

Nosocomial Infections and the Ways to Control

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ABSTRACT

In recent years, new buildings have been built and equipped which are called "hospital" and provides diagnostic and therapeutic services to patients but sometimes these measures inevitably leads to the acquisition of nosocomial infection in patients and may even lead to the death of patients. The history of nosocomial infection refers to the many year ago. In the eighteenth and nineteenth centuries, poor women were gone to maternities for parturition but the death rate for them was so high so that in 1850 AD Thomas Lightfoot wrote in London Medicinal Journal that: "Hospital are gates leading to the death of women".

Surveillance for nosocomial infections Florence was established the first Surveillance for nosocomial infections system by the nurses (Deaths reported by nurses). William Farr also showed a higher incidence of mortality due to communicable diseases among the nurses and the hospital Personnel's.

KEYWORD: *Nosocomial infections - control*

INTRODUCTION

In 1860, Dr. James Simpson was reported the amputation-induced death in large Hospitals and emphasized on the needs to isolation of patients and hospitalization of less patients in any room of the hospital and as a result Reduce the spread of infections in hospitals. Lister published results of his studies in 1867, and showed that by dipping fingers in disinfectants and cleaning local of operation before surgery can prevent infection. German surgeons were quickly accepted the Lister methods, and until 1910 AD, surgical instruments, gowns, masks and sterile gloves as standard were used in large hospital of universities.

Definitions

Nosocomial Infection (Hospital-induced infection)

Nosocomial Infection (Garner and Favero, 1986) known as Infections that are occurs after hospital admission (48 Or 72 hours after) or within a specific period (10 to 30 days) after the patient discharge (25 to 50% of surgical wound infection after patient discharge are displayed), and there wasn't in admission time, and also there weren't in incubation period.

If, following the surgery foreign body implanted in the body, the nosocomial infection can occur a year after operation (CDC, 1997). In addition to patients, Nosocomial infections can also affected the staff and visitors.

Any member of the human body can be affected by hospitals infection, but among the varies type of hospital-induced infection, Urinary tract infections (42%), lower respiratory tract infection or pneumonia (15 to 20%), surgical wound infections (42%), and bloodstream infections (5-10 %) are of particular importance, which According to the Center for Disease Control and Prevention (CDC) definitions for nosocomial infections surveillance system are described in Table 1. According to studies, Urinary tract infections, is the most common and pneumonia is the most fatal nosocomial infections, although in some clinical centers, hospital-induction infections of circulatory system is the main cause of death. (CDC, 1994)

The importance of hospital-induction infections

Nosocomial infections are important by several aspects:

- Mortality and morbidity in patients
- Increased the period of hospitalization
- Increased costs due to prolongation of hospitalization, diagnosis and treatments

The ways to transmission of microorganisms in hospitals

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Microorganisms can be transferred in the hospital by different ways and sometimes a given microbe can be transmitted in several ways. Ways for transmission of microorganisms in hospitals are include:

- 1) Transfer by contact: Contact is considered as the most common route for transmission of nosocomial infections and it was divided into three subgroups:
 - Direct contact of the body and physical transfer of microorganisms between a susceptible host and who was infected or colonized by microbes.
 - Indirect contact of susceptible host with infected subject (infected instruments, needles, bandages, gloves)
 - Produced drops by the person during sneezing, coughing and talking, suctioning or bronchoscopy and exposed to conjunctiva, nasal or oral.
- 2) Transport by air (airborne)
- 3) Transport by infected shared tools, such as food, water, medicines and equipment
- 4) Transport by carriers such as mosquitoes, flies, and mice that are not important in the transmission of nosocomial infections.(CDC, 2002)

Transmitted pathogens in hospital based on transport way

- Contact with patients or equipment: Staphylococcus, the bacteria from Enterobacteriaceae, viral infections such as rotavirus, candida and fungi.
 - Drop: adenovirus, the virus Nflanza
 - Pin: Hepatitis B, HIV
- Air • tubercle Bacilli
- shared by:
 - Intravenous fluid, disinfectants, water: Acinetobacter, Serratia.
 - Endoscopy: Pseudomonas, Acinetobacter spp.
 - Food: Salmonella, Pseudomonas.

