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Healthcare-Associated & Hospital Acquired Infection and its Infection Control

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Abstract:

Background: Healthcare-associated infections (HCAIs/HAIs) are increasingly driving the outcomes of patients in both acute and long-term care health facilities. Device-associated infections (DAIs) such as ventilator-associated pneumonia (VAP), central line-associated bloodstream infections (CLA-BSIs), catheter-associated urinary tract infections (CA-UTIs) and surgical-site infections (SSIs) together account for most of the HAIs across the world.[1,2] **Objectives:** The prevalence of healthcare-associated & nosocomial infections.Monitoring of hospital-associated infections-by the development of surveillance system. **Prevalence:** Prevention of nosocomial infections requires an integrated, monitored, programme, which includes the following key components-Confining transmission of microorganisms amid patients in direct patient care over 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 acknowledge use of prophylactic antimicrobials, nutrition, and vaccinations. Checking the risk of endogenous disease by minimizing invasive procedures and promoting optimal antimicrobial use. Enhancing team patient care practices, and enduring team education. Infection control is the authority of all healthcare experienced - doctors, nurses, therapists, pharmacists, engineers and others.[49] **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. Moreover Microbiology laboratory is becoming an integral part of HAI prevention programmes.[65] **Keywords:** Hospital Acquired Infection, Control, Microbiology, Healthcare-associated infections , nosocomial infections.

INTRODUCTION:

Healthcare-associated infections (HCAIs/HAIs) are increasingly driving the outcomes of patients in both acute and long-term care health facilities. Device-associated infections (DAIs) such as ventilator-associated pneumonia (VAP), central line-associated bloodstream infections (CLA-BSIs), catheter-associated urinary tract infections (CA-UTIs) and surgical-site infections (SSIs) together account for most of the HAIs across the world.[1,2] HAIs have tremendous implications in terms of associated mortality, morbidity, increased cost of treatment, adverse patient outcomes and social impact. Apart from their escalating rates, HAIs are now frequently being caused by multi- and pan-drug-resistant organisms, causing therapeutic dilemma. DAIs continue to be one of the main threats to the patient safety, particularly in Intensive Care Units (ICUs) of low- and middle- income countries (LMICs).[3-6] Of the annual 12 million deaths, 95% occur in LMICs, where infection prevention and control (IPC) policies are non-existent, poorly adapted or insufficiently funded by governments.[7,8]

A growing body of evidence from well-designed studies indicate that up to 10%–70% of HAIs can be prevented by implementation

of appropriate infection control protocols. Most studies support the observations that at least 1/3rd of HAIs can be prevented in HCFs by surveillance and implementation of evidence-based guidelines for prevention of infections (especially device-related infections and SSIs).[10,11] Some of the most effective infection prevention measures are the most basic, easy and cost-effective practices that can be incorporated in routine patient care workflows.

Observational studies confirm that evidence-based approaches can reduce infections.[12,13]

Antimicrobial resistance (AMR) and the spread of multidrug resistant bacteria is a global patient safety problem and a major public health concern.[14] In India, as elsewhere in South East Asia, many interlinked factors—including overuse of antibiotics, limited clinical diagnostic and laboratory capacity, and poor infection control, hygiene, and sanitation—have contributed to the emergence and spread of AMR.[15-17]Healthcare facilities are high risk environments for the development and spread of drug resistance[18-21]and frequently have the highest burden of multidrug resistant pathogens, such as carbapenem resistant Enterobacteriaceae. Healthcare associated infections thus increase the threat of AMR and contribute to poor patient outcomes.[22-24]

The data available indicate that the burden of healthcare associated infections in low and middle income countries like India is high, with an estimated pooled prevalence of 15.5 per 100 patients, more than double the prevalence in Europe and the US.[25] Infection prevention and control measures and practices reduce the opportunities for resistant pathogens to spread in healthcare facilities. They are therefore important to efforts to contain AMR.[26] At present, however, a lack of adequate systems and infrastructure for infection prevention and control in many healthcare facilities contributes to the development of healthcare associated infections and the spread of resistant pathogens.[23,27]

In India, accurate estimates of the burden of healthcare associated infections are limited by the absence of reliable and routine standardised surveillance data. Published reports of healthcare associated infections are mostly from individual health facilities and include short term prospective studies and point prevalence surveys conducted in selected patient units of large hospitals.[28-32]

