ASIA PACIFIC SOCIETY OF INFECTION CONTROL

A Handbook of

Infection Control

for the

Asian Healthcare Worker

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4th Edition

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CHAPTER 1

INITIATING NATIONWIDE INFECTION PREVENTION AND CONTROL PROGRAMS IN THE ASIAN CONTEXT

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OUTLINE

A. INTRODUCTION

The field of hospital Infection Prevention and Control (IPC) started in the middle of the 1800s when Semmelweis and Nightingale introduced sanitation and hygienic practices into the hospital. However, modern 'infection control', as practiced today, was initiated when a series of widely publicized hospital outbreaks of *Staphylococcus aureus* infection in the 1950s occurred in North America and the UK. In response to these outbreaks, various healthcare institutions, including the American Hospital Association (AHA), initiated programs for the surveillance and control of these infections.[1] Today, after more than 30 years, such programs are fully integrated into the routine practice of hospitals in the Western hemisphere and are recognized as essential elements of quality practice.[2] Nevertheless, in the developing world, the infrastructure for such programs is still often inadequate. The problem is not simply the lack of resources, but a lack of awareness of the importance of preventing hospital-acquired infections (HAIs).[3]

In Asia, the state of development of IPC practice varies between countries. It is reassuring to know, however, that the movement is vibrant and active in many countries. A group of senior IPC professionals' from 16 countries gathered in Hong Kong, in 1998, to launch the Asia Pacific Society of Infection Control (APSIC). They reported that full-time personnel and infrastructure exist in most of the countries represented. The WHO also has released a guideline on the essential Core Components for Infection Prevention and Control Programmes, first in 2010 and the latest edition in 2016.[4,5] The guideline is now adopted in many countries in Asia.

IPC must now be fully implemented in all countries in Asia. To foster the realization of this goal, this introductory chapter will deal with initiating nationwide hospital IPC programs. Most of the material in the chapter is taken from a paper presented by one of the authors at the 20th International Congress on Chemotherapy in Sydney in 1997.[6] These same principles can be applied to initiate programs for a hospital or a healthcare network. This chapter will be in two sections: an outline of the steps needed for the implementation of an IPC program, and a brief overview of the infrastructure necessary for such a program.

B. STEPS IN IMPLEMENTING NATIONWIDE HOSPITAL INFECTION CONTROL PROGRAMS

Starting IPC programs in a country almost amounts to initiating a new movement in the healthcare arena. The suggested steps listed here are recommendations for the initiator, which could either be an innovative person or group, willing to undertake this task.

Step One: Learn the expertise and skills required for the practice of infection control in the hospital

IPC is a distinct field of knowledge with at least three dedicated international reference journals and a host of national and international professional organizations. It is essential for workers in the field to be fully equipped, especially the person or group seeking to start the movement in the community. There is clear indication that, even for infectious disease specialists and clinical microbiologists, some kind of formal training will be helpful.[7] There are now many training courses available around the world, including the Asia-Pacific region.

Step Two: Collect data on HAIs in the country

It is important to have data that show that HAI is, indeed, a problem in the country. Without such data, it will be difficult to convince the administrative authorities to invest resources for the cause. The simplest way is probably to conduct a prevalence survey. A reasonable protocol is the one developed by the Hospital Infection Society of the United Kingdom.[8] This will also allow approximate comparison of local data with that of the UK. It will naturally be more precise to collect incidence data, but this may be too laborious at this stage. The prevalence survey will be sufficient to document that HAIs are present in the country.

Step Three: Press the health authorities to provide resources and deploy fulltime IPC nurses (IPCNs)

Even a stated national policy will not guarantee the implementation of IPC programs in a hospital. For example, in 1976, the Ministry of Health in Brazil recommended that infection control programs be implemented in all hospitals. However, in 1980, a survey by the College of Surgeons of 3,225 hospitals reported that only 13 hospitals had a nurse involved in infection control activities. In 1995, it was reported that, of the 214 hospitals in São Pãulo, only a few had a well-organized IPC team (IPCT).[9] This experience is common in many countries. It is important, therefore, that we do not strive only for a written policy, but also for the allocation of resources, especially the deployment of full-time IPCNs for the program. To obtain these resources, the data obtained in step two must be presented at the appropriate time to the authorities, and proposals written explaining the need for the resources. The type of resources required will be dealt with in Chapter 7 on “Surveillance”. Persistence is needed, and often several high-profile outbreaks will occur before the authorities are jolted into action, as the historic *Staphylococcus* outbreaks in the 1950s show.

Step Four: Initiate training for IPC personnel

Once the authorities consent to deploy full-time personnel, consisting usually of nurses initially, it is important to provide them with adequate professional training. Sending them overseas is an expensive option, but if the appropriate local experts are co-opted, a reasonable local training course can even be organized. Many countries have microbiologists, epidemiologists and infectious disease specialists who are capable of providing a course that will help healthcare personnel embarking on IPC, if they work together as a team. Nurse specialists from the relevant fields must also be recruited into the faculty to teach patient care practices; unquestionably, a trained IPCN in the teaching team will considerably enhance the value of the course. Such a course was organized in Hong Kong when 14 IPCNs were initially deployed in a single year in 1985. The experience is fully described elsewhere,[10] but the curriculum of that early course is shown in Table 1-1. In fact, the entire curriculum is subsequently condensed into a two weeks full time course. This is now being conducted in several countries, some together with the WHO Collaborating Centre for Infection Control in Hong Kong and also with APSIC. The curriculum is still appropriate and relevant today for the training of full-time IPC personnel. In many localities in Asia, such training courses are still being conducted on a regular basis, as in Hong Kong and Singapore and participations from overseas are most welcomed.

Step Five: Initiate IPC programs at the local hospital level

The benefits of IPC can only be felt when effective programs are initiated within individual hospitals. The infrastructure described in the next section must be instituted and kept functional. This will ultimately depend on the IPCT of the particular hospital, but there are ways to further facilitate the process. In Hong Kong, for example, in 1985, special half-day seminars were organized for the CEOs (known then as ‘Medical Superintendents’) of the various hospitals so that they understood what IPC was and could participate in the implementation process. Government policies on infrastructure can also help. Although it is true that written policies will not guarantee success, after the appropriate personnel are deployed, these policies, if properly drafted, can provide guidance and also ensure cooperation of the hospital administration in the initiation process.

Step Six: Provide vehicles for collaboration and continuing education

As infections are often epidemiologically linked in a community, it is important that IPCNs and doctors in the field communicate on a regular basis. In Hong Kong, such a network is in place for the 44 public hospitals and a central 'IPC Task Force' coordinates activities. A postgraduate infection control day organized on a regular basis for all infection control staff also provides continuing education.

Table 1-1: Curriculum for IPC Course

a) Basic course — day release (20 weeks; 6 hours/week)

1. *Basic IPC: definitions, foundation and role of IPC nurse (IPCN) and IPCofficer (IPCO); formation and function of IPC team (IPCT)*
2. *Basic microbiology and infectious disease*
3. *Microbiology specimens: proper handling and interpretation of results*
4. *Basic epidemiology I (definitions and methods)*
5. *Surveillance techniques and options*
6. *Practical prevalence survey in respective hospitals*
7. *Participation and response to a Public Health Emergency of International Concern.*

b) Advanced course — full-time (2 weeks)

1. *Administration skills for IPCNs*
2. *Infection control in major systems: urinary tract, lower respiratory tract, surgical wounds and infusion therapy*
3. *Infection control for special pathogens: Legionella sp, multidrug-resistant Staphylococcus aureus, multidrug-resistant Gram-negative bacteria, hepatitis viruses, HIV*
4. *IPC in special areas: kitchen, renal unit, burn unit, nursery, operating theatre and the laundry*
5. *The inanimate environment, ventilation, pest control, water in the hospital and waste disposal*
6. *Sterilization, disinfectants and Central Service Department*
7. *Staff health*
8. *Principles and techniques of isolation*
9. *Basic epidemiology II (simple statistics) and outbreak investigation*
10. *Miscellaneous topics: the compromised host, education principles, understanding antibiotics, liaison with community health program.*

C. BASIC INFRASTRUCTURE OF AN IPC PROGRAM

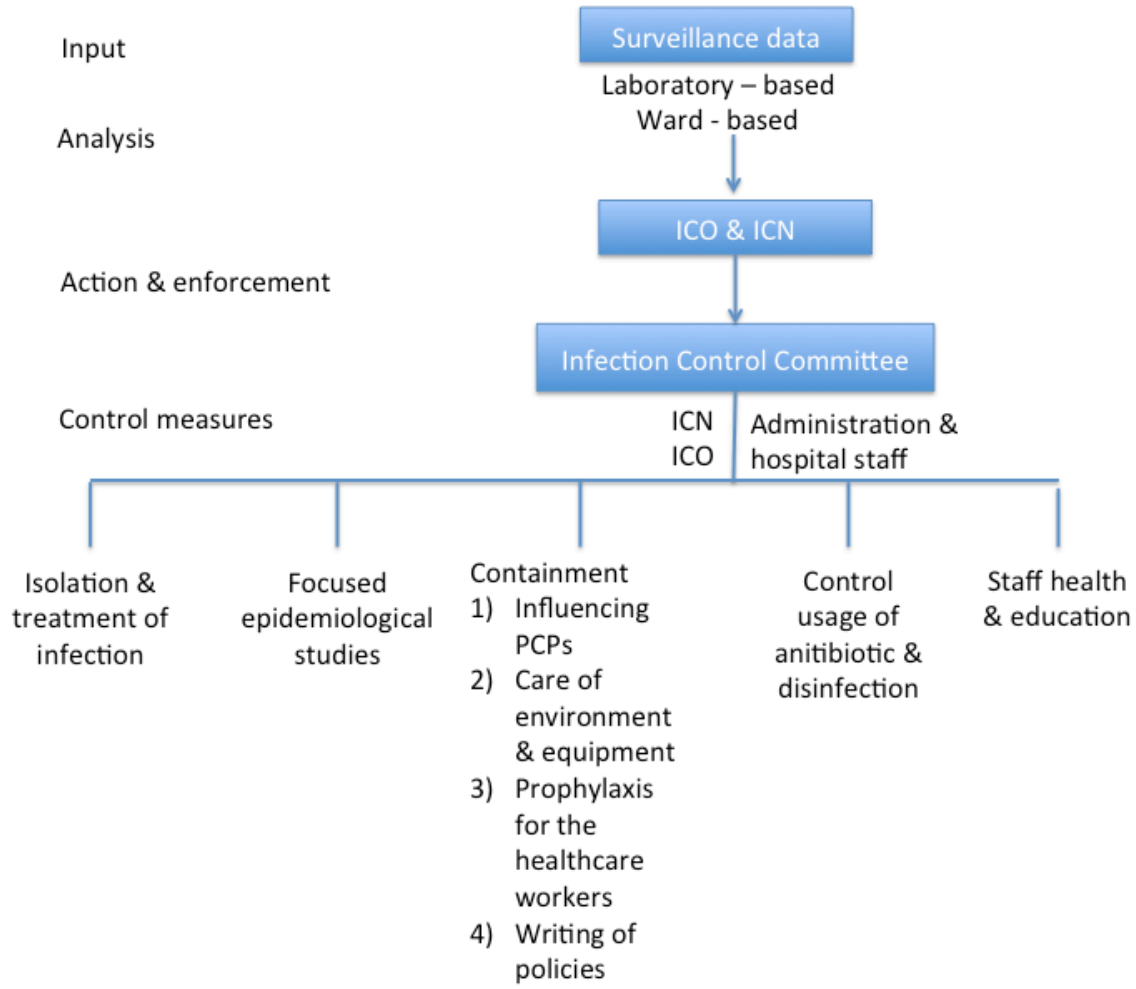
In this next section, the basic infrastructure of an IPC program will be described. The main components are described here, and further information on the control measures will be dealt with in the subsequent chapters.

Figure 1-1 shows the essential infrastructure for an IPC program. The program starts with surveillance, which will require the input of a microbiology laboratory, but must also involve visiting the wards. This is because, for most isolates, the laboratory cannot ascertain whether the bacterium is a pathogen (i.e., causes an infection) or simply a colonizer. Confirmation necessitates examining the patient and, thus, bedside surveillance is essential. After the data are collected, personnel with the relevant expertise must be in position to analyze and interpret the data. This responsibility falls on the IPCT, which consists of one or more full-time IPCNs and a doctor, who is generally given the title 'IPC Officer' (IPCO) in Europe or 'Hospital Epidemiologist' in the USA. The IPCO and the IPCNs must work together as a team. Usually, the IPCO is only deployed part-time, while ICNs are the full-time personnel. Therefore, the IPCNs would be expected to handle most of the 'nuts and bolts' operations of the IPC program and the IPCO would only have a supervisory role. However, it is important to appreciate that they have differing roles in the IPC program, and they must each fulfill their functional role. Only then can we expect optimal efficacy of the IPCT.

The IPCO — who is usually a doctor — would be expected to especially contribute to the following:

1. The proper diagnosis and treatment of infections
2. Guidance on usage and surveillance of antibiotics prescriptions
3. Provision of expertise on clinical epidemiology and statistics
4. Familiarization with infection control issues related to treatment procedures in the hospital
5. Understanding of the workings of doctors in patient care
6. Liaison with all staff in an authoritative manner on IPC issues
7. Education in IPC, especially making it relevant to the doctors

Figure 1-1: Overview of Infrastructure of Hospital IPC Program



IPCO = IPC officer (doctor); IPCN = IPC nurse; PCP =patient-care practice

The IPCNs — usually nurses — would be expected to especially contribute to the following:

1. Completing the daily routine work needed in the program, especially surveillance and implementation of control measures
2. Implementation of correct patient-care practices for infection prevention, as nurses are generally most familiar with the patient care practices in the hospital
3. Supervising the appropriate use of disinfectant
4. Familiarization on the working routine in the wards and central sterilization
5. Understanding of the workings of nurses, paramedical and minor staff
6. Liaison with all staff in a less threatening manner on IPC issues
7. Education in IPC, especially making it relevant to the nonmedical staff.

An IPC committee (IPCC) must be established with the help of the hospital administration to oversee the entire infection control program. The IPCC meets regularly to receive reports of surveillance data,

and the plans and activities of the IPCT. As the work of infection control involves the implementation of hospital-wide policies, the IPCC will help by providing the necessary administrative authority for the IPCT. The members of the IPCC must, therefore, have sufficient seniority and breadth to ensure that the IPCC has this authority.

Next, the IPCT, with the help of the administration and all hospital staff, implements infection containment measures. These measures fall into five main categories:

1. Patients who are already infected must be appropriately isolated and treated.
2. Some IPC problems identified in the course of the hospital-wide surveillance program will require further study. Usually, this will take the form of further surveillance or data collection and is listed in Figure 1-1 as 'focused epidemiological studies', as the activity is focused on a particular issue.
3. A host of activities must be activated for containment of infections. The most important are those designed to influence and implement good patient care practices (PCPs). The PCP known to all is handwashing or hand hygiene as it is known now, but there are many others that will be discussed in this handbook. Influencing PCPs is crucial because it is now known that most HAIs are caused by inappropriate PCPs.[11] Other containment measures that must be included in this category include proper care of the hospital environment and equipment, prophylaxis for hospital staff and writing official infection control policies for the hospital.
4. The use of disinfectants and antibiotics in the hospital needs to be controlled. Traditionally, unlike disinfectants, the use of antibiotics is not within the portfolio of the IPCT, because it pertains to treatment rather than prevention of infections. Nevertheless, infection control personnel are increasingly being drawn into controlling the usage of these compounds because the spread of antibiotic-resistant bacterial strains, an important worldwide problem, is viewed as intimately related to infection control.
5. Education of and protection for the hospital staff is required. Staff education is vital in infection control because it is the primary way to influence PCPs, which is crucial in any infection control program.

One document that will be extremely helpful for countries seeking to set up the basic organization of an IPC program can be obtained by download from the WHO website [http://www.who.int/csr/resources/publications/WHO_HSE_EPR_2009_1/en/]. This is the "Core Components for Infection Prevention and Control Programs" written in 2008[12]. In the WHO, there are frequent requests to define the essential core components for the development of effective IPC programs. A meeting was convened in 2008 with experts from four continents and WHO representatives of four regional offices to identify these components and related research priorities. Eight core components were identified, and they are related to organization infrastructure, establishing

technical guidelines, human resources, surveillance, microbiology laboratory services, environmental issues, monitoring of the infection control programs and links with public health and other services.

In conclusion, it must again be stated that it is important for all healthcare workers to participate in the hospital IPC program. Much morbidity and even mortality can result from HAIs. Any commitment to patient care must entail the prevention of these illnesses. This spirit is aptly captured in Florence Nightingale's statement that "*above all, a hospital must do the patient no harm*".

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CHAPTER 2

EMERGING INFECTIONS

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OUTLINE

A. METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS

Methicillin-resistant *Staphylococcus aureus* (MRSA) was first recognized in 1961 in the UK. Thereafter, hospital outbreaks were reported in the UK, Europe and the USA in the late 1970s. Factors associated with its acquisition include prolonged prior admission, previously administered antimicrobials, especially β-lactams, proximity to other colonized or infected patients and admission to an intensive care unit (ICU).

Mechanism of methicillin resistance[1]

1. Intrinsic methicillin resistance

   This is due to the production of penicillin-binding protein (PBP) 2, which has a low affinity for various β- lactams. The resistance is chromosomally mediated and encoded by the *mec* gene. The strain is usually associated with multiple resistance mechanisms to antimicrobials of several classes.
2. Acquired or borderline resistance (BORSA)

   This is due to the hyperproduction of penicillinase. It is recognized in vitro by the presence of minute colonies within the zone of inhibition around the oxacillin disk or a very small zone of inhibition around the penicillin (10 U) disk. The minimum inhibitory concentration (MIC) to oxacillin is in the range of 1–2 µg/mL. Large zones of inhibition are seen with clavulanate- or sulbactam containing disks. Generally, the strain is not multi-resistant.
3. Methicillin-intermediate S aureus (MODSA)

   The MIC to oxacillin is in the range of 1–2 µg/mL, but the strain produces low-affinity PBPs 1 and 2 and elevated quantities of PBP 4.

Therapy

The drug of choice for the treatment of MRSA is a parenteral glycopeptide, vancomycin or teicoplanin. Borderline resistant strains due to the hyperproduction of penicillinase may be treated with high-dose cloxacillin.

Prevention and control[2]

1. Surveillance
   a) Laboratory-based surveillance will detect MRSA among patients for whom cultures are available, but MRSA infection in patients for whom cultures are not available will not be detected. The microbiology laboratory should use approved methods for the antimicrobial susceptibility testing, e.g., those of the US National Committee on Culture and Laboratory Standards (NCCLS).
   b) A line listing of MRSA cases for easy reference will be useful. The information needed would include: name of patient, room and bed number, age, sex, date of admission, clinical discipline,

site of infection or colonization, date of first MRSA-positive culture and date of transfer/ discharge.

c) Routine screening for MRSA in patients is not recommended except in cases of suspected outbreaks. In that case, culture samples should be taken from the anterior nares of the patient.

d) Screening for MRSA in patients who are at high risk of having MRSA at the time of admission is a costly measure. It is only practical in situations where MRSA colonization is relatively common in the facility from which the patient is transferred, e.g., another hospital or nursing home.

e) As MRSA patients remain colonized for a long period, it may be useful to screen known MRSA cases upon readmission. In this case, the database record of the patient may be flagged in the computer so that the patient's status is known upon readmission and Contact Precautions can be implemented immediately by the hospital staff.

2. Isolation or cohort nursing

   The placement of patients in single rooms will help staff in the implementation of Contact Precautions for the patient. However, as many hospitals have inadequate isolation facilities, cohorting patients in the same room is a practical alternative measure. As it is known that MRSA is transmitted mainly via direct contact, it may not be necessary to isolate all MRSA cases if Standard Precautions are a routine practice in the hospital. It is critical that hand hygiene be practiced diligently according to WHO guidelines. Isolation or cohorting, however, is necessary for patients who have MRSA respiratory infections or wounds that cannot be adequately covered.

3. Management of colonizers or carriers

   a) Decolonization therapy is not recommended, as it has been shown to result in the emergence of resistance to the agents used. Therefore, this measure should only be considered for use during outbreaks.

   b) Healthcare workers found to be nasal culture positive for MRSA on one occasion may not necessarily be the source of MRSA transmission. In contrast, healthcare workers with colonized or infected skin lesions, or dermatitis and persistent nasal carriage, are more likely to transmit MRSA to patients. Hence, it is recommended that nasal screening for MRSA in healthcare workers be carried out in facilities where MRSA is endemic with serious infections and in outbreak situations. Topical mupirocin is the most effective regimen for the eradication of nasal carriage of MRSA in most healthcare workers. If that fails, a combination regimen of two of the following oral agents may be used after the antimicrobial susceptibility of the isolate has been confirmed by the microbiology laboratory: rifampicin, trimethoprim/sulphamethoxazole, minocycline, ciprofloxacin.

