

SOME IMPORTANT MICROBIAL AGENTS OF NOSOCOMIAL INFECTIONS, THEIR SOURCES AND MODES OF TRANSMISSIONS

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ABSTRACT

The hospital environment usually becomes contaminated with many pathogens, that are directly or indirectly derived from the various sources of the hospitals and patients itself. These microbial agents give rise to many hospital-associated infections, called 'Nosocomial infections'. Such micro-organisms are most commonly Gram-negative and Gram-positive bacteria, viruses, drug-resistant pathogens, and other infectious agents. The commonly prevalent nosocomial or hospital-acquired infections usually include urinary tract infections, surgical wounds, infections of respiratory tracts, and intestinal site infections. The sources of infections are external and internal as well, and transmission takes place through different routes. The present article reviews about some of the important infection-causing microbial agents, their sources and modes of transmission.

KEYWORDS: Pathogens, Microbial agents, Drug-resistant microbes, Nosocomial infections, Hospital-acquired or Health care-associated infections.

Different types of diseases and infections acquired by the patients due to their prolonged stay in hospitals are known as 'Nosocomial infections'. These are called 'Hospital-acquired-' or 'Health care-associated -' infections (HAI). These, in extreme conditions, often result in death of the patients. The patients suffering from various ailments and their low immunity mechanisms is responsible for the increased activity of infectious agents. Certain medical procedures, surgeries and not-so-effective control practices also are the important sources of Hospital-acquired infections. The fast urbanization and the over-crowded hospitals are the sole causes of the increased risk of nosocomial infections among hospitalized patients (Brusafferro *et al.*, 2015).

Hospital-associated infections may not be obvious in many hospitalized patients, due to the acquired drug-resistant pathogens from the hospital environment (Obiero *et al.*, 2015; Mc Laws *et al.*, 1988). Thus, such infections include all those diseases which the patients didn't suffer from earlier, *i.e.*, at the time when they were hospitalized. Many

incidences of nosocomial infections become evident after the discharge of patients from the hospital. Patients are considered infected as the pathogens dwell in the body fluids and sterile body sites (Murray *et al.*, 2005).

The present review article emphasizes on the significant microbial agents causing hospital-acquired infections, sources and modes of transmission of nosocomial infections.

MICROBIAL AGENTS OF NOSOCOMIAL INFECTIONS

A large variety of microbes cause nosocomial infections in health care settings such as bacteria, viruses, protozoans, fungi and myobacteria (Gatermann *et al.*, 2005). Some of the significant microbial agents of nosocomial infections are as follows :

A. Bacterial Species

Escherichia coli (*E. coli*)

E. coli has been reported to be the most commonly emerging nosocomial pathogen. It is one

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of the predominant Gram-negative aerobic bacteria. It inhabits as parasite in gastro-intestinal tract of human beings and other animals. UTI, pneumonia, neonatal meningitis and gastro-enteritis are some of the common infections caused by *E.coli*. Endotoxins, capsule and type-3 secretion systems are the virulence factors that account for its pathogenicity (Lausch *et al.*, 2013; Zhao *et al.*, 2015).

Klebsiella pneumonia (K. pneumonia)

K. pneumonia is a Gram-positive bacillus, responsible for about 3-7 % of hospital-acquired bacterial infections. This bacteria inhabits gastro-intestinal tract, pharynx and also skin. The diseases caused by it are neonatal septicemia and pneumonia. Wound infections and skin problems are also caused by it. Cell wall receptors, polysaccharide capsule and endotoxins attribute to the bacteria's virulence factor (Lin *et al.*, 2015).

Pseudomonas aeruginosa (P.aeruginosa)

P.aeruginosa and other related species constitute about 11-12% of infection data. It is a non-fermentar Gram-negative bacteria causing diseases in immunity-hampered people. Their characteristic towards easy infection is their antibiotic-resistant property. They are known to carry drug-resistant plasmids. *P.aeruginosa* colonizes in kidney, urinary tract and respiratory passage. Proteases, exotoxins, hemolysins and adhesions are the virulence factors of *P.aeruginosa* (Balasoiu *et al.*, 2014).

