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Indian Academy of Pediatrics
Infectious Diseases Chapter



Infection Control
in Healthcare Settings



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Contents

1. Burden of Healthcare-associated Infection: World and India **1**
Bhaskar Shenoy

• Healthcare-associated Infections in High-income Countries 2 • Healthcare-associated Infections in Low- and Middle-income Countries 3 • Challenges in India 5

2. Epidemiology of Hospital-associated Infections **6**
Shivananda

• Magnitude 6 • Catheter-associated Infections: Urinary Tract Infections 11 • Ventilator Associated Pneumonia 12 • Organism-related Healthcare-associated Infections 12 • Viruses 13
• Other Nosocomial Infections 13

3. Importance of Infection Control **15**
Jaydeep Choudhury

• Magnitude of the Problem 15 • Pathogenesis 16

4. Basic Principles of Infection Control **26**
Anita Shet

• Chain of Infection 27 • Strategies for Infection Control Measures 30 • Hospital Infection Control Program 30

5. Role of Microbiology Laboratory in Infection Control **34**
Sangeeta Joshi

• Role in Diagnosis 34 • Role in Infection Control 35

6. Isolation Precautions **38**
Bhaskar Shenoy

• Standard Precautions 38 • Hand Hygiene 38
• Healthcare-associated Infection and Hand Hygiene 38
• Practicing, Teaching and Observing Hand Hygiene 44
• Healthcare Activities and Indications 46 • Indications for Hand Hygiene when Medical Gloves are Required 46

• Other Aspects of Hand Hygiene 47 • Respiratory Hygiene/ Cough Etiquette 50 • Personal Protective Equipment 51 • Type of PPE and Barriers and Criteria for Selection 52

Transmission Based Precaution Droplet, Contact and Airborne Infections **57**
Ritabrata Kundu, Joydeep Das

7. Infection Control Methods for Common Diseases **64**
Kheya Uttam Ghosh, Santanu Bhakta, Sanjay K Ghorpade, Dhanya Dharmapalan

Flu (H1N1) **64**
Kheya Uttam Ghosh

• Prevention 64

Tuberculosis **69**
Santanu Bhakta

• Strategy to Prevent Transmission 70 • Digital Health Agenda 70 • How Tuberculosis Spread? 71 • Prevention of Spread of Infection and its Control 71 • Prevention of Transmission in Household 72

Chickenpox **74**
Sanjay K Ghorpade

• Infectious Agent 74 • Transmission 74 • Prevention 75

Methicillin-resistant *Staphylococcus aureus* (MRSA) **79**
Dhanya Dharmapalan

• Prevalence 79 • Measures to Contain MRSA Infections 80 • Gloves and Mask 81

8. Infection Control in Clinic and Office Practice **85**
Dhanya Dharmapalan, Vijay N Yewale

• Infections Transmissible Inside the Waiting Area 85

9. Infection Control Protocols in Intensive Care Unit **91**
GV Basavaraja

• Sources of Cross-infection in the Intensive Care Unit 92 • Strategies to Reduce Infection Risk 93 • Environment Factors and Design Issues for the Intensive Care Unit 96

10. Bed Spacing Recommendations in NICU, PICU and Wards **101**
Pragalatha Kumar

11. Hospital Infection Control Program **104**
Narayanappa D
• Hospital Infection Control Committee 104
• Infection Control Team 106

12. Needle Stick Injuries **108**
Abhay K Shah
• Incidence 108 • Risk Factors 109
• Predisposing Events 110 • Postexposure Measures 113
• Postexposure Prophylaxis 114 • HIV Prophylaxis 116

13. Disinfection and Sterilization **122**
Govindaraj M, Shalini Sharma
• Cleaning of Bedding, Mattresses and Pillows 124
• Cleaning and Reprocessing of Non-critical, Semi-critical and Critical Patient Care Equipment 125

14. Hospital Waste Management **130**
Digant D Shastri
• Hospital Waste Management 130

15. Outbreak Management **141**
Bhaskar Shenoy, M Rajesh Babu
• Describing the Outbreak 141 • Investigation of an Outbreak 142 • Investigation Procedures 142
• Outbreak Control 143 • Identify the Source and Route of Infection 144

