PREVALENCE AND RISK FACTORS FOR HOSPITAL-ACQUIRED INFECTIONS “CLEAN CARE IS SAFER CARE”

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ABSTRACT

Hospital acquired infections commonly known as nosocomial infections, is defined as medical related issues that are not associated with the patient’s original diagnosis on admission into the hospital, they typically surface 72 hours after the patient has been admitted in the hospital for treatment. These infections are usually bacteria but may also be viruses, fungi or parasites. Patients in hospitals have been found to be more susceptible to infections and may even die as a consequence of nosocomial infections. Cross transmission of microorganisms by the hands of healthcare personnel from ward-based computers at the patients’ bedside, might introduce an additional risk for critically ill patients, considering the frequent contact with nurses and other healthcare workers. Several reports have also demonstrated contamination of a wide variety of environmental sites including stethoscopes, blood-pressure cuffs, thermometers, beds, doors, furniture surfaces and other medical equipment with gram-negative rods, mainly Escherichia coli, pseudomonas, enterobacter and gram-positive cocci such as enterococcus and staphlococcus aureus. MRSA and vancomycin-resistant enterococcus that are multiresistant organisms are increasing in frequency and more difficult to treat. A study suggested that ward-based computers pose a low risk for cross-infection problems. Two other investigations conducted within a burns unit and an intensive care unit respectively described the presence of acinetobacter baumannii and methicillin-resistant staphylococcus aureus (MRSA) on computer keyboards. It has been shown that nosocomial infections or hospital acquired infections are recurrent problems, identified chiefly in intensive care facilities, surgical, and medical wards. In Trinidad and Tobago information on nosocomial infections are lacking. Within the period 1992-1995, 7,158 nosocomial infections were documented from 72,532 patients (10.0/100 admissions). In Europe, incidences vary from 1% for all types of nosocomial infections and up to 23.6% in pediatric intensive care units. In the United States of America, the centre for disease control and prevention calculated approximately 1.7 million nosocomial infections from all types of microorganisms resulting in 99,000 deaths annually. (2)

INTRODUCTION

Around 12–17 microorganisms cause 80%–87% of HAI. S. aureus, Enterococcus species (eg, faecalis, faecium), E. coli, coagulase-negative Staphylococci, Candida species (eg, albicans, glabrata), K. pneumoniae and Klebsiella oxytoca, P. aeruginosa, A. baumannii, Enterobacter species, Proteus species, Yeast NOS, Bacteroides species, and other pathogens (3,4). Several studies suggest that simple infection-control procedures such as cleaning hands with an alcohol-
based hand rub can help prevent HCAIs and save lives, reduce morbidity, and minimize health care costs. Routine educational interventions for health care professionals can help change their hand-washing practices to prevent the spread of infection. (5) Health care-associated infections (HCAIs) are those infections that patients acquire while receiving health care. (6) More recently, health-care-associated infections declined for central-line associated bloodstream infections, surgical site infections, and methicillin-resistant Staphylococcus aureus (MRSA) infection, but the progress has been steady but slow for many of the priority health problems in the United States. (7) In a study carried out in 17 countries in Western Europe it represented about 12%, and it was among the most frequent types of ICU infection reported (Blood stream infections) BSI acquired in the ICU are associated with significant morbidity and mortality. ICU infection prevention programs that include chlorhexidine body wash, central line bundles, and hand hygiene interventions (8).

BSI occurred in close to 85% of patients. Enterococcus (14%) and Klebsiella (14%) species were the most common organisms, and those patients with BSI had higher comorbidity scores and were more likely to be male, critically ill, on immunosuppression, and had a central venous catheter in place. (9) The distribution of pathogens responsible for NI has changed over the years. In the early antibiotic era, hospital acquired infections were dominated by Staphylococcal infections, well controlled initially by Penicillin. Then Staphylococci became Beta lactamase producers, Beta-lactamase stable compounds controlled them. Then methicillin resistant S. aureus (MRSA) and gram negative bacilli emerged as agents responsible for NI. In the late 1960, resistant bacteria belonging to family enterobacteraceae (Klebsiella spp., Escherichia spp., Proteus spp.) (10). Bacteria are the most common pathogens responsible for nosocomial infections. Some belong to normal flora of the patient and cause infection only when the immune system of the patient becomes prone to infection. Acinetobacter is the genre of pathogenic bacteria responsible for infections occurring in ICUs. It is embedded in soil and water and accounts for 80% of reported infections. (11) Bacteroides fragilis is a commensal bacteria found in the intestinal tract and colon.