4. Treatment of infected patients[3]

   Infected patients require parenteral glycopeptide therapy. Because of the associated toxicity with the use of vancomycin, serum concentrations of the drug must be monitored closely.

B. VANCOMYCIN-INTERMEDIATE OR –RESISTANT S. AUREUS

The first isolate of *S. aureus* with intermediate resistance to vancomycin (MIC = 8 µg/mL) was reported in Japan in May 1996.[4] Since then, three other reports of vancomycin-intermediate *S aureus* (VISA) isolated in the USA were made in 1997–8.[5,6] The resistance is not the result of transfer of enterococcal vancomycin resistance genes (*vanA* or *vanB*) and it is believed that prolonged intermittent use of vancomycin in the treatment of MRSA infections is the likely factor leading to the development of VISA.[7]

The method of prevention of the development of VISA or vancomycin resistant *S aureus* (VRSA) is, therefore, the prudent use of vancomycin. Contact Precautions are adequate as a measure to prevent the transmission of organisms from person to person. It is the responsibility of the microbiology laboratory staff to ensure that correct methods are being used to be able to detect VISA or VRSA.

C. VANCOMYCIN-RESISTANT ENTEROCOCCUS SPECIES

Enterococcus species are Gram-positive cocci that are part of the normal flora of the gastrointestinal and genitourinary tracts. Hospital-acquired infections (HAIs) due to *Enterococcus* species comprise 12% of all HAIs. The risk factors for HAIs are patients' underlying diseases, length of hospital stay, prior surgery, renal insufficiency, intensive care setting, presence of urinary or vascular catheters, broad-spectrum antimicrobial therapy or use of vancomycin.

Vancomycin-resistant enterococci (VRE) have recently emerged as significant hospital-acquired pathogens. They were first reported in France, in 1986, and then in the USA, in 1989. Shortly after that, increasing numbers were isolated in hospitals in Europe and the USA. Most of the isolates reported in the USA are *Enterococcus faecium*, whilst those in Europe are *E faecalis.* The epidemiology of the spread of VRE in hospitals involves patient–patient transfer, contaminated equipment, and possibly transmission through the food chain.

Mechanism of vancomycin resistance[8,9]

Resistance develops through the acquisition of a series of novel genes that enable the bacterium to build a new cell wall that no longer contains the binding site for vancomycin. The origin of these genes is unknown. In Europe, the oral administration of avoparcin as a feed additive in animal husbandry has probably favored the intestinal carriage of glycopeptide-resistant enterococci outside hospitals via the food chain. VRE have been isolated from pigs and chickens in German and Danish

farms. In North America, the heavy use of both intravenous and oral vancomycin in hospitals has probably led to the selection of resistant enterococci. The genetic transfer of resistance is postulated to be due to plasmids and transposons.

Treatment options

1. Teicoplanin may be used if the organism is susceptible to it, e.g., vanB strains
2. Combination regime of penicillin, ampicillin or glycopeptide with an aminoglycoside for synergistic activity
3. Chloramphenicol has been used for *vanA E faecium* with 57% success and is worth trying
4. Quinupristin/dalfopristin, but this is not active against *E faecalis*
5. For urinary tract infections, nitrofurantoin or quinolones may be useful.

Control and prevention of VRE

Recommendations from the US Hospital Infection Control Practices Advisory Committee (HICPAC), 1994, on the prevention of the spread of vancomycin resistance include:[10]

1. Prudent vancomycin use

   Hospitals are recommended to develop an education programme on antimicrobial utilization for their medical staff (including medical students), oversee surgical prophylaxis and develop guidelines for the proper use of vancomycin. These should include situations in which use is appropriate and those when it should be discouraged.

2. Educational programmes

   Continual updates on the epidemiology of VRE and its impact on patient outcome and cost should be given to all medical staff.

3. Laboratory surveillance

   This may be conducted in the following manner:

   a) Antimicrobial susceptibility survey with periodic testing on enterococci recovered from all specimen sources, especially from high-risk patients, e.g., those from ICUs, or oncology or transplant wards.

   b) Culture survey of stools or rectal swabs of high-risk patients (as above). The prompt and accurate identification of VRE by the microbiology laboratory is the first-line of defense against the spread of VRE in the hospital.

4. Policy

   a) Notify appropriate hospital staff promptly.

   b) Isolate or cohort colonized/infected patients, institute contact precautions and reinforce handwashing practices.

   c) Dedicate use of non-critical items to a single patient or cohort.

d) Screen patients (rectal swab or stool culture) who share a room with colonized/infected patients.
e) Remove patients from isolation precautions after at least three consecutive negative cultures from multiple body sites (including stool or rectal swab) taken at least 1 week apart.
f) Flag records of colonized/infected patients so that isolation precautions are carried out upon readmission.
g) Consult local and state health departments on the discharge of patients to nursing homes.

Table 2-1: Characterization of Vancomycin-resistant Enterococci (VRE)

Gene	MIC_{van}(µg/mL)	MIC_{tei}(µg/mL)	Strains	Comments
vanA	≥ 64	≥ 16	*Enterococcus faecium, E faecalis*	Indelible, plasmid or transposon-mediated by conjugation
vanB	4 to ≥ 128	0.5–1	*E faecium, E faecalis*	Indelible, transferable by transposon via conjugation
vanC	2–32	0.5–1	*E gallinarum, E casseliflavus*	Constitutive expression, not transferable
vanD	16–64	2–4	*E faecium*	Not transferable by conjugation
MICvan = minimum inhibitory concentration of vancomycin; MICtei = minimum inhibitory concentration of teicoplanin.				

D. EXTENDED-SPECTRUM B-LACTAMASE-PRODUCING BACTERIA

What are ESBLs?

Extended-spectrum β-lactamases (ESBLs) are plasmid-mediated β-lactamases derived from TEM-1 or TEM-2 and SHV-1 enzymes.11 They confer resistance or decreased susceptibility to third-generation cephalosporins, e.g., cefotaxime, ceftazidime and ceftriaxone, and other β-lactams such as aztreonam. They usually do not affect the activity of cephamycins (cefoxitin, cefotetan, moxalactam) or carbapenems (imipenem, meropenem). They are produced by Enterobacteriaceae, predominantly Klebsiella species and Escherichia coli. They are inactivated by β-lactamase inhibitors such as clavulanic acid, sulbactam or tazobactam.

Emergence

ESBLs arise from mutations of a single amino acid substitution in an existing enzyme. This is probably due to the selection pressure from widespread use of late-generation cephalosporins, which enhances the colonization of resistant strains in the gastrointestinal tracts of patients. The enzymes can spread rapidly between unrelated bacteria, and often co-transfer resistance to other structurally related drugs such as aminoglycosides and trimethoprim/sulphamethoxazole.

Significance

ESBLs were first reported in Germany in 1983 and they spread rapidly across Europe in the mid-1980s. In the late 1980s, they appeared in the USA,12 and since then have been entrenched in many hospitals worldwide. Their prevalence varies from institution to institution. Hospital outbreaks have been reported worldwide, too.

Prevention and control

Like many other multi-resistant organisms, once ESBL-producing organisms invade a hospital, it is quite difficult to eradicate them. Termination of empirical ceftazidime monotherapy has helped in controlling outbreaks. Other effective control measures include Contact Precautions. In a long-term effort to reduce the incidence of ESBL-producing organisms in an institution, the implementation of an antimicrobial policy involving discouraging the use of cephalosporins and encouraging the use of penicillins or another class of antimicrobial has proven to be effective. Early detection and prompt containment is the key to the limitation of the spread of these multi-resistant organisms.

Treatment of ESBL infections

Imipenem is the most active drug against ESBL-producing organisms, but some have noted a rise in the incidence of imipenem-resistant *Acinetobacter baumannii* infections with the increased use of imipenem.

E. CARBAPENEMASE PRODUCING CARBAPENEM RESISTANT ENTEROBACTERIACEAE (CPE)

Introduction

This was first detected in a *Klebsiella pneumoniae* isolate in 2008 from a Swedish patient of Indian origin[13]. Initially, it was reported in increasing numbers of infections in patients from India, Pakistan, and the United Kingdom; but lately, it is noted to have a wider epidemiology with isolates reported from other countries. Initially identified in both *E.coli* and *Klebsiella pneumoniae*, it has now been identified in many *Enterobacteriaceae* species and *Acinetobacter* species. The most commonly encountered carbapanemase in CP-CREs are:

a) Klebsiella pneumoniae carbapenemase (KPC)
b) New Delhi metallo-β-lactamase (NDM)
c) Oxacillinase (OXA)
d) Others such as Verona Integron-encoded metallo-β-lactamase (VIM) and Imipenemase Metallo-β-lactamase (IMP)

Mechanism of resistance

It is believed that the resistance came about from inappropriate use of antimicrobials, especially in countries where antimicrobials can be easily bought over the counter.

Prevention and control

Contact precautions will apply in preventing the transmission of the bacterium from patient to patient. As the epidemiology shows its high association with antimicrobial use, it is highly recommended that antibiotic stewardship program be implemented to help curb further the growing threat of resistance.

F. SEVERE ACUTE RESPIRATORY SYNDROME (SARS- COV-1)

Introduction

This is a new severe febrile respiratory illness caused by the SARS-associated coronavirus (SARS-CoV-1).[14] It was first recognized on 12 March 2003 and quickly spread worldwide involving 8,429 probable cases and 813 deaths in 29 countries. The origin of the virus is believed to be the civet cat.

Clinical features

The mode of transmission is via direct contact and droplet transmission. Median period of incubation is 4–6 days with most patients becoming ill within 2–10 days after exposure. Initial symptoms include fever, myalgia and headache, with respiratory symptoms of non-productive cough and dyspnoea appearing 2–7 days later. In 70–90% of cases, pneumonia develops and the overall case fatality rate is 10%; this may increase to > 50% in those above 60 years of age. There are no effective vaccines or treatment for this disease.

Prevention and control

Epidemiological data suggest that transmission does not occur before the onset of symptoms and that most transmission occurs late in illness when the patients are hospitalized. The early identification of a case is important for immediate single room isolation to prevent an outbreak. Strict contact and droplet precautions are adequate in preventing further transmission of the virus. The use of proper hand hygiene practices, and careful removal of used gloves and gowns are equally important preventive measures, too. For aerosol-generating procedures, it may be advisable to use the N95 mask to prevent inhalation of any droplet nuclei created.

G. COVID-19

Introduction

This is a new severe febrile respiratory illness caused by the virus SARS-CoV-2, a coronavirus. It was first reported on 31 December 2019 in Wuhan, China but quickly spread worldwide as a pandemic involving more than 16 million cases and more than 600,00 deaths. The origin of the virus is still unknown.

Clinical features

The mode of transmission is via direct contact and droplet transmission. Median period of incubation is 2–14 days with most patients becoming ill within 5 days after exposure. Common signs and symptoms include fever, cough and tiredness but may also include loss of taste or smell. Most cases are very mild but about 20% require management in a healthcare setting. The following have a higher risk of serious illness:

a) Elderly >60 years old
b) Serious heart disease e.g., heart failure, coronary artery disease or cardiomyopathy
c) Cancer
d) Chronic obstructive pulmonary disease (COPD), asthma
e) Diabetes
f) Severe obesity
g) Chronic kidney disease
h) Immunocompromised host e.g., solid organ transplant patients

The disease can cause severe medical complications e.g., thrombosis, organ failure, additional viral and bacterial infections. The overall case fatality rate is about 2%. There is no specific antiviral treatment for COVID-19. However, vaccines are now available against SAR—CoV-2. Management is largely symptomatic treatment and isolation.

Prevention and control

Epidemiological data suggest that transmission is highest in acute phase of infection. The early identification of a case is important for immediate single room isolation to prevent an outbreak. Strict contact and droplet precautions are adequate in preventing further transmission of the virus. The use of proper hand hygiene practices, careful removal of used personal protective equipment as well as environment and equipment hygiene are equally important preventive measures, too. For aerosol-generating procedures e.g., intubation or extubation, it is advisable to use the N95 respirator and eye protection.

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CHAPTER 3

IPC ISSUES FOR REGIONAL INFECTIOUS DISEASES

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OUTLINE

A. TYPHOID

Etiology: *Salmonella typhi*

Transmission: Food-borne, water-borne, contact with infected animals, direct person–person transmission via fecal–oral route

Incubation period: 3–60 days, usually 7–14 days

Diagnostic tests

Cultures of stool, blood, urine, bone marrow aspirate; Widal's test may suggest an infection, but false-positive and false-negative results do occur and, hence, the test is unreliable.

Precautions and control measures

Standard Precautions are usually adequate. However, Contact Precautions are recommended for diapered and/or incontinent patients for the duration of illness. Infected children should be excluded from childcare centre activities until cultures of three consecutive stool specimens obtained after cessation of antimicrobial therapy are negative for *S typhi*.

The following precautions should be taken:

- Proper sanitation methods for food processing and preparation
- Sanitary water supplies
- Proper handwashing and personal hygiene
- Sanitary sewage disposal
- Exclusion of infected persons from handling food

Raw eggs and food containing raw eggs should not be eaten. Eggs and other foods of animal origin should be cooked thoroughly.

Several typhoid vaccines are available. Parenteral inactivated vaccine causes more adverse reactions and is no more effective than the oral Ty21a or Vi CPS vaccine.

B. TUBERCULOSIS

Etiology: Mycobacterium tuberculosis mainly; M. bovis occasionally, M. africanum rarely

Transmission: Inhalation of droplet nuclei

Incubation period: 2–12 weeks (usually within 10 weeks; median of 3–4 weeks) from infection to development of a positive reaction to tuberculin skin test; years may elapse between infection and development of disease

Diagnostic tests

- Microscopy — acid-fast bacilli in sputum, early morning aspirates, pleural fluid, cerebrospinal fluid, urine, other body fluids or biopsy material
- Cultures of these specimens
- Polymerase chain reaction (PCR) for respiratory specimens
- DNA fingerprinting by restriction fragment length polymorphism (RFLP) for epidemiological evaluation
- Chest x-ray and tuberculin skin testing for asymptomatic cases

The Mantoux skin test results should be read by experienced healthcare professionals trained in the proper assessment of readings for reliability.

Precautions and control measures

Airborne Precautions should be instituted for pulmonary tuberculosis patients until the patient has received 2 weeks of effective anti-tuberculosis therapy; or has three consecutive negative sputum smears.

The following control measures should be taken:

- Appropriate effective antimicrobial regime (directly observed therapy)
- Close follow-up and evaluation of infected patients
- Contact tracing and treatment/prophylaxis of contacts
- Bacille Calmette-Guérin (BCG) vaccine for young infants to prevent disseminated and other life-threatening tuberculosis
- Good national surveillance system for prompt notification, identification, and management of outbreaks.

C. HEPATITIS A

Etiology: Hepatitis A virus (HAV), an RNA virus in the picornavirus (enterovirus) group
Transmission: Person–person via fecal-oral contamination and oral ingestion of contaminated water
Incubation period: 15–50 days, average of 25–30 days

Diagnostic tests

Anti-HAV immunoglobulin (Ig)M and IgG tests — serum IgM is present at onset of illness and usually disappears within 4 months but may persist for 6 months or longer; anti-HAV IgG is detected shortly after the appearance of IgM.

Precautions and control measures

Standard Precautions are adequate for most patients. However, Contact Precautions are recommended for diapered and/or incontinent patients for 1 week after onset of symptoms. Improved sanitation and personal hygiene should be instituted. Children and adults with acute HAV infection should be excluded from activities at schools, childcare centres and workplaces for 1 week after the onset of illness.

Intramuscular Ig is 80–90% effective if given within 2 weeks after HAV exposure. Hepatitis A vaccines are available in pediatric and adult formulations.

D. HEPATITIS B

Etiology: Hepatitis B virus (HBV), a DNA hepadnavirus

Transmission: Blood or body fluids that are hepatitis B surface antigen (HBsAg)-positive

Incubation period: 45–160 days, average of 120 days

Diagnostic tests

- Serological tests — HBsAg, hepatitis B early antigen (HBeAg), anti-hepatitis B core protein (HBc) IgM, anti-HBc IgG
- PCR or branched DNA methods to quantitate HBV-DNA

Precautions and control measures

- Standard Precautions for patients with acute or chronic HBV infection
- Hepatitis B vaccine for pre- and post-exposure prophylaxis
- Hepatitis B Ig is effective if given within 72 hours after exposure

E. VARICELLA ZOSTER

Etiology: Varicella zoster virus, a herpesvirus

Transmission: Person–person transmission by direct contact, occasionally by airborne spread from respiratory secretions and, rarely, from zoster lesions

Incubation period: 14–16 days

Diagnostic tests

- Antigen detection from vesicular lesions during the first 3–4 days of eruption by immunofluorescent staining or culture
- Serological tests include enzyme immunoassay and indirect fluorescent antibody

Precautions and control measures

Airborne and Contact Precautions for:

- Infected patients for a minimum of 5 days after onset of rash and as long as rash remains vesicular
- Susceptible patients from 8 until 21 days after onset of rash in index patient; maintain precautions until 28 days after exposure for those who received varicella zoster Ig (VZIG)
- Immunocompromised patients for the duration of illness.

Standard Precautions should be followed for normal patients with localized zoster until all lesions are crusted.

Varicella vaccine is effective if used within 3–5 days of exposure for post-exposure prophylaxis.

VZIG is suitable for susceptible individuals at high risk of developing severe varicella and should be given within 96 hours for maximum effectiveness.

F. SCABIES

Etiology: Sarcoptes scabiei subsp. hominis
Transmission: Close personal contact
Incubation period: 4–6 weeks

Diagnostic tests

Identification of the mite or eggs from skin scrapings

Precautions and control measures

- Contact Precautions until patient has been treated with appropriate scabicide
- Prophylactic therapy for household members
- Bedding and clothing worn next to the skin during the 4 days before initiation of therapy should be washed in hot water.

G. INFLUENZA

Etiology: Influenza virus
Transmission: Person–person by direct contact, large droplet infection, or articles contaminated by nasopharyngeal secretions
Incubation period: 1–3 days

Diagnostic tests

- Rapid antigen detection in nasopharyngeal aspirate by immunofluorescence test
- Culture of nasopharyngeal aspirate obtained during the first 72 hours

Precautions and control measures

- Droplet Precautions
- Influenza vaccine for immunosuppressed patients and travellers to outbreak areas.

H. ENTEROVIRAL INFECTIONS

Etiology: Enterovirus

Transmission: Fecal–oral and direct contact with respiratory routes. The virus may survive on environmental surfaces for long periods to allow transmission via fomites

Incubation period: 3–6 days for hand-foot-mouth disease

Diagnostic tests

Rapid virus culture (Shell vial) and direct detection by molecular technique (reverse transcription [RT]-PCR) of throat, stool and rectal swabs or cerebrospinal fluid. Serological tests are of limited value.

Precautions and control measures

- Standard Precautions for adult patients
- Contact Precautions for children and infants for the duration of illness.

I. SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

Etiology: SARS-CoV (SARS-associated coronavirus)

Transmission: Person–person transmission via direct contact and/or droplets. The virus may survive on environmental surfaces for long periods to allow transmission via fomites

Incubation period: 2–10 days

Diagnostic tests

- Direct detection by molecular technique (RT-PCR) and confirmed by second reference laboratory of two clinical specimens of different sources (e.g., nasopharyngeal swab and stool) OR two different clinical specimens taken from same source on 2 different days (e.g., two nasopharyngeal aspirates).
- Isolation in cell culture of SARS-CoV from a clinical specimen and PCR confirmation validated by the Centers for Disease Control and Prevention (CDC)
- Detection of serum antibodies to SARS-CoV by a validated test (e.g., ELISA) and confirmed by second reference laboratory from a single specimen, OR a 4-fold or greater increase in antibody titre between acute and convalescent phase serum specimens tested in parallel, OR a negative antibody test on acute phase serum with positive test on convalescent-phase serum tested in parallel.

Precautions and control measures

- Contact and Droplet Precautions for period of illness
- Airborne Precautions advisable when performing aerosol-generating procedures

J. COVID-19 (SARS-COV-2)

Etiology: SARS-CoV-2

Transmission: Person–person transmission via direct contact and/or droplets. The virus may survive on environmental surfaces for long periods to allow transmission via fomites

Incubation period: 2–14 days

Diagnostic tests

- Direct detection by molecular technique (PCR) of two clinical specimens of different sources (e.g., nasopharyngeal swab and oropharyngeal swab) OR two different clinical specimens taken from same source on 2 different days (e.g., two nasopharyngeal or oropharyngeal aspirates).