16. Prevention of Antimicrobial Resistance **147**
Abhay K Shah, Bhaskar Shenoy
• Factors that Increase the Emergence and Spread of Antimicrobial Resistance in HCFs 148 • Control of Antimicrobial Resistance in HCFs 149 • Judicious Use of Antimicrobials and Formulary Restriction 149
• Measures to Ensure Appropriate Antimicrobial Use in HCFs 150 • Surveillance 151

17. Role of Paramedics in Infection Control **152**
Unis Beulah
• Infection Control Nurse 152

Index *155*

Chapter

3 Importance of Infection Control

Jaydeep Choudhury

INTRODUCTION

Infections are a leading cause of disease in most part of the world and infection control is an integral part of pediatric practice in hospitals as well as in ambulatory patients. Most of the infections are acquired in the community. Infections which manifest only after 48 hours of hospitals stay are called "nosocomial" or "healthcare-associated infections (HCAI)". Nosocomial infection may manifest even after discharge. The profile and severity of nosocomial infections are different than those acquired in the community. These infections lead to significant morbidity, mortality and also economic burden, which is beyond those expected from the patients' underlying disease alone. Under ideal circumstances, these infections should be prevented.

MAGNITUDE OF THE PROBLEM

Nosocomial infections can occur as outbreaks or as sporadic cases. Outbreaks of infections are visible and worrying. From microbiological and pharmacological point of view, sporadic infections have far-reaching consequences.

Most of the nosocomial infections are in neonatal intensive care unit (NICU), pediatric intensive care unit (PICU), hematology-oncology unit and neonatal surgery. These patients are at greater risk as they are not adequately immunocompetent.

In Western world, the nosocomial infection rate is 5–10 infections per 100 patient admissions, that is 5-10%. In the developing world, the rate may be as high as 25% or more. The distribution of infections by anatomic site in acute care hospitals in developed countries is shown in Table 3.1.

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Table 3.1: Distribution of infection by anatomic site in developed countries

Site	*Percent infection*
Urinary tract	35
Postoperative wound	25
Bloodstream	10
Pneumonia	10
Others	20

Bloodstream infections are less in developing countries since fewer devices are used. Incidence of gastrointestinal infections and postoperative wound infections are more.

PATHOGENESIS

Nosocomial infections can be exogenous or endogenous. In exogenous infections, the pathogens gain direct access to the patient from the environment and initiate disease. Endogenous infections are derived from the patient's own microflora. It may be primary endogenous and secondary endogenous. In primary endogenous, the pathogens are derived from patient's own normal flora. In secondary endogenous, the pathogen colonizes the patient, becomes part of the normal flora and subsequently causes infection.

Modes of Spread

Nosocomial infections are transmitted by contact, vehicles, air or vectors. Person-to-person transmission through the hands of hospital staff or even patients is the most important mode. Decrease in hand washing by staff, and staff having contact with many patients are the most important factors.

Vehicles of transmission could be food, water, intravenous solutions or blood and blood products. Medical equipments are also important. Rodents and cockroaches are also known vectors of infection which is common in many hospitals.

Pathogens Involved

About 70% of pediatric nosocomial infections are bacterial, of which 50% are gram-positive and about 20% gram-negative. The etiology

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varies according to the age of the patient, site of infection and prevailing pathogen in the hospital. Coagulase negative *Staphylococcus* is particularly associated with infections related to intravascular catheters.

Children are at increased risk of viral infections. Respiratory syncitial virus and adenovirus cause outbreaks of respiratory infections. Rotavirus and hepatitis A virus cause gastrointestinal infections. Varicella zoster infection outbreak in NICU is also documented.

Mortality and Morbidity

Bloodstream and pulmonary infections carry the highest mortality rates. Even in developed countries, it is as high as 25–30%.

Costs

There are direct costs due to additional stay in hospital, costs of investigations and antibiotics. The indirect costs include rehabilitation, outpatient visits and follow-up.

Isolation

Isolation of infectious patients is important to limit the spread of nosocomial infection. Various modes of isolation in different diseases are shown in Table 3.2.