Factors that causes patients prone to nosocomial infections are include:

- Age of patient (infants, elderly)
- Basic Diseases such as organ failure (liver cirrhosis, mellitus diabetes, chronic obstructive pulmonary disease, renal disease), cancer, neutropenia
- Congenital or acquired immunodeficiency (AIDS, treatment with immune suppressive drugs, malnutrition)
- Vulnerability to viral infections
- Mucocutaneous barrier dysfunction following trauma, burns, surgery, endoscopy, catheters affluent, skin and mucosal diseases.
- Anesthesia, drowsiness that lead to decreased pulmonary ventilation or suppression of cough.
- The use of antibiotics, antacids drugs (change the body's flora and reduce resistance to replacement of hospital flora against, select of mutant bacteria and fungi and resistant to antibiotics)
- Colonization of flora and subsequently occurrence of carrier mode of opportunistic fungal and bacterial
- Off latent infection and activation them again after the suppression of the immune system.

Microorganisms responsible for nosocomial infections

Different organisms can cause endemic and epidemic nosocomial infections that are dependent on several condition such as basic disease, the use of invasive devices and already use of antibiotics.

One of the best sources of information on patterns of bacterial nosocomial infections is National Nosocomial Infections Surveillance System (NNISS) (CDC, 2003; Garner, 1993).

The studies which were conducted from 1990 to 1994 AD by the NNISS, it was found that aerobic bacteria in 87% of the cases, anaerobic bacteria in 3%, funnies in 9% and other types of viruses, fungi and parasites in 1 % cases have been implicated in nosocomial infections. Generally, E. coli was the most common pathogen among the all types of nosocomial infections and second rank is belong to Staphylococcus aureus.

In Figure 1, the most common type of nosocomial infection by pathogenic microbes are shown. As shown in this figure, E. coli is the most common cause of urinary tract infection, Staphylococcus aureus is the common cause of surgical wound infection, Pseudomonas aeruginosa and Staphylococcus aureus are the most common bacterial infection of the lower respiratory tract and Gram-positive Coccies are the most common microorganisms in primary bacteremia. In epidemics, the bacteria were also most common microorganism causes of nosocomial infections. In the study of occurrence of nosocomial outbreaks occurred in 1980 and 1990, bacteria have been recognized as major factor of 62% of all epidemic (CDC,

2007). Figure 2 shows the pathogens of these epidemics. The reviewing of 555 articles on Medline about outbreaks of nosocomial infection from 1984 to 1995 years also has shown that bacteria in 71% of cases and viruses in 21% of cases, fungi in 5%, and parasites in 3 % of all cases have been recognized as major cases of nosocomial outbreaks and also in 2% of cases the factor of infection were unidentified. Among bacteria, Gram-negative bacteria almost in half of the cases was causing the infection, and among them, *Acinetobacter*, *Serratia*, *Pseudomonas*, and *Salmonella* were more common. Among the gram-positive bacteria, *Staphylococcus aureus* (60 %) was the most common organism (Bennett, 1998).

Hospital infection control procedures

The main goal of an infection control program is to reduce the risk of acquiring nosocomial infection and subsequently protection of patients, hospital staff (and students) and the visitors. To achieve this goal, an organization has emerged in hospitals as "Hospital Infection Control Committee". Hospital Infection Control Committee is responsible for planning and evaluating of all cases in related to the control of infection and its member are included:

- Hospital administrator or chief
- Infection control physician or epidemiologists
- Infection Control Nurse
- Clinical Microbiologist or Clinical Laboratory expert
- Director of Nursing
- Other members, such as internal physician, surgeons, representatives of health units, nutrition, and services and etc, Doctor, Nurses and hospital Mycrologist are form of hospital infection control team and are considered as the most important and most active committee members (Weber and Rutala, 1997).

Education

One of the main tasks of the Hospital Infection Control Committee, is to developing educational programs and the infection control nurse has an essential role to performances of educational programs. Training of hospital staff is including of infectious disease control, sterilization, disinfection and proper use of equipment, hygiene and handwashing compliance issues, and protection against blood transportable diseases such as hepatitis and HIV and etc.

Hospital isolation or separation

To prevent the transmission of infectious disease or pathogens from colonized with microorganisms to other patients, staff and even visitors, it is necessary to adopt practical policies. In 1983, the Center for Disease Control and Prevention (CDC) has applied two separation systems, which were included disease group (Category Specific I) and disease type (Disease Specific I). In 1985, to prevent the transmission of blood-borne pathogens such as hepatitis B and HIV, general are universal precautions were also recommended. Because of the risk of transmitting pathogens from the other ways addition of blood, such as direct contact, or by contact with droplets of airway, standard precautions and transmission-based precautions were advised in 1966, which will be discussed. Today, regard to standard precautions is the most important of isolation of the patient actions (Greene,1969).

Standard precautions

To reduce the risk of microorganism transmission from known or unknown sources in hospitals, standard precautions is applied. Performance of recommended standard precautions is necessary for all patients without regard to their disease type.