It causes infections when combined with other bacteria. Clostridium difficile cause inflammation of colon leading to antibiotic-associated diarrhea and colitis, mainly due to elimination of beneficial bacteria with that of pathogenic. C. difficile is transmitted from an infected patient to others through healthcare staff via improper cleansed hands (12). Enterobacteriaceae cause infections if travel to other body parts from gut, where it is usually found. Enterobacteriaceae constitute Klebsiella species and Escherichia coli. Their high resistance towards carbapenem causes the defense against them more difficult. Methicillin-resistant S. aureus (MRSA) transmit through direct contact, open wounds and contaminated hands. It causes sepsis, sepsis and SSI by travelling from organs or bloodstream. It is highly resistant towards antibiotics called beta-lactams (13). Catheter associated urinary tract infections (CAUTI) is the most usual type of nosocomial infection globally. According to acute care hospital stats in 2011, UTIs account for more than 12% of reported infections. CAUTIs are caused by endogenous native microflora of the patients. Catheters placed inside serve as a conduit for entry of bacteria whereas the imperfect drainage from catheter retains some volume of urine in the bladder providing stability to bacterial residence. CAUTI can develop to complications such as, orchitis, epididymitis and prostatitis in males, and pyelonephritis, cystitis and meningitis in all patients (14).

Surgical site infections (SSI) SSI are nosocomial infections be fall in 2%–5% of patients subjected to surgery. These are the second most common type of nosocomial infections mainly caused by Staphylococcus aureus resulting in prolonged hospitalization and risk of death (15). The pathogens causing SSI arise from endogenous microflora of the patient. The incidence may be as high as 20% depending upon procedure and surveillance criteria used (16). Nosocomial pathogens Pathogens responsible for nosocomial infections are bacteria, viruses and fungal parasites. These microorganisms vary depending upon different patient populations, medical facilities and even difference in the environment in which the care is given. 3.1. Bacteria Bacteria are the most common pathogens responsible for nosocomial infections. Some belong to natural flora of the patient and cause infection only when the immune system of the patient becomes prone to infections. Acinetobacter is the genre of pathogenic bacteria responsible for infections occurring in ICUs. It is embedded in soil and water and accounts for 80% of reported infections (17) Bacteroides fragilis is a commensal bacteria found in the intestinal tract and colon.

**Figure 1** The figure depict CDDEP data based on emergence and dynamics of infections in health care facility.

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**Figure 2** The figure depict nosocomial infection in medical care facility.

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antibiotic-associated diarrhea and colitis, mainly due to elimination of beneficial bacteria with that of pathogenic. C. difficile is transmitted from an infected patient to others through healthcare staff via improper cleansed hands (18). Enterobacteriaceae (carbenem resistance) causes infections if travel to other body parts from gut; where it is usually found. Enterobacteriaceae constitute Klebsiella species and Escherichia coli. Their high resistance towards carbenem causes the defense against them more difficult Methicillin-resistant S. aureus (MRSA) transmit through direct contact, open wounds and contaminated hands. It causes sepsis, pneumonia and SSI by travelling from organs or bloodstream. It is highly resistant towards antibiotics called beta-lactams (19). Besides bacteria, viruses are also an important cause of nosocomial infection. Usual monitoring revealed that 5% of all the nosocomial infections are because of viruses. They can be transmitted through hand-mouth, respiratory route and fecal-oral route. Hepatitis is the chronic disease caused by viruses. Healthcare delivery can transmit hepatitis viruses to both patients and workers. Hepatitis B and C are commonly transmitted through unsafe injection practices other viruses include influenza, HIV, rotavirus, and herpes-simplex virus (20).

