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Review on Nosocomial Infections

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Abstract: Nosocomial infections (NIs) are most contributing factors affecting the patients during the hospital visit and has become challenging for the healthcare professionals, also increasing the health expenditure of the patient. There are number of factors affecting spread of infections such as advanced age, low immunity of body, surgical procedure, lack of cleaning facilities, overcrowding of people. The commonly found nosocomial infections, includes Methicillin-resistant *Staphylococcus aureus* (MRSA), neonatal infections, caused, Catheter-associated urinary tract infections, Hemodialysis associated infections, Vancomycin-resistant Enterococci (VRE) infection, which are generally caused by *S. aureus*, *S. epidermids*, Streptococci, *E. coli*, Pseudomonas, Enterococci, KlebsiellaClostridium difficile, Escherichia coli andProteus mirabilis. The main infecting sites were found to be blood stream, urinary tract, respiratory tract, surgical site. Better prevention methods should be made by healthcare authority and various treatment options should be used.

Key words: Nosocomial infection · Factors affecting · Infecting sites · Prevention

INTRODUCTION

A hospital-acquired infection (HAI) also called asnosocomial infection is an infection which is generally supported by the environmentalcondition of the hospital, such as an infection that is acquired by a patient during its hospital visit or one which is developing from amongstthe hospital staff. For suchnosocomial infection there is no evidence for the presence of infection at the time of hospital admission [1]. Urinary tract infections, surgical site infections, bloodstream infections and pneumonia are among the most common types of nosocomial infection [2].

Factors affecting the spread of infections [3, 4].

- Low body immunity in patients
- Patient of advanced age
- Patients suffering from diabetes
- Immunosuppressive patients
- Patients undergoing treatment with chemo the rapeutic drugs
- Catheterization, intravenous therapy, surgical procedures
- Improper ventilation in operation theatre and wards
- Overcrowding of hospital
- Lack of proper cleaning facilities
- Lack of knowledge about spread of infections
- Intensive care unit of the hospital represents a high risk area which is more likely to have infection
- Moreuse of antibiotics can develop resistant bacteria, making the antibiotic less effective
- Improper hand washing by the patient and hospitalstaff may increase the risk.
- Hospital stay for a long time can increase the risk, for example, admission for complex or multiple illnesses.
- Operations and surgical procedures – the length and type of surgery can also impact
- Invasive procedures;the hospital can introduce infection into the body system, for example, surgical procedures, use of equipment such as urinary catheters, IV drips and infusions, respiratory equipment and drain tubes.
- The incisions (surgical cuts), wounds, burns and ulcers are also more prone to infection.

Aim of the Study: The aim of the present study was to focus on nosocomial infections, about the factors affecting the spread of infections, various types of commonly found nosocomial infections and the preventive measures for nosocomial infections.

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Commonly found HAI: Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major category of nosocomial pathogens worldwide. It was found that the patients with MRSA infection had a long length of stay (LOS) before infection and were more likely to receive antimicrobial therapy. It is due to increased use of antibiotics like, ceftazidime, cefsulodin, fluoro-quinolones and co-amoxiclav [5]. MRSA can spread in the following ways such as increased skin-to-skin contact, compromised skin (cuts or abrasions), crowding, contaminated surfaces and items and lack of cleanliness [6].

Neonatal Infection: Among pediatric group, the newborn are representing the most affected populations, especially the neonates getting hospitalized in the neonatal intensive care unit (NICU) where there is more use ofantimicrobial drugs, medical devices and there is improper maturation of immune system of the child which increase the chances of acquiring nosocomial infection. At birth, the newborns babies, especially premature babiesand low birth weight neonates are not having more effective structural barriers, endogenousmicrobial flora and of matured immune system. The newborn babies are also affected by number of therapeutic procedures that provide an environment for pathogenic organism to infect the neonates and making them susceptible to nosocomial infections; following like intubation, total parenteral nutrition, ventilation, central venous catheters, peripheral intravenous lines, venipuncture and urinary catheters. These factors had led to about40% of all neonatal deaths in the developing countries [7]. The most common neonatal infections are pneumonia followed by blood stream infection, skin infection, surgical site infection, eye infection, urinary tract infection, oral cavity infection, upper respiratory tract infection and gastroenteritis. The most common pathogenic microorganism isolatedfrom neonates was *S.aureus* followed by *S. epidermids, Streptococci, E. coli, Pseudomonas, Enterococci, Klebsiella* and very less was *Proteus* [8].

