English from different countries with diverse levels of hospital settings and units. Any articles that focused on risk factors for HAI and/or prevention of HAI and that I could have free access to the full text were included. Those that I could not access the full text or those that I had access only to the abstract were not included.

The procedure: After obtaining the articles and the guidelines, I read through them classifying them according to the hospital unit and the types of hospital acquired infections they focused on, the risk factors and/or preventive measures were summarized and classified according the agent, host environment model. The guidelines were used to review recommendations and other epidemiological data on HAIs.

Chapter 5

Results

Following the review of the identified peer reviewed articles 7 articles focusing on general ward together with intensive care units, 3 of the articles on neonatal intensive care units, 3 article on non-intensive care unit and 1 article on neurological intensive care unit and 1 in the pediatric unit. .

5.1 Risk factor associated with patient acquisition of hospital acquired infections

5.1.1. Micro-bacteria resistance:

Two of the articles reviewed indicated that micro bacterial resistance was a risk factor for the development of HAI (Virginia and Catherine 2013; Yallow et al, 2017). Patients who received antimicrobials had 8.63 higher odds of acquiring HAI.

5.1. 2 .Patient factors:

5.1.2.1 The patient age featured as on important factor in the development of hospital acquired infection. Three of the articles indicated that the neonatal age exposed them to hospital infection, (Sahu et al, 2017; Sohn et al 2001; olivier et al, 2006). One of the articles pointed out that old age was associated with the risk of acquiring urinary tract infection from the hospital, patients who were 60 or more years had 22.6% infection rate as compared to 4.3% for patients less than 60 years. (Feng et al, 2012).

5.1.2.1 Underlying Disease. Of the three articles that indicated that underlying disease was a risk factor for HAI, one of the articles found that respiratory diseases and blood stream infection were risk factors for ventilator associated pneumonia in children (Virginia and Catherine, 2013); another found that diabetes was a risk factor for hospital acquired urinary tract infection (Feng et al, 2012), and patients with low immunity who underwent surgery had 2.35 higher odds of HAI. (Yallow et al, 2017).

5.1 3. The hospital environment:

Five articles indicated how the hospital environment favor acquisition of infections: Koukou et al, (2015) identified infected hospital surfaces and medical tools as an environment

risk; Constance and Sarah identified a dusty hospital environment and inappropriate hospital designs as risk factors; some others research identified a humid hospital environment and the longer duration of stay in the hospital environment as risk factors, (Olivier et al, 2006; Feng et al 2012; Sahu et al 2017).

5.1. 4.The frequent and prolonged use of invasive medical devices;

Four of the reviews articles indicated that medical equipment were an important risk factor for acquiring infection from the hospital. One of the studies found that patients who had urinary catheters had infection rates of 78% as compared to 11% for non-catheter patients, (Feng et al, (2012); Yallow et al, (2017) found an association between the use of central vascular catheter and HAI, while others found that ventilator associated pneumonia had an association with the use of respiratory ventilators (Virgina and Catherine 2013; Singh et al, 2010).

5.2. Evidence based prevention measures for HAI.

5.2. 1 Hand hygiene practices.

Four articles identified that one of the preventive measures for HAIs was the appropriate practice of hand hygiene by the hospitalized patients and the health care workers (Drakulovic et al, 1999; Constance and Sarah 2005; Koukou et a, 2015; Olivier et al, 2006).

5. 2.2. Effective nursing care practices:

Four articles identified that nursing practices were found to be effective in preventing the acquisition of hospital infections. Such practices involved proper positing of critically ill patients or patients with specific devices, the proper use of antiseptic oral care, the use of basin wipes, administration and removal of patients diapers (Virginia and Catherine, 2013; Drakulovic et al, 1999, Strouse , 2005; Olivier et al, 2006).

5.2.3. The maintenance of high hospital hygiene:

Two of the studies indicated that filtration of the hospital air, dust reduction and preventing humidity in the hospital could reduce HAI (Constance and Sarah, 2005; Olivier et al, 2006).

5.2.4 Less frequent use or shorter duration use of invasive medical procedures and devices.

Five of the articles reviewed indicated that the lesser the use of medical devices for hospitalized patients the lesser the risk of acquiring hospital infections, the shorter the duration

of the device being in situ the lesser the acquisition of hospital infection, (Feng et al, 2012) ; Yallow et al, 2017 found an association between the use of central vascular catheter and HAI, they indicated that patients who receive a central vascular catheter had 6.91 higher odds of acquiring HAI than those who did not . Also Virgina and Catherine 2013; Singh et al, 2010, found an association between device use and the development of HAI.