Precautions and control measures

- Contact and Droplet Precautions until day 21 from date of onset of symptoms
- Airborne Precautions advisable when performing aerosol-generating procedures e.g., intubation or extubation

CHAPTER 4

ISOLATION PRECAUTIONS AND PRACTICES

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OUTLINE

A. HISTORY

Different isolation systems have been designed since the 1970s. In 1983, the US Centers for Disease Control and Prevention (CDC) modified its recommendations to category-specific, disease-specific and facility-designed systems. In 1984, Lynch et al developed Body Substance Isolation (BSI), which uses gloves for touching moist body sites.[1] Largely in response to the HIV/AIDS epidemic, in 1987, the CDC developed specific strategies for blood-borne infections (Universal Precautions).

The category-specific isolation system divides precautions into seven groups, namely strict, contact, enteric, acid-fast bacilli, respiratory, blood and body fluid, and wound and drainage. Each category has specific procedures for special disease groups. The advantage is that it is very easy to follow, although over-isolation is common. The disease-specific system is more discriminate in the implementation of precautions, yet it is difficult to follow because there are too many infectious diseases.

In 1996, the CDC developed a revised guideline for Isolation Precautions in hospitals that has two components[2]:

1. **Standard Precautions** for the care of all patients. This is similar to the Universal Precautions except that gloves are indicated for touching all moist areas on patients including excretions and secretions — that is, it is a combination of the Universal Precautions and BSI.
2. **Transmission-based Precautions** are based on patients diagnosed or suspected infections that are transmitted by the airborne, droplet or contact routes or with infection or colonization with epidemiologically important organisms.

Airborne Precautions are used for infections spread by droplet nuclei smaller than 5μ. Three diseases transmitted by air are pulmonary tuberculosis (TB), chickenpox and measles. **Droplet Precautions** are for infections transmitted by bigger droplets (>5μ) such as influenza and respiratory syncytial virus. **Contact Precautions** are for patients known or suspected to be colonized or infected with epidemiologically important organisms such as multidrug-resistant organisms (MDRO) like multidrug resistant *Staphylococcus aureus* (MRSA) or vancomycin-resistant *Enterococcus* (VRE) species etc.

The Transmission-based Precautions encompass a comprehensive guideline to include infection prevention for blood-borne, airborne, droplet and contact infections. It is simple to apply, but each institution must have an assessment system in place to facilitate routine evaluation of patients for defined clinical syndromes.

B. GUIDELINES ON ISOLATION PRECAUTIONS

Two international guidelines on isolation precautions are published after the SARS 2003 outbreak by the Center for Diseases Control (CDC) in the United State of America as well as the World Health

Organization (WHO). They are evidence-based guidelines after intensive review of hundreds of scientific literatures. Many of the recommendations are practical for the local setting.

I. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings- CDC[3]

In the revised guideline, the basic isolation techniques of Standard Precautions and Transmission-based Precautions are similar to the one published in 1996. There are several important changes updated that include:

1. The term nosocomial infection is replaced by "healthcare-associated infection" because the transition of healthcare delivery now extends from acute care hospitals to day surgery and even homecare. Thus, the term "healthcare-associated infections" widened the scope to cover infections that may be acquired in all healthcare settings.
2. The emergence of new pathogens such as SARS-CoV, associated with severe acute respiratory syndrome (SARS), avian influenza and re-emergence of evolving known pathogens such as *C. difficile*, norovirus, community-acquired MRSA and the development of multiple drug resistant organisms, establish a need to address a wider scope of issues than in the past.
3. New additions to the Standard Precautions are Respiratory Hygiene / Cough Etiquette and safe injection. The need of Respiratory Hygiene / Cough Etiquette is based on the observations during the SARS outbreak where failure to implement simple source control measures with patients, visitors and healthcare workers with respiratory symptoms may have contributed to SARS-CoV transmission. Injection safety is emphasized due to the continued occurrence of hepatitis B and hepatitis C in many ambulatory care settings specifying a need to restate the importance of safe injection as part of standard precautions.

   The CDC guideline for isolation is updated frequently in response to changes in healthcare delivery and addresses new concerns about transmission of emerging and reemerging infectious agents to patients and healthcare workers.

In 2014, after the Ebola outbreak in West Africa, the Ebola Virus Disease (EVD) isolation precautions are updated based upon the considerations of high rate of morbidity and mortality among infected patients, risk of human-to-human transmission and lack of FDA-approved vaccine and therapeutics. Three key points added:

1. CDC recommends a combination of measures to prevent transmission of EVD in hospitals including PPE. These should be implemented in addition to routine IPC practices on a daily basis to prevent transmission of infectious diseases from patient to patient and patient to healthcare personnel.

2. Healthcare personnel might need to take additional IPC steps if a person under investigation or patient with confirmed EVD has other conditions or illnesses caused by specific infectious diseases, such as tuberculosis.
3. Healthcare personnel can be exposed to Ebola virus by touching a patient's body fluids, contaminated medical supplies and equipment, or contaminated environmental surfaces. Splashes to unprotected mucous membranes (for example, the eyes, nose, or mouth) are particularly hazardous. Procedures that can increase environmental contamination with infectious material or create aerosols should be minimized.

The Ebola viral disease update was supplemented with three new recommendations as follows:

1. Infection Prevention and Control Recommendations for Hospitalized Patients with Known or Suspected Ebola Virus Disease in U.S. Hospitals.[4]
2. Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus.[5]
3. Ebola Virus Disease for Healthcare Workers [2014]: Updated recommendations for healthcare workers can be found at Ebola: for Clinicians.[6]

Noroviruses gastroenteritis precaution was updated in May 2019 in response to the continuous outbreaks in the healthcare setting and in the community. The new recommendation is to include Contact Precautions in addition to Standard Precautions during outbreaks, for a minimum of 48 hours after the resolution of symptoms to prevent further exposure of susceptible patients. This is to align with Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings (updated in 2017). [7]

II. WHO Interim Guideline 2007 - Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases (ARD) in health care[8]

The purpose of this document is to provide IPC guidance for preventing the transmission of acute infectious respiratory diseases with emphasis on those that may constitute a public health emergency of international concern as defined in the International Health Regulations. This guideline provides recommendations for the non-pharmacological aspects of infection prevention and control for ARDS in health care. The importance of administrative and environmental controls for decreasing transmission of acute respiratory infections was well illustrated during the SARS outbreak. Administrative controls and IPC measures, including early detection, isolation and reporting, and establishment of IPC infrastructure, are key components for containment and mitigation of the impact of pathogens that may constitute a major public health threat. Environmental controls, such as adequate ventilation and proper patient placement, were highlighted during the SARS experience as crucial measures that help to reduce the spread of respiratory pathogens associated with health care. In this guideline, the options of using natural ventilation and/or exhaust fan assisted ventilation in health-

care facilities (HCF) are considered. This is especially beneficial to resource-limited countries because a negative pressure air-conditioned room is expensive. When caring for patients with infectious acute respiratory diseases, Standard and Droplet Precautions should be practiced, whenever possible. If there are insufficient single patient rooms and cohorting of patients with the same known etiological diagnosis is not possible, maintain spatial separation of at least 1 meter between the infected patient and other patients. In pediatric patients with ARDs, when clinical symptoms and signs suggest a likely diagnosis during the peak season of certain viruses, e.g., croup and parainfluenza, acute bronchiolitis and respiratory syncytial virus, Contact, Standard and Droplet Precautions should be implemented, whenever possible. Additional protective measures may be necessary when providing care for patients infected with some specific pathogens. If the patient has indications suggestive of an ARDS caused by a novel pathogen with epidemic/pandemic potential and the route of transmission has not been established, Airborne and Contact Precautions should be added to Standard Precautions.

III. WHO guideline 2009 on Pandemic (H1N1) virus infection and influenza-like illnesses[9]

During the recent H1N1 outbreak, the WHO issued recommendations of using Standard and Droplet Precautions and the N95 is not required. Airborne Precautions is needed only for aerosol generating procedures, which are defined as aspiration or open suctioning of the respiratory tract, including for the collection of lower respiratory tract specimens, intubation, resuscitation, bronchoscopy and autopsy.

IV. WHO Guideline 2014 - Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care[10]

The WHO interim guideline - Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases (ARD) in health care 2007 was reviewed and updated as a formal WHO guideline. The new guideline is developed with the strength of infection prevention and control recommendations based on GRADE. Acute respiratory infections (ARIs) that may constitute a public health emergency of international concern are covered in this current document including Severe acute respiratory syndrome (SARS), Avian influenza (H5N1, H7N9, H7N2 and H9N2), Pandemic influenza A (H1N1) 2009 and Middle East Respiratory Syndrome (MERS) coronavirus from 2012. [10] Newly emerging acute respiratory infections infectious diseases with potential for a high public health impact will continue to be identified.

The issue on airborne transmission is reviewed. Finding showed that transmission of droplet nuclei at short range may occur with SARS-CoV, human influenza, and perhaps with other viral respiratory infections, during special circumstances; for example, such as when performing aerosol generating procedures associated with pathogen transmission or in rooms that are inadequately ventilated. In addition, staff are infected when lack of adequate use of PPE e.g., use surgical mask instead of N95.

This type of transmission has been referred to as opportunistic airborne transmission, and does not involve transmission over long distances as obligate (e.g., pulmonary tuberculosis) and preferential (e.g., measles and varicella zoster) airborne transmission do.[11]

The recent SARS-CoV2 is a novel virus causing the COVID-19 pandemic worldwide with significant mortality and morbidity. Special WHO guidance was developed. The first edition of WHO Interim guidance on infection prevention and control (IPC) during health care when coronavirus disease is suspected or confirmed is developed based on the WHO Guideline Infection Prevention and Control of epidemic- and pandemic-prone acute respiratory infections in health care 2014. At the start of COVID-19 pandemic, when the modes of transmission are not well understood, Airborne and Contact Precautions, as well as eye protection, are added to the routine Standard Precautions.[12]

Epidemiological and microbiological studies are reviewed to determine the modes of transmission and to identify IPC measures. It is also essential to maintain close surveillance on healthcare workers when outbreak occur. This could offer important information about means of transmission, both for community and healthcare associated transmission.

The principles of IPC for COVID-19 are following the ARI guideline 2014 and essential elements include:

- Early and rapid recognition of patients.
- Application of routine IPC precautions (Standard Precautions) for all patients.
- Additional precautions in confirmed or suspected patients (e.g., droplet, contact and airborne when aerosol generating procedures).
- Establishment of an IPC infrastructure for the health-care facility, to support IPC activities.

IPC strategies in health-care facilities are commonly based on early recognition and source control, administrative controls, environmental and engineering controls, and personal protective equipment (PPE).

V. WHO's interim guidance on infection prevention and control (IPC) strategies during health care when coronavirus disease - 29 June 2020[12]

Risks and precautions for aerosol generating procedures (AGP)

Two areas are reviewed in depth in the WHO COVID-19 interim guideline. At the COVID-19 pandemic, 2020, the concern is whether COVID-19 can be transmitted by air. Airborne transmission of the COVID-19 virus is possible under circumstances and settings where aerosol generating procedures (AGPs) are performed. The current WHO list of these AGPs is: tracheal intubation, non-

invasive ventilation (e.g., BiPAP, CPAP), tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy, sputum induction induced by using nebulized hypertonic saline, and autopsy procedures. It remains unclear whether aerosols generated by nebulizer therapy or high-flow oxygen delivery are infectious, as data on this is still limited.[13, 14, 15]

During the COVID-19 pandemic, systematic reviews are published showing that there are many gaps in the literature and there is a need for researchers to undertake further studies of aerosolisation during patient care procedures to provide firm evidence on the risk of AGPs. [16, 17, 18]

The other area reviewed is environmental and engineering controls during AGP. Environmental and engineering controls play a key role aiming to reduce the concentration of infectious respiratory aerosols, droplet nuclei, in the air consequently reducing the contamination of surfaces and inanimate objects. Such controls are particularly important in the context of SARS-CoV-2, a novel virus with a high public health impact, which spreads primarily via respiratory droplets that may aerosolize under certain conditions such as AGPs.

For areas where AGPs are performed, adequate ventilation rates are indicated. Ideally, AGPs should be performed in rooms equipped with negative pressure ventilation systems, according to airborne precautions.

In health-care facilities where a mechanical ventilation system is available, negative pressure should be created to control the direction of airflow. The ventilation rate should be 6-12 ACH that is equivalent to 40-80 L/s/patient for a 4x2x3 m^3 room, ideally 12 ACH for new constructions, with a recommended negative pressure differential of ≥2.5Pa (0.01- inch water gauge) to ensure that air flows from the corridor into the patient room.[19, 20] Airflow direction can be assessed by measuring the pressure difference between the rooms with a differential pressure gauge. If measuring the pressure difference is not feasible, the airflow direction from a clean to a less-clean area can be assessed using smoke pen (smoke test puffer).

Health-care facilities using natural ventilation systems should ensure that contaminated air exhaust directly outdoor, away from air-intake vents, clinical areas, and people. Because natural ventilation provides fluctuating airflows, higher ventilation rate values than for mechanical ventilation are recommended. Installation of exhaust fans could facilitate air exhaust efficiency. However, care is needed because the fans need to be installed so that the air is released directly outdoors. The recommended average natural ventilation rate is 160 L/s/patient.

Alternative is installation of high-efficiency particulate air (HEPA) filters. When appropriately

selected, deployed and maintained, single-space air cleaners with HEPA filters, either ceiling mounted or portable, can be effective in reducing concentrations of infectious aerosols in a single space.

C. GENERAL GUIDELINES FOR ISOLATION PRECAUTIONS[3]

I. Handwashing / hand hygiene

Hands should be washed whenever they are visibly soiled. Proper handwashing requires running water, soap and vigorous rubbing, especially if it is necessary to remove physical soiling, such as blood or mucus. Alcohol hand rub is effective for disinfection of clean hands[6]. Hand hygiene should be performed according to WHO 5 moments of hand hygiene: before touching patient before clean and aseptic procedures, after touching blood and body fluid, after touching patients and after touching patients' immediate environment.[21]

II. Gloves

Appropriate gloves should be worn for contact with blood and body fluids, as recommended by the Standard Precautions. It is proven that if gloves are worn for touching patients' mucous membranes and non-intact skin, patient infection and colonization with multidrug-resistant Gram-negative rods decrease significantly.[7] However, wearing gloves does not replace the need for hand hygiene, because gloves may be defective or torn during use. Gloves should be changed between patients; failure to do so is an infection control hazard.[22]

III. Masks and gowns

A mask is indicated only when caring for a patient with an airborne disease; it should cover the nose and mouth. Masks should not be lowered around the neck and then reused. Filter masks are more effective than single-ply paper masks, while special N95 masks should be used when caring for a patient with active TB.

Healthcare personnel should wear procedure mask to protect them from contact with infectious material from patients e.g., respiratory secretions and sprays of blood or body fluids, that is consistent with Standard Precautions and Droplet Precautions. Place mask on coughing patients is useful in limiting potential dissemination of infectious respiratory secretions from the patient to others i.e., Respiratory Hygiene/Cough Etiquette. For airborne precautions, wear a fit-tested NIOSH-approved N95 filter respirator or higher level respirator for respiratory protection when entering the room of a patient on airborne precautions.

A gown or apron is especially indicated when soiling by infective material is likely. Personnel caring for patients infected with epidemiologically important microorganisms must also wear gowns to reduce the chance of transmitting such pathogens from patients to the environment and other personnel.

When gowns are worn for this purpose, they are removed before leaving the patient's room and hands are cleaned after. Putting on gowns on entering an isolation room before giving care is not proven to be effective in reducing infection.

IV. Private rooms

A private room is indicated when the infection is highly infectious, e.g., chickenpox or Lassa fever. Sometimes, a patient infected or colonized with a microorganism of special clinical or epidemiological significance, e.g., methicillin-resistant *Staphylococcus aureus* or VRE etc, may need a single room to prevent spread of the infection. However, patients infected by the same microorganism may share a room.

Rooms should be equipped with private bath and toilet. An anteroom is not a mandatory but would provide storage space for gowns, gloves and masks. For airborne infections, negative-pressure ventilation is essential, with air discharged outside or filtered before recirculation. Doors should be closed at all times.

V. Disinfection of patient items

Critical reusable items are reprocessed by either disinfection or sterilization to reduce the risk of transmission of the organism to other patients. Non-critical items are cleaned or disinfected before the next patient use. Disposable single use items must be disposed of as regulated waste.

VI. Routine and terminal disinfection of bedside equipment and environment

Daily cleaning of the environment and bedside equipment is necessary to prevent the transmission of bacteria to other patients. Thorough cleaning and disinfection especially the high touch area such as bedside rails, bedside table, commodes, doorknobs, sinks, surfaces and equipment in close proximity to the patient is useful in reducing the microbial load and consequently minimize infection spread. This is especially true for VRE, which can survive in the inanimate environment for a prolonged period of time.

VII. Respiratory hygiene / Cough etiquette

The elements of Respiratory Hygiene/Cough Etiquette include:

1. Education of healthcare facility staff, patients, and visitors;
2. Posted signs with instructions to patients and accompanying family members
3. Source control measures such as covering the mouth/nose with a tissue when coughing and prompt disposal of used tissues, using surgical masks on the coughing person when tolerated and appropriate;
4. Hand hygiene after contact with respiratory secretions; and

5. Spatial separation, ideally >1m (≥3 feet), of persons with respiratory infections in common waiting areas when possible.

D. HOSPITAL-BASED GUIDELINES

Throughout the years, different systems of isolation precautions have been developed after intensive systematic reviews. Each individual facility should formulate hospital base guideline that is practicable and evidence base. Regular audit is important to ensure consistent practices. These should include details practices such as when to perform hand hygiene, when to wear gloves and when to change them; and when or whether susceptible persons can share rooms. The policies should address each of these issues after consideration is given to the needs and resources that exist.

E. INEFFECTIVE RISK-REDUCTION PRACTICES[25]

IPC measures that have proven to be ineffective include the following:

- Fogging of air in isolation rooms with formaldehyde
- Double bagging waste and linen from isolation rooms
- Routine environmental culture
- Use of disposable dishes and utensils for patients on Isolation Precautions.

Disinfection of air

Disinfection of air is a common practice, particularly in developing countries. Some institutions have used machines to spray formaldehyde to fumigate the isolation room of discharged patients with infectious diseases so that the air and surfaces are disinfected. Formaldehyde is toxic and not recommended for disinfection of room. Thorough cleaning and surface disinfection of the isolation room, however, is important and effective between patients. Unfortunately, the manual process may not give optimal results. No touch disinfection system, Ultraviolet-C (UV-C) light and Hydrogen Peroxide (HP) disinfection methods have been proven to be able to reduce residual room contamination especially in busy acute care institutions. Thus, no touch disinfection system may provide an incremental benefit to standard IPC practices by further reducing the bioburden of the inanimate environment and potentially limiting the cross-transmission of pathogens via hospital surfaces.[23, 24]

Double bagging of isolation room waste and linen

Some personnel believe that patients with infections must disperse more organisms into the environment than other patients, and that these organisms might contaminate the outer surface of the garbage bags and laundry bags. The use of a second bag would, therefore, reduce the number of organisms contaminating caregivers. In fact, studies have shown that the inner bag has no more organisms than the outer bag, so double bagging is a waste of money and personnel time. [26]

Routine culture of environment

Some countries in Southeast Asia still practice routine culture of environment and air. Most use settle plates. The environment has microorganisms surviving in the air and on inanimate surfaces, most of which are non-pathogenic, so it is a waste of resources to monitor environmental culture. As environmental microorganisms have not been proven to cause major outbreaks, this monitoring should be discontinued.

Use of disposable meal trays for patients in isolation room

Meals for isolation patients have often been served with disposable dishes and utensils. It is a general misconception that enteric infection might be transmitted from the used utensils to the dietary staff. There is no evidence that such transmission has ever occurred. Regardless of the type of infection, contaminated utensils and trays do not serve as an effective mode of transmission. Standard food sanitation measures would reduce risks for common-source outbreaks.

F. ISOLATION PRACTICES IN COUNTRIES WITH LIMITED RESOURCES

Hospitals in countries with limited resources are usually large and overcrowded without proper isolation rooms. Handwashing sinks and hand hygiene facilities are limited. However, much effort has been spent on ineffective infection control practices such as disinfection of air using ultraviolet light; monthly air sampling by settle plates; fogging of isolation rooms with formaldehyde; excessive use of masks and caps in the general ward; and excessive use of disinfectants and antibiotics. All these are wasteful and costly practices that are proven to be ineffective. It would be useful to discontinue these ineffective IPC practices and focus on improving hand hygiene facilities, i.e., affordable alcohol hand rub, sinks with liquid detergent and paper hand towels. Healthcare personnel should change the current concept of concentrating on environmental decontamination to a more rational approach so that resources are utilized effectively.