Clostridium Difficile Infection: A Clostridium difficileinfection is a type of infection caused by bacteria that is affecting the digestive system. It is commonly affecting people who are being treated with antibiotics. The symptoms caused by *C. difficile* infection may be mild to severe and these include: painful abdominal cramps, diarrhea and high fever. It can also lead to life-threatening complications such as severe swelling of the bowel from a build-up of gas. The spores of the *C. difficile* bacteria can spread through the human body in faeces and they can survive for many weeks and also sometimes months, on objects and surfaces. By touching a contaminated object or surface and then touching the mouth or nose can lead to ingestion of the bacteria. The *C. difficile*bacterium usually does not affect healthy people. But usually the antibiotics interfere with the natural balance of bacteria in the gut that provide protection against *C. difficile* infection [9]. Some antibiotics when used in high doses or for a prolonged time period will increase the chance of developing a C. difficile infection. Antibiotics can cause alteration in the normal levels of bacteria found in the gastrointestinal tract. If there are fewer bacteria present in the gastrointestinal tract, C. difficile bacteria can have the chance to thrive and produce toxins, which can cause damage to the bowel and cause diarrhea [10]. Clostridium difficileis a major cause of antibiotic associated with diarrhea and colitis problems. The incidence of this infection is increasing in the hospitals worldwide, which is due to the consequence of the widespread use of broad-spectrum antibiotics. Hospital-acquired C. difficile infection is associated with the use of not only the antimicrobial, but also due to laxative use, advanced age, proton pump inhibitors use, anticancer drug use, renal dysfunction and with gastrointestinal surgery [11].

Catheter-Associated Urinary Tract Infections (CAUTIs): Catheter-associated urinary tract infections (CAUTIs) are representing the most common type of nosocomial infection and thereby are a major health concern due to its frequent recurrence and complications. These infections are usually caused due to the pathogenic organisms likeEscherichia coli and Proteus mirabilis.Indwelling urinary catheters are the standard medical devices which are utilized in both hospital and nursing home settings for relieving the problems of urinary retention and urinary incontinence. The insertion of indwelling catheter into the bladder increases the chance of the patient to UTIs and these devices are acting as initiation site of infection by induction of opportunistic organisms into the urinary tract. The majority of these urinary pathogens are from fecal contaminants, skin residents from the patient's ormicroflora that are colonizing the periurethral area. The possible modes of bladder entry during CAUTIs areextraluminal (66%), where organisms areascending from the urethral meatus along the catheter urethral interface. Organisms can also gain entry into the bladder intraluminally (34%), where the bacteria can enter into the bladder due to the manipulation of the catheter system [12].

Hemodialysis Associated Infections (HeAIs): Patients those receiving hemodialysis for long period are significantly at greater risk of hospital-acquired infections than the population in general hospital. This greater risk is reflecting impairment in immune system, more frequent hospitalizations and also need for vascular access. The most common HAIs in this patient population are urinary tract infections and bloodstream infections [13]. Urinary tract infections (UTIs) were found to be most common nosocomial infection in chronic hemodialysis patients that is accounting for about 47% of all infections in this patient population. When compared, the UTIs were more common in chronic hemodialysis patients (4.2/1, 000 patient-days) than the non-chronic hemodialysis patients (0.7/1, 000 patient-days). In chronic hemodialysis patients, the pathogens found were Candida spp and enterococci [14]. Patients with end-stage renal disease (ERSD) undergoing dialysis are also at greater risk for bloodstream infection (BSI). This type of infection is representing the main cause of morbidity, along with increasing the cost and hospitalization. Impairment in immune system of body due to renal dysfunction, co-morbidities, malnourishment are increasing the virulence, the adherence properties of hospital bacteria as well as the weakening of protective anatomical barriers due to repeating intravascular procedure required for hemodialysis process, representing the main reasons for the prevalence of bloodstream infection in these patient population. Earlier studies are suggesting that the vascular access for hemodialysis process is the major risk factor for bacteremia in patients with ESRD. The infection riskswere found to be less when the vascular access occurred through arteriovenous graft or fistula and more when it occurred through the central venous catheter (CVC), either permanent or temporary.Chronic dialysis patients are having risk for infections caused by nosocomial multidrug resistant (MDR) pathogens showing reduced susceptibility to many antimicrobials drugs. Hence, empirical administration of such antimicrobials may result in chances of morbidity, mortality and cost to the health care system [15].