Discussion:

The main objective of this paper is to identify the risk factors in a variety of settings associated with patient development of hospital acquired infection and to identify the most effective evidence based preventive measures.

Regarding the risk factors associated with development of HAI, we found that microbacterial resistance was a risk factor for the development of HAI (Virginia and Catherine 2013; Yallow et al, 2017). The progress in the antibiotic treatment and the widespread use of antimicrobials for therapy or prophylaxis (including topical) is the major determinant of resistance. As an antimicrobial agent becomes widely used, bacteria resistant to this drug eventually emerge and may spread in the health care setting. This problem is particularly critical in developing countries where more expensive second-line antibiotics may not be available or affordable.

Secondly, we found that the age of the patient especially the neonatal age was associated with acquisition of HAI.. Neonates within the few days of life and those with low birth weights were more susceptible to hospital infection, (Sahu et al, 2017; Sohn et al, 2001). The fact that their immune system is still less develop to be able to fight infections if they are exposed becomes more challenging. The elderly patients were also prone to infections (Feng et al, 2012) because of their reduce defense mechanism. During my practical experience in Emek medical center in 2017, analyzing the hospital data obtained in 2016, we found out that the neonatal unit had one of the highest hospital acquired infection with HAI prevalence of 2.5 % after the general intensive care unit.

In addition, another risk factor identified was that patients who had chronic diseases such as diabetes, Urinary stones, benign prostatic hyperplasia, were more prone to acquiring hospital infections, (Feng et al 2012). The presence of sugar in urine provides a conducive medium for

bacteria to strive, exposing diabetic patients to infections such as those of the urinary tract. Patients with other chronic disease such as malignant tumours, leukaemia, acquired immunodeficiency syndrome (AIDS) have an increased susceptibility to infections with opportunistic pathogens. When the body's immunological differences are compromised even part of the normal bacteria flora in the human body may become pathogenic.

Thirdly, we also identified that the hospital environment was responsible for the patients acquiring HAI. Hospital designs that promote contamination such as false ceiling and closed spaces which accumulate spores containing dust, crowded conditions within the hospital, frequent transfers of patients from one unit to another, poor environmental hygiene and poor management of infectious medical waste all contribute to the development of HAI infections (WHO 2002; Constance and Sarah H.,2005; Koukou et al, 2015 ; Olivier et al,2016). The length of patient stay in the hospital environment accounted for some of the risk factors for hospital infection. Prolonged hospital stay further exposed the patient for a longer period of time increasing the risk of acquiring infection because other new patients with other infections organism continue to add to previous ones thus more risk, (Feng et al,2012; Sahu et al, 2017)

Furthermore, the frequent use of medical devices was another risk factor for HAI. The frequent use of urinary indwelling catheters was mostly associated with hospital acquired urinary infection while mechanical ventilators were associated with the acquisition of ventilator associated pneumonia and for intravascular infections, the number of lines a patient have for monitoring or nutrition increases the risk of line related infections , (Yallew et al, 2017; Virgina and Catherine, 2013). These medical devices although might be sterile at the time of administration on the patient, they might be exposed to pathogenic micro-organism from the patient themselves or from the environment if the devices or the procedures are poorly manage.

During my practical experience in the Emek Medical Center from January to September 2017, I observed two ventilator associated pneumonias. Of the 2 patients identified with ventilator associated pneumonia, one of them was 80 years old, have had a long stay in the hospital for over 3 months and was seriously ill presenting with respiratory distress and was bed ridden. He had undergone a tracheostomy and Hartman procedure and was infected with MRSA (methicillin-resistant Staphylococcus aureus). The second patient was 60 years and had stayed in the hospital for over 9 days , transferred from the surgical unit to the intensive care unit with perforation of the horizontal colon and had undergone a laparotomy and colostomy. He also had ischemic heart disease and had undergone a tracheostomy. In addition, data from 2016 statistic I

obtained from the Emek Medical Center, out of 104 patients who were places on respiratory ventilators, 1 had ventilator associated pneumonia giving an annual rate of 1.9%. Of the 50 patients who receives central line catheterization (femoral, Jugular and subclavian) 1 had a central line associated blood stream infection giving an annual rate of 2%. All these multiple conditions both of which can be prevented and other might not be prevented further exposes patients to the development of HAI. Therefore, the need for local identification of risk factors and re-enforcement of the best practices in the hospital settings.

