

Review Article

An overview of hospital acquired infections and the role of the microbiology laboratory

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ABSTRACT

Every year, many lives are lost because of the spread of infections in hospitals. These nosocomial infections, also called hospital acquired infections (HAI) are infections that patients acquire during the course of receiving healthcare treatment for other conditions. HAIs are a cause of significant morbidity and mortality in patients receiving healthcare, and the costs direct and indirect of these infections deplete the already limited financial resources allocated to healthcare delivery.

Keywords: Hospital Acquired Infection, Control, Microbiology

INTRODUCTION

According to the World Health Organization a Hospital-Acquired Infection is, “an infection acquired in hospital by a patient who was admitted for a reason other than that infection. This includes infections acquired in the hospital but appearing after discharge and also occupational infections among staff of the facility”.¹ In other words nosocomial infections are those infections acquired in hospital or healthcare service unit that first appear 48 hours or more after hospital admission or within 30 days after discharge following in-patient care.²

HAI is a localized or systemic condition that results from adverse reactions to the presence of an infectious agent(s) that was not present or incubating at the time of admission to the hospital from the centre for disease control.³

MAGNITUDE OF THE PROBLEM

Hospital acquired infections are a worldwide phenomenon. Patient care is provided in settings ranging from small health care clinics with basic facilities to large

sophisticated highly equipped hospitals with state of the art technology. Despite progress in public health and hospital care, infections continue to develop in hospitalized patients and also in hospital staff. The World Health Organization (WHO) called HAIs a major cause of death and disability for patients. A survey on HAIs reveals that at any time, over 1.4 million people worldwide are suffering from infections acquired in treatment centres, with an estimated 80,000 deaths annually. The actual rates vary from 5% to 10% of all patients admitted to modern healthcare centres in the industrialized world to up to 25% in developing countries. The risk of health care-associated infection in developing countries is 2 to 20 times higher than in developed countries.¹

IMPACT OF NOSOCOMIAL INFECTIONS

Hospital-acquired infections add to functional disability and emotional stress of the patient and may, in some cases, lead to disabling conditions that reduce the quality of life. The costs of nosocomial infections in terms of both money and human suffering are enormous.⁴

In March 2009, the CDC released a report estimating overall annual direct medical costs of healthcare-associated infections that ranged from \$28-45 billion.⁵

Nosocomial infections are also one of the leading causes of death. Prolonged hospital stay not only increases direct costs to patients but also indirect costs due to lost work. The increased use of drugs, the need for isolation, and the use of additional laboratory and other diagnostic studies also contribute to costs.⁶

Hospital-acquired infections add to the imbalance between resource allocation for primary and secondary health care by diverting scarce funds to the management of potentially preventable conditions. Limited resources represent the main challenge for governments in developing countries.⁷

ROUTES OF TRANSMISSION

Microorganisms are transmitted in hospitals by several routes and same microorganisms may be transmitted by more than one route. The main routes of transmission include contact, airborne, common vehicle and vector borne.¹

1. Contact route

There are two types of contact routes:

Direct Contact: It requires physical contact between the infectious individual or contaminated object and the susceptible host.

Indirect contact: This requires mechanical transfer of pathogens between patients through a health care worker or a medical kit.

2. Air borne route

Airborne transmission occurs by dissemination of either airborne droplet nuclei (small particle residue 5 microns or smaller in size of evaporated droplet containing microorganisms that remain suspended in the air for long periods of time) or dust particles containing infectious agent.⁸ Microorganisms carried in this manner can be dispersed widely by air current and may become inhaled by a susceptible host within the same room or over a long distance from the source patient depending on environmental factors. Examples include *Mycobacterium tuberculosis*, *Legionella*, and the Rubeola and Varicella viruses.

3. Droplet route

Droplet particles, produced by coughing, sneezing and even talking, can settle either on surrounding surfaces or on the body mucosa which can be transferred to others. Examples include meningitis and pneumonia.