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CHAPTER 5

HAND HYGIENE

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OUTLINE

A. INTRODUCTION

WHO launched its 1st Global Patient Safety Challenge, 'Clean Care is Safer Care' in October 2005. Since then, more than 90% of the world is committed to promotion of hand hygiene. During COVID-19 pandemic, hand hygiene was greatly emphasized as a necessary measure to break the transmission of the virus. Hand rubbing with alcohol is preferred over handwashing with soap and water for the following reasons[1]:

1. handrub takes only 10-20 seconds compared to 40-60 seconds of handwashing
2. alcohol gives a greater log reduction of bacteria and longer kill as compared to soap.

The recommended alcohol composition in alcohol hand rub agents by WHO is either

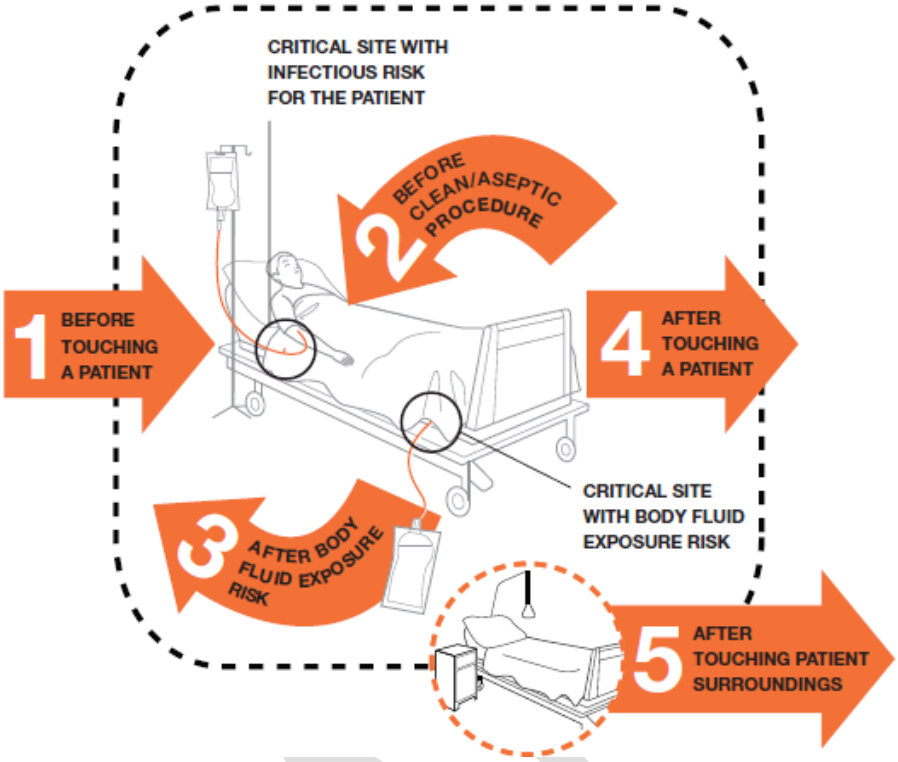
1. ethanol 80% v/v, glycerol 1.45% v/v, hydrogen peroxide (H_2O_2) 0.125% v/v OR
2. isopropyl alcohol 75% *v/v*, glycerol 1.45% *v/v*, hydrogen peroxide 0.125% *v/v*:

B. FIVE MOMENTS FOR HAND HYGIENE

During patient care, hand hygiene is recommended for the following moments:

1. before touching a patient
2. before a clean or aseptic task or procedure
3. after touching a patient
4. after touching patient's body fluid
5. after touching patient's surroundings (defined as the patient's intact skin and his/her immediate surroundings colonized by the patient flora i.e., for inpatient, it will be within the curtain zone around patient)

Figure 5-1: 5 moments for hand hygiene



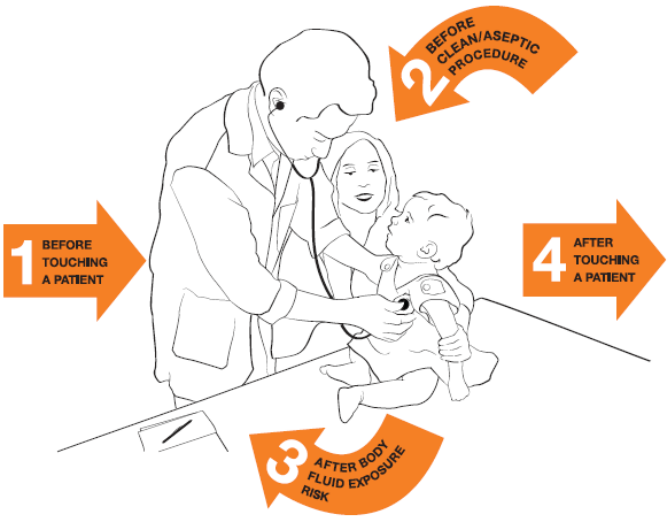
C. FOUR MOMENTS FOR HAND HYGIENE[2]

In outpatient settings, particularly in primary care situations, four moments are identified as the 5th moment does not exist (Figure 5-2 and 5-3). Moreover, the patient's time during ambulatory care is usually limited to a short period of time and the space allocated to care delivery accommodates numerous successive patients.

Similarly, in the long-term care settings and home care, four moments of hand hygiene applies except for specialized nursing homes where residents are mentally or physically disabled and mainly cared for in a dedicated space with dedicated equipment; where the 5 moments then are applicable, as in hospital setting.

Figure 5-2: 4 moments for hand hygiene during vaccination[2]

Figure 5-3: 4 moments for hand hygiene during clinic consultation[2]



D. STEPS IN HAND HYGIENE

Refer to Figure 5-4 and 5-5 for the recommended steps in hand hygiene to ensure a good clean. Attention should be made to ensure the following areas are adequately cleaned:

- webs of fingers
- fingertips
- thumb

Hand hygiene is to be done after removal of gloves as these are not free from pin-holes.

The cleaning of hands before a clean or aseptic task or procedure should follow the steps recommended as for surgical hand rub (see Figure 5-6 and 5-7).

Figure 5-4[1]


Hand Hygiene Technique with Alcohol-Based Formulation
Duration of the entire procedure: 20-30 seconds
1a
1b
2
Apply a palmful of the product in a cupped hand, covering all surfaces;
Rub hands palm to palm;
3
4
5
Right palm over left dorsum with interlaced fingers and vice versa;
Palm to palm with fingers interlaced;
Backs of fingers to opposing palms with fingers interlocked;
6
7
8
Rotational rubbing of left thumb clasped in right palm and vice versa;
Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;
Once dry, your hands are safe.

Figure 5-5[1]


Hand Hygiene Technique with Soap and Water
Duration of the entire procedure: 40-60 seconds
0
Wet hands with water;
1
Apply enough soap to cover all hand surfaces;
2
Rub hands palm to palm;
3
Right palm over left dorsum with interlaced fingers and vice versa;
4
Palm to palm with fingers interlaced;
5
Backs of fingers to opposing palms with fingers interlocked;
6
Rotational rubbing of left thumb clasped in right palm and vice versa;
7
Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;
8
Rinse hands with water;
9
Dry hands thoroughly with a single use towel;
10
Use towel to turn off faucet;
11
Your hands are now safe.

Figure 5-6[1]

The handrubbing technique for surgical hand preparation must be performed on perfectly clean, dry hands.
On arrival in the operating theatre and after having donned theatre clothing (cap/hat/bonnet and mask), hands must be washed with soap and water.
After the operation when removing gloves, hands must be rubbed with an alcohol-based formulation or washed with soap and water if any residual talc or biological fluids are present (e.g. the glove is punctured).

Surgical procedures may be carried out one after the other without the need for handwashing, provided that the handrubbing technique for surgical hand preparation is followed (Images 1 to 17).

1

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the dispenser

2

Dip the fingertips of your right hand in the handrub to decontaminate under the nails (5 seconds)

3

Images 3–7: Smear the handrub on the right forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

4

See legend for Image 3

5

See legend for Image 3

6

See legend for Image 3

7

See legend for Image 3

8

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your right hand, using the elbow of your other arm to operate the dispenser

9

Dip the fingertips of your left hand in the handrub to decontaminate under the nails (5 seconds)

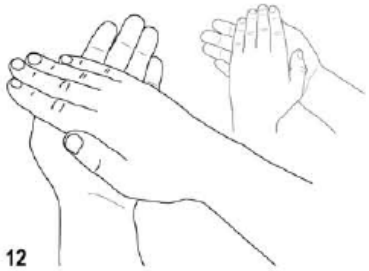
Figure 5-7[1]

10

Smear the handrub on the left forearm up to the elbow. Ensure that the whole skin area is covered by using circular movements around the forearm until the handrub has fully evaporated (10-15 seconds)

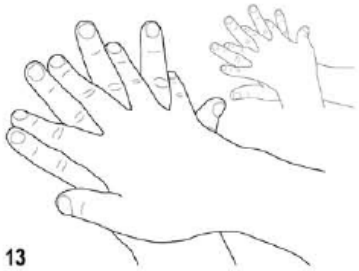
11

Put approximately 5ml (3 doses) of alcohol-based handrub in the palm of your left hand, using the elbow of your other arm to operate the distributor. Rub both hands at the same time up to the wrists, and ensure that all the steps represented in Images 12-17 are followed (20-30 seconds)



12

Cover the whole surface of the hands up to the wrist with alcohol-based handrub, rubbing palm against palm with a rotating movement



13

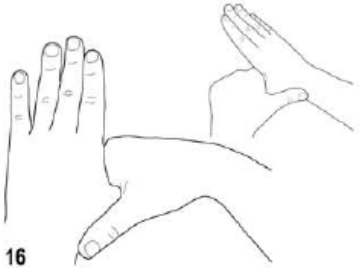
Rub the back of the left hand, including the wrist, moving the right palm back and forth, and vice-versa

14

Rub palm against palm back and forth with fingers interlinked

15

Rub the back of the fingers by holding them in the palm of the other hand with a sideways back and forth movement



16

Rub the thumb of the left hand by rotating it in the clasped palm of the right hand and vice versa

17

When the hands are dry, sterile surgical clothing and gloves can be donned

Repeat the above-illustrated sequence (average duration, 60 sec) according to the number of times corresponding to the total duration recommended by the manufacturer for surgical hand preparation with an alcohol-based handrub.

E. SUCCESSFUL IMPLEMENTATION OF THE HAND HYGIENE PROGRAM

A self-assessment tool is available from the WHO that helps in determining areas for improvement in the program.[3] The five components in the tool reflect the five elements of the WHO Multimodal Hand Hygiene Improvement Strategy:

1. System change
2. Education and training
3. Evaluation and feedback
4. Reminders in the workplace
5. Institutional safety climate

1. System change

The changes that are to be implemented across the system of the organization include:

- Hand rubbing is promoted over handwashing – this is to encourage better compliance
- Discouraging the dual use of both chlorhexidine and alcohol as these lead to greater degree of dryness of skin
- Use of hand moisturizer to reduce potential drying of skin from frequent hand hygiene practices
- Alcohol hand rub agents to be made freely available and accessible during point of patient care

2. Education and training

Creative adult learning-based approaches are encouraged in the implementation of educational elements in the program. Healthcare workers need to understand rationale for hand hygiene. This will then lead to greater compliance as beliefs influenced attitude and behaviour[4].

3. Evaluation and feedback

Random but frequent audit on hand hygiene compliance is to be done in clinical areas. The audit results are then analyzed, and it is highly recommended that immediate feedback be given to process owners so that they can execute prompt actions for improvement. Surveys or focus groups amongst staffs are recommended to help understand unique factors for non-compliance in the healthcare facility.

4. Reminders in the workplace

These are useful cues to healthcare workers to practice hand hygiene at point of care. Posters, stickers or electronic messaging have been tried successfully in various healthcare facilities – walls, floors, mirrors, buses, lift doors, building walls, etc.

5. Institutional safety climate

Leadership plays a key role towards success of the program. Their visible presence and support are a clear statement to staffs the priority the organization places over the hand hygiene program. Where needed, budget and manpower allocation are other issues that leadership needs to review and act on.

F. SUSTAINABLE HAND HYGIENE PROGRAM

Sustainable significant improvement has been demonstrated with use of multi-modal strategy aiming at behavior change resulting finally in reduction of healthcare associated infections.5,6 In addition, creative means are to be explored for enhanced work flow, where applicable, e.g. there are now applications that can be used on hand phones for ease of performing audits without attracting attention.7 A collaborative system with accountability mechanism has shown to be effective in sustaining improvement over time – this highlights the important role that structure, system and process play in ensuring sustainability following change.[8]

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CHAPTER 6

ENVIRONMENT HYGIENE

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OUTLINE

A. INTRODUCTION

Contamination of hospital equipment, medicines, and water supplies with hospital pathogens is a well-recognized cause of common-source outbreaks of infection [1-2]. The full APSIC Guidelines for the Prevention of Surgical Site Infections is available at https://apsic-apac.org as reference to guide practice.

Health care settings comprised areas that require either *Hotel Clean* or *Hospital Clean* based on the risk of the patient population in the area. *Hotel Clean* is a measure of cleanliness based on visual appearance that includes dust and dirt removal, waste disposal and cleaning of windows and surfaces. In addition to routine cleaning, additional cleaning practices and/or the use of personal protective equipment for cleaning may be required in health care settings under special circumstances. *Hotel Clean* is the basic cleaning that takes place in all areas of a health care setting [3].

Components of Hotel Clean

- Floors and baseboards are free of stains, visible dust, spills and streaks
- Walls, ceilings and doors are free of visible dust, gross soil, streaks, spider webs and handprints
- All horizontal surfaces are free of visible dust or streaks (includes furniture, window ledges, overhead lights, phones, picture frames, carpets etc.)
- Bathroom fixtures including toilets, sinks, tubs and showers are free of streaks, soil, stains and soap scum
- Mirrors and windows are free of dust and streaks
- Dispensers are free of dust, soiling and residue and replaced/replenished when empty
- Appliances are free of dust, soiling and stains
- Waste is disposed of appropriately
- Items that are broken, torn, cracked or malfunctioning are replaced

Hospital Clean is a measure of cleanliness routinely maintained in care areas of the health care setting. *Hospital Clean* is '*Hotel Clean*' with the addition of disinfection, increased frequency of cleaning; auditing and other infection prevention and control measures in client/patient/resident care areas [3].

B. CLEANING BEST PRACTICES AT PATIENT CARE AREAS

Housekeeping in the health care setting should be performed on a routine and consistent basis to provide for a safe and sanitary environment. The frequency of cleaning and disinfecting individual items or surfaces in a particular area or department depends on:

a) Whether surfaces are high-touch or low-touch;

b) The type of activity taking place in the area and the risk of infection associated with it (e.g., critical care areas vs. meeting room);

c) The vulnerability of patients housed in the area; and

d) The probability of contamination based on the amount of body fluid contamination surfaces in the area might have or be expected to have spills of blood and other bodily substances must be contained, cleaned and the area disinfected immediately.

Frequency of cleaning may be scheduled using the matrix shown in Table 6-1.

Table 6-1: Risk Stratification Matrix to determine the frequency of cleaning (example)

Discipline	Probability of contamination	Potential for Exposure	Population	Total score
	Light:1 Moderate:2 Heavy: 3	High-touch:3 Low -touch:1	Less susceptible: 0 More susceptible: 1	
Renal	2	3	1	6
Burns	2	3	1	6
Respiratory Medicine	2	3	0	5
General Medicine	2	3	1	6
Colorectal Surgery	2	3	0	5
Oncology	2	3	1	6
Neurology / Neurosurgery	2	3	0	5
SICU	3	3	1	7
MICU	3	3	1	7

Interpretation of total score: **7: High risk:** clean after each case/event/procedure and at least twice per day, clean additionally as required; **4-6: Moderate Risk**: clean at least once daily, clean additionally as required (e.g., Gross soiling), **2-3 : Low risk**: clean according to a fixed scheduled, clean additionally as required (e.g., Gross soiling)

C. INFECTION PREVENTION DURING CONSTRUCTION AND RENOVATION

Construction and renovation activities in the hospital may be associated with transmission of pathogens such as filamentous fungi, including *Aspergillus spp, Candida spp, Fusarium* and also bacteria such as *Legionella* and *Nocardia* [4-5]. The most commonly reported hospital construction-related infection is *Aspergillus,* which represent the greatest threat to neutropenic patients.

'*Construction Clean*' is the level of cleaning performed by construction workers to remove gross soil, dust and dirt, construction materials and workplace hazards within the construction zone. This is done at the end of the day, or more frequently if needed, to avoid accumulation of dust. *Hotel Clean* and *Hospital Clean* begin where the construction site ends, i.e., outside the hoarding and are generally done by the staff of the health care setting.

Prior to the construction and renovation activities, an 'Infection Control (IC) Risk Assessment' must be completed. The risk assessment consists of the following 3 steps:-

I. Identify the type of construction project
II. Identify those patient areas at risk
III. Match the type of construction activity with the patient risk group.

Infection prevention precautions are to be taken for respective class of risks as described in Chapter 11 Ventilation System Issues.

D. CLEANING AND SANITATION PRACTICES IN FOOD PREPARATION AREAS

The manufacturer's instructions regarding the use and maintenance of equipment as well as the use of chemicals for cleaning and sanitizing food contact surfaces should be followed. Food contact surfaces such as those of sinks, tables, equipment, utensils, thermometers, carts should be washed, rinsed and sanitized before each use, between uses and anytime contamination occurs.

E. CARE AND STORAGE OF CLEANING SUPPLIES AND UTILITY ROOMS

All chemical cleaning agents and disinfectants should be appropriately labelled and stored in a manner that eliminates risk of contamination, inhalation, skin contact or personal injury. Chemicals must be clearly labelled with Safety Data Sheets (SDS) readily available for each item in case of accidents.

F. LAUNDRY AND BEDDING

Policies and procedures should address the collection, transport, handling, washing and drying of soiled linen, including protection of staff and hand hygiene. National regulations must be followed if the facility does its own laundry.

G. ASSESSMENT OF CLEANLINESS AND QUALITY

There are several methods for assessing environmental cleanliness:

a. Conventional program of direct and indirect observation (e.g., visual assessment, observation of performance, patient/resident satisfaction surveys);
b. Enhanced program of monitoring residual bioburden (e.g., environmental culture, adenosine triphosphate - ATP -bioluminescence); and environmental marking tools (e.g., fluorescent marking)

Environmental marking measures the thoroughness of cleaning using a surrogate marking system. It involves the use of a colourless solution or Glo Germ powder or gel that is applied to objects and surfaces in the patient's environment prior to cleaning, followed by detection of residual marker (if any) immediately after cleaning, usually involving fluorescence under ultraviolet (UV) light. [6, 7] Environmental marking may be used either on a daily basis to assess routine cleaning, or prior to discharge to assess terminal cleaning.

There should be a process in place to measure the quality of cleaning in the health care setting. Methods of monitoring cleanliness should include at least the conventional visual assessment and/or fluorescent marking. Results of cleaning audits should be collated and analysed with feedback to staff, and an action plan developed to identify and correct deficiencies.

H. NEW TECHNOLOGIES

Despite education and use of fluorescent markers to assess adequate cleaning with feedback to environmental service personnel, cleaning still remains inadequate as it is largely a manual task. Hence, continuous room disinfection with hydrogen peroxide vapour (HPV) or UV-C has proven to be attractive adjunct options to enhance environmental hygiene. Hydrogen peroxide systems have demonstrated ability to inactivate >4 $\log_{10}$ up to 6 $\log_{10}$ microorganisms on surfaces. Its main disadvantage, however, is the down time of 4-6 hours in sealing and keeping the room inactive during the treatment. Alternatively, the UV-C treatment is a shorter duration (about 15 mins) but is able to achieve between 2-4 $\log_{10}$ reduction of microorganisms. [8, 9] A general initial clean is still required before using HPV or UV-C treatment.

I. CONCLUSION

All healthcare facilities should include an environmental hygiene program as part of their Infection Prevention & Control program. The goal of this program is to keep the environment safe for patients, staff and visitors. The best practices set out in the APSIC Guidelines for Environmental Cleaning and Decontamination will provide criteria for cleanliness that may be adopted by Environmental Services managers for their use or for the use of contracted service.