Standard precautions should be applied when exposure or contact to each of the following:

- Blood
- All body fluids, secretions, and fecal material body except sweat, regardless of visible blood in it.
- Damaged Skin
- Mucosal

Principles of standard precautions

i) Handwashing

Hands immediately after touching blood, body fluids, secretions, fecal material or contaminated, regardless of the fact whether or not gloves are used, must be washed. After putting off gloves from hands, after every contact with patients to prevent of the transfer of microorganisms to other patients, staff or the environment, hands should be washed. If invasive or different practices actions were carried out on a patient, hands should be washed at these intervals to prevent of contaminant transmission to the other body parts.

ii) Gloves

- When touching blood, body fluids, secretions, fecal material body, and the contaminated blood vessels and other invasive procedures should wear on clean gloves.
- Before contact with mucous membranes or damaged skin should wear on clean gloves.
- If various tasks and invasive actions performs for a patient gloves should be replaced at the interval of doing these works. After contact with material that may contain high concentrations of microorganisms, the gloves also should be replaced.
- Immediately after use of gloves, before touching uncontaminated items and surfaces and before contact with another patient, gloves should be removed from the hands.

iii) Mask, eye protection, face protection

In order to protect the mucous membranes of eyes, nose and mouth during work activities and patient cares that may be aggressive or there is the risk of splashing of blood, body fluids, secretions and fecal material, mask and face shield or eye should be used.

iv) Gown

During doing of invasive and patient care activities that may there is splashing of blood, body fluids, secretions and fecal material to protect the skin and avoid of dirtying of clothes gowns should be wear on.

v) Equipment and Tools for Patient Care

- Collecting and transporting equipment and tools of patients care which contaminated with blood, body fluids, and secretions or by fecal material should be done in such ways that preventing from the exposure of the skin and mucous membranes to them and contamination of clothing and transfer of microorganisms to other patients and environments.
- Devices which are reusable and are contacted with damaged skin, blood, body fluids, or mucous membranes must be disinfectant and cleaned completely by appropriate disinfectant in hospitals before using for other patients. Before their cleaning completely, should not place them in other clean space or patients rooms.
- Any type of care tools that is sent to repair from different parts should be cleaned with hospital disinfectant.

vi) Bedsheet

When collecting and transporting of Bedsheets which were contaminated with blood, body fluids, secretions or fecal material, exposure of the skin or mucous membranes to them, contamination of clothing and transfer of microorganisms to other patients and environments should be avoided. Dirty Bedsheet should never be placed on the floor or clean surfaces.

vii) Occupational health and blood-borne pathogens

- To prevent damage during collection and transferring of needles, scalpel and other sharp instruments, should be very careful and immediately placed them into sharps container objects.
- Needle cap never should never be used on the new needle and never use any ways that causes the tip or sharp objects back toward to body should not be used. If in the clinical situation, it is necessary to put the cap on the needle, this must be done by one hand or by mechanical means using a special forceps for holding the needle sheath.
- Do not removed used needles from disposable syringes.
- Used needles must not be bent by hand, it cannot be broken or modified. Syringes, needles or sharp tools which are reusable must be putted in a special containers which is puncture resistant and have label for environmental hazards and then transported it to appropriate location for cleaning and disinfection.
- To restore the patient, resuscitation bag, Mouthpiece, or other breathing tools can be used as an alternative method instead of Mouth-to-Mouth breathing.
- In order to prevent infection with hepatitis B, hepatitis B vaccination must be done by medical personnel.
- In case of splashing of blood or other potentially infectious materials, mucous membranes, eyes, mouth, or other mucous membranes of the body or the needle or sharp objects into the body, the face should be reported.
- In case of splashing of blood or other potentially infectious materials into eyes mucous membranes, mouth, or other mucous membranes of the body, or sinking the needle or sharp objects into body, the event should be reported.

viii) Patient and care location

If a patient contaminated the environment or cannot control of health and environmental, a individual room must be provided for him/her.

In addition to standard precautions, sometimes it is necessary based on transmit of infection or bacteria type (air, droplet, and contact) special precautions such as the use of private rooms, room air conditioning, use of masks, gowns, gloves and washing hands with disinfectants and reduced mobility of patients must be considered.

Handwashing

Hand washing is considered as the important single way to prevent infection (McKee, 1998). Hand washing can be done by conventional or antimicrobial soaps types. Hand washing with conventional soap and rinse causing

microorganisms away from the skin (mechanical method), hand washing with antimicrobial products cause kill microorganism or inhibited their growth, which is called disinfection.

