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SECOND EDITION

Hospital-Associated Infections: Epidemiology, Prevention & Control

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Foreword
Mrudula A Phadke

JAYPEE

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Chapter 4

Prevention of Hospital Infections

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Chapter Outline

- Exclusion of Sources of Infection
- Breaking the Chain of Infection
- Enhancing the Host's Ability to Resist Infection by Boosting Immunity
- Appropriate use of Antibiotics
- Care of Invasive Devices
- Reducing the Risks of Postoperative Infections

There are three main strategies for preventing hospital infection. They are:

1. Excluding sources of infection from the hospital environment.
2. Interrupting the transmission of infection from source to the susceptible host.
3. Enhancing the host's ability to resist infection.

EXCLUSION OF SOURCES OF INFECTION[1]

Exclusion of inanimate sources of infection can be achieved but it can be difficult to avoid contamination by humans.

Exclusion of inanimate sources can be achieved in many ways, e.g. the provision of sterile instruments and dressings, sterile medicaments and intravenous fluids, use of blood and blood products screened for infectious agents, clean linen and uncontaminated food.

However, when human being is a source of infection, the task becomes more difficult. Hospitals must prevent patient contact with staff that are carriers of infection and relocate them to less hazardous positions. Staff must undergo health screening before employment and must have regular health check-ups. They should report any incidences of infection (e.g. infected cut, bout of diarrhea, etc.). Work restriction for personnel with selected infectious diseases is essential.

Infectious diseases where staffs contact with patient should be avoided:

- Diarrhea
- Hepatitis A
- Herpes simplex on hands (herpetic whitlow)
- *Streptococcus pyogenes* infections (e.g. sore throat, pyogenic infections)

- *Staphylococcus aureus* skin lesions
- Measles
- Mumps
- Whooping cough
- Rubella
- Varicella zoster infections
- Upper respiratory tract infections (high-risk patients).

However, healthy carriers, for example of virulent staphylococci are difficult to identify unless bacteriologic screening is undertaken which is not feasible on routine basis. In addition, hospital staff are sources of opportunistic organisms such as *Coagulase negative staphylococci* or enterobacteria, which are part of their normal flora and cannot be excluded.

BREAKING THE CHAIN OF INFECTION[1]

This is possible in two ways:

1. Breaking the structural chain: Hospital structure and equipment play a role in preventing air-borne spread of infection.
2. Breaking the human chain.

Breaking the Structural Chain

Ventilation Systems in Hospital Wards/ Operating Theaters/Rooms

Ventilation systems and airflow can play an important role in the dissemination of organisms by air-borne route.

Ventilation systems in operating theaters must be properly installed and maintained to prevent the entry of contaminated air and to minimize air currents carrying organisms from the staff in the operating room to the operation site. Ultraclean air is passed through high efficiency filters to remove bacteria and other particles and has been shown to contribute positively to a reduction in the number of postoperative wound infections developing after long orthopedic operations.

Wards comprising separate rooms have been shown to afford protection against airborne spread, and rooms with controlled ventilation are even better. However they neither prevent the carriage of organisms into the room on staff and their clothing, and some studies suggest that this is a more important route of transmission of infection than airborne spread. There is no doubt however that *Legionella* infection is acquired by airborne route and therefore air-conditioning systems should be so maintained so as to prevent multiplication of these organisms. Hospital-acquired *Aspergillus* infection has been attributed to dissemination of the spores in hospital air, especially when building work is going on in the locality.

Isolation of Patient

Isolating patients can also reduce airborne infections significantly. Patient isolation can be carried out in two ways:

a. Protective isolation: Protective isolation to protect a particularly susceptible patient from exposure to pathogens.
b. Source isolation: It protects the spread of pathogens from an infected patient to the others in the ward.