4. Common vehicle transmission

It applies to microorganisms transmitted to the host by contaminated items such as food, water, medications, devices and equipments.

5. Vector borne transmission

It occurs when vectors such as mosquitoes, flies, rats and other vermin transmit microorganisms.^{1,9,10}

DIFFERENT TYPES OF INFECTIONS ACQUIRED IN HOSPITALS INCLUDE

Bloodstream infections, ventilator-associated pneumonia, Urinary Tract Infection (UTI), lower respiratory infection, gastrointestinal, skin, soft tissue, surgical-site infections, ear, nose, and throat infections.⁹

ETIOLOGY

Although viruses, fungi and parasites are recognized as sources of nosocomial infections, bacterial agents remain the most commonly recognized cause. Nosocomial blood stream infections are usually caused by gram-positive organisms including Coagulase Negative Staphylococcus, Staphylococcus aureus and Enterococci.² *Escherichia coli* is a very common cause of nosocomial urinary tract infection, but other pathogens including *Pseudomonas aeruginosa*, *Klebsiella* spp, *Proteus mirabilis*, *Staphylococcus epidermidis*, Enterococci and *Candida* spp can also cause UTI. *Legionella pneumophila* may also be responsible for epidemic lower respiratory tract infection in hospitals. *Klebsiella* spp, *Pseudomonas* spp, *Proteus* spp, *Escherichia coli* and *Staphylococcus aureus* are common cause of blood stream nosocomial infections in neonates.⁹ The widespread use of broad spectrum antibiotics has led to nosocomial infections with drug resistant microbes.² Examples include Methicillin Resistant Staphylococcus aureus (MRSA) penicillin resistant *precumococci*, Vancomycin Resistant Enterococci, (VRE) and Multi Drug Resistant Tuberculosis (MDR-TB).¹¹

HIGH-RISK SITUATIONS FOR ACQUIRING HOSPITAL-ACQUIRED INFECTIONS

There are numerous risk factors which predispose a host to acquire HAIs including low body resistance as in infancy and old age, serious underlying illnesses, major surgeries,¹² immune deficiency states¹³ and prolonged hospital stay.¹⁴

There are areas in the hospital which carry a greater risk of patients acquiring HAI's.^{15,16} These include intensive care unit, dialysis unit, organ transplant unit, burns unit, operation theatres, delivery rooms, post-operative wards.

PREVENTION¹⁷

Prevention of nosocomial infections requires an integrated, monitored, programme, which includes the following key components:

- Limiting transmission of organisms between patients in direct patient care through adequate hand washing and glove use, and appropriate aseptic practice, isolation strategies, sterilization and disinfection practices, and laundry
- Controlling environmental risks for infection
- Protecting patients with appropriate use of prophylactic antimicrobials, nutrition, and vaccinations
- Limiting the risk of endogenous infections by minimizing invasive procedures and promoting optimal antimicrobial use
- Surveillance of infections, identifying and controlling outbreaks
- Prevention of infection in staff members
- Enhancing staff patient care practices, and continuing staff education. Infection control is the responsibility of all healthcare professionals - doctors, nurses, therapists, pharmacists, engineers and others

HOSPITAL INFECTION CONTROL PROGRAMME

“The first requirement of a hospital is that it should do the sick no harm” was Florence Nightingale’s dictum. Each healthcare facility needs to develop an infection control programme to ensure the well being of both patients and staff.¹⁴

It also needs to work on developing an annual work plan to assess and promote good health care, and provide sufficient resources to support the infection control programme.