Staphylococcus aureus & Staphylococcus epidermidis (S. aureus & S. epidermidis)

Species of *Staphylococcus* are drug-resistant strains belonging to phage-type 80/81. These Gram-positive bacteria are disease-causing and also commensal, and usually inhabit in nasal passages. Infections are caused in hospitalized patients with decreased immunity. Superficial and deep tissues, are

damaged, leading to local abcess and lesions. Enzymes, toxins and immune modulators are virulence factors. Global spread of *Staphylococcus* with high frequency in hospitals, gave it the name, 'Hospital *Staphylococci*' (Vandensch *et al.*, 2012).

Clostridium tetani & Clostridium difficile (C. tetani & C. difficile)

Tetani is the bacterial species present in dust and health wastes. Tetanus spores contaminate many of the hospital items, clothings, beds and linens. They easily find their way into the human circulation through the wounds, causing muscular and respiratory disorders, and when spread in the body completely result in death. *C.difficile*, the Gram-positive bacillus is anaerobic, that mainly causes diarrhea and colitis. It is present in the intestinal tract. The virulence mechanisms of *Clostridium* include hydrolytic enzymes, capsules, fimbriae and toxins.

**B. Antibiotic-resistant Nosocomial pathogens
Vancomycin-resistant *Enterococci* (VRE)**

Enterococcal species are the second leading pathogens of hospital-acquired infections world wide. These are Gram-positive enteric microbes. They dwell in female genital tract and in gastro intestinal passages. Blood bone infections and UTI are caused by enterococci. Virulence factors include extra cellular proteins, adhesions, gelatinase, hemolysins and extra cellular super oxide (Karki *et al.*, 2015; Kafil *et al.*, 2014).

Methicillin-resistant *Staphylococcus aureus* (MRSA)

Staphylococcus aureus are penicillin-resistant, and also are Methicillin-resistant. This resistant was due to the modified state of protein (Kavanagh *et al.*, 2015; Frikdin, 2001).

β -Lactam-resistant *Klebsiella*

Klebsiella species is resistant to β -lactamase antibiotic. This itself is a major cause of extreme conditions of nosocomial infections (Lin *et al.*, 2015).

C. Viral microbes

Viruses are the causative organisms of the most dreadful diseases such as HIV and Hepatitis B & C. Infections are transmitted through blood and blood products. Viral infections commonly observed in hospitals are viral diarrhea, influenza, herpes and infections by enteroviruses and arenaviruses.

D. Other pathogenic microbes of Nosocomial infections

Yeasts (*Candida albicans*), moulds (*Aspergillus*, *Mucor*), and many Protozoan species (*Toxoplasma gondii*, *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma*, etc.) also constitute the micro-flora of the varied range of hospital-acquired infections (Gatermann *et al.*, 2005).

SOURCES OF NOSOCOMIAL INFECTIONS

The sources of hospital-acquired infections can be broadly categorized as Endogenous and Exogenous sources.

Endogenous Sources of Infections

The patient's own flora constitute the endogenous sources of infections. These include many of the opportunistic infections, which are not pathogenic under normal conditions but outbreak into diseases only in the hospital environment. Such infections may be induced by some therapeutic or diagnostic interventions in the hospital itself (Therapeutic guidelines, 2000; Murray *et al.*, 2005).

Exogenous Sources of Infections

The sources of infection from any part of the hospital ecosystem, involving patients, surgical instruments, food, water, air, linens, washrooms, etc. constitute the exogenous sources. Some of the important ones are as follows:

People as the Source of Infection

People in general, such as other hospitalized patients, attendants, hospital staff and personnel and visitors are the main exogenous sources of infections.