Isolation will also help to prevent the transmission of infection by other routes by limiting access to the patient and this will also help the staff in understanding the importance of contact in the spread of infection.

a. *Protective isolation:* Protective isolation can be provided in a single room in a ward. If possible appropriate positive pressure ventilation should be provided with airflow from the clean patient area out of the room. Staff entering the room or in contact with the patient should wear sterile gowns, gloves and masks to prevent organisms they are carrying or have picked up from other patients from coming in contact with the patient in protective isolation.
b. *Source isolation:* Ideally source isolation is arranged by accommodation in an

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isolation unit in a separate building like tuberculosis sanatoria of the past. In general, source isolation is more often arranged in a separate ward or in a separate room of the main ward. To prevent airborne transmission of organisms from patients' room to the ward, airflow should be from ward to isolation room.

In practice, it is difficult to maintain correct airflows without sophisticated designs, including double doors and air locks.

Breaking the Human Chain

Facilitation of Aseptic Behavior

A general state of cleanliness is essential in the hospital, so the staff should make a habit to practice good techniques. The design of the hospital facilities will affect the ease with which this can be done.

Bacteriologically effective hand washing is one of the most important ways of controlling hospital infection.

The hands of staff transfer the organisms to patients from septic lesions and healthy carrier sites of other patients. They can also transfer organisms from equipment contaminated by these sources and from carrier sites of the staff themselves.

Staff should therefore wash their hands:

- Before any procedure for which gloves or forceps are necessary
- After contact with an infected patient or one who is colonized with multiply resistant bacteria
- After touching infective material.

Soap and water are adequate in most circumstances, but when dealing with infected patients disinfectants are recommended. Drying hands after washing is important. A more prolonged and thorough scrub is required before commencing surgery.

It has been seen that there has been a disappointingly low compliance with the simple technique of hand washing. Therefore, training and regular reinforcement of appropriate behavior is essential.

ENHANCING THE HOST'S ABILITY TO RESIST INFECTION BY BOOSTING IMMUNITY[1]

Boosting immunity and reducing risk factors can enhance host resistance. Although attempts should be made to control and prevent hospital infection by removing sources of infection and preventing transmission from sources to susceptible hosts, these strategies may sometimes fail. So also they do not protect the host from endogenous infection. Therefore, a way could be adopted which would tilt the balance in favor of the host. This can be done by enhancing his/her ability to resist infection, both by boosting immunity and reducing personal risk factors. The following aspects should be considered:

- Boosting specific immunity by active or passive immunization
- The appropriate use of prophylactic antibiotics
- Care of invasive devices that breach the natural defenses, e. g. urinary catheter, intravenous lines.
- Attention to the risks predisposing to postoperative infection.

Boosting Immunity

Passive immunization provides short-term protection, but this is important especially in case of immunocompromised patients, because he/she may not be able to mount an antibody response. Passive immunization can also afford short-term protection in patients who are neutropenic as a result of cytotoxic therapy and whose white cell count should recover after successful treatment. With the advent of hepatitis B vaccine, it is recommended that all seronegative patients in dialysis units (and all staff) should be immunized.

Other immunizations for protection of hospital patients are summarized in Table 4.1.

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Table 4.1: Immunizations for protection of hospital patients

	Active	Passive
1. Elderly (especially Those with multisystem disease)	Influenza vaccine	------
2. Prespleenectomy Prerenal or bone marrow transplant	Pneumococcal vaccine	-------
3. Hemodialysis patient	Pneumococcal vaccine Hepatitis B vaccine	---------
4. Infants born to HbsAg positive mothers	Hepatitis B vaccine	-------
5. Immunocompromised Exposed to varicella-zoster	Live attenuated VZ vaccine in trials	Zoster immune globulin within 3 days to prevent severe disease
6. Exposed to measles	----------	Normal human immunoglobulin within 5 days

APPROPRIATE USE OF ANTIBIOTICS[1]

There are well-documented uses for prophylactic antibiotics, but antibiotics tend to be misused.

There are several well-documented uses for prophylactic antibiotics in dirty surgery and when the consequences of infection would be disastrous (e.g. in cardiac, neuro and transplant surgery). However, there is a tendency to misuse antibiotics.