Vancomycin-Resistant Enterococci (VRE) Infection in Healthcare Setting: Enteroccocci are bacteria that are normally found in the human intestines and in the female genital tract and are often found in the environment. These bacteria can often cause infections. Vancomycin is an antibiotic that is used to treating some of the drug-resistant infections caused by enterococci. There are some chances that the enterococci have become resistant to this drug and so called as vancomycin-resistant enterococci (VRE). Most VRE infections occur in hospitals. VRE often spread from person to person by the contaminated hands of caregivers. VRE can also be spread directly to people after touching surfaces that are contaminated with VRE. VRE does not spread through the air by coughing or sneezing. The following categories of populations are at increased risk for becoming infected with VRE: such as population previously treated with the antibiotic vancomycin or other antibiotics for long periods of time, thosewho are hospitalized, particularly when they receive antibiotic treatment for long periods of time. Populationswith weakened immune systems, those undergone surgical procedures such as abdominal or chest surgery, those contacted for some time with medical devices such as urinary catheters or central intravenous (IV) catheters, those who are colonized with VRE [16].

Gastrointestinal Endoscopy Associated Infections: Gastrointestinal endoscopy is a procedure in which a doctor is able to see the inner lining of the digestive tract. This examination is performed by using an endoscope which is a flexible fiber-optic tube having a tiny TV camera at the end. The camera is connected to either an eyepiece for direct viewing or to a video screen that can display the images on a color TV. The endoscope allows for diagnosis of gastrointestinal (GI) disease as well as treatment [17].

When bacterial infections are transmitted, they can be recognized, as incubation periods of bacterial infections are often less and patients develop overtclinical symptoms. After the adoption of the current reprocessing guidelines, transmission of bacterial infectionfrom endoscopes is rare, which were found to be effective in eliminating microorganisms.Earlier studies states that a total of 84 cases of endoscopy-related transmission of Salmonella species in patients were reportedbetween 1974 and 1987. Forty-five cases of endoscopic transmission of Pseudomonasspecies were reported between 1974 and 1993. The bacterium's chances for the growth in moisture-rich conditions due to improper reprocessing of endoscope have been a factor that has result in facilitated transmission. It was found that in some instances, an unsterilizedirrigation water bottle which is attached to the endoscope wasalso identified as a source of infection. Due to lack of cleaningand drying of the air-water and/or the elevator channelsof duodenoscopies some cases of transmission of Pseudomonasinfection had resulted. A few cases of endoscopic transmission of Helico-bacterpylori were found which were related to inadequate reprocessing ofendoscopes and biopsy forceps. Current reprocessing guidelines wereshown to be adequate in

eradicating mycobacteria and inactivating *Clostridium difficile* spores. There were no reports of transmission of mycobacteriaby a GI endoscopy [18].