Regarding the evidence based preventive measures; **hand hygiene was** an important preventive measure. Thorough hand washing with adequate quantities of water and soap is effective in removing more than 90% of superficial flora including all or most contaminants (WHO 2002). The use of antimicrobial soap to further reduce the superficial flora, and killing all superficial flora with all contaminants within a short time necessitates hygienic hand disinfection with alcohol or alcoholic preparations because they act sufficiently fast,(WHO 2014). The respect of hygiene practices is essential especially because many asymptomatic patients are a great source of infection and because less precaution is taken because of lack of symptoms, the practice of appropriate hand hygiene can reduce this risk. During my practical experience, it was also noticed that during the fourth quarter in 2016 when there were more infections in the neonatal intensive care unit, hand hygiene practices was also low at 80% . The questionnaires I administered to the health workers in this hospital on hand hygiene indicated that the majority of health care workers needed their colleagues to act as a role model for others, so that they can collectively carry out best practices in favor of prevention of HAI..

Nursing care activities. There are specific nursing activities that have been identified to be effective in the prevention of HAI. Some studies found out that education of the health care staff on regular use of antiseptic oral care , use of non-invasive ventilation when possible and placing patients in an semi-recumbent position reduced that VAP (Virginia and Catherine ,2013; Drakulovic , 1999, Strouse, 2015; Olivier et al, 2006). Many nursing activities to be continuously implemented necessitate a nursing care plan which is usually done by the most competent nurses in the unit so that all other junior staff can adhere to it. In the Emek Medical center, I observed that in each shift of work, the team leader does a nursing care plan of activities for the day and once implemented, the time is charted and the next time for the procedure is again indicated in the chart for each specific patients. Nurses spend many hours with the patients

as compared to the time spend by other health workers such as the medical doctors. The nurses are therefore, better place to actively carry out the nursing care plans for the individualized patients and provide them with the appropriate nursing intervention to reduce hospital infection transmission. Also the changing of diapers for all the neonates with or without infectious disease was the sole responsibility of the nurses in the Emek Medical Center. We thought that all these prevented measures accounted for the 0% of HAI in the neonatal unit of this hospital in 2015.

Thirdly, to be able to reduce HAI due to greater use of medical devices , employing the use of impregnated catheter is one way to decrease rates of catheter associated urinary tract infection and removal of catheters as soon as possible to prevent further exposure. For intravascular infection prevention, adherence to recommendation regarding insertion, line care, access and tubing changing can help reduce this risk. Also, since the use of ventilator increase the risk of HAI, this could be prevented by following the established protocol for head of the bed elevation, tubing changes and suctioning practices. The practice of aseptic techniques during nursing and medical practices is therefore an essential component to reduce HAI.

Moreover, thorough cleaning of the hospital environment can remove more than 90% of microorganisms (WHO 2002). Diluting and removing the dirt also removes the breeding-ground or culture medium for bacteria and fungi. Non-sporulating bacteria are unlikely to survive on clean surfaces. Toilets in the hospital need to be welled constructed with consistently provided with disinfectants. Designing the hospital to minimize risk factors such as improvement in the proper flow of air and prevention of dust from settling in the departments such as avoidance of false ceiling can help to reduce HAI.

Although none of the articles did mention about the cultural practices which exposes patients to acquire hospital infections, during my practical experience at the Emek Medical center, analyzing the data on the patients demographic characteristic, we found out that 80% of neonates who acquired infections from the hospital in 2016 were from Arabic Palestinian background. It was suggested that the cultural practices of having many relatives and families over-crowding the hospital and being in direct contact with the patients might have been a contributing factor. Education of patients' families on the importance of limiting the number of visitors for a patient and reducing the direct contact with patients might be helpful in preventing infections.

Conclusion:

The risk factors identified in this study are very important for the prevention and control of hospital-acquired infection in both the developed and resource limited countries. Microbacteria resistance, patient characteristics, Hospital environment, frequent and prolonged used of medical devices were independent predictors for hospital acquired infections.

Hospitals can significantly reduce the HAI rate if their infection control programs effectively implement the important component of infection prevention stressing on surveillance of HAI; adherence to standard precaution measures including hand hygiene; effective implementation of isolation precaution; cleaning, disinfection and sterilization processes. Hospitals and clinicians need to give attention to neonates and the elderly patients, patients with underlying conditions and follow the appropriate safe medical procedures for use of external devices while hospital managers and medical workforce should consider the availability of resources.