Environmental Sources of Infections

The environment of the hospital, *i.e.*, its surrounding air, water and the food supplied to the patients is responsible for infections. The patients with impaired body physiology easily fall prey to atmospheric and pathogenic bacteria. Many drug-resistant bacteria and viral species invade into various body systems and disrupt their functioning (Sood *et al.*, 2008).

Biological and Surgical Instruments

Medical equipments and instruments such as catheters, needles, spatula, endoscopes, syringes, etc., which remain in contact with blood derivatives are responsible for infections, if they skip proper cleaning and sterilization (Morgan, 1999; Rutala *et al.*, 2010).

Cultures and Pathological Wastes

Cultures and stocks of micro-organisms and tissues in research and clinical laboratories of the hospital, if not maintained properly, spread many kinds of infections. Wastes from vaccines, injections, saline, sera, as well as, urine and faeces samples submitted for clinical diagnosis are hazardous.

Objects of Sanitary Use

Bed pans, tables, chairs, stools, blankets, linens, towels, utensils, etc., used by the patients in

the hospital, if not maintained at required hygiene levels, cause infections.

MODES OF TRANSMISSION

Hospital-acquired infectious agents are transmitted through four significant modes.

Direct Physical Contact

Contact route is probably the important means of pathogen transmission in hospitals. Person-to-person contact through hands, clothing, objects, etc., are responsible for infection.

Air-Borne Transmission

Aerial route is another common mode of transmission of infectious agents. Agents of respiratory infection are transmitted through mucous, cough and inhalation. Allergies are caused by the dust mites developed in the dust elements deposited in various places of the hospital. Aerosols from humidifiers and air conditioners also carry the pathogens to the lungs and liver, causing severe disorders.

Oral Mode of Transmission

Food and water from the hospital sources carry bacterial and viral species despite of all the caretaker. The utensils and kitchen surface may also transmit the pathogens by contaminating eatables and fluids.

Parenteral Transmission

Many a times, the infectious organisms are transmitted through blood transfusion, blood donation or tissue grafting. Contaminated infusion fluids and cell lead to easy transmission of pathogens.

DISCUSSION AND CONCLUSION

The hospital-acquired infections are new infections that result due to health care interventions to treat other conditions. A survey conducted by

WHO (1992) showed the prevalence of nosocomial infection as 3-21%. The recent data from the United States reflected an increase over the past two decades (Hacek *et al.*, 1999). This resulted in the increase of morbidity and mortality rates by 1-3%.

The world wide survey reports show that more than 40% hospitalizations with nosocomial infections are common in Latin America, some parts of Africa and Asia. The lesser percentage of infection incidences were observed in Europe and North America, *i.e.*, only 5-10% (WHO, 2002 ; 2015). Duque *et al.*,(2007) reported the increase in prevalence rate of pneumonia and other infections from 17-30% in the past few years. The frequent use of chemotherapy, diagnostic and therapeutic techniques was considered to be responsible.

Amongst all the infection causing microbes in hospital settings, bacteria cause about 90% of infections. Rest infections are caused by protozoans, fungi and viruses, which have lower percentages (Gatermann *et al.*, 2005). Out of many enterococci species, *Pseudomonas aeruginosa*, *Escherichia coli* and *Staphylococcus aureus* are majorly responsible for the nosocomial infections (Horan *et al.*, 2008). The frequent use of antibiotics in hospitals lead to the increased incidences of infections, as more of the pathogens become drug-resistant, eg., *Staphylococcus aureus* (Kavangh *et al.*, 2015).

The awareness in control of nosocomial infections may be brought about, if the guidelines formulated for disinfection of invasive devices and surgical instruments is followed religiously. Training of health care professionals and personnel is also extremely important. The control attempts of nosocomial infections would be effective only when

the proper layout of guidelines is followed rigidly (Pegram *et al.*, 2015 ; Brusaferrero *et al.*, 2015).

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