Infection prevention and control programmes were initially implemented in hospitals in the US in the 1960s, but it was not until the publication of the Study on the Efficacy of Nosocomial Infection Control (SENIC) in 1985 that the best evidence of their efficacy in reducing HAIs became available.² This study showed that hospitals with an infection control programme that included surveillance and control components were able to reduce HAIs by 32% compared with those hospitals that did not have this type of programme or the critical components.¹⁸

The infection control and prevention programme at the hospital is a planned, systematic approach to monitor and evaluate the quality and appropriateness of infection control procedures and practices. The programme is a plan of action which is designated to identify infections that occur in patients and staff that have the potential for disease transmission, identify opportunities for the reduction of risk for disease transmission, recommend risk reduction practices by integrating principles of sound infection control management into patient care, education and training of employees, sterilisation and disinfection practices at the hospital and manage surveillance through internal audits and various reporting tools.

The main aim of the infection control programme is to lower the risk of an infection during the period of hospitalization. Hospital infection control programs can prevent 33% of nosocomial infections.³

OBJECTIVES OF THE INFECTION CONTROL PROGRAMME

- Monitoring of hospital-associated infections; by the development of surveillance system. The SENIC investigators found that surveillance was the one essential component of an infection prevention and control program necessary to reduce rates of HAIs.¹⁸ Surveillance implies that the observed data are regularly analyzed and reported to those who are in position to take appropriate actions. The surveillance system will establish a database, which will give endemic rates of Nosocomial infection.
- Training of staff in prevention and control of HAI
- Investigation of outbreaks, Five percent of HAIs occur as epidemics or outbreaks.¹⁹ Outbreak investigations often provide critical information about the epidemiology of important pathogens
- Controlling the outbreak by rectification of technical lapses, if any
- Monitoring of staff health to prevent staff to patient and patient to staff spread of infection
- Advice on isolation procedures and infection control measures
- Infection control audit including inspection of waste disposal, laundry and kitchen
- Monitoring and advice on the safe use of antibiotics

INFECTION CONTROL ORGANIZATIONS IN A HOSPITAL

Infection control organizations are essential features of an infection control programme.

These organizations are:

1. *Infection Control Committee (ICC)*

The American Medical Association first recommended in 1958 that hospitals set up infection control committees. Though not initially widely accepted, with modification of the original policy in 1976, it is now a worldwide accepted phenomenon that the infection control committee is the policymaking body for infection control in all individual hospitals.²⁰

Representatives of medical, nursing, engineering, administrative, pharmacy, CSSD and Microbiology departments are the members. The committee formulates the policies for the prevention and control of infection.²¹

One member of the committee is elected chairperson and has direct access to the head of the hospital administration. The infection control officer is the member secretary. The committee meets regularly and not less than three times a year.

2. *Infection Control Team (ICT)*

Members of the Infection control team undertake the day to day measures for the control of infection. Infection Control Team is responsible for establishing infection control policies and procedures, providing advice and guidance regarding infection control matters, regular audits and surveillance, identification and investigation of outbreaks, awareness and education of staff.²²

3. *Infection Control Officer (ICO)*²³

The Infection Control Officer is usually a medical microbiologist or any other physician with an interest in hospital associated infections.

Functions:

- Secretary of Infection Control Committee and responsible for recording minutes and arranging meetings
- Consultant member of ICC and leader of ICT
- Identification and reporting of pathogens and their antibiotic sensitivity
- Regular analysis and dissemination of antibiotic resistance data, emerging pathogens and unusual laboratory findings
- Initiating surveillance of hospital infections and detection of outbreaks
- Investigation of outbreaks

- Training and education in infection control procedures and practice

4. *Infection Control Nurse (ICN)*²³

A senior nursing sister should be appointed full-time for this position. Adequate full-time or part-time nursing staff should be provided to support the programme.

Functions:

- To liaise between microbiology department and clinical departments for detection and control of HAI
- To collaborate with the ICO on surveillance of infection and detection of outbreaks
- To collect specimens and preliminary processing; the ICNs should be trained in basic microbiologic techniques
- Training and education under the supervision of ICO
- To increase awareness among patients and visitors about infection control

5. *Infection Control Manual (ICM)*

It is recommended that each hospital develops its own infection control manual based upon existing documents but modified, for local circumstances and risks.