**History**

In 1841, Ignaz Semmelweis, a Hungarian obstetrician was working at a Vienna maternity hospital. He was "shocked" by the death rate of women who developed puerperal fever. He documented that mortality was three times higher in the ward where the medical students were delivering babies than in the next ward that was staffed by midwifery students (21) The medical students were also routinely working with cadavers. He compared the rates of infection with a similar hospital in Dublin, Ireland and hypothesized that it was the medical students who somehow were infecting the women after labor. He instituted mandatory hand-washing in May 1847 and infection rates dropped dramatically. Louis Pasteur proposed the germ theory of disease and began his work on cholera in 1865 by identifying that it was microorganisms that were associated with disease (22,23) For centuries, hospitals have been known as dangerous places. In 1847, Ignaz Semmelweis presented evidence that childbed fever was spread from person to person on the unclean hands of health-care workers (24). Semmelweis's findings did not immediately improve sanitary conditions in hospitals, but surgeons gradually adopted aseptic and antiseptic techniques and became leading innovators of techniques to reduce patients' susceptibility to postoperative infections. Concerns about the spread of infection by air, water, and contaminated surfaces gradually changed practices in hospitals, making them safer. During the 1950s, epidemic penicillin-resistant *Staphylococcus aureus* infections, especially in hospital nurseries, captured the public's attention and highlighted the importance of techniques to prevent hospital-acquired infections, now also referred to as healthcare-associated infections (HAIs; i.e., nosocomial infections) (25). By the mid-20th century, some surgeons, microbiologists, and infectious disease physicians had focused their studies on the epidemiology and control of HAIs (26,27)

**Organisms that are responsible in causing HAI**

<table>
<thead>
<tr>
<th>S No</th>
<th>Types of Infections</th>
<th>Organism</th>
</tr>
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<tbody>
<tr>
<td>4.</td>
<td>Urinary catheter</td>
<td>Klebsiella Sp., Pseudomonas aeruginosa, Steptococcus faecalis, Escherichia coli</td>
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**Critical Gaps in Knowledge of the Hospital Acquired Infection**

The past decade has witnessed an intense interest in healthcare-associated infections as well as increases in legislation and reporting requirements aimed at decreasing the number of these costly infections. In the next decade, healthcare epidemiology must address major gaps in understanding of the epidemiology and pathogenesis of healthcare-associated infections and in knowledge of the efficacy of interventions for healthcare-associated infections and the efficacy in implementing such interventions. (28) Tray tables, bed rails, light switches, and toilets: All are common vectors for swapping germs between patients and health care workers. While a new systematic overview in this week's *Annals of Internal Medicine* points to several promising cleaning tactics of these "high-touch surfaces," there's a lack of evidence as to which is the most effective at reducing healthcare-associated infections (HAIs). Few studies measured patient outcomes or focused on newer technologies, and even less compared cleaning tactics against one another -- important gaps to fill as the U.S (29)

**Surgical site infection**

Any purulent discharge, abscess, or spreading cellulitis at the surgical site during the month after the operation. The infection is usually acquired during the operation itself; either exogenously (e.g. from the air, medical equipment, surgeons and other staff), Endogenously from the flora on the skin or in the operative site or, rarely, from blood used in surgery. Surgical Site Infections (SSI) are the infection following an invasive surgical procedure and are the most frequently reported hospital acquired infections (HAI) (30,31) SSI is a type of hospital-acquired infection (HAI) that arises following surgery and it is related to the surgical site (32). Currently, SSI is defined as an infection that happens within 30 days of the operation if no implant is left in place or within 1 year of operation if an implant is left in place (33) SSI may result in increased morbidity and mortality, prolonged hospital stay, increased hospital readmissions even reoperation and healthcare costs (34,35) It has been reported by numerous studies that diverse surgical specialties were associated with elevated costs next to the development of an SSI in United Kingdom (36,37,38)
CA-UTI (Catheter Urinary tract infection)

The most frequent pathogens associated with CA-UTI in hospitals reporting to National Healthcare Safety Network (NHSN) between 2009-2010 were Escherichia coli (26.8%) and Pseudomonas aeruginosa (11.3%), followed by Klebsiella (11.2%), Candida albicans (8.9%), Enterococcus faecalis (7.2%), Proteus spp. (4.8%), other Enterococcus spp. (4.8%), Enterobacter spp. (4.2%), other Candida spp. (3.8%) and Enterococcus faecium (3.1%). A smaller proportion was caused by Staphylococcus aureus (2.1%), coagulase-negative staphylococci (2.2%), Serratia spp. (1.0%), Acinetobacter baumannii (0.9%), and other pathogens (7.7%).

Urinary tract pathogens such as Serratia marcescens and Pseudomonas cepacia have special epidemiological significance. Since these microorganisms do not commonly reside in the gastrointestinal tract, their isolation from catheterized patients suggests acquisition from an exogenous source, likely through the hands of personnel. HUTIs comprise perhaps the largest institutional reservoir of nosocomial antibiotic-resistant pathogens, the most important of which are vancomycin-resistant enterococci, extended-spectrum β-lactamase (ESβL)-producing Enterobacteriaceae, and carbapenem-resistant Enterobacteriaceae.