Prevention

More than 20% of all hospital-acquired infections can be prevented. Hand washing, appropriate isolation, use of gloves when required and proper use of devices help in prevention of nosocomial infections. Other issues also require attentions are as follows:

1. Availability of soap and water at all times placed in a convenient location for easy access.
2. Surgical patients should receive preoperative antibiotics.
3. Isolations of patients with communicable disease.

Infection Control Program

Authority should take the initiative to develop a program to support hospitals and healthcare system in reducing the risk of healthcare-associated infections. The infection control team is responsible for

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Table 3.2: Isolation and precautions for infection control

Modes of isolation	*Diseases*	*Methods*
Strict isolation	Diphtheria, rabies	Single room, gown, gloves, mask. Hand washing. Proper care of contaminated articles.
Contact isolation	Bronchiolitis, conjunctivitis, methicillin-resistant *Staphylococcus aureus* (MRSA)	Single room, mask for close contacts. Gloves for touching infected area. Strict hand washing. Proper care of contaminated articles.
Respiratory isolation	Measles, whooping cough, meningococcal diseases	Single room, mask for close contacts. Strict hand washing. Proper care of contaminated articles.
Enteric isolation	Rotavirus, shigellosis, any diarrhea	Preferably single room, gowns if soiling likely, gloves for handling infective material. Strict hand washing. Proper care of contaminated articles.
Blood and body fluid precautions	Hepatitis B, HIV	Isolation not indicated, no masks, gloves for handling blood or body fluid. Gowns, if soiling likely. Proper care of contaminated articles.
Protective isolation	Immunosuppressed patients	Single room, gowns, gloves, mask. Strict hand washing. Sterilized food and drink.

day-to-day activities of infection control program. The program must focus on the following factors:

- A definite objective consistent with the national or local healthcare objectives.
- Develop and regularly update guidelines.
- Facilitate access to materials essential for hygiene.
- Monitor nosocomial infections.
- System to monitor selected infections and plan interventions.
- Training program for healthcare professionals.

Components of Infection Control

- Basic measures for infection control.
- Education and training of healthcare workers.
- Protection of healthcare workers.

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- Routine practice for infection control—antisepsis and asepsis, antibiotic usage, handling and use of blood products, hospital waste management.
- Surveillance.
- Incidence monitoring.
- Outbreak investigation.
- Research.

The infection control program will be effective, only if it is comprehensive and includes surveillance and prevention activities along with staff training.

Infection control practices can be divided in to two categories, standard precautions, which must be applied to all patients at all times, regardless of diagnosis or infectious status and additional precautions, which are specific to modes of transmission of the disease.

Standard Precautions

Standard precaution includes simple measures like hand hygiene, environmental cleaning and waste handling. These are cheap and feasible. Strict adherence to these methods is important for successful control of HCAI. The following are the various aspects of standard precautions:

- Hand hygiene – Hand washing and antisepsis.
- Use of personal protective equipment when handling organic materials like blood or other body fluids, excretions and secretions.
- Appropriate handling of patient-care equipment and soiled linen.
- Prevention of needle stick or sharp injuries.
- Environmental cleaning and management practices.
- Appropriate handling of waste.
- Patient placement and transportation.

Hand Hygiene

Proper hand hygiene is the single most important practice to reduce nosocomial infection. The following are the indications for hand washing with soap and water for 2 minutes.

- At the entry of intensive care units (PICU, NICU)
- Before performing any invasive procedures before wearing gloves
- When hands are visibly soiled with dirt or organic material

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- After touching soiled linen or other items, mucous membranes, wounds, dressings even, if the hands are not soiled
- After examining a culture-proven sepsis patient
- Every time after removing gloves.

Alcohol-based hand rubs are recommended to be used after drying hands following hand washing and also routinely before and after every patient contact. Alcohol-based hand antiseptics are not effective on hands that are visibly dirty or contaminated with organic material, unless they are first washed with soap and water.

Use of Personal Protective Equipment

It provides a physical barrier between microorganisms and the wearer. Personal protective equipment are gloves, mask, gown, cap, protective eye wear (goggles), apron and boots or shoe covers.

It should be used by healthcare workers who provide direct care to patients and support staff including cleaners, laundry staff who may have contact with patient's organic materials. It should also be used by laboratory staff who handle patient specimens and family members who provide care to patients.