ROLE OF THE MICROBIOLOGY LABORATORY^{1,4,23-26}

The microbiology laboratory has a pivotal role in the control of hospital associated infections. The clinical microbiology laboratory is an essential component of an effective infection control program. The microbiology laboratory should be involved in all aspects of the infection control program. Particularly important are its roles in the hospital's infection surveillance system and in assisting the infection control program to effectively and efficiently use laboratory services for epidemiologic purposes.⁴ Clinical microbiology laboratory plays a pivotal role in patient care providing information on a variety of microorganisms with clinical significance and is an essential component of an effective infection control program.²⁸ The microbiologist is usually the infection control officer.

The role of the department in the HAI control programme includes:

- Identification of pathogens - the laboratory should be capable of identifying the common bacteria to the species level
- Provision of advice on antimicrobial therapy

- Provision of advice on specimen collection and transport
- Provision of information on antimicrobial susceptibility of common pathogens.²⁹ On basis of periodic summaries of laboratory data and data on antibiotic consumption, the microbiologist can keep the clinicians informed about antibiotic resistance and compliance with the antibiotic guidelines.
- Periodic reporting of hospital infection data and antimicrobial resistance pattern - The periodic reporting of such data is an important service provided by the microbiology department. The frequency of this should be as determined by the ICC.³⁰
- Identification of sources and mode of transmission of infection - Culture of carriers, environment for identifying the source of the organism causing infection (outbreak organism).³¹ The selection of sites for culture depends upon the known epidemiology and survival characteristics of the organism
- Epidemiological typing of the isolates from cases, carriers and environment
- Microbiological testing of hospital personnel or environment.³² Testing for potential carriers of epidemiologically significant organisms. As a part of the infection control programme, the microbiology laboratory at times may need to culture potential environmental and personnel sources of nosocomial infections. Usually this is limited to outbreak situation when the source and method of transmission needs to be identified. Routine microbiological sampling and testing is not recommended³³
- Providing support for sterilization and disinfection in the facility including biological monitoring of sterilization.
- Providing facilities for microbiological testing of hospital materials when considered necessary.³⁴ These may include: sampling of infant feeds; monitoring of blood products and dialysis fluids; quality control sampling of disinfected equipment; Additional sterility testing of commercially sterilized equipment is not recommended
- Providing training for personnel involved in infection control³⁵ - This forms an important part of the Infection Control Programme. Each hospital should develop an employee training programme. The aim of the training programme is to thoroughly orient all hospital personnel to the nature of HAI and to ways of prevention and treatment. As the various

hospital employees have different functions and their level of education is different, the training programme needs to be altered to suit the functional requirements of each category of staff and should be adapted accordingly.

The training programme should include the following:

- Basic concepts of infection
- Hazards associated with their particular category of work;
- Acceptance of their personal responsibility and role in the control of hospital infection;
- Methods to prevent the transmission of infection in the hospital
- Safe work practice.

COMMUNICATION BETWEEN THE PHYSICIAN AND THE MICROBIOLOGY LABORATORY

Effective communication is one of the most important characteristics of a microbiology laboratory, wherever it is located. To be effective, the opportunity for dialogue between health care providers and laboratory personnel must be readily accessible, if not immediately available. Provision must be adequate for bidirectional interaction, because the information provided is nearly always qualitative and interpretive.³⁶

Finally, microbiologists and microbiology services constitute a central element where all the activities required for the diagnosis, treatment and control of infection performed by the various hospital services converge.³⁷

CONCLUSION

Infection control is a never ending struggle as medicine becomes more invasive and the proportion of ageing and immuno-compromised patients in our population continues to increase. Hospitals should come up with an in-house awareness programme where staff members, patients and their relatives can be educated on maintaining hygiene. Moreover Microbiology laboratory is becoming an integral part of HAI prevention programmes. The emergence of new pathogens, and new resistances in old pathogens, makes microbiology laboratory indispensable for successful prevention of HAI, not only outbreaks, but sporadic cases too.

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