Among coli isolates reported to the NHSN from CA-UTIs in ICU and non-ICU settings, 29.1% and 33.5%, respectively, were resistant to fluoroquinolones. Many Enterobacteriaceae produced ESβLs; 26.9% of Klebsiella spp. and 12.3% of E. coli isolates were resistant to extended-spectrum cephalosporins. Furthermore, 12.5% of Klebsiella spp. from patients with CA-UTIs were resistant to carbapenems.

A continuously closed urinary drainage system is pivotal to the prevention of CA-UTI. For short-term catheterization, this measure alone can reduce the rate of infection from an inevitable 100% when open drainage is employed to less than 25%. Breaches in the closed system, such as unnecessary emptying of the urinary drainage bag or taking a urine sample, will increase the risk of catheter-related infection and should be avoided. Before manipulating the closed system, hands must be washed with an antiseptic agent and gloves worn.

Non-infectious complications secondary to indwelling urinary catheters are common, and in case of long-term catheterization are 4 times higher than CA-UTI. Although the most frequent complications are minor (for example, leakage around the catheter), serious complications, such as urethral strictures and gross hematuria, occur in a substantial proportion of patients. Moreover, long-term catheterization and catheter use in patients with spinal cord injury result in even greater illness, with more than 30% of patients having several complications.

Studies comparing mental cleansing with a variety of antiseptic/antimicrobial agents or soap and water demonstrated no reduction in bacteriuria when using any of these preparations for mental care compared with routine bathing or showering. Mental cleansing is not necessary and may increase the risk of infection. Daily routine bathing or showering is all that is needed to maintain mental hygiene.

Antibiotic prophylaxis should not be administered to patients for catheter-placement or catheter-removal or replacement in order to prevent CA-UTI. Overall, potential disadvantages of antibiotic prophylaxis are an increased risk of development of antimicrobial resistance, an increase in costs, and potential side effects.

A 2013 meta-analysis by Marschall et al. found that antibiotic prophylaxis was associated with an absolute reduction in risk of CA-UTI of 5.8% (RR 0.45, 95% CI 0.28 to 0.72) (40) Another 2013 meta-analysis by Lusardi et al. revealed that there is limited evidence that antibiotic prophylaxis reduces the rate of bacteriuria and other signs of infection, such as pyuria, febrile morbidity, and Gram-negative isolates, in surgical patients who undergo bladder drainage for at least 24 hours postoperatively, and there is also limited evidence that prophylactic antibiotics reduce bacteriuria in non-surgical patients (41).

Another proposed approach to prevent CA-UTI is to coat catheters with antibacterial materials. Antimicrobial catheters are typically coated with nitrofurazone, minocycline, or rifampin. In patients with short-term indwelling urethral catheterization, antimicrobial (antibiotic or silver alloy)-coated urinary catheters may reduce or delay the onset of catheter-associated bacteriuria, but do not decrease the frequency of CA-UTI. Therefore, their routine use is not recommended.

Respiratory Infection – HAI

The term healthcare-associated pneumonia (HAP) was defined as pneumonia in non-hospitalized patients who had significant experience with the healthcare system. Such contact could include (A) intravenous therapy for wound care within the preceding 30 days, (B) residence in a long-term care facility, (C) hospitalization in an acute-care hospital within the preceding 90 days, and/or (D) outpatient treatment in a hospital or hemodialysis clinic within the preceding 30 days. These individuals were believed to be at an increased risk for infection with multidrug-resistant (MDR) organisms because of such contact. However, more recent studies have indicated that many individuals who met the criteria for HAP were not infected with MDR pathogens. The risk of infection with MDR organisms appears to depend much more on specific risk factors of the given patient than on contact with various aspects of the healthcare system. Patients who would have met the criteria for HAP should not be empirically treated with antibiotics to cover MDR bacteria unless they have valid risk factors for acquiring MDR organisms (42).

Blood Stream Infections

Vital statistics outlining the major causes of death in a population are an important measure of public health. Ranking disease agents according to the number of deaths they cause can be used for strategic planning and public health resource allocation. In the United States, vital statistics support efforts to control coronary artery disease, cancer, cerebrovascular diseases, and infections (43). A listing of causes of death, however, provides little insight on how the diseases were acquired or managed or how they might have been prevented. Infections acquired in the hospital are an important cause of death, especially those involving the bloodstream or lung. If hospital infection and death occur at high rates, we can examine the process of institutional care: access to infection control personnel, systems for prevention and early recognition, and early and appropriate therapy. With improved
care, improved outcome could be anticipated. We explore the impact of hospital-acquired infections, with a focus on bloodstream infections.\(^{(44)}\).