Handling of Patient care Equipment and Soiled Linen

Patient care equipment soiled with organic materials should be handled with care in order to prevent exposure. The method and periodicity of decontamination depends on the equipment type as shown in Table 3.3.

Prevention of Needle Stick/Sharps Injuries

Needles, scalpels and other sharp instruments or equipment should be used with utmost care. Used disposable syringes and needles, scalpel blades and other sharp items should be placed in a puncture-resistant container with a lid that closes. Extra care should be taken while cleaning sharp reusable instruments or equipment. Needles should never be recapped or bend. Sharps must be appropriately destroyed.

Patient Placement

Spacing between beds: There should be adequate space between beds to reduce the risk of cross infection due to direct or indirect contact or droplet transmission. Optimum spacing between beds is 1–2 meters.

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Table 3.3: Patient care equipment and linen decontamination

Item	Activity	Periodicity
Incubators, warmers, trolleys	In use: Detergent and water	In use: Daily
	Not being used: 2% cidex	Not being used: Dismantle weekly and clean with 2% cidex
Ventilator body	2% carbolic acid	Once daily
Infusion pumps/monitors	Clean with moist cloth	Once daily
Ambu bag and accessories	Dismantle, wash visible contamination then 2% cidex for 30 minutes	After each use
	Dismantle, wash visible contamination then 2% cidex for 6 hours	Once weekly
Rubber and plastic tubings	2% cidex for 6 hours	Once daily
Humidity bottles, suction bottles and oxygen hoods	Clean with detergent	Once daily
Laryngoscopes	Clean with spirit	After each use
	2% cidex for 30 minutes	Once daily
Thermometer, stethoscopes, measuring tapes	Wipe with spirit	Before and after each use
Weighing machines	Wipe with moist cloth	Once daily
Saturation probes	Preferably use disposable, when reusing wipe with spirit	Before and after each use
BP cuff	Ideally use disposable, while reusing wipe with spirit	Before and after each use
Procedure sets	Autoclave	After each use
Linen and gowns	Manually clean and then autoclave	After each use
Feeding utensils	Wash with detergent, boil 20 min	Before each use

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Cohorting: If separate rooms are not feasible patients infected or colonized by the same organism can be cohorted.

Environmental Cleaning and Management Practices

A clean environment plays an important role in the prevention of HCAI. Most patient-care areas should be cleaned by wet mopping with neutral detergent solution.

Areas contaminated with blood or body fluids should be cleaned immediately with detergent and water. Isolation rooms and other areas that have patients with known transmissible infectious diseases should be cleaned daily with a detergent/disinfectant solution daily. All horizontal surfaces and all toilet areas should be cleaned daily.

Air ventilation: Ventilation systems should be designed and maintained to minimize microbial contamination. The air conditioning filters should be cleaned periodically. Unidirectional laminar airflow systems should be available in appropriate areas in the hospital construction.

Special air handling: For the operating room and for immunocompromised patients special air handling is needed.

Handling of Waste

Hospital waste is a reservoir of infectious microorganisms and requires safe and appropriate handling. The main risk associated with infection is sharps contaminated with blood. There should be a person or a team responsible for the organization and management of waste collection, handling, storage and disposal. Waste management practices must meet national and local requirements. Following are the steps in the management of hospital waste:

Segregation and collection: Infectious waste should be collected and segregated from non-infectious waste in dedicated containers at the source.

Transportation: Waste should be transported in a dedicated trolley. They should be cleaned regularly.

Storage: Waste should be stored in a specific area with restricted access. Sharps should be stored in sharps containers. Sharps containers should be made of plastic or metal and have a lid that can be closed. They should be marked with the appropriate label or logo.

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Treatment: Each healthcare facility should identify a method for the treatment of infectious waste. This may consist of transportation of infectious waste to a centralized waste treatment facility or on-site treatment of waste.

Final disposal: Sharps should be autoclaved after chemical treatment and land-fill or microwave. Deep burial should be done in a secure area. Burial should be 2–3 meters deep and at least 1.5 meters above the groundwater.