All efforts aimed at continuous identification of these risk factors and implementation of the preventing measures can reduced morbidity and mortality due to HAI, reduced cost of care while assuring patients safety.

Recommendation.

Investing in the construction of hospitals that can limit the likely hood of spread of HAI such as the use of automatic water taps and automatic doors in the hospital can reduce the frequent contamination of hands of both patients and health workers thus minimizing the spread of HAI due to contaminated hands.

Although most of the articles focused on the hospital setting, consideration of the cultural practices such as many family members visiting hospitalized patients frequently, touching patients and sharing of meals in the hospital environment might be a risk factor in the acquisition of HAI. Therefore education of the patient's relatives and families on those predisposing cultural factors can help reduce the acquisition of HAI by hospitalized patients.

Frequent and continuous research and provision of the results and feedback on the personnel point of view to be able to tap relevant information from the health workers themselves can help empower the health care system and prevent HAI.

Competences that were demonstrated during the execution of the Capstone.

-Competence demonstrated that were acquired from Research methods courese:

I made used of the scientific method approach to prepare my research paper notably, writing of the introduction, the objectives, the method, the results, Discussion and conclusion. Knowledge that I gained from the Research Method was used to choose the methodology that I used writing up this paper.

I also demonstrated the knowledge gained on how to structure a research paper , notably; Writing out a clear title of the study, the abstract, the table of content, the objective and goal of the study, the background etc.

In addition, I employed the knowledge I gain from the concept of literature review which I used to carry out my work. I was able to search for the articles to be reviewed and classified them according to different aspects that I was studying.

I use the competences acquired from the knowledge about the concept of evidence- based medicine involving the use of clinical guidelines and different levels of strength of evidence in drawing conclusions.

In addition, being able to prepare to communicate both in writing and oral forms of my findings to my class mates and academic supervisors is another skill that I am able to demonstrate.

Integrating my capstone paper with my practicum, I was able select a quantitative data collection tool appropriate to find out the health care personnel option on hand washing practices. I used a validated questionnaire to collect data from health personnel in the neonatal intensive care and general intensive care units to find out the health personnel's opinion on hospital acquired infection and hand hygiene in the Emek medical center and some of the findings are presented in this capstone write-up.

-Competences demonstrated that were acquired from Biostatistics.

I demonstrated the competence in using statistical measures in presenting some of the results of this capstone paper such as calculating percentages, rates of HAI from my practical experience in the Emek medical center. I used the knowledge acquire from biostatistics to understand the

finding that were presented in the research articles using measures such as Odd ratios, percentages, rates etc and the understanding of other statistical concepts such confidence intervals, statistical significance of results and non-statistical significant results (the p value). This enabled me to analyze and synthesize results obtained from various articles on magnitude of the risk factors and prevention of HAI.

I also further demonstrated the competence in understanding of the articles that I read in terms of descriptive statistic (Frequencies, variance, standard deviations, graphic presentations etc) and inferential statistics (eg t test).

Furthermore, clinically speaking I was competent to be able translate the meaning of HAI in a sample population to infer its probability of it occurring in another population from the knowledge gained from the concepts of normal (or symmetrical) distribution and standard normal distribution in biostatistics.

-Competences demonstrated that were acquired from epidemiology

Competences acquired from epidemiology such as the epidemiological model of 'The epidemiological triad' of causal factors (otherwise known as the Agent, Host and Environment model of disease) to present some of my finding from the articles read.

Using knowledge from epidemiology on exposure –outcome model, I demonstrated competency to Interpret results of data analysis in public health practice about the risk factors associated with patient's development of HAI and their outcomes. Being competent in the understanding of other epidemiological concepts such as incidence and prevalence of disease help me understood the importance of primary and secondary prevention of HAI in clinical practice.

The Descriptive epidemiology helped me to understand who are at risk of hospital infections, when and where the HAI is highest etc. While the analytic epidemiology helped me to understand the risk associated with certain types of patients acquiring hospital infections and the magnitude of the risk using measure such as relative risk, odd ratios etc.

The competency of being able to differentiate between the different study designs enable me to understand the different results in terms of risk of acquiring HAI (relative risk and odd ratio).

- Demonstrated competences from Global Health and sociology of health

None of the articles I read focused on the cultural practices that might be a risk factor to patient developing HAI. I used the competences on socio-cultural awareness and social determinants of health to provide recommendations on a shift from biological and infrastructural factors to cultural aspects that affect health and predisposed patients to having HAI.