**Sources of Infection**

Sources of infection can be discussed under two headings: 1. Endogenous or self-infection. 2. Exogenous or cross-infection. The infection from the environment. Endogenous or self-infection may be endogenously acquired from one’s own body flora. Bacteria are present on the skin, in the nose, mouth, throat, gastrointestinal tract and in the female genital tract. Whenever there is a lowering of general or local resistance, these organisms invade the tissues. Such opportunistic infections are difficult to prevent and control. Prolonged hospital stay and the use of antibiotics alters the normal flora, both in the type of organisms and in their susceptibility towards antibiotics. Studies have shown that hospitalised individuals have a greater incidence of faecal carriage of Pseudomonas aeruginosa than the general population and intestinal carriage of multiply resistant strains of Gram-negative bacteria often precedes self-infection and cross infection. Exogenous or cross-infection and infection from the environment on staphylococcal carriage in hospitals have shown that certain individuals shed large numbers of organisms from their body surface especially the perineum and are referred to as ‘dispersers’, such individuals may also contaminate their hands and clothing and other inanimate objects. Contamination of environment results from human activity. Food, fluids, disinfectants, instruments, equipment, wound dressing, all act as sources of infection as a result of contamination from human organic waste, pus, blood and blood products. Rarely free living bacteria and saprophytic fungi which are derived from the environment may cause infection in susceptible individuals.\(^{(45)}\).

**Recent advances**

Ninety percent of the NIs are caused by bacteria, whereas mycobacterial, viral, fungal or protozoal agents are less commonly involved. Klebsiella pneumoniae, Staphylococcus aureus, Escherichia coli, Proteus spp, and Pseudomonas aeruginosa are among the most common causative agents of NI. Large usage of broad spectrum antibiotics in hospital environment promoted emergence of newer organisms such as Acinetobacter baumannii, S. maltophilia and B. cepacia. Recent surveys on nosocomial infections have pointed out significant changes in microbial flora and their distribution in various parts of body.\(^{(46)}\) In the early antibiotic era, hospital acquired infections were dominated by Staphylococcal infections, well controlled initially by Penicillin. Then as Staphylococci became Beta lactamase producers, Beta-lactamase stable compounds controlled them. Then methicillin resistant S.aureus (MRSA) and gram negative bacilli emerged as agents responsible for NI. More recent surveys have indicated the re-emergence of gram positive cocci including coagulase positive staphylococci, coagulase negative staphylococci and streptococci, whereas incidence of Escherichia coli and Klebsiella pneumoniae has decreased from 23 to 16% and from 7 to 5% respectively. In addition all surveys report the increasing or simultaneous persistence of Pseudomonas aeruginosa.\(^{(47)}\)

**Nosocomial Pathogenesis**

While urinary tract infections are the most common nosocomial infection in developed countries, surgical site infections are the most common in developing countries, affecting up to one-third of operated patients, and this is up to nine times higher than in developed countries.\(^{(48)}\) A wide range of microbial pathogens including bacteria, parasites, and viruses are implicated in nosocomial infections, though the majority of the infections are associated with bacteria.\(^{(49)}\) Nosocomial pathogens tend to differ depending on patient populations, medical facilities, and even differences in the environment in which patient care is administered. Epidemiological evidence indicates that principal nosocomial pathogens include Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Acinetobacter baumannii, and coagulase-negative staphylococcus.\(^{(50)}\) There is also evidence of emerging nosocomial pathogens such as Cryptosporidium parvum, Helicobacter pylori, and hepatitis C virus.\(^{(51)}\) The success of nosocomial pathogens are partly related to their persistence on surfaces in the hospital environment. Relevant nosocomial pathogens such as S. aureus and E. coli could persist on dry inanimate surfaces for several months.\(^{(52)}\) The longer a nosocomial pathogen persists on a surface, the longer it may be a source of transmission in the hospital. Generally, a high inoculum of the nosocomial pathogen, high relative humidity (>70%), and low temperature (around 4 °C) will provide the best chance for long persistence.\(^{(53)}\) Highly antibiotic-resistant strains frequently encountered in healthcare infections include methicillin-resistant S. aureus (MRSA), vancomycin-resistant Enterococci (VRE), carbapenem-resistant Enterobacteriaceae (CRE), and extended-spectrum beta-lactamase producing E. coli.\(^{(54)}\)