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CHAPTER 7

SURVEILLANCE

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OUTLINE

A. INTRODUCTION

Surveillance is generally recognized as essential to the practice of hospital infection prevention and control (IPC). When resources are scarce, a common mistake is to omit the tedious task of collecting data and simply get on with the work of infection prevention and control. This is counter-productive. A widely accepted dictum today in quality management is that "*You can't manage what you can't measure*".[1] Delegating resources to measure is indispensable, and surveillance in infection prevention and control falls into this same category. Furthermore, the collection, analysis and dissemination of surveillance data have been shown by careful research to be the single most important factor in the prevention of hospital-acquired infections (HAIs).[2] It would, therefore, be foolhardy to omit surveillance altogether. Even in the initial stages of implementing IPC, it is important that surveillance is carried out for the key projects in the programme.

This chapter will deal with three important aspects of surveillance:

- Objectives of surveillance
- Infrastructure requirements for surveillance
- Methods of surveillance

Important issues will be discussed briefly, and readers must refer to a more comprehensive text for further information.

B. DEFINITION OF SURVEILLANCE

Surveillance has been defined as the "ongoing, systematic, collection, analysis, interpretation of health data essential to the planning, implementation, evaluation of IPC practices, closely integrated with timely dissemination of these data to those who need to know".[3] Simply stated, surveillance is careful monitoring and feedback to relevant stakeholders.

C. OBJECTIVES OF SURVEILLANCE

The objectives will depend on the needs of the institution. In any hospital embarking on surveillance for the first time, the initial data collected will help to establish the endemic baseline HAI rates.

Monitoring the data on a regular basis will help IPC personnel to identify HAI outbreaks early and, hence, help them to control it promptly. The data collected will also prompt the implementation of appropriate IPC practices or policies to achieve the goal of reducing infection rates. Occasionally, the implementation of these practices or policies may incur extra costs in manpower, equipment or protective apparel. The data collected may then be used to convince medical personnel or administrators of the need for these recommendations.

IPC measures are best evaluated when there are rates to observe over a period of time. Each country will have its own health regulators or accreditation system. HAI rates are an objective and reasonable indicator of quality healthcare. In inter-hospital comparison of such rates, it is important that the rates are derived from a standard surveillance protocol with defined and clear terms and methods of collection and analysis. Risk-factor adjustments should be made where appropriate for the data to be reasonably interpretable. In these days of possible malpractice claims, a good surveillance programme with good compilation of data provides supporting evidence of quality health management in the hospital.

D. ESSENTIAL INFRASTRUCTURE REQUIREMENTS FOR SURVEILLANCE

A consensus report was published on this subject.[4] It is important that readers refer to this publication, but the key issues will be briefly discussed here. For a surveillance programme to successfully achieve the stated objectives, the following infrastructure is required.

I. Plan

A programme can only be good if clear objectives are laid out first and then steps mapped out to achieve them in the most cost-effective manner. Objectives must be based on the IPC priorities of the hospital and it is important for the IPC team to list the projects or activities that they can realistically initiate for the year. A surveillance programme can then be developed, catering only to these activities. Haley called this surveillance by objectives,[6] and if properly executed, it will ensure that the IPC team will not overstretch itself or conduct surveillance that is not entirely relevant.

A surveillance programme must address certain important elements and these include:

1. ***Definitions of infection***

   These must be standardized for the entire hospital if the data are to have meaning. There are already several consensus definitions that can be used for reference when drafting the list of definitions for the hospital.[7,8]

2. ***Population under surveillance***

   It is now recognized that the collection of hospital-wide infection rates is not as helpful as previously thought. These rates are not comparable between hospitals.[9] because they are dependent on a multitude of risk factors. The present recommendation is to survey the specific events that have been targeted for control.[4] Possible starting points are high risk groups or areas, e.g., intensive care units (ICUs) or surgical wounds.

3. ***Identification of data source***

   After the target population is identified, it is important to evaluate what data source is available or accessible. For example, in surgical wound surveillance, the operating theatre

records are often referred to for denominators; these should be well kept if they are to be used. The related units must also be willing to allow the surveyor access to the relevant records.

4. ***Selection of method for surveillance***

   The first issue here is to assess manpower and resource availability and then design a reasonably cost-effective programme to achieve the desired goals. A list of the different methods will be presented in the next section.

5. ***Distribution of reports and feedback***

   Although this is the 'tail end' of surveillance, it must be considered in the planning stage. It is pointless to collect data if they are not used. The IPC team should identify the final consumers of the surveillance data and envisage the effect the data might have, even before the exercise begins.

II. People

The scope of work for the IPC personnel has widened over the years. A useful guide to the number of infection prevention and control practitioners needed for surveillance and other infection prevention and control programmes is one IPC personnel to 100 beds in acute care and one IPC personnel to 150-250 beds in long term care facilities.[5] However, most hospitals in Asia are unable to meet this recommendation. A more practical approach is to determine needs and then design a surveillance programme that can meet the more urgent needs. It is also important that adequate clerical support and expertise in computerization is accessible to workers if they are to be effective. Alternatively, ward staff may assist in data collection – these are usually appointed IPC linked or liaison officers who also act as IPC champions in their clinical areas.[5]

III. Computers

As the data increase, the analysis required can be unmanageable without the assistance of computers. A number of user-friendly computer programmes are available for use by the IPC personnel for the analysis of data, e.g., Microsoft Access or EXCEL

IV. Funding and other non-personnel resources

Support is needed from the administrators in releasing adequate funds for the necessary manpower or computer support. Adequate office space for the IPC team is also important.

E. METHODS OF SURVEILLANCE

The common surveillance methods are summarized below:

1. ***Passive self-reporting surveillance***

   Hospitals with limited resources often resort to this method. Doctors or wards are requested to report infected cases to the hospital and the IPC team simply tallies up the total. This has been

shown to be grossly inaccurate. Even if a list of standardized definitions is circulated to the hospital staff, they are often too busy to gather these data accurately or consistently. Furthermore, there is no obvious incentive for them to do so. Active surveillance in which the IPC team initiates procedures to collect the data is recommended. This is more demanding, but grossly inaccurate data collected passively may be more detrimental than no data at all.

2. ***Periodic prevalence surveillance***

   This may be done for different units over different periods of time. Usually, the point prevalence rate is obtained, i.e., the number of patients with an HAI at a particular point in time over the total number of patients surveyed. The frequency of such surveys may be adjusted according to the overall IPC programme and it is less laborious than an incidence survey. The disadvantage is that it is like a 'snapshot' photograph, which will not be precise enough to pick up all relevant problems, and data on trends will be incomplete. As trends are often not evident from a prevalence survey, the data will not provide timely indicators for the IPC team to respond.

3. ***Incidence surveillance***

   This includes all methods in which an attempt is made to obtain the incidence rate. The incidence rate is the number of **new cases** with an HAI in a specified period of time over the population at risk (e.g., all patients undergoing surgery). Usually, the focus is directed to areas with high potential for infection, so that effective measures can be drawn up to reduce these infections; this is referred to as 'targeted surveillance'. The choice of location for surveillance is either driven by unit, e.g., ICUs, or priority, e.g., surgical site infections, or a particular multi-resistant bacterium, e.g., methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant enterococci, etc. This is a more cost-effective approach, as resources are directed to areas known to be at high risk of HAIs. In an incidence survey, there are various methods of case identification. These include:

   a) Prospective case review

   This will be the most accurate. The surveyor reviews all cases in the target population on a regular basis, while the patient is still in the hospital. It is often taken as the 'gold standard', but is, however, rather labour intensive and most units will not be able to afford the manpower.

   b) Review of nursing card index

   If some preset criteria (e.g., fever) are used, the card index may first be reviewed to select patients for further surveillance. Hospitals with well-kept card indexes may find this method relatively accurate.

   c) Review of patients on antibiotics

   Since most patients with an infection will be prescribed antibiotics, the IPC personnel reviews only patients on these compounds. The list of patients can often be obtained from the pharmacy. It is reported by some workers that sensitivity of more than 90% can be achieved by this method.

   d) Review of patients with a bacterial isolate

As many infections will have bacteria isolated in the laboratory, the surveyor will first obtain a list of such patients from the microbiologist before visiting the ward. The accuracy of this method, however, will depend on the intensity of specimen submission and the quality of the laboratory. As expected, sensitivity rates reported with this method are highly variable, from 30% to more than 70%.

e) Retrospective chart review

This method is limited by all the disadvantages of the retrospective methodology and is not recommended. However, it is often the only available option, especially when the IPC team is expected to produce data on historical events.

f) Automated surveillance

With implementation of electronic health records and information technology, it is now feasible to develop a semiautomated or fully automated algorithms using logistic regression, machine learning methods.[10] Its performance relies heavily on high quality data. Careful evaluation and validation need to be done before converting to this system.

F. SURVEILLANCE TO DETECT CLUSTER OF INFECTION

The surveillance methods described so far would be useful for detecting nosocomial infections that are sporadic or endemic in nature. However, it is common knowledge that outbreaks of HAIs do occur and these usually present as a cluster of cases. The recent COVID-19 pandemic has drawn immense attention to cluster detection in the hospital. Although their detection is critical because it is important to bring these outbreaks under control, it should be noted that clusters of HAIs constitute the minority of HAIs. Wenzel et al reported in a 5-year study that only 10% of HAIs presented as clusters and only 4% were subsequently confirmed to be epidemics.[10] Early detection of these clusters is crucial because the outbreak could be spreading rapidly in the hospital. Therefore, IPC personnel should be screening for these clusters on a daily basis.

The IPC personnel should, first of all, routinely visit the microbiology laboratory to review results and screen for unusual clusters. The laboratory technicians could be provided with a list of circumstances to which they could alert the IPC personnel.

Some refer to this as an ‘organisms alert programme’ and the circumstances could include:

1. Any unusual results (e.g., SARS-CoV-2)
2. Organisms isolated that are known to cause outbreaks (e.g., group A *Streptococcus* or methicillin-resistant *S. aureus* [MRSA])
3. All notifiable diseases
4. Unusual antimicrobial resistance (e.g., vancomycin resistance in *Streptococcus*)

5. Any clustering of organisms in a clinical area. Computer software are available that can alert the laboratory when the number of isolates of any organism is significantly higher than usual
6. Any unusual environmental isolates (e.g., a positive spore strip culture)
7. Isolation of an emerging infection that one is alerted to identify (e.g., COVID-19, MERS-CoV, avian influenza).

The IPC personnel would need to also review data from certain patient groups to screen for possible clusters. These could include the sick leave data submitted by hospital staff, patients admitted with fever from the emergency room, all patients under intensive care, severely neutropenic patients, children admitted to the diarrhoea ward, and others. The hospital should focus on areas where outbreaks had occurred before, and in patient groups that are especially common in the hospital. It would vary in hospitals, as the profile of patients would differ. Every IPC team would have to formulate a cluster detection programme that is appropriate for their hospital.

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CHAPTER 8

MANAGEMENT OF AN OUTBREAK

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OUTLINE

A. INTRODUCTION

Outbreaks vary in extent and severity. It is the responsibility of the Infection Prevention and Control (IPC) Committee to draw up a detailed policy and plan for the management of outbreaks in the hospital or community. Management of an outbreak requires the expertise of an IPC doctor/officer who is usually the person identified to take the leading role. Arrangements will have to be made by the IPC doctor/officer to form an Outbreak Control Team, as the control of any outbreak requires the co-operation of people from various disciplines.

In the event of a national infectious disease outbreak, it is vital that close co-ordination and collaboration occurs with the national/state health authority and the various health facilities as well as supporting ministries — media, trade, community/home affairs, communication, etc. Each country's emergency preparedness plans should include that for an infectious disease outbreak. A strong central source of command is vital for smooth co-ordination of resources and actions. Within each healthcare facility, the basic mechanism set for the effective management of a nosocomial infection outbreak is an adequate base for the establishment of a larger team to meet with the increased demands. The Outbreak Control Team will need expansion to include more representatives from the facility, e.g., pharmacy, supplies, housekeeping, engineering, etc. A continual system of infection control training and audit is required to help disseminate quick pertinent infection control measures for the particular infectious disease concerned. Daily regular communication with clear updates on the situation with hospital staff and patients is necessary to keep morale up and good co-operation from all on the preventive measures instituted.

B. OUTBREAK CONTROL TEAM

1. Personnel

a. IPC Committee representatives — IPC doctor/officer and IPC nurse
b. Medical director/administrator
c. Infectious disease doctor
d. Executive nurse director/senior nurse
e. Clinical head/senior doctor

2. Responsibilities

a. Ensure continual care of patients
b. Clarify resource implications
    i. additional staff/supplies required
    ii. media handling
c. Agree upon and coordinate policy decisions
d. Review progress

e. Define the end of the outbreak

C. CHECKLIST OF ACTION

1. Investigation

a. Confirm outbreak; provide case definition
b. Demonstrate outbreak — compare current rates with pre-epidemic rates
c. Analyze cases — line-listing with time, person and place
d. Do literature search if indicated
e. Conduct microbiology investigations to confirm reservoir and mode of transmission
f. Conduct microbiological screening of patients and staff (if necessary)
g. Conduct serological screening of patients, staff and other contacts, if necessary
h. Follow-up contacts — patients, staff, visitors, etc

2. Communication

a. Inform hospital authorities — senior management
b. Consult infectious disease doctor/IPC doctor/officer
c. Inform departmental heads, microbiology director
d. In major outbreaks, inform other services - clinical support, ambulance, general practitioners and primary health physicians
e. Arrange for media release, if necessary

3. Management

a. Define isolation facilities/ward
b. Define type of isolation precautions
c. Inform nursing, medical and paramedical staff of isolation precautions
d. Increase clinical staff - nursing and medical
e. Increase support services staff - housekeeping, laundry, central sterile services department
f. Increase laboratory assistance
g. Increase clerical staff, telephones, IT equipment
h. Keep diary of interviews and progress notes
i. Plot epidemic curve and geographical areas involved
j. Review charts of infected persons and develop list of potential risk factors
k. Formulate hypothesis about likely reservoir and mode of transmission
l. Perform case-control study and typing studies
m. Review and update control measures
n. Continue surveillance for secondary cases and efficacy of control measures

4. Control

a. Implement isolation policies
b. Administer active/passive immunization where needed
c. Administer antibiotic prophylaxis, where necessary
d. Define patient admission, transfer and discharge policy
e. Define visiting arrangements
f. Evaluate control measures

5. End of outbreak

a. Announce end of outbreak to relevant authorities informed earlier
b. Compile report for IPC Committee
c. Change policies and practices, if necessary

D. HOW TO CONDUCT A CASE-CONTROL STUDY

1. Preliminary questions to ask:
   a) Can I get the information needed?
   b) Can I get good controls?
2. Review line-listing of patients involved in the outbreak.
3. Formulate a hypothesis. Be clear of the risk factors you want to prove.
4. Have a clear case definition and exclude long-staying patients, if possible.
5. Have two to four controls per case if there are less than 10 cases. Select from uninfected patients, matching them for age, sex and service. It is wise to exclude controls who have stayed in the hospital for a long time.
6. In collecting data, be careful of recall bias as you interview patients. If data are collected from medical records, use data that have been routinely recorded to avoid bias in recording process.

E. PANDEMIC PREPAREDNESS

IPC personnel should play a key role in the facility IPC preparedness planning and risk assessment.[1] The facility should be prepared in the detection, management and response to outbreaks. The role of the IPC personnel is to give guidance on the management of the outbreak as well as relevant IPC measures. Lessons should be drawn from past experiences in managing SARS-CoV-1 2003 and the H1N1 2006 pandemics.[2] Issues to be considered include surge capacity, medication availability and rationing, stockpiling, staff shortages and communication with respective Ministry of Health or equivalent authorities.

As seen in the COVID-19 pandemic, a national multidisciplinary task force is necessary to lead the daily assessment of the situation, risk assessment and planning of policies influencing the country in

all sectors as well as integrated smooth execution of plans with ultimate goal of good control and termination of the outbreak.

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CHAPTER 9

STERILIZATION AND DISINFECTION

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OUTLINE

A. INTRODUCTION

Disinfection is a process that is able to remove microorganisms to a level that is not harmful to health. Sterilization, however, implies the destruction of all microorganisms, including the most resistant microorganisms like spores.[1] There is a wide range of methods for disinfection and sterilization. It is necessary to standardize these methods to ensure the disinfection and sterilization methods are up to standard.

Choice of disinfection and sterilization depends on situations such as the compatibility of material to be treated, the resistance of organism involved, the time available for decontamination and the risks to patients and staff (Tables 9-1 and 9-2).

Table 9-1: The risks to patients from equipment

Risk	Definitions	Examples	Method
High	A break in skin or mucus membrane	Surgical instruments, laparoscopes, prosthesis, dressing	*Sterilization* Steam autoclave ETO, gas plasma
Intermediate	Intact mucus membrane	Gastrointestinal endoscopes, ventilator tubes	*Disinfection* High level disinfectant Pasteurization
Low	Contact normal intact skin	Wash bowls, toilet *MRSA patient	*Cleaning & drying* *disinfection
Minimal	Not in close contact with patients	Floor, wall, beds	Cleaning & drying

Table 9-2: High level disinfectant or sterilants (Reference: CDC Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008)

	HLD Claim	**Sterilization Claim**	**Reuse life**	**OSHA Exposure limit**
Hydrogen peroxide 7.5%	30 mins at 20^0C	6 hours at 20^0C	21 days	1 ppm TWA
Peracedic acid 0.2%	NA	12 mins at 50-60^0C	Single use	None
Gluteraldehyde ≥2%	20-90 mins at 20-25^0C	10 hours at 20-25^0C	14-30 days	None
Ortho-phthalaldehyde (OPA) 0.55%	12 mins at 20^0C 5 mins at 25^0C in AER	None	14 days	0.05ppm
Hydrogen peroxide / Peracetic Acid (7.35% / 0.23%)	15 mins at 20^0C	3 hours at 20^0C	14 days	HP 1 ppm

TWA= total weight average

B. STERILIZATION

I. Method

Heat is the most reliable method of sterilization. It can generally be divided into moist and dry heat.

1. *Steam sterilization*

   This is the most common and reliable method of sterilization used in hospitals, because steam under pressure has been shown to destroy even the most resistant bacterial spores effectively in a brief exposure[2]. Autoclave is used for the sterilization of heat resistant equipment. A major feature of the steam autoclave is first removal of contaminated air from the load, following by infusing hot steam to infiltrate the sterilization packs or loads in the autoclave. There are different mechanisms for steam sterilization process include gravity displacement, mass flow dilution, pressure pulsing, high vacuum, and pressure pulsing with gravity displacement. Regular quality control; and assurance need to be performed including the air-tightness of the chamber, atmospheric pressure, the quality of steam. Preventive maintenance should be done regularly by the hospital bio-engineers.

2. *Dry heat sterilization*

   Hot air ovens are used for sterilizing glassware, instruments, and fine sharps such as eye instruments. The advantages of dry heat over steam sterilization include low corrosiveness and deep penetration. However, the heating process is slow, and long sterilization times of 1–2 hours at 160°C are required. Materials may also be damaged by exposure to high temperature for long periods.

3. *Ethylene oxide*

   Ethylene oxide (EtO) is effective because its sporicidal effect. The EtO gas is volatile and gives good penetration, but it is also flammable and explosive. Sterilization by EtO gas gives the advantage of general compatibility with most materials and the effective penetration of long and narrow luminal instruments. The disadvantage of EtO is the long exposure of 4 hours and aeration time of 12 hours. Thus, the turnaround time is prolonged and becoming unfavorable as a low temperature sterilization option. The 12/88 mixture of EtO and chlorofluorocarbon (CFC) is currently being phased out because of environmental concerns. Other EtO mixtures with stabilizing gases such as carbon dioxide or hydrochlorofluorocarbon as well as 100% EtO are now available as substitutes.

II. Sterilizing Practices and Monitoring

The delivery of sterile products for use in patient care depends on the effectiveness of the sterilization process. Correspondingly rely on appropriate processes on decontamination, disassembling and

packaging of the device, loading the sterilizer, monitoring, sterilant quality and quantity, and the appropriateness of the cycle for the load contents of device reprocessing. It is recommended that reprocessing of patient care sterile patient-care supplies should be in a central processing department in order to more easily control quality. The aim of central processing is the orderly processing of medical and surgical instruments to protect patients from infections while minimizing risks to staff and preserving the value of the items being reprocessed.

Ensuring consistency of sterilization practices requires a comprehensive program that ensures proper methods of cleaning and packaging instruments, loading the sterilizer, operating the sterilizer, and monitoring of the entire process.

1. *Sterilization Cycle Verification*

   A sterilization process should be verified before it is put into use in healthcare settings. All steam, ETO, and other low-temperature sterilizers are tested with biological and chemical indicators upon installation, relocated, redesigned, after major repair and after a sterilization, failure has occurred to ensure they are functioning prior to service resumption.

   The sterilization procedure should be monitored routinely by using a combination of mechanical, chemical, and biological indicators to evaluate the sterilizing conditions and indirectly the microbiologic status of the processed items.