Nebulizers Associated Infections: A nebulizer is a small machine that changes the liquid medicine into a mist form. By sitting with the machine and we breathe in through a connected mouthpiece. Then medicine goes into the lungs as we take slow, deep breaths for about 10 to 15 minutes. It is easy and pleasant to breathe the medicine into the lungs in this way. In cases of asthma, COPD, or another lung disease, the doctor prescribes medicine that has to be taken using a nebulizer [19]. Bronchodilators, corticosteroids, antibiotics, anticholinergic and mucolytic agents can also be administered through a nebulizer. There are two different types of nebulizers: pneumatic jet nebulizers and ultrasonic nebulizers [20]. P. aeruginosa was isolated from four of 22 tested nebulizers. This was further confirmed by sero- and phage-typing and by arbitrarilyprimed polymerase chain reaction (AP-PCR). Earlier data had provided evidences for the co-relation between P. aeruginosa as a cause of infection and the contamination of the nebulizers. It was found that by changing the nebulizer mouthpiecesevery 24 h and also when sterilized between patients, there was no more occurring contamination and the outbreak was stopped [21].

Organ Transplant: Organ transplantation is a procedure done surgically for replacing a failing, diseased organ with a healthy donor organ, such as a liver, kidney, heart or lung. Donor organs are accessed from deceased donors, which is always the case in heart transplants, or from the living donors, which usually happens in liver, kidney and, rarely, lung transplants. Organ transplantation is the last option for a person with a failing or diseased organ. In children, it is usually due to a birth defect in the organ, such as the heart. In adults, it is occurring may the result of a disease, such as cancer, or could be damage to the organ over time due to other conditions, such as heart disease, high blood pressure, or diabetes. Usually, medications are tried first, or changes in diet and lifestyle are preferred for treatment of disease [22].

The most commonly occurring complication is bacterial infection after solid organ transplantation. It is commonly found in organ transplantation which involves the abdominal cavity, such as pancreas or pancreas transplantation and less occurring in heart transplant recipients. The sources, clinical characteristics, antibiotic resistance and clinical outcomes vary according to the time of onset after transplantation. Most of the bacterial infections developingduring the first month after transplantation are hospital acquired and also thereis high incidence of multidrug-resistant bacterial infections. The higher incidence of complications from bacterial infection in the first month post-transplantation may be associated with high morbidity. The infections are caused commonly by *S. aureus, enterococci,* Gram-negative enteric and non-fermentative bacilli. Opportunistic bacterial infections may also occur frequently between months two and six after transplantation. The most frequent developing opportunistic infections in organ transplant recipients are *Listeria monocytogenes and Nocardia spp*. After month six, solid organ transplant patients commonly develop community-acquired bacterial infections, mainly urinary tract infections by *E. coli and S. pneumoniae pneumonia* [23].

Bloodstream Infections: Line removal should be considered if the line is no longer needed; if the infection is caused by *S. aureus*, Candida species, or mycobacteria; if the patient is critically ill; if the patient fails to clear bacteremia in 48-72 hours; if symptoms of bloodstream infection persist beyond 48-72 hours; and if noninfectious valvular heart disease, endocarditis, metastatic infection, or septic thrombophlebitis is present [24].

Antibiotics with coverage against Gram-positive and Gram-negative organisms, including Pseudomonas, should be empirically started and then tailored according to susceptibility pattern of isolated organisms.Antifungal therapy (e.g. fluconazole, caspofungin, voriconazole, amphotericin B) in some cases is added to empiric antibiotic coverage. Antiviral therapy (e.g.ganciclovir, acyclovir) can be used in the treatment of suspected disseminated viral infections.

Duration of therapy depends on several factors, including isolated pathogen, retention of catheter, or presence of complications (endocarditis, sepsis). For most bacterial organisms, the duration of therapy is 10-14 days after blood cultures become negative.

Pneumonia: Initial empiric antibiotic therapy should be broad and later on streamlined based on results of examination and cultures of sputum, endotracheal suction material and bronchial lavage wash. The choice of empiric antibiotic coverage should take into consideration the risk for multidrug-resistant (MDR) pathogens. Risk factors for MDR include antimicrobial therapy over the past 90 days, current hospitalization of 5 days or more, high frequency of antibiotic resistance in the community, or hospital and immunosuppression [25].