The skin of Medical staff hands have endemic and temporary or permanent types of microorganisms. Most of hands microbes residing in the surface layers of the skin, but about 10 to 20% of them are located in the deep layer of epidermis which may not remove following of hand washing with ordinary soap, but usually be killed or their growth be inhibitor by conventional antimicrobials soaps. Handwashing with soap will cause temporarily remove bacteria from the skin (Bennett, 1998; Greene, 1969).

Indications for handwashing include:

Except in very emergency situation, the Medicinal personnel should always wash their hands:

- 1) After removing gloves form hands
- 2) At the beginning of the work shift.
- 3) When hands are contaminated, after sneezing, coughing or cleaning the nose
- 4) With every contact with patients
- 5) Before the preparation of drugs
- 6) After going to the toilet
- 7) Before applying invasive procedures
- 8) Before the care of vulnerable patients such as infants and people with severely suppressed immune systems
- 9) Before and after touching wounds
- 10) Before eating.
- 11) After touching of objects that are possible contaminated with pathogenic bacteria, such as measuring containers of urine and body fluid collection devices
- 12) After taking care of infected patients or patients who are likely colonized by bacteria with epidemiology importance such as resistant bacteria against to several antibiotics

Hand washing methods

- I- Conventional or routine hand washing
- II- Wash hands with antimicrobial or disinfectant substance
- III- Hand washing without using water.

Conventional or routine hand washing

Hand washing is consisting of cover hands with soap foam (liquid, solid) and firmly rub all hands surfaces together and rinse all of them with running water (tap water). The whole process should take 10 to 15 seconds. The hands should be dried by napkins (towels). If closing of water valves was done by towel that used for drying of hands, the re-contamination of hands with water walves would be prevented.

Wash hands with antimicrobial or disinfectant substance

To disinfection of hands we can use of Betadine, Scrub and Chlorhexidine solutions with 2 to 4% concentrations.

Indications for disinfecting hands with antimicrobial agents are

- 1) Prior to surgery or invasive procedures-like
- 2) During the care of patients who are isolated or it is necessary to observe some precautions
- 3) Before entering the Neonatal Intensive Care Unit (NICU) or nursery

Hand washing without using water

In cases that there is no sink and means for hand washing by water, materials which do not require water for washing, such as alcohol can be used.

Attention

The soap with tetravalent ammonium compounds should never be used alone for surgical skin preparation, unless the patient had allergic to all approved disinfectant.

- Hand washing can be reduced nosocomial infections to 50% .

Disinfection, sterilization, hospital waste management

One of the necessary actions to control of nosocomial infection is to planning and policy on disinfection and sterilization of equipment in the hospital because there is always the risk of transmission of infection

following of contamination of tools. Depending on the application material types, surface disinfection is different.

Destroy all of microbial life forms during physical or chemical process, including bacterial spore known as sterilization, but if all microorganisms except bacterial spores are destroyed, it is so called high-level disinfection. It is obvious that before sterilization or disinfection, decontamination or cleaning of equipment is necessary. If a chemical microbicide substance is used to inhibit or destroy microorganisms on living tissue or skin, the action is called Antisepsis. Therefore, for disinfection of surfaces and objects should not be used Antisepsis substances (Garner, 1993; Weber and Rutala, 1997).

For critical devices such as catheters and needles that are in contact with blood or sterile body parts, the sterilization method should only be used. If the device is in contact with mucous membranes (Semicritical), such as endoscopy devices, sterilization is preferred to disinfection, but high-level disinfection of device is acceptable method. Devices such as mobile phones and devices for measuring blood which are contacted with intact skin (noncritical), or cleaning of the floor, walls and surfaces, only low-level disinfection or cleaning of device or level is sufficient.

Methods of disinfection and sterilization in hospital (McKee, 1998).

A) Sterilization

- Autoclave or steam (121 ° C for 15 to 30 minutes) for steel surgical instruments
- Dry heat (171 ° C for one hour)
- Ethylene oxide or ETO for heat-sensitive plastically materials and surgical instruments
- Formaldehyde gas and steam at low heat for heat-sensitive materials such as plastics
- Plasma gas for metal and plastic materials which are sensitive to heat and humidity
- Germicidal fluids such as glutaraldehyde
- Gamma-ray for implants devices (catheters, prostheses)

B) Disinfection with chemicals

- Glutaraldehyde for high level Disinfection of instruments, such as endoscopy devices
- Peracetic acid
- Chlorinated compounds for disinfection of surfaces (particularly those infected with HIV) and water
- Compounds containing iodine for skin disinfection
- Alcohol for skin disinfection
- Tetravalent ammonium compounds for low-level disinfection, like disinfection of surfaces

Note:

Periodic control of sterilization devices such as autoclave or ethylene oxide from viewpoint of microbiologic monitoring by means of biological indicators containing heat-resistant bacilli is necessary to assure their performance.