**Treatment of Nosocomial infections**

Appropriate use of antibiotics is important. Up to 30% of ventilator associated pneumonias are treated inadequately. There is increasing evidence to suggest that the use of appropriate and early antibiotics improves morbidity and mortality. Appropriate antibiotic use requires a thorough knowledge of their mode of action, previous antibiotic history, local bacterial resistance profile and local pathogen prevalence. Antibiotics should be administered at the right dose and for the appropriate duration. The local antibiotic formulary and consultant microbiologist are valuable resources. Daily ICU ward rounds with the microbiologist can lead to rational use of antibiotics tailored to benefit individual patients. Antibiotic-resistant bacteria prolong hospitalization, increase the risk of death, and require treatment with toxic and expensive antibiotics. Empirical use of antibiotic is often necessary as laboratory results are often not available for 48 h after the samples are sent to the laboratory for culture.\(^{(55)}\) Antibiotic resistance is responsible for the death of a child every five minutes in South-East Asia region. Drugs that were used to treat deadly diseases are now losing their impact due to emerging drug resistant microorganisms.\(^{(56)}\) Self medication with antibiotics, incorrect dosage, prolonged use, lack of standards for healthcare workers and misuse in animal husbandry are the main factors responsible for increase in resistance. This resistance threatens the effective control against bacteria that causes UTI, pneumonia and bloodstream infections. Highly resistant bacteria such as MRSA or...
multidrug-resistant Gram-negative bacteria are the cause of high incidence rates of nosocomial infections worldwide (57) South-East Asian region reports reveal that there a high resistance in E. coli and K. pneumoniea for third generation cephalosporin and more than quarter of S. aureus infections aremecillicin resistant (58) “Immediate action is needed to stop the world from heading towards pre-antibiotic era in which all achievements made in prevention and control of communicable diseases will be reversed”, said Dr Poonam Khetrapal Singh, Regional Director of WHO South-East Asia Region (59)

*Nosocomial Infections-Current Situation*

The nosocomial infection (NI) is defined as an infection that is not present or incubating on admission in establishment of care. It can be caused by the patient's germs, care personnel or hospital environment. Multidrug resistant (MDR) bacteria are particularly common in intensive care units that lead to a serious infections and increase morbidity, mortality and cost of care (60) With increasing use of antimicrobial agents and advance in lifesaving medical practices which expose the patients for invasive procedures, are associated with the ever increasing of nosocomial infections. Despite an effort in hospital infection control measures, health care associated infections are associated with significant morbidity and mortality adding additional health care expenditure which may lead to an economic crisis. The problem is further complicated with the emergence of difficult to treat multidrug resistant (MDR) microorganism in the hospital environment. Virtually every pathogen has the potential to cause infection in hospitalized patients but only limited number of both gram positive and gram negative bacteria are responsible for the majority of nosocomial infection. Among them Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa and Enterococci takes the leading. (61)

*Prevention of Nosocomial Infection*

Frequent hand washing remains the single most important intervention in infection control. Gloves, gowns, and masks have a role in preventing infections, but are often used inappropriately, increasing service costs unnecessarily. Many are visibly upset when their poor hygiene practices are exposed and are offended when it is suggested that they may be potential vectors of disease and are spreading virulent microorganisms among their patients, putting some difficulties in infection control (62) There must be policies to ensure the cleaning and use of cleaning agents on wards, floors, windows, beds, baths, toilets and other medical devices. Proper ventilated and fresh filtered air can eliminate airborne bacterial contamination. Regular check of filters and ventilation systems of general wards, operating theatres and ICUs must be maintained and documented. Infections attributed to water are due to failure of healthcare institutions to meet the standard criteria. Microbiological monitoring methods should be used for water analysis. Infected patients must be given separate baths. Improper food handling may cause food borne infections. The area should be cleaned and the quality of food should meet standard criteria (63)

*Development of Infection control programs*

Guidelines for the sterilization and disinfection of invasive devices and medical instruments used for surgeries were developed as the infection rates tend to raise (64) Moreover, guidelines for the prevention of catheter-associated UTI were also devised in 2009 (65) Lack of compliance with the guidelines, leads to the transmission of nosocomial infections. CDC provides the methodology for surveillance of nosocomial infections along with investigation of major outbreaks. Infection prevention and control guidelines have been developed but the implementation is not yet much known (66) Training of healthcare professionals, especially nurses, is extremely important for the control and prevention of infection (67)

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