No clear consensus has been reached as to the duration of antimicrobial therapy for ventilator-associated pneumonia (VAP). Many experts treat for 14-21 days. However, shorter course of antibiotic therapy (about 1 wk) may be adequate therapy for some cases [26].

Antiviral medications against influenza have been used to treat symptomatic patients and patients with immunodeficiency or chronic lung diseases to limit morbidity and mortality.

Urinary Tract Infection: To avoid the persistence and recurrence of infection, the indwelling catheters should be removed if possible. It was found that in few cases, the removal of catheter has resulted in spontaneous resolution of bacteriuria or asymptomatic cystitis. Empiric antibiotic and antifungal therapy should be done to avoid the major complications, including pyelonephritis, renal damage and bloodstream infections. Duration of therapy may be controversial. Most experts hasrecommended a minimum 10-14 days therapy for children with sepsis, pyelonephritis, or urinary tract abnormalities [27].

Surgical-Site Infection: Surgical-site infections (SSIs) should be managed with a combination of surgical care and antibiotic therapy. Antibiotic coverage should be modified once culture results are available. Severe infections such as streptococcal gangrene and extensive tissue necrosis need aggressive surgical intervention. For these kinds of infections, antibiotics alone may not work [27].

Other Healthcare-Associated Infections: Rotavirus gastroenteritis is a self-limited disease and only needs supportive care. Medical management should focus on preventing dehydration. Treatment is not necessary for asymptomatic carriers of Clostridium difficile. For those who have mild symptoms, discontinuance of antibiotics alone may result in resolution of symptoms. For those who have more severe diarrhea, oral metronidazole is the preferred treatment. Oral vancomycin is reserved for treatment failure with metronidazole. Clinical improvement is usually seen within 2 days of initiating therapy and duration of treatment is usually 10 days [27].

Signs and symptoms of nosocomial infections are as follows [28]:

- Pain, Fever, Night sweats, Breathing difficulties, Infection, Inflammation, Swelling

Prevention of Nosocomial Infection

- Hand hygiene-The importance for the need of hands in the spread of hospital infections has been well recognized [29] and can be minimized by appropriate hand hygiene [30-32]. The hand hygiene can be done by running water, antiseptic soap and facilities for drying without contamination, alcoholic rubs withantiseptic and emollient gels.
- Personal hygiene-staff must maintain good personal hygiene. Nails must be clean and kept short. Cloth should be neat and clean.
- Use of mask -staff must wear masks when caring for patients with airborne infections, staff wear masks to work inthe operating room, to care for immuno-compromisedpatients.
- Use of caps -In aseptic units, operating rooms, or performing selected invasive procedures, staff must wear capsor hoods which completely cover the hair.
- Use sterile needle and syringe
- Routine cleaning is necessary to ensure a hospital environment which is visibly clean and freefrom dust and soil.
- 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 medicaldevices [32-35].
- Sterilization is the destruction of all microorganisms.Operationally this is defined as a decrease in the microbial load by 10-6. Sterilization can be achieved by either physical or chemical means. Sterilization is required for medical devices penetrating sterile body sites, as well as all parenteral fluids and medications.Proper storage conditions are essential to maintain the integrity of sterilized items.
- Avoiding urethral catheterization unless there is a compelling indication
- Maintaining appropriate aseptic practice during urinary catheter insertion and other invasive urological procedures (e.g. cystoscopy, urodynamic testing, cystography)
- Appropriate staff training in catheter insertion and care
- Maintaining unobstructed drainage of the bladder to the collection bag, with the bag below thelevel of the bladder [36, 37].
- All persons entering the surgical theatre must wear surgical attire restricted to being worn only within the surgical area. The design and composition ofsurgical attire should minimize bacterial sheddinginto the environment.

- All head and facial hair, including sideburns andneckline, must be covered. All personnel entering inthe operating suite must remove any jewellry; nailpolish or artificial nails must not be worn.
- Full coverage of the mouth and nose area with asurgical mask for everyone entering the operatingsuite[38].
- The number of persons entering the operation theatre during an operation should be minimized. Unnecessary movement or conversation should be avoided.

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