   In a prevacuum steam sterilizer Bowie-Dick test, biological and chemical indicator testing should be done daily for ongoing quality assurance testing. When major changes are made in packaging, wraps, or load configuration, biological and chemical indicators are placed in products, which are processed in a full load. When three consecutive cycles show negative biological indicators and chemical indicators with a correct response, the change can be modified into routine practices.[3,4]

2. *Monitoring*

   The sterilization procedure should be monitored routinely by using a combination of mechanical, chemical, and biological indicators to evaluate the sterilizing conditions and indirectly the microbiologic status of the processed items. The mechanical monitors for steam sterilization include the daily assessment of cycle time and temperature by examining the temperature record chart (or computer printout) and an assessment of pressure via the pressure gauge. The mechanical monitors for ETO and Hydrogen Peroxide Gas Plasma include time, temperature, and pressure recorders that provide data via computer printouts, gauges, and/or displays[5]. Generally, for ETO and Hydrogen Peroxide Gas Plasma sterilization internal chemical indicators can monitor the gas concentration.

III. New Technologies in Low-temperature Sterilization

Advances in medicine have brought new techniques and procedures such as microscopic surgery, laser surgery, ultrasonic surgery and endoscopic or laparoscopic surgery, which use delicate and expensive equipment often sensitive to heat.[6] To achieve sterilization of such instruments, ideally, a low temperature sterilant is needed, with the following attributes:

- Low temperature — it should be active at temperatures of less than 60°C
- High efficiency — it should be virucidal, bactericidal, tuberculocidal, fungicidal and sporicidal
- Rapid activity — it should be able to penetrate common medical device packaging material and into the interior of device lumens
- Material compatibility — it should produce negligible changes in both the appearance and function of processed items and packaging materials, even after recycling
- Nontoxic — it should present no health risk to the operator or to the patient and pose no hazard to the environment
- Organic material resistance — it should withstand reasonable organic material challenge without loss of efficacy
- Adaptability — it should be suitable for large or small (point of use) installation
- Monitoring capability — it should be monitored easily and accurately with physical, chemical and biological process monitors
- Cost-effectiveness — it should be available at a reasonable cost for installation and routine operation.

Hydrogen Peroxide Gas Plasma Sterilization

This type of low-temperature sterilizer uses hydrogen peroxide in the vapor phase and low-temperature gas plasma to rapidly and safely sterilize surgical instruments. There are no harmful residuals and no toxic risks to patients, healthcare workers or the environment, as water vapor and oxygen are the residuals after the cycle. Dry, wrapped or pouched instruments are sterilized and can be used immediately or stored sterile until their next intended use.

Sterilization cycles range from 43 - 75 minutes depending on the specific model. Pouches, wraps, trays, chemical and biological indicators, and other accessories are available. Due to the absence of any toxic or harmful residuals after the cycle, there are no special requirements for the installation of the machine.

C. DISINFECTION

There are three main methods of disinfection, namely cleaning, heating and chemical disinfection.[7]

I. Cleaning

Effective cleaning followed by thorough drying of the surface removes a high proportion of microbes. In many hospital situations, thorough cleaning of the equipment and environment with detergent and hot water is, therefore, adequate i.e., floors, walls, etc.

II. Heat disinfection

This can be achieved by pasteurization (60–80°C), boiling or low-temperature steam disinfection. Disinfection by heat is most reliable and effective and should be recommended whenever possible.

III. Chemical disinfection

Chemical disinfectants are often used to reduce the count of pathogenic organisms on inanimate surfaces, especially when heat disinfection is not possible. However, chemical disinfection is inherently complicated.[8] Therefore, for effective usage of disinfectant; the following points need to be observed:

a. ***Microbial sensitivity*** Different organisms vary in their sensitivity to different disinfectants, e.g., phenolics (PrintolTM) possess limited virucidal effect, and chlorhexidine (HibitaneTM) is not an effective tuberculocidal disinfectant.
b. ***Inactivation*** Disinfectants should only be used on clean surfaces as they may fail to penetrate overlying soil, e.g., blood and pus on instruments and feces on bedpans. Therefore, cleaning prior to chemical disinfection is essential.
c. ***Incompatibility*** Materials that are incompatible can neutralize the activity of disinfectants, e.g., soap, cork, rubber and plastics.
d. ***Decomposition*** Many disinfectants are unstable and, after chemical breakdown, the solution may even support the growth of resistant organisms, e.g., *Pseudomonas* spp in old CetavlonTM. Hence, it is essential that fresh solutions be made up regularly. Used bottles should be returned to the pharmacy for cleaning before refilling and should never be 'topped up'. The shelf life and rotation of stock should be observed.
e. ***Hazard*** [9] Some chemical components of disinfectants are corrosive to skin; therefore, care must be taken to avoid splashing and gloves should be worn when handling them. Some disinfectants are corrosive to metal and others to plastics. Furthermore, in order to avoid harmful effects, items immersed in disinfectant require thorough rinsing before use. Thus, disinfectants are no 'miracle water', and should be used cautiously. Failures have been documented when some disinfectants are subjected to conditions such as dilution, age and presence of organic matter that challenge their microbial activity. The use of disinfectant is an intricate procedure, and a disinfectant guideline is useful to ward personnel.

IV. High level disinfectant and low level disinfectant[12,13]

High-level disinfection processes destroy vegetative bacteria, mycobacteria, fungi and enveloped (lipid) and non-enveloped (non-lipid) viruses, but not necessarily bacterial spores. Medical equipment/devices must be thoroughly cleaned prior to high-level disinfection. Refer to Table 9-2 with list of HDL.[11] Low-level disinfection eliminates vegetative ('live') bacteria, some fungi and enveloped viruses and is used for non-critical medical equipment/devices and some environmental surfaces. Low-level disinfectants include 3% hydrogen peroxide, 0.5% accelerated hydrogen peroxide, some quaternary ammonium compounds (QUATS), and diluted sodium hypochlorite (e.g., bleach) solutions. LLD is performed after the equipment/device is thoroughly cleaned, rinsed and excess rinse water is removed. The container used for disinfection must be washed, rinsed and dried when the solution is changed.

D. THE IMPORTANCE OF CLEANING BEFORE STERILIZATION AND DISINFECTION OF INSTRUMENT / EQUIPMENT

Cleaning is the removal of visible soil (e.g., organic and inorganic material) from objects and surfaces and normally is accomplished manually or mechanically using water with detergents or enzymatic products. Thorough cleaning is essential before high-level disinfection and sterilization because inorganic and organic materials that remain on the surfaces of instruments interfere with the effectiveness of these processes. *Decontamination* removes pathogenic microorganisms from objects so they are safe to handle, use, or discard.[13]

E. UNACCEPTABLE METHODS OF DISINFECTION OR STERILIZATION[14]

The following methods of disinfection or sterilization are NOT recommended:

1. Boiling – the use of boiling water to clean instruments and utensils is not an effective means of sterilization as boiling water is inadequate for the destruction of bacterial spores and some viruses.
2. Ultraviolet (UV) irradiation – the germicidal effect of UV is influenced by organic matter, wavelength, type of suspension, temperature, types of microorganism and UV intensity. The use of UV is only limited to the destruction of airborne organisms inside the ventilation ducts or inactivation of microorganism located on surfaces such as laboratory safety hoods. It is NOT an acceptable method of disinfection or sterilization for medical devices or equipment.
3. Glass bead sterilization - Glass bead sterilizers use small glass beads and high temperature for brief exposure time to inactivate microorganisms. Such sterilizers are difficult to monitor of the effectiveness, have inconsistent heating resulting in cold spots and often have trapped air which affects the sterilization process.
4. Chemiclave – unsaturated chemical vapour sterilization involves heating a chemical solution primarily alcohol with 0.23% formaldehyde in a closed pressurized chamber. Because of environmental risks associated with formaldehyde, this method of sterilization is discouraged.

5. Microwave oven sterilization – microwave ovens are unreliable and difficult to monitor for effective sterilization. The concern is there is uneven distribution of microwave energy over the entire device. The use of microwave ovens for sterilization of medical equipment and devices are not recommended

F. CONCLUSION

When properly used, disinfection and sterilization can ensure the safe use of reusable medical devices for patient care. However, it is important that hospitals should compile an evidence base guideline on cleaning, disinfection and sterilization. There should also be regular audit on the guideline compliance to make sure the sterilization and disinfection standards are strictly followed.

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CHAPTER 10

PREVENTION OF CATHETER-ASSOCIATED URINARY TRACT INFECTION (CAUTI)

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OUTLINE

A. INTRODUCTION

Catheter associated urinary tract infection (CAUTI) is the most common healthcare associated infection accounting for >80% of infections in intensive care patients on indwelling catheters1,2. Average daily risk for a patient with indwelling catheter to acquire CAUTI ranges from 3%-10% which increases with the length of hospital stay3. Though the CAUTI associated morbidity is limited, the consequent complications together impose significant burden on patients. The adverse outcomes of CAUTI include nonbacterial urethral inflammation, urethral strictures, mechanical trauma and mobility impairment4. As per National Health and Safety Network (NHSN) report 2013, CAUTI rate ranges from 1.2 to 4.7 per 1000 catheter days in adult Intensive Care Units (ICUs) and 2.1 to 3.4 per 1000 catheter days in pediatric ICUs5.

Risk factors predisposing to CAUTI

- **Duration of catheterization** (catheter dwell-time) is the most significant risk factor to CAUTI development, with an 8.1% risk of infection in post insertion period which increases to 12% by day 30[6,7].
- Females, elderly age groups, and patients not maintaining a closed drainage system are at a higher risk[3].
- Immunocompromised state, chronic illnesses, myocardial infarction, congestive heart failure, cerebrovascular disease, pulmonary disease, connective tissue disease, paraplegia, renal disease and severe liver disease are additional risk factors for development of healthcare associated urinary tract related blood stream infections (BSI)[7].
- The drainage bag of CAUTI patients acts as a reservoir for organisms to transmit infections to other patients through fomites.

Types of urinary catheter[8]

- Indwelling catheters (Foley): Commonly urethral or suprapubic
- External catheters: Used for men with functional or cognitive injury. It usually carries lower risk of infection and is more comfortable e.g., condom catheter, Paul's tubing
- Short term catheters: used for a short time period such as post-surgery duration.
- Urinary catheters come in different sizes (for adult and pediatric patients) and material (latex,
- silicon etc). Silicon-elastomer, hydrogel coated, and antimicrobial coated catheters minimize
- biofilm formation.

Pathogenesis[9]

Urine in the bladder under normal conditions is sterile. An indwelling urinary catheter leads to a bypass of the local defenses and increase the chances of bacteria gaining entry and causing infection. This is because of the following reasons:

- Injury to urinary tract during catheterization and damage to uroepithelial mucosa exposes the tract to colonization and infections (bacterial adhesins have affinity for binding sites in mucosa)
- Residual urine retained in catheter balloon supports bacterial growth
- Backflow of urine from collection bag increases the risk of infection

There are two possible routes of entry for pathogens in the urinary tract:

- **Extraluminal:** bacteria gain entry into urinary tract either through perineum or urethral meatus and ascend to the bladder either at the time of insertion or later due to inadequate catheter care.
- **Intraluminal:** bacteria ascent through the closed drainage system or via breach in asepsis during catheter handling for example, sample collection process.

Types of infections[10]

- Endogenous: Infection to self via meatal, rectal, or vaginal colonization.
- Exogenous: Infections associated with contaminated equipment (catheter etc) or hands of healthcare workers.

B. CAUTI SURVEILLANCE

CAUTI[11] is defined as a urinary tract infection developed when an indwelling catheter is in place for more than 2 consecutive days in an inpatient location and the patient has significant bacteriuria $\geq 10^5$ colony-forming units (CFU) per ml and develops **at least one** of the following symptoms

- Fever (>38.0°C)
- Suprapubic tenderness,
- Costovertebral angle pain or tenderness
- Urinary urgency
- Urinary frequency
- Dysuria

Definition for CAUTI surveillance may be referred from the USA Centers for Disease Control and Prevention/National Healthcare Safety Network web site (http://www.cdc.gov/nhsn/) reviewed and released every year in January.

Diagnosis of CAUTI

Diagnosis of CA-UTI in patients with indwelling catheters is established by the following[12]:

- Presence of signs or symptoms as per the CDC CAUTI definition with no other identified source of infection

And

- A colony count of $\geqslant 10^5$ CFU/ml with no more than two bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose catheter has been removed within the previous 48 h.

Colony counts <=10^2 CFU/ml in urine culture are often associated with symptomatic UTI in non - catheterized patients. However, in catheterized patients, low colony counts refer to contamination by periurethral flora or may reflect significant bacteriuria in patients with intermittent catheterization. Among the pathogens causing CAUTI, *Escherichia coli* is the commonest followed by *Proteus, Pseudomonas, Klebsiella, Enterobacter, Enterococcus*, *Candida* and *Serratia* etc[13].

C. INDICATIONS FOR CATHETERIZATION

I. Appropriate indications for indwelling catheters

- Patients with diagnosis of acute and/or chronic urinary retention or bladder outlet obstruction
- In patients with voiding difficulties in order to maintain continuous outflow of urine (e.g., neurological disorders that cause paralysis or loss of sensation affecting urination)
- In critically ill patients requiring accurate urinary output measurements
- Perioperative catheterization opted in selected surgical procedures, e.g., surgeries involving genitourinary tract
- Anticipated prolonged duration of surgery – such catheters should be removed in operation theater (OT) recovery unit as a priority
- Patients anticipated to receive large-volume infusions or diuretics during surgery or need for intraoperative monitoring of urinary output
- To aid in healing of open sacral or perineal wounds in incontinent patients
- Patients requiring prolonged immobilization, e.g., potentially unstable thoracic or lumbar spine or multiple traumatic injuries such as pelvic fractures
- In order to improve comfort for end-of-life care if needed

II. Inappropriate indications

- Use of indwelling catheters as a substitute for nursing care of the patient or resident with incontinence
- Use as a means of obtaining urine for culture or other diagnostic tests when the patient can voluntarily void
- Use for prolonged postoperative duration without appropriate indications

D. CAUTI PREVENTION STRATEGIES: BUNDLED CARE[8,9,14]

A care bundle is a group of interventions, which is implemented together for all patients with indwelling urinary catheters in order to obtain substantial and sustained reductions in CAUTIs[9].

I. Insertion Bundle

- Avoid catheterization if possible. Remove as soon as feasible.
- Insertion should be performed by a trained professional (doctor/nurse)
- Strict hand hygiene before insertion (Appendix, Figure. 10-1)
    - **Moment 2 - before** an aseptic/clean procedure
    - **Moment 3 -** after blood and body fluid exposure
- Always use a new and disposable catheter and single use lubricant jelly for insertion
- Practice maximal sterile barrier precaution (wearing sterile gloves, mask by inserter and using a sterile drape for the patient)
- Periurethral cleaning before procedure using aseptic solutions (Betadine)
- Secure indwelling catheter after insertion to prevent displacement or urethral injury
- Use closed drainage system with sampling port

II. Maintenance Bundle

- Daily assessment for the need of catheter
- Hand Hygiene before and after periurethral cleaning/ manipulation of catheter or collecting system
    - **Moment 2 - before** an aseptic/clean procedure
    - **Moment 3 -** after blood and body fluid exposure
- Maintain a closed drainage system and unobstructed urine flow
- Drainage bag position: Above floor but below bladder level to prevent reflux or contamination
- Appropriate perineal hygiene with soap and water twice daily
- Avoid urine reflux during patient movement
- Properly secure catheter to prevent displacement or urethral injury
- Urine sample collection: Do not disconnect the catheter and bag for sampling. Collect sample using a syringe through the port after cleaning the port with alcohol swab.
- Change urinary catheter when there is evidence of obstruction or infection or on routine basis.

E. ADDITIONAL STRATEGIES[9, 14]

I. Catheter size

Catheters come in various sizes, types and materials. Urinary catheters should be selected based on their size to allow free flow of urine; smallest diameter catheters are preferred. Large diameter catheters may cause unnecessary pressure on the urethral mucosa and thereby leading to trauma and ischemic necrosis.

II. Drainage bag

Appropriate securing of the drainage bag is essential to prevent injury and trauma to the urethra, the urinary drainage tubing should be secured to the patent's thigh with straps and adjusted to a comfortable fit. Placement of catheter drainage bag should always be below the level of the bladder to promote good drainage. If a catheter stand is used, the drainage bag and drainage tap must not come in contact with the floor. The drainage tube should be temporarily clamped to prevent back-flow of urine during patent movement. In order to maintain closed drainage system, the drainage bag should not be disconnected unnecessarily. It is emptied when 3/4th full maintaining strict hand hygiene after emptying the drainage.

III. Condom catheters

Use of condom catheters is suggested for short-term drainage in cooperative male patients. Daily penile care along with frequent catheter change should be followed. In case of penile irritation or skin breakdown indications the catheter should be immediately removed.

IV. Antimicrobial coated catheters

Silver based products and antibiotic combinations are recommended to combat development of antimicrobial resistance e.g., silver alloy catheters are used for patients with short-term catheterization (2–10 days) to reduce asymptomatic bacteriuria. Other materials used for coating were nitric oxide, chlorhexidine, antimicrobial peptides, enzymes, and bacteriophages.

V. Antimicrobial agents

Administration of systemic antibiotics on routine basis at the time of catheter insertion/removal is not recommended. Routine prophylactic antibiotics while the catheter is in place should be avoided as it leads to development of resistant bacteria. In long-term indwelling catheters the bacteria may be embedded in biofilm on the surface of catheter and therefore antibiotic administration doesn’t prove effective for treating such infections.

VI. Perineal care and meatal cleaning

Regular perineal care is recommended to avoid formation of encrustations in the meatus. Cleaning twice a day with soap and water is acceptable; application of antimicrobial ointment/ disinfectant is harmful and should be avoided.

VII. Bladder irrigation

Bladder irrigation and installation of antiseptics or antimicrobial agents are not found evident in preventing CAUTI and therefore should be avoided for this purpose. These agents are found associated with damage to bladder mucosa and mediate the development of resistant bacteria.

VIII. Specimen collection

Routine bacteriological testing is not recommended in asymptomatic patients as it has no clinical benefit. Sample collection should be performed using aseptic technique from the sampling port. The sampling port needs to be disinfected with a 70% isopropyl alcohol impregnated swab followed by aspirating the sample using a sterile needle and syringe. It is then transferred into a sterile container. In case the urinary catheter has no sampling port, the sample can be obtained from the urinary catheter by disinfecting the tube with 70% isopropyl alcohol. Alcohol should be allowed to dry followed by aspirating the sample using a sterile small bore needle and syringe. The sample should be sent to the microbiology laboratory at the earliest or should be stored at 2-8°C. Obtaining a sample from the drainage bag is not recommended.