Collection and exclusion of hospital waste

Collection and exclusion of hospital waste in a safe form is one of the essential steps in the hospital.

Hospital waste are included all types of disposed hospitals waste, both biological and non-biological types that there is no plan to reuse them. Medical waste is a part of hospital waste, which is results of diagnosis and treatment for patients. Infectious waste including part of medical waste which are capable of transmitting infectious diseases.

Center for Disease Prevention and Control (CDC) considered five types of hospital wastes infectious that includes microbiological waste, pathological, contaminated animal carcasses, blood and sharp objects. In addition to the above five types of waste, Environmental Protection Agency (EPA) the waste from patients to be involved in the epidemics disease consider infectious.

Removing trash from each other and put it in a separate plastic containers or bags, sharp devices disposed within the robust packaging, and there is a special label on the infectious waste, helps to the safe disposal of waste.

The most effective and cheapest method of disposal of infectious waste, incineration and steam sterilization which it is, but radioactive waste and anticancer drugs should be sterilized with steam. Waste incineration is suitable

for all types of infectious waste and pathological waste and sharp objects. Liquid wastes after disinfection of by chemical materials can be poured into sewer (Weber and Rutala , 1997; McKee,1998).

Prevention of microorganism resistance to antibiotics

Increasing resistance of bacterial to antibiotics increased mortality and morbidity and length of hospital stay following the acquisition of nosocomial infections. Overuse of antibiotics can lead to a waste of financial resources so that 20-50% of hospital drug costs includes. More than half of hospitalized patients treated with antibiotics, however, are about 5% of all antibiotics prescribed to the wrong drug, the wrong dose or had been used to a false period. According to studies at a foreign university the center of Vancomycin use increased 200 times but in two thirds of cases, it is unnecessary.

The emergence of antibiotic resistance which is equivalent to \$ 4 million annual cost to the United State imposes. The incorrect use of antibiotics due to the increased use of invasive procedures, increasing the sensitive hosts and non-compliance Practical Tips Immuno compromised on sensitive control of infection. Increasing incidence of bacterial resistance to antibiotics is particularly evident in ICU. And the incidence of methicillin resistant *Staphylococcus aureus* (MRSA) Vancomycin resistant enterococci (VRE), And gram-negative bacilli resistant in ICU is rising. According to available data, at least 70% of cases of nosocomial infection, there is resistance to an antibiotic.

There is epidemiology of antibiotic resistance in nosocomial infections. 5-10% of all cases of nosocomial outbreaks of nosocomial infection and has a prevalence of one in every 10,000 hospital admissions. During the study of epidemiology was found that 85% of all bacteria *Staphylococcus aureus*, and 69% of enterococci resistant to Methicillin and Vancomycin respectively.

Compliance with infection control programs in hospitals, such as restrictions on the use of broad spectrum antibiotics, use of treatment planning protocols for antibiotics, staff training and emphasis on hand washing can reduce microbial resistance (McKee,1998).

Conclusion

Nosocomial infection is defined as the infection that occurs from 24 to 72 hours after hospital admission. Nosocomial infection rate is 2.5 - 10% variable and 20 years (up to 1995) has increased to 36%. Nosocomial infection annual is 5 billion \$ losses resulting in U.S., leading to death in 1% of patients directly and 3% mortality has been attributed to it, and the increase in the length of hospitalization 1 to 30 days .

The most common nosocomial infection was urinary tract infection (30-40%), and then pneumonia (15-20%) and wound infection (24%) and bloodstream infections (10%) of infections are common. According to study, in most cases, bacteria are causative agents of nosocomial infections and *Escherichia coli* (common bacteria in adults), *Staphylococcus aureus* (the most common infection in children and infants), *Pseudomonas aeruginosa*, *Enterococcus* and *Clebsiella*, are the most common organisms, the most important route of infection transmission is through direct or indirectly contact in the hospital.

Hospital infection control strategies include activating the hospital infection control committee, establish under surveillance of nosocomial infection, staff training and specially infection control nurses, emphasis on hand washing, proper isolation of patients and evaluation of all epidemics, observing facts and principles of sterilization and disinfection, waste disposal, treatment and vaccination of staff and limitation in use of broad spectrum of antibiotics. It is worth noting that despite all of the arrangements, only one third of nosocomial infections are preventable

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