Because my project on applied practical experience was so related to the capstone project, I was able to demonstrate socio-cultural awareness skills in analyzing and presenting practicum findings about the cultural practices of the Arab Palestinians that predisposed their neonates in acquiring HAI as compared with the neonates with a Jewish background. Although many health care organizations mostly focus on biological and health care factors as the main determinants of health, I used this cultural awareness skill to act as a change agent in laying more emphasis on the culture practices as a social determinants of health during one of the hospital meeting that I participated in the Emek medical center on hospital acquired infection.

References. .

Amy, Nicole, and Kathleen, (2014). The Impact of Hospital-Acquired Conditions on Medicare Program Payments. Midicare and Mediaid Research Review, no 4.

Constance M. and Sarah H. (2005). Prevention of systemic mycoses by reducing exposure to fungal pathogens in hospitalized and ambulatory neutropenic patients. Oncology Nursing Forum – 565-579.

CDC. Estimates of Health-care associated infections (2007) http://www.cdc.gov.ncidod/dhqp/hai,html.

Drakulovic MB, Torres A, Bauer TT, Nicolas JM, Nogue S, Ferrer M. (1999). Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomized trial. Lancet,1851-1858

European Centre for Disease Prevention and Control. (2013). Point prevalence survey of Healthcare Associated infections and antimicrobial use in European acute care hospitals. Stockholm: ECDC; 2013.

Ellen Elpern,(2016) .Prevention of Catheter-Associated Urinary Tract Infections in Adults Critical CareNurse Vol 36, No. 4. 9.

Feng Wang, Tao Xing, Junhui Li, Yingzi He, Mei Bai And Niansong Wang, (2012). Survey on Hospital-Acquired urinary tract infection in neurological intensive care unit. APMIS 121: 197-201.

Koukou D, Chatzichristou P, Trimis G, Siahanidou T, Skiathitou A-V, Koutouzis EI, et al. (2015). Rotavirus Gastroenteritis in a Neonatal Unit of a Greek Tertiary Hospital: Clinical Characteristics and Genotypes. PLoS ONE : 10.137 .

Marta, Stefano, Marco , Sonia and Francesco Blasi, (2016). Non-Intensive Care Unit Acquired Pneumonia:A New Clinical Entity? International Journal of molecular Sciences. 17, 287.

Olivier Gleizes, Ulrich Desselberger, Vladimir Tatochenko, et al, (2006). Nosocomial Rotavirus Infection in European Countries A Review of the Epidemiology, Severity and Economic Burden of Hospital-Acquired Rotavirus Disease. Pediatr Infect Dis J 25: S12–S21)

Sahu MK, Siddharth B, Devagouru V, Talwar S, Singh SP, Chaudhary S, et al.(2017). Hospital-acquired infection: Prevalence and outcome in infants undergoing open heart surgery in the present era. Indian J Crit Care Med;21:281-6.

Sohn, Garrett, Sinkowitz-Cochran et al (2001). Prevalence of nosocomial infections in neonatal intensive care unit patients: Results from the first national point-prevalence survey. The Journal of Pediatrics 39:821–7 .

Singh S, Pandya Y, Patel R, Paliwal M, Wilson A and Trivedi S, (2010) . Surveillance of device-associated infections at a teaching hospital in rural Gujarat –India Indian Journal of Medical Microbiology,28(4): 342-7 1

Strouse, A.C. (2015). Appraising the literature on bathing practices and catheter associated urinary tract infection prevention. Urologic Nursing, 35(1), 11-17. .

Virginia Cooper AND Catherine Haut, Preventing Ventilator- Associated Pneumonia in Children: An Evidence- Based Protocol. Critical Care Nurse.:21-30)

WHO (2002) .Prevention of hospital-acquired infections A Practical guide 2nd edition.

Yallew WW, Kumie A, Yehuala FM. (2017). Risk factors for hospital-acquired infections in teaching hospitals of Amhara regional state, Ethiopia: A matched-case control study. PLoS ONE 12(7): https://doi.org/10.1371/journal

Zhang SQ, Peng B, Stary CM, Jian ZH, Xiong XX, Chen QX (2017). Serum prealbumin as an effective prognostic indicator for determining clinical status and prognosis in patients with hemorrhagic stroke. Neural Regen Res 12(7):1097-1102.