Sample collection from a urinary catheter port

Sample collection can be performed through the sampling port for urine testing in case of possible or probable CAUTI. Routine sampling for urine culture is not recommended. Aseptic technique must be used for sample collection (Hand hygiene moments 2 and 3):

- Disinfection: Wipe the port with a 70% alcohol swab.
- Closed drainage system should be maintained
- Sample collection from drainage bag and catheter tip culture are not recommended.
- In case of non-availability of sampling port, urine sample is aspirated from the connecting tube using a sterile small bore needle-syringe and transferred into a sterile container.
- Sample transportation to lab should be immediately after collection or stored under refrigeration (2-8°C)

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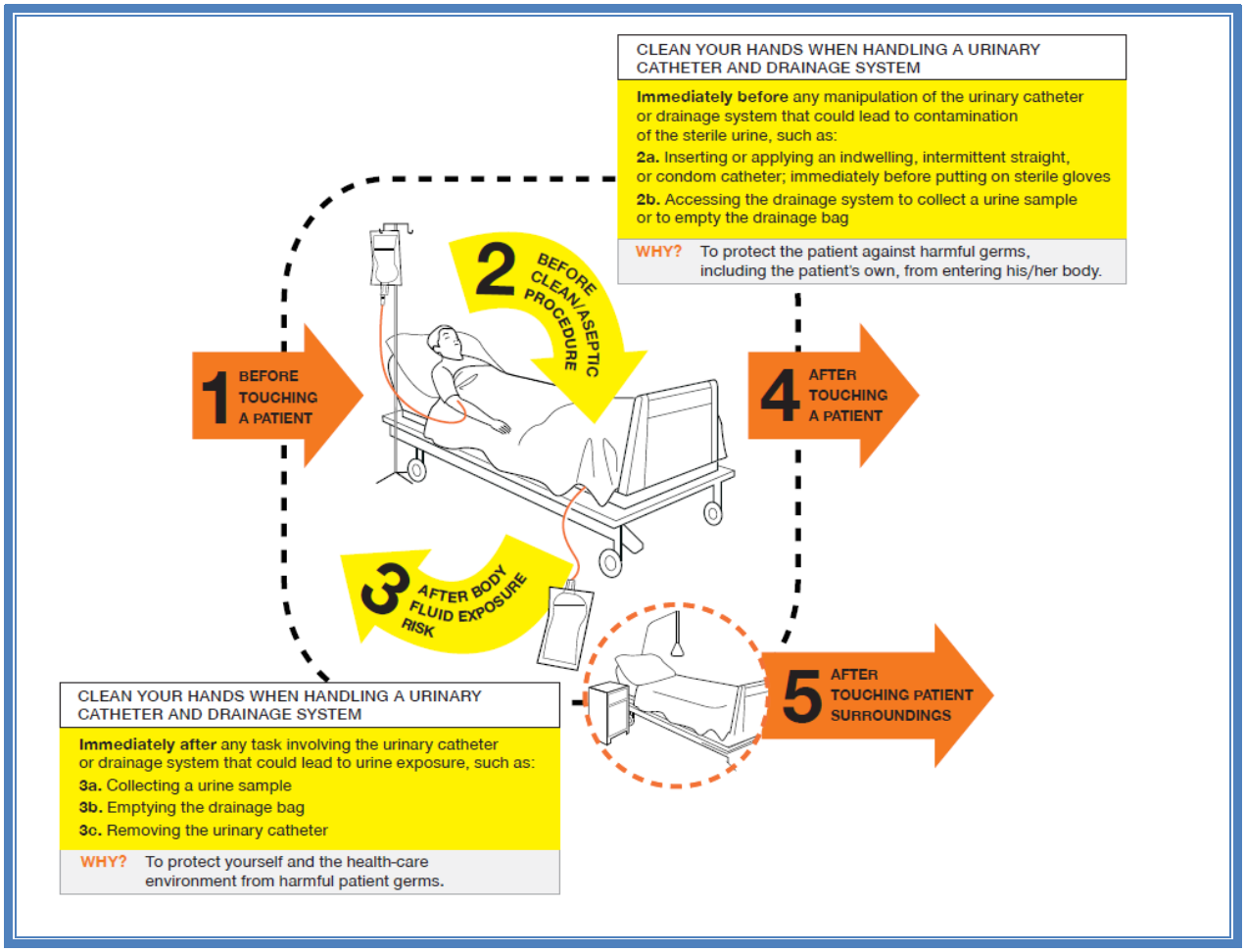
Appendix

Figure 10-1: Hand Hygiene moments to be focused in providing urinary catheter care (Resource: WHO)[8]



CHAPTER 11

PREVENTION OF CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTION (CLABSI)

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OUTLINE

A. INTRODUCTION

Central Line-associated Bloodstream Infection (CLABSI)

Central line–associated bloodstream infections, or CLABSIs, are associated with increased morbidity, mortality, and health care costs[1]. The cost of these infections is substantial both in terms of morbidity and financial resources expended. Patients with CLABSI will have prolong length of stay up to three weeks. Of patients who get a bloodstream infection from having a central line up to 1 in 4 die from the infection. It is now recognized that CLABSIs are largely preventable when evidence-based guidelines are followed for the insertion and maintenance of Central Venous Catheters (CVC).[2]

The effort for prevention of CLABSI should be multidisciplinary, involving healthcare professionals who order the insertion and removal of CVCs, those personnel who insert and maintain intravascular catheters, IPC personnel, healthcare managers including the chief executive officer (CEO) and those who allocate resources, and patients who are capable of assisting in the care of their catheters.

Sustained elimination requires continued effort. The goal of prevention of CLABSI is to reduce the rate to as low as feasible given the specific patient population being served, the universal presence of microorganisms in the human environment, and the limitations of current strategies and technologies.

What is central line?[3]

The term “central line” used in the guidelines is defined as an intravascular access device or catheter thatterminates at or close to the heart or in one of the greavessels. The following are considered great vessels for the purpose of defining a central line; pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, common iliac veins or femoral veins. A hollow introducer is considered a central line if the tip is situated in a great vessel. The line may be used for infusion, or hemodynamic monitoring. Examples include central venous catheter for infusion, pulmonary artery (PA) catheter, sheath/introducer for a PA catheter, dialysis or hemofiltration catheter in a great vessel and a peripherally inserted central catheter (PICC). A central line may be inserted centrally or peripherally (PICC) in a patient.

Pathogenesis

There are 4 recognized routes for contamination of catheters:

1. Migration of skin organisms at the insertion site into the cutaneous catheter tract and along the surface of the catheter with colonization of the catheter tip; this is the most common route of infection for short-term catheters.[4,5,6]
2. Direct contamination of the catheter or catheter hub by contact with hands or contaminated fluids or devices.[7,8]
3. Less commonly, catheters might become hematogenously seeded from another focus of infection.[9]
4. Rarely, infusate contamination might lead to CLABSI.[10]

B. RECOMMENDATIONS FOR PREVENTION OF CLABSI

Practical recommendations presented is in a concise format designed to assist healthcare settings in the Asia Pacific region in implementing CLABSI prevention efforts. This is a summary of international CLABSI prevention guidelines developed by the Asia Pacific Society of Infection Control (APSIC).[3]

Use of bundle care for the prevention of CLABSI

A bundle is a set of evidence-based interventions for a defined patient population and care setting. It has been shown that when implemented together will result in significantly better results than implemented individually. Hence, to prevent CLABSI, the insertion bundle and maintenance bundle are recommended. The 'all or none' compliance measurement, bundle compliance monitoring, is essential to emphasize the importance of implementing all elements to achieve the best outcome.

I. Insertion of intravenous catheter – the insertion bundle

The Central Line Insertion Bundle components include:

1. Optimal site selection[10-13]

   The catheter insertion site affects the risk for catheter-related infection and phlebitis. The risk for catheter infection can be related to the risk for thrombophlebitis and the density of local skin flora. Femoral catheters are associated with a higher risk of infection and deep venous thrombosis, than internal jugular or subclavian catheters and where possible avoid femoral catheter insertion. A subclavian site is preferred in adult patients and factors such as potential for mechanical complications and risk for subclavian vein stenosis should be considered when determining the catheter insertion site.

   Place catheters used for short-term hemodialysis and pheresis in a jugular or femoral vein, rather than a subclavian vein, to avoid venous stenosis. Use ultrasound guidance when available to place central venous catheters to reduce the number of cannulation attempts and mechanical complications

2. Hand hygiene[14,15]

   Hand hygiene before catheter insertion, combined with proper aseptic technique during catheter manipulation and care, provides protection against infection. Perform hand hygiene either by washing hands with liquid soap and water or with alcohol-base hand rub. Perform hand hygiene before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing or dressing an intravenous catheter. Palpation of insertion site should not be performed after the application of antiseptics unless aseptic technique is maintained.

3. Alcohol-based chlorhexidine skin preparation[16,17]

   Prepare and clean the skin site with an alcoholic chlorhexidine solution containing a concentration of 0.5 - 2% chlorhexidine and 70% alcohol before central venous catheter insertion and during dressing changes. If there is a contraindication to chlorhexidine (e.g.,

hypersensitivity), tincture of iodine, an iodophor, or 70% alcohol can be used as alternatives. Allow the skin antiseptic being used to dry completely before catheter insertion.

4. Maximum barrier precautions[18]

   These refer to the wearing a sterile gown, sterile gloves, mask and a cap along with the use of a full body sterile drape to cover the patient (similar to the sterile drapes used in the operating room) during the insertion of central venous catheters. Use maximal sterile barrier precautions during insertion of central venous catheters. Use a sterile sleeve to protect pulmonary artery catheters during insertion.

II. Maintenance care of intravenous catheters – the maintenance bundle

CLABSI maintenance bundle componentsinclude:- [19-30]

1. Daily review of line necessity and replacement

   The central venous catheters should be reviewed daily for ongoing need. This is because the risk of CLABSIs increases with the duration of time the catheter is left in place, so daily evaluation of central lines is an important aspect of CLABSI prevention. Catheters that are no longer needed should be promptly removed.

   Do not routinely replace CVCs, PICCs, hemodialysis catheters, or pulmonary artery catheters. Do not remove CVCs or PICCs on the basis of fever alone. Use clinical assessment to determine if infection is evidenced elsewhere or if there is another non-infectious cause of the fever. Do not routinely change CVCs over guidewire exchanges for non-tunneled catheters.

   Do not use guidewire exchanges to replace a non-tunneled catheter suspected of infection. Use a guidewire exchange to replace a malfunctioning non-tunneled catheter if there is no evidence of infection is present.

2. Hand hygiene glove use and aseptic technique

   Hand hygiene should be performed before and after palpating catheter insertion sites as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained. Maintain aseptic technique for the insertion and care of intravascular catheters. Wear either clean or sterile gloves when changing the dressing on intravascular catheters. Use new sterile gloves and aseptic technique before handling the new catheter when guidewire exchanges are performed.

3. Disinfection of hubs and changing the access lumens/devices

   The hubs on CVCs are a common source of bacterial colonization and serve as immediate portal of entry of microorganisms to the intraluminal surface of the catheter. These colonizers from the catheter hub and lumen can be dispersed into the bloodstream resulting in CLABSI. The disinfection of catheter hub surface is therefore, critical every time before they are accessed.

Use a CVC with the minimum number of ports or lumens essential for the management of the patient. Change the needleless components at as the same time the administration set are changed or according to manufacturers' recommendations for the purpose of reducing infection rates. There is no benefit to changing administration sets and hubs/connectors more frequently than every 72 hours. Ensure that all components of the system are compatible to minimize leaks and breaks in the system.

Minimize contamination risk by scrubbing the access port and hub with an appropriate antiseptic (alcohol-based chlorhexidine, povidone iodine, an alcohol-based iodophor, or 70% alcohol) and accessing the port only with sterile devices.

When needleless systems are used, a split septum valve may be preferred over some mechanical valves due to increased risk of infection with the mechanical valves.

4. Strict aseptic technique for dressing changes

   Transparent semipermeable dressings are preferred over gauze dressings as they allow continuous visual inspection of the catheter site. However, gauze dressings can be used if the patient is sweating or the site is bleeding or oozing following CVC insertion. Replace catheter site dressing if the dressing becomes damp, loosened, or visibly soiled.

   Do not use topical antibiotic ointment or creams on insertion sites, except for dialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance.

   Do not submerge the catheter or catheter site in water. Showering should be permitted if precautions can be taken to reduce the likelihood of water reaching the catheter site such as protect the catheter and administration connections and hubs with a waterproof cover during showering. This is because it increases the risk of organisms being introduced into the insertion site.

   Replace transparent dressings used on CVC sites at least every 7 days, except pediatric patients in which the risk of dislodging the catheter may outweigh the benefit of changing the dressing. Replace transparent dressings whenever the dressing is soiled or loose. Ensure that catheter site care is compatible with the catheter material.

   Use a chlorhexidine-impregnated sponge dressing for central venous catheters in patients older than 2 months of age if the CLABSI infection rate high and not decreasing despite adherence to maintenance bundle prevention measures, including education and training.

   Encourage patients to report any changes in their catheter site or any new discomfort to staff.

5. Standardize administration sets changes

   Administration sets are used for transfer of fluids, medicines and nutrition to patient's body. Prolonged use of these sets increases the risk of infection. Therefore, routine change of the administration systems (primary and secondary sets and add-on devices) is recommended.

In patients not receiving blood, blood products or fat emulsions, replace administration sets that are continuously used, including secondary sets and add-on devices, no more frequently than at 96H intervals, but at least every 7 days.

Regarding the frequency for replacing intermittently used administration sets, need to consider drug competibility as well as enforcing aseptic technique. Replace tubing used to administer blood, blood products, or fat emulsions (those combined with amino acids and glucose in a 3-in-1 admixture or infused separately) within 24 h of initiating the infusion. Replace tubing used to administer propofol infusions every 6 or 12 hours, when the vial is changed, refer to the manufacturer's recommendation.

C. GUIDELINE IMPLEMENTATION[31-34]

A key success factor to the implementation of the central line insertion and maintenance bundles is to adopt the model of improvement approach involving multidisciplinary process stakeholders. The Plan-Do-Study-Act (PDSA) methodology such as planning a test, trying it, observing the results, and acting on what is learned; is the scientific approach for effective implementation.

1. Quality Improvement approach

The use of the CLABSI insertion and maintenance bundles is best done using a quality improvement approach with a multidisciplinary team. Build teams which include all staff involved in CVC insertion and maintenance including local champions. Enhanced communication to share data and take action. Hospital leadership and policymakers are to continue providing support to build a culture of zero tolerance. Lines of accountability need to be established to link every level of staff in a hospital so that everyone has a shared understanding of the organization's goals. Teams will receive feedback (e.g., dashboards) on how they are performing.

2. Training and education

Education and training programs is critical and should be assessed for their content, relevance and impact on work performance. Adherence to evidence-based practices reduces inconsistencies in practice and can significantly improve the overall quality of care and best practices. Thus, identifying and removing barriers to adherence to these practices is essential to a successful implementation of best practices in the era of patient safety.

D. ADDITIONAL MEASURES TO REDUCE CLABSI[35-54]

The rationale for the use of chlorhexidine antiseptic bathing in place of soap and water bathing relates to the patient's resident skin flora that can enter the bloodstream at the CVC insertion site or the extraluminal surface of the catheter. Reducing skin contaminants with chlorhexidine bathing can further reduce the risk of CLABSI.

Similarly, a chlorhexidine-impregnated dressing is now recommended by the Centers for Disease Control and Prevention (grade IB) when basic prevention measures are ineffective to decrease CLABSIs.

Additional measures to reduce infection include:

1. ***Chlorhexidine bathing in addition to maximal barrier precautions and maintenance bundle prevention measures.***
2. ***If the CLABSI rate is not decreasing despite successful adherence to maintenance bundle prevention measures use a chlorhexidine impregnated dressing at the catheter site in patient older than 2 months of age if there are no contraindications***
3. ***Minocycline-rifampin or chlorhexidine-silver sulfadiazine impregnated catheters should be considered in adult patients whose catheter dwell time is expected to be >7 days and in units where the CLABSI infection rate is not meeting the set goal.***
4. ***Patients using minocycline-rifampin or chlorhexidine-silver sulfadiazine-impregnated catheters should be monitored for side effects, such as anaphylaxis.***
5. ***Prophylactic antimicrobial or antiseptic lock solution should be considered for the following:***
    a. Patients with long-term hemodialysis catheters.
    b. Patients with limited venous access and a history of recurrent CLABSI.
    c. Pediatric cancer patients with long-term catheters.
    d. Scrubbing the hub or access port of connectors with a appropriate antiseptic and accessing the port only with sterile devices.

E. THE IMPORTANCE OF SURVEILLANCE[3, 30]

Surveillance for outcomes (CLABSI infection rates) is a primary outcome. It is useful to monitor adherence to evidence-based central line insertion and maintenance practices i.e., insertion bundle compliance rates using a 'bundle compliance checklist' as a method for identifying quality improvement opportunities and strategically targeting interventions for the reduction of CLABSI.

1. The CLABSI rate are calculated per 1000 central line days. [this is computed using data collected from checklist in the Appendix C in APSIC Guide for prevention of Central Line Associated Bloodstream Infections (CLABSI) in 2015]
2. The Central line insertion bundle compliance rate is calculated as a percentage of central line insertions per month (%) [this is computed using data collected from checklist in the appendix A in APSIC Guide for prevention of Central Line Associated Bloodstream Infections (CLABSI) in 2015]
3. The Central line maintenance bundle compliance rate is calculated as a percentage of central line insertions per month (%) [this is computed using data collected from checklist in the

appendix B in APSIC Guide for prevention of Central Line Associated Bloodstream Infections (CLABSI) in 2015]

4. Improvement takes place over time. Run charts can be used to monitor these changes. Run charts are graphs of data over time and are one of the single most important tools in performance improvement. Feedback the data is best done in a timely manner to relevant clinical groups so that targeted CLABSI prevention and control measures can be introduced and reported on.

CLABSI is one of the most common and yet preventable healthcare associated infections. It is recommend hospitals especially in the Asia Pacific region that have yet to achieve zero CLABSI rates continue surveillance of CLABSIs and implement Central Line Insertion and Maintenance Bundles using quality improvement approaches to improve practices as described in the APSIC Guide For Prevention Of Central Line Associated Bloodstream Infections (CLABSI), 2015.

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CHAPTER 12

VAP PREVENTION

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OUTLINE

A. INCIDENCE AND BURDEN

The pool mean incidence density of ventilator-associated pneumonia (VAP) from a multi-national network in medical, pediatric, and neonatal intensive care units (MICU, PICU, and NICU) were 12.7, 11.8, and 7.5 per 1,000 ventilator-days from 2012 to 2017.[1] In Southeast Asia, the pooled incidence density of VAP was 14.7 per 1000 ventilator-days.[2] The common resistant pathogens of VAP were carbapenem-resistant *Acinetobacter baumanii* (CRAB 92.8%), *Klebsiella pneumoniae* (ceftriaxone or ceftazidime 72.8%), and *Escherichia coli* (ceftriaxone or ceftazidime 57.8%).[1]

Extra pooled crude mortality rates of patients with VAP compared with non-VAP in MICU-PICU and NICU were 23.1% (36.6%-13.5%) and 16.3% (25.8%-9.5%), respectively. Moreover, extra pooled average length of stay of patients with VAP compared with non-VAP in MICU-PICU and NICU were 9.4 (17.6-8.2) days and 30.5 (43.6-13.1) days, respectively.[1]

Burden	MICU-PICU		NICU	
	VAP	non-VAP	VAP	non-VAP
pooled crude mortality rate, %	36.6	13.5	25.8	9.5
pooled average length of stay, days	17.6	8.2	43.6	13.1

B. PREVENTION OF VAP IN ADULTS

For a multidisciplinary team using a multifaceted approach, both patient and personnel aspects prevent VAP.