- First by using them for too long, thereby increasing the selection pressure for the immergence of resistant organisms.
- By choosing inappropriate agents.

Treatment of patients and staff who are carriers of pathogens such as *S. aureus* or *S. pyogenes* has been used successfully to prevent endogenous infection, and to control outbreaks of infection with these organisms. Topical preparations of antibiotics such as bacitracin, neomycin and fucidin, have been used, but there is no doubt that the emergence of resistance is a problem. Pseudomonic acid (mupirocin), a fermentation product of *Pseudomonas fluorescens,* has been shown to be efficacious. It is unrelated to any other class of antibiotic, and is very effective against gram-positive cocci. In recent years, it has played an important role in eradicating carriage of MRSA but resistance is now beginning to emerge.

Gut contamination regimes and selective bowel decontamination to reduce the reservoir of potential pathogens in gut: Gut decontamination regimes to reduce the aerobic gram-negative flora of neutropenic patients have been practiced for sometime. More recently selective bowel decontamination (SBD) has been used especially in intensive care units (ICU). The aim to reduce the reservoir of potential pathogens in the gut by oral administration (or via a nasogastric tube) of a high concentration of mixture of antibiotics (Polymixin + Tobramycin+Amphotericin or a similar combination) to ICU patients throughout their stay in the unit. At present, there is still a controversy about the efficacy and safety of SBD.

CARE OF INVASIVE DEVICES[1]

Care of invasive devices is essential to reduce the risk of endogenous infection, e.g. from skin organisms, and of catheters from peri-urethral flora causing infection of bladder in catheterized patients.

Up to 35% of hospital-acquired bacteremias and majority candidemias are infusion related. They are derived mainly from vascular catheters. Most of the bacteremia associated with invasive devices are caused by patients' own skin flora, although this may be a more resistant flora acquired during

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patients' stay in the hospital, replacing his/her community acquired flora. *S. epidermidis* accounts for more than 50% of infections, but other aerobic bacteria including *S. aureus*, Enterococci, *Coryneforms, various* gram-negative rods and *Candida* are implicated. These infections are largely preventable if appropriate steps are taken.

REDUCING THE RISKS OF POSTOPERATIVE INFECTIONS[1]

Prevention of postoperative infection involves minimizing the risks. This can be done in the following ways:

- The preoperative length of stay in hospital should be kept at minimum.
- Intercurrent infections should be treated appropriately before surgery whenever possible.
- Operations should be kept to the minimum duration and associated with good operating techniques.
- Adequate debridement of dead and necrotic tissue is essential, together with adequate drainage, and maintenance or reestablishment of a good blood supply to provide the body's natural defenses with optimum working conditions.
- Prevention of pressure sores and stasis to minimize the risk of developing respiratory tract infection or UTI or good nursing techniques and active physiotherapy.

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1. Mims C, Playfair J, Roitt I, Wakelin D, Williams R. Medical Microbiology (2nd Edn). CV Mosby International Ltd; 1999.pp.485-90.

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Hospital-Associated Infections:
Epidemiology, Prevention and Control

Salient Features

- A comprehensive book covering all the theoretical and practical aspects of hospital-associated infections
- Provides the updated guidelines for all the device-associated infections, such as catheter-associated urinary tract infections, ventilator-associated pneumonias, catheter-associated bloodstream infections and surgical site infections
- Presents an updated discussion on the most important aspects of disinfection and sterilization
- Deals with postexposure prophylaxis for hepatitis B vaccine (HBV) and human immunodeficiency virus infections, monitoring HBV infections in dialysis unit, examination of dialysis fluid, etc.
- Provides latest guidelines for disposal of waste, use of surgical antimicrobial prophylaxis, infections in intensive care unit, hospital infections associated with various departments, including kitchen, laundry and monitoring of operation theaters, etc.
- Includes new chapters like Central Sterile Supply Department, Antibiotic Policy and Infection Control in Cardiac Catheterization Units
- Useful immensely to the medical students, nursing staff, clinicians, hospital administrators, etc.



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