These indicate a prevalence of healthcare associated infections ranging from 7 to 18 per 100 patients, which is similar to that reported from other low and middle income countries. As in other settings, healthcare associated infections in India are associated with longer hospital stays, increased mortality, and added costs.[29,30,32]

The frequent use of indwelling devices is also reported, particularly in intensive care units, where one centre reported that over 70% of patients had indwelling devices in its intensive care unit for more than 48 hours.[29] While microbiological confirmation of the healthcare associated infections was not a requirement in each of these reports, the data indicate that many of these infections were due to multidrug resistant pathogens, including meticillin resistant *Staphylococcus aureus* (MRSA) and extended spectrum β-lactamase producing and carbapenem resistant Enterobacteriaceae, *Pseudomonas* spp, and *Acinetobacter* spp.[29,30] However, the results reported are not comparable across studies or sites in India as the healthcare facilities did not necessarily use standardised case definitions and surveillance methods

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CAUSATIVE ORGANISMS:

Around 12–17 microorganisms cause 80%–87% of HCAIs: *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.[33,34.35] Among these pathogens, 16%–20% include multidrug-resistant (MDR) phenotypes: MRSA, vancomycin-resistant *E. faecium,* carbapenem-resistant *P. aeruginosa*, extended-spectrum cephalosporin-resistant *K. pneumoniae*, *K. oxytoca*, *E. coli*, and *Enterobacter species*, and carbapenem-resistant *P. aeruginosa*, *K. pneumoniae/ K. oxytoca*, *E. coli*, *Enterobacter* species, and *A. baumannii*.[33,34] Some of these Gram-negative microorganisms have a much higher rate (20%–40%) of resistance than others[33] with the organisms isolated from device-associated HCAIs having the highest antimicrobial resistance phenotypes.[35] In the latter study, although similar to the percentage resistance for most phenotypes was that in an earlier research study,[33] an upsurge in the scale of the resistance fractions against *E. coli* pathogens was observed, especiall with fluoroquinolones.[35]*Acinetobacter, Burkholderia spp.* and *Pseudomonas spp*. isolates were 100% were 92% resistant to cephalosporins respectively. *Burkholderia* spp. was again totally resistant to fluoroquinolones and *Acinetobacter* spp. and *Pseudomonas* spp. were 94.2% and 95.8% resistant, respectively. The same study reported that 86.4% *Acinetobacter* spp. and 62.5% *Pseudomonas* spp. showed a high resistance to carbapenems, the preferred drug regime in ICUs. Carbapenems were found moree effective against *Burkholderia* spp. with 20% resistance.[36] In another study, *Enterobacteriaceae* community were found to be completely resistant to third-generation cephalosporins.[36]

Over 80% of the *Klebsiella* spp. community were resistant to ciprofloxacin, gentamicin, piperacillin, tazobactam, and imipenem showing 48.6% resistance. *E. coli* was equally resistant although carbapenems were effective in almost 80% cases. Although *Citrobacter* spp. related HCAIs are a relatively minor proportion, they also show resistance toward cephalosporins, fluoroquinolones, and aminoglycosides.[37] Another study reported that although the *Acinetobacter* spp. were 76.99%–92.01%, resistant to most antimicrobials, only 30% of *Acinetobacter* spp. isolated were susceptible.[38] It can be seen therefore that the causative pathogenic microorganisms differ from country to country as does patterns of resistance

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.[39]

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.[40]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.[39,41,42]

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.[41]

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,[42] immune deficiency states[44] and prolonged hospital stay.[45]

There are areas in the hospital which carry a greater risk of patients acquiring HAI's.[46,47] These include intensive care unit, dialysis unit, organ transplant unit, burns unit, operation theatres, delivery rooms, post-operative wards.

PREVENTION[49]

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.[45]

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.[50] 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.[51]

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.[52]

ROLE OF THE MICROBIOLOGY LABORATORY[53,54,55,56]

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.[54] 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.[57] 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.[58] 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 date is an important service provided by the microbiology department. The frequency of this should be as determined by the ICC.[59]

Identification of sources and mode of transmission of infection - Culture of carriers, environment for identifying the source of the organism causing infection (outbreak organism).[60]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.[61]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 recommended[62] 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.[63]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 control[64] - 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.

CONCLUSION:

Infection control I s 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.[65]

KEYWORDS: Hospital Acquired Infection, Control, Microbiology, Healthcare-associated infections , nosocomial infections.

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