1. Patient care and interventions[3-11]

Interventions	Probable impact on VAP rates	Comments
Head-of-bed elevation	May lower rates	Understudied, few and contradictory randomized trials
Automated endotracheal tube cuff pressure monitoring	May lower rates	Continuous control may be effective but frequent control not beneficial. Understudied, merits further evaluation
Subglottic secretion drainage	May lower rates	Extensively studied but despite lower VAP rates no impact on duration of mechanical ventilation, ICU length-of-stay, ventilator-associated events, or mortality. Unclear impact on antibiotic utilization
Closed tracheal suctioning[9]	May lower rates	Reduced VAP rates but underreported and low quality of included trials
Oral care with chlorhexidine[4,12]	May lower rates	Extensively studied. Meta-analysis suggests lower VAP rates (especially 0.2% chlorhexidine and chlorhexidine solution) without significant impact on associated mortality in ventilated patients

Interventions	Probable impact on VAP rates	Comments
Selective oral and digestive decontamination	Likely lowers VAP rates	Extensively studied. Less net antibiotic utilization and lower mortality rates in Dutch studies. No impact on mortality in units with high baseline rates of antibiotic resistance and antibiotic utilization
VAP prevention bundles	Likely lower VAP rates	Extensively studied, almost exclusively in before–after and time-series analyses. May be associated with lower mortality rates. Most benefit likely from minimizing sedation and encouraging early extubation
Tapered endotracheal tube cuffs and ultrathin polyurethane[5]	No impact	In vivo studies document persistently high rates of subclinical aspiration despite the theoretical advantages of these designs
Heat and moisture exchangers (HME)[8]	No impact	no statistical difference in artificial airway occlusion, mortality or VAP but hydrophobic HMEs may reduce the risk of VAP compared to heated humidifiers
Routinely change the ventilator circuit[13]	No impact	No effect in reducing VAP in the ICU
Chest physiotherapy[6]	No impact	No significant reduction in the incidence of VAP, ICU mortality, length of ICU stay, and duration of mechanical ventilation
Chlorhexidine bathing[7]	No impact	No effect in reducing VAP in the ICU
Probiotics	Unclear	Many studies but most of limited quality, with mixed results. Lower VAP rates on meta-analysis but no signal when restricted to double-blind studies and not recommend for routine use
Silver-coated endotracheal tubes[14]	Limited evidence	Probably effective, may not be cost-effective and not recommend for routine use
Daily Sedation interruption	Limited evidence	Evaluated on a daily basis and discontinued as early as possible
Stress ulcer prophylaxis	May increase VAP rates	Observational studies and some meta-analyses suggest higher VAP rates but a recent large randomized trial found no impact

2. Healthcare personnel

2.1 Team

2.2 Education

2.3 Surveillance (hand hygiene)

2.4 Measurement (process and outcomes)

2.5 Performance monitoring

2.6 Feedback

C. PREVENTION OF VAP IN CHILDREN AND NEONATES

In PICU and NICU, respiratory interventions to prevent VAP are similar to adult interventions. The main components of the pediatric and neonatal ventilator bundles studied were head of the bed elevation, daily assessment of readiness to extubate, oral care, and peptic ulcer prophylaxis.[15] In neonates, special interventions to prevent VAP are oral care (oropharyngeal colostrum 0.2 mL divided into two cheeks every 2-4 h in very low birthweight neonates),[16] and avoid sedative medication[17] and histamine-2 receptor antagonists (associated with infection as well as VAP).[18]

D. PREVENTION STRATEGIES FOR VAP[11,19]

In general practices, interventions to reduce VAP rates are composed of:

- Semi-recumbent positioning (30–45°)
- Avoid mechanical ventilation, if possible, minimize duration of mechanical ventilation, and use noninvasive ventilation and high-flow nasal cannula oxygen therapy
- Daily interruption of sedation followed by assessment for readiness to wean and spontaneous breathing/awakening trials, and facilitate early mobility
- Change the ventilator circuit only if visibly soiled or malfunctioning
- Automated endotracheal tube cuff pressure monitoring
- Closed tracheal suctioning, and utilize endotracheal tubes with subglottic secretion drainage ports for patients expected to require greater than 48 or 72 hours of mechanical ventilation

Special interventions composed of:

- Selective oral or digestive decontamination
- Oral care with chlorhexidine (adult patients) or oropharyngeal colostrum (neonatal patients)

Some interventions are not generally recommended including:

- Silver-coated endotracheal tubes
- Kinetic beds or prone positioning
- Stress ulcer prophylaxis
- Early tracheotomy
- Monitoring residual gastric volumes, and early parenteral nutrition

E. VENTILATOR BUNDLE CHECKLIST

1. Head-of-bed elevation 30-45°
2. Adequate endotracheal tube cuff pressure (20-30 mmHg)
3. Endotracheal tube with an in-line suction system and subglottic suctioning.
4. Oral care with chlorhexidine solution

5. Daily “sedation vacation” and daily assessment of readiness for extubation
6. Peptic ulcer disease prophylaxis
7. Deep vein thrombosis prophylaxis

F. PREVENTIVE STRATEGIES FOR MULTIDRUG RESISTANT (MDR) VAP

Multifaceted preventive strategies can lower both VAP rates and MDR organism’s colonization pressure, even resulting in a decreased incidence of MDR-VAP. MDR pathogens colonization pressure may focus on oral hygiene or body washing with chlorhexidine, selective oral and/or digestive decontamination, multiple decontamination regimens, probiotics, subglottic secretions drainage, special cuff material and shape, silver-coated endotracheal tubes, universal use of gloves and contact isolation, alcohol-based hand gel, vaporized hydrogen peroxide, and bundles of care;[20] however, the effectiveness of such bundles should be tested in well-designed trials. In NICU, the effects of environmental cleaning (sodium hypochlorite 5,000 ppm in the NICU and 500 ppm in the neonatal environment) and the installation of heat and moisture exchangers reduce endotracheal CRAB colonization with a reduction in broad-spectrum antimicrobial use.[21]

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CHAPTER 13

PREVENTION OF SURGICAL SITE INFECTIONS

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OUTLINE

A. INTRODUCTION

The full APSIC Guidelines for the Prevention of Surgical Site Infections is available at https://apsic-apac.org as reference to guide practice.

Surveillance of surgical site infections (SSIs) with feedback of appropriate data to surgeons and other healthcare workers involved in the care of those undergoing operative procedures has been shown to be an important component of strategies to reduce the risk of SSIs.[1,2] A successful surveillance program includes the use of standardized SSI definitions and surveillance methods, stratification of SSI rates according to risk factors associated with SSI development, and timely feedback of data.[3]

B. PRE-OPERATIVE PREVENTIVE MEASURES

1. Pre-operative bath

It is generally accepted that preoperative bathing with soap (antimicrobial or non-antimicrobial) is beneficial prior to surgery, despite the lack of study comparing preoperative bath versus no-preoperative bath on the occurrence of SSIs.

Although recommendations on preoperative bathing in relation to time of administration and the most effective protocol for perioperative bath remains an unresolved issue, it is advisable to take at least 2 baths pre-operatively.[4] Countries with high incidence of multidrug resistant organisms may want to consider the use of an antiseptic instead of plain soap as a preoperative bath. In some Asian countries where allergy to chlorhexidine (CHG) is common or CHG is not available, alternative agents such as octenidine may be used.

2. Mechanical bowel preparation (MBP) and oral antibiotics for elective colorectal surgery in adults

Oral antibiotics have been used to decrease the luminal bacterial load since the 1930s, but it does not decrease SSI. Similarly, oral or intravenous antibiotics alone showed suboptimal effects. A 2014 Cochrane review also recommended that antibiotics should be administered both orally with mechanical bowel preparation and intravenously in 1 hour before surgery to reduce SSIs.[5]

3. Hair removal

There are several methods to remove hair at the surgical site preoperatively. Hair removal by shaving and the night before an operation is associated with and increased risk of SSI. Shaving and/or clipping can cause microscopic cuts in the skin that later serve as foci for bacterial multiplication.[6,7] Hair removal should be avoided unless hair interferes with the operative

procedure. If hair removal is necessary, a razor should be avoided, and an electric clipper should be used.

4. *Methicillin-resistant Staphylococcus aureus (MRSA) screening and decolonization*

It is well recognized that MRSA colonization is associated with worse outcomes and a higher risk for both MRSA SSI and overall SSl. The use of MRSA bundle comprising of screening, decolonization, contact precautions, and vancomycin-containing antibiotic prophylaxis was associated with decreased rates of SSI where there was high compliance with the bundle strategies.[8,9] Patients undergoing cardiothoracic and orthopedic surgery with known nasal carriage of S. aureus should receive perioperative intranasal application of mupirocin 2% ointment with or without a combination of CHG body wash.

5. *Surgical hand/forearm preparation*

The objective of cleaning hands and forearms prior to surgery is to reduce the bioburden of bacteria on the skin of the surgical team. The second objective is to inhibit the growth of bacteria. Hands and forearms should undergo a surgical scrub with a suitable antiseptic soap and water or a suitable ABHR before donning sterile gown and gloves. When using alcohol-based hand rub (ABHR) solutions containing 60–80% alcohol is recommended. ABHR used in surgical hand preparation should comply with EN 12791 or ASTM E-1115 standards. Water quality may be compromised with the use of tap aerators where these are known to be easily colonized with non-fermentative Gram-negative bacteria e.g., *Pseudomonas aeruginosa, Acinetobacter baumannii*, etc. Hence, where there are issues with the quality of water used in rinsing hands after hand scrubbing, hand rubbing with ABHR agent is a suitable alternative.[10,11]

6. *Skin antiseptic*

Current evidence suggested that alcohol-based preparations are more effective in reducing SSI than aqueous preparations, and should be used, unless contraindicated.[12,13] Alcohol has a rapid bactericidal effect, albeit with the lack of persistent antibacterial effect. The benefit of iodine or chlorhexidine and alcohol solutions is prolonged bactericidal activity.

7. *Surgical Prophylaxis*

Current guidelines suggest the use of narrow spectrum antibiotics, such as cefazolin for most surgical procedures, or cefoxitin for abdominal surgery, as surgical antimicrobial prophylaxis. In situations where the incidence of MRSA-associated SSI is high or in case/s of penicillin allergy, vancomycin or fluoroquinolone can be used as an alternative. Current evidence supports the administration of an antimicrobial for surgical prophylaxis within 1 hour before incision or before

inflation of a tourniquet in orthopaedic procedures, or within 2 hours for vancomycin or fluoroquinolones, because of their recommended infusion times.[14] In most cases, it is recommended that a single dose of surgical antimicrobial prophylaxis is adequate. Re-dosing should be considered to maintain adequate tissue levels based on agent half-life.

8. *Nutrition*

Changes in host immunity may increase a patient's susceptibility to SSIs and malnutrition may contribute to poor surgical outcomes, including delayed recovery, morbidity and mortality, prolonged hospital stay, increased health care costs and readmission. Underweight patients undergoing major surgical procedures, especially oncology and cardiovascular operations, may benefit from the administration of oral or enteral multiple nutrient-enhanced nutritional formulas for the purpose of preventing SSI.

9. *Glycemic Control*

To optimize the care of the patient with diabetes and reduce the risk of complications, a team-oriented approach to treatment is highly recommended.[15-17] Preoperative HbA1C levels should be less than 8%.

C. INTRA-OPERATIVE PREVENTIVE MEASURES

1. *Normothermia*

Exposure of large surfaces of skin to cold temperatures in the operating room can cause hypothermia, raising the risk for other complications such as SSI.[18,19] To avoid these complications, *maintain perioperative normothermia by using active warming devices* e.g., a forced-air warming system, water bed system, and passive warming system such as blankets.

2. *Normovolemia*

Hypovolemia and reduced cardiac output theoretically trigger musculocutaneous and splanchnic vasoconstriction, causing hypoperfusion and tissue hypoxia. Hemodynamic goal-directed therapy, a treatment based on the titration of fluid and inotropic drugs infused to physiologic flow-related end points, is recommended.[20,21]

3. *Irrigation*

Wound irrigation is considered to be one of the most useful SSI prevention methods by many surgeons. There is insufficient evidence to recommend for or against saline of incisional wounds before closure for the purpose of preventing SSI. Avoid using antimicrobial agents to irrigate the incisional wounds before closure to reduce the risk of SSI.

4. *Antimicrobial impregnated sutures*

Where there are high SSI rates in clean surgeries, in spite of basic preventive measures, individual centers may consider the use of antimicrobial impregnated sutures.[22]

5. *Drapes*

In various guidelines, it is generally accepted not to recommend non-iodine- impregnated adhesive incise drapes, since it is associated with SSI risk. However, in several observational studies especially in clean surgeries, marked SSI reduction reported with the proper use of iodine-impregnated drapes,[23,24] especially in orthopedic and cardiac surgeries.

6. *Wound protectors*

In the WHO Global Guidelines for the prevention of SSI, the expert panel concluded that the use of a wound-protector device (single-ring or double-ring) was associated with a significantly lower risk of SSI than with conventional wound protection (OR 0·42; 95% CI 0·28–0·62).[25] Careful evaluation of wound protectors needs to be done before introducing the use of wound protectors as a routine measure to reduce SSI.

7. *Vancomycin powder*

Latest guidelines from the Centers for Disease Control and Prevention (CDC) strongly recommended not to apply antimicrobial agents (i.e., ointments, solutions, or powders) to the surgical incision for the prevention of SSI.[26,27] Vancomycin powder is not recommended for the purpose of preventing SSIs at this point, including spinal surgery.

8. *Laminar air flow*

Heterogeneity is seen with data published, and lack of standardization is noted in the surveillance methods and registers used regarding the use of laminar air flow and its association with SSI. In the latest meta-analysis from the WHO, with some additional studies, the risk for deep SSI in association with laminar air flow showed no significant difference compared with a conventional air flow system, with OR: 1.08(95% CI 0.77-1.52, p=0.65) for knee arthroplasty, OR: 1.29 (95% CI 0.98-1.71, p=0.07) for hip arthroplasty, and OR: 0.75(95% CI 0.43-1.33, p=0.33) for abdominal and open vascular surgeries.[25] Installation of laminar airflow is not required in new or renovated operating rooms to prevent SSIs.

D. RECOMMENDATIONS FOR POST-OPERATIVE WOUND MANAGEMENT

Aseptic technique should be used when undertaking wound dressings and wound management. Choice of dressing will depend on patient and wound needs, i.e., exudate level, wound depth, need for conformability, antimicrobial efficacy, odor control, ease of removal, safety and patient comfort.[28,29]

Primary vacuum dressings or Negative Pressure Wound Therapy (i.e., for clean-contaminated and contaminated surgeries) and silver-based dressings have mixed results and individualized decisions on their use are suggested. Routine use for prevention of SSI is not recommended.

E. CONCLUSION

Hospitals with high surgical site infection rates are highly encouraged to consider reviewing their practices in accordance with the APSIC Guidelines for the Prevention of Surgical Site Infections to identify areas for improvement. This should be followed by a process improvement plan using the approach described in the APSIC Guide for Prevention of Central Line Associated Bloodstream Infections (CLABSI) to close the gaps identified.[30]

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CHAPTER 14

CLINICAL WASTE MANAGEMENT

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OUTLINE

Hospital waste refers to waste that is generated from clinical areas such as hospitals, clinics and laboratories. Not all hospital waste is hazardous. It is mainly infectious waste that poses a health hazard to those handling its disposal, and nearly all reported cases of disease transmission from hospital waste are the result of injuries by contaminated sharps. Some other waste is specially managed for aesthetic reasons.

A. DEFINITIONS

Hospital waste refers to all waste generated in the hospital, biological or non-biological, discarded and not intended for further use.
Medical or clinical waste is a subset of hospital waste and refers to materials generated as a result of patient diagnosis and treatment, or immunization of human beings or animals.
Infectious waste is a subset of medical waste and refers to that portion of medical waste that could transmit an infectious disease.

Most hospital waste can be disposed of as municipal waste and only a small portion will require special disposal for public health reasons. Data demonstrates that household waste contains at least 100 times as many microorganisms as medical waste.[1] Studies also show that there is no significant difference in the mean log total colony-forming units between isolation rooms and standard patients' rooms.[2] In many countries, over-inclusion of medical waste is common because legislation is not made on scientific grounds, thus wasting millions of dollars.

According to the recommendations of the Centers for Disease Control and Prevention, medical waste categories requiring special treatment are:[3]

- Contaminated sharps
- Laboratory stocks and cultures of infectious agents
- Pathological tissues and organs
- Blood and blood products
- Contaminated animal carcasses

B. DISPOSAL AND PRE-TREATMENT METHODS

Contaminated sharps are the only medical waste with a demonstrated risk of infection to waste handlers. They must be disposed of after use into puncture-resistant and waterproof sharps boxes and should be incinerated.

Laboratory stocks, cultures and blood samples can be autoclaved at 121°C for a minimum of 20 minutes, then disposed of as municipal waste. Alternatively, these items can be incinerated.

Human tissue, organs, animal carcasses, dressings and waste that is dripping or caked with blood should be incinerated.

Cytotoxic drugs in bulk (more than 3% of total) or significant residual volume in containers should be incinerated.

Liquid blood is usually poured down a drain connected to a sanitary sewer (e.g., sluice).[3]

C. ALTERNATIVE METHODS

Incineration is a common practice for medical waste disposal because waste volumes are reduced by as much as 90%. Many non-incineration alternatives are being developed as concerns about air pollution increase in many parts of the world. These include mechanical and chemical disinfection, microwave decontamination, steam disinfection and compacting.[4] These technologies need to be closely evaluated to prevent additional staff occupational exposure. Special landfill disposal of medical waste in deep trenches is an acceptable alternative in developing countries where resources are limited.

D. RECYCLING OF HOSPITAL WASTE

There are no infectious risks associated with recycling hospital waste. Effective management of hospital waste incorporates a waste reduction and recycling program. Recycling efforts by hospitals should focus on both non-patient care items as well as patient care items such as glass intravenous bottles, as there is no infectious risk posed by recycling these items.

E. WASTE REDUCTION AND MINIMIZATION

Many of the most effective measures to eliminate or minimize waste streams in health care are applicable at the manufacturing, supply, and import stages of the supply chain. These include: reducing product packaging; reducing shipping waste; and modifying the design of health care products themselves to utilize less material or to dispose of them in an easier way

A hospital waste disposal program should be based on scientific data to avoid over-inclusion for special treatment and incineration. This can be reinforced by staff education and emphasis on careful segregation. Such an approach may prevent the wasteful expenditure of precious healthcare resources and safeguard both the environment and the public's health.

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CHAPTER 15

PROPER MANAGEMENT OF HOSPITAL LINEN

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OUTLINE

A. INTRODUCTION

Soiled hospital linen, like any other used patient care item, is contaminated with a large number of microorganisms, yet the risks of disease transmission are negligible.[1] Even when such transmission occurs, it is usually related to a breach in the accepted linen handling recommendations. The use of high temperatures to solve the problem is unnecessary, as the cleaning and drying processes can remove most, if not all, bacteria from dirty linen. Effective laundry processes should be scientifically based to achieve cost-effective results. Due to the increased use of heat-labile synthetic linen, the surge in energy costs and the trend towards environmental awareness, low-temperature laundry processes are growing in popularity. This is a challenge for both the infection control team and laundry personnel.

B. RISKS FROM HOSPITAL LINEN

It is important, first of all, to understand the risk of disease transmission from hospital linen to patients. In the literature, there are only a few reports of linen as a possible source of healthcare-associated infection (HAI) and all suggested only a causal relationship. In these reports, the implicated organisms were also found in other environmental sources and on the hands of healthcare workers.

In fact, sources of organisms causing HAIs are more commonly related to the hands of staff than to inanimate surfaces.[2] Thus, the inherent risks of disease transmission to patients from hospital linen, if properly laundered, is minimal.

Dirty linen often contains a significant number of microbes (10^4–10^8 bacteria per 100 cm^2 of soiled bed sheets), mostly Gram-negative rods and bacilli.[3] These are usually non-pathogenic and can generally be found in the hospital environment. Therefore, infections among laundry workers are rarely reported; those reported are frequently related to the handling of soiled linen without proper barrier precautions.

C. SAFE PRACTICES IN HANDLING HOSPITAL LINEN

Proper handling of both soiled and clean linen is essential to reduce infection risks to patients and laundry workers. Therefore, it is vital to streamline the laundry process from collection, sorting, washing and transport to storage. The healthcare facility should:

- Supply adequate clean linen
- Deliver linen in a manner to minimize microbial contamination from surface and airborne deposition
- Collect soiled linen in a manner to minimize microbial dissemination into the environment.

1. *Collection*

Soiled linen should be handled as little as possible and with minimal agitation to prevent gross contamination of the air and personnel. All soiled linen should be bagged at the site of use. When packing linen soiled with blood and body fluid, a folding or rolling technique should be used to place the most soiled part in the centre of the linen bundle; this containment is helpful to prevent contamination.

2. *Bagging of infectious linen —single versus double bag*

Dirty linen should be placed in impervious bags to prevent leakage and contamination of the environment and transport personnel. Studies have proved that there is no difference in the amount of bacteria contaminating linen from patients in isolation rooms or in the general ward.[4] Double bagging is now proven to be both expensive and unnecessary.[5,6] Hot-water-soluble bags are commonly used as inner bags. They are designed for immediate containment so that infected linen is placed into the washers without sorting, which is a wasteful practice because:

a. ***the inner water-soluble bags are expensive;***
b. ***there is tainting associated with hot-water washing;***
c. ***re-washing adds to the cost; and***
d. ***if metal instruments are inadvertently left in the linen without sorting, damage to the washing machine and linen may occur. Discontinuing double bagging, in particular the use of hot-water-soluble bags, can result in significant cost savings. Both plastic and canvas bags are water resistant and can be used for the collection and transportation of soiled linen.***

3. *Transportation of soiled linen*

Transport of soiled linen can be by hand carts or chutes. Use of hand carts remains a common practice. Different carts should be used for clean and dirty linen to avoid recontamination of clean linen by dirty containers. Soiled linen chutes are an alternative for the transportation of soiled linen. However, design and use problems are common and soiled linen chutes can be a source of environmental contamination.

4. *Sorting*

Soiled linen should not be sorted or pre-rinsed in patient care areas. Sorting has been associated with infection transmission among laundry workers and is to be discouraged. If sorting is unavoidable, it must be done in the laundry department by trained personnel with proper barriers such as gloves and gowns.

5. *Washing*

A proper laundering process can remove soil as well as reduce microbial contamination to an acceptable level. However, no standards for maximal safe levels exist. Walter and Schillinger suggested that levels of microbes on laundered fabrics of 20 colony-forming units or less per 100 cm^2 are equal to complete pathogen removal, while Christian et al proposed that a 10^6–10^7 reduction in viable counts is effective.[7,8] Nonetheless, regular assessment of the microbial levels on laundered linen is unnecessary unless laundry-related outbreaks occur.

6. *Washing cycles — is high-temperature laundry warranted?*

Today, high-temperature laundering is a common practice in many hospitals. However, several investigators have suggested that low-temperature laundering with a chemical rinse can eliminate the same level of microbes as high temperature laundering. At 22°C, a 3-log bacterial reduction can be achieved and an additional 3-log reduction by bleach rinse of 50–150 ppm.[9] Reduction in bacterial contamination depends not just on high temperature. Other factors, including agitation, dilution, and addition of bleach and drying, have a supplementary impact. Thus