Anatomical parts, animal carcasses, cytotoxic drugs (residues or outdated) and toxic laboratory chemicals other than mercury should be incinerated. Patient-contaminated non-plastics and non-chlorinated plastics may be also incinerated.

Plastics, non-plastics contaminated with blood, body fluids, secretions and excretions and infectious laboratory wastes also should not be incinerated. Chemical treatment with 1% hypochlorite or a similar disinfectant is recommended. However, excessive use of chemical disinfectants should be avoided. Radioactive waste should be dealt with according to national laws. Treatment and final disposal of waste is shown in Table 3.4.

Table 3.4: Treatment and final disposal of waste

Color coding	*Waste*	*Treatment and final disposal*
Yellow (solid infectious)	Human tissues, organs, body parts Microbiology and biotechnology waste (wastes from laboratory cultures, specimens, live-attenuated vaccines, etc.) Waste items contaminated with blood and body fluids including cotton dressings, soiled plaster casts, linen and other materials	Incineration
Red (solid non-infectious)	Waste generated from disposable items other than sharps such as tubings, catheters, IV sets	Disinfect by chemical treatment (1% hypochlorite), then either autoclave and later shredding
Blue (sharps)	Needles, syringes, scalpel blades, glass, etc.	Disinfect by chemical treatment (1% hypochlorite), then either autoclave and later shredding
Black (other wastes)	Discarded medicines and left over foods	Taken for landfill

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Additional Precautions

Airborne Precaution

Airborne transmission occurs when droplet nuclei <5 micron in size are disseminated in the air, they can remain suspended in the air for a long time. Diseases which spread by this mode include open/active pulmonary tuberculosis, measles, chickenpox, and other viral infections.

Droplet Precautions

Droplets are usually generated from the infected person during coughing, sneezing, talking or when healthcare workers undertake procedures such as tracheal suctioning. Droplet transmission occurs when there is adequate contact between the mucous membranes of the nose and mouth or conjunctivae of a susceptible person and large particle droplets > 5 microns. Diseases, which are transmitted by this route, include viral and bacterial pneumonias, pertussis, diphtheria, influenza type B, mumps and meningitis. Mouth and nose should be covered during coughing and sneezing. Healthcare persons should wear surgical mask.

Contact Precautions

Diseases which are transmitted by this route include colonization or infection with multiple antibiotic resistant organisms, enteric infections and skin infections. Here patient should be placed in a single room. Clean, non-sterile gloves and gown should be used when entering the room. Patients should be moved from the room for essential purposes only. If transportation is required, then use precautions to minimize the risk of transmission.

KEY POINTS

- Nosocomial or healthcare associated infections (HCAI) are those which manifest among patients only after 48 hours of stay in hospitals.
- These infections lead to significant morbidity, mortality and economic burden.
- Most of the nosocomial infections are present in NICU, PICU, hematology-oncology and neonatal surgery.

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- Nosocomial infections are transmitted by contact, vehicles, air or vectors.
- About 70% of pediatric nosocomial infections are bacterial.
- More than 20% of all hospital-acquired infections can be prevented by simple interventions.
- Hand washing is the single most important step for prevention.
- Hospital waste is a potential reservoir of pathogenic micro-organisms and requires appropriate, safe and reliable handling.

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Infection Control
in Healthcare Settings

Infections are most common situations encountered in day-to-day practice. Hence, its control remains an integral part of pediatric practice both in office as well as in hospital settings. Healthcare professionals should be aware of the routes of infections, transmissions and their preventions. Nosocomial infections or healthcare-associated infections (HAIs) are essentially preventable conditions. Nosocomial infections are important causes of mortality and morbidity in hospitalized patients. It remains a major issue of patient safety and adds the burden of resource use. The prevention of HAIs poses a major challenge to healthcare delivery. The HAI rates have been quality indicators for accreditation of hospitals.

This book provides a comprehensive account of various aspects of prevention of HAIs such as hand washing, droplet precautions and prevention of antimicrobial resistance. This book will be useful for hospitals, pediatricians, infectious disease specialists and nurses.

The contributors and editorial board consist of experts in the field of pediatric infectious diseases and infection control. Their expertise has been conceptualized in this book, which will be a great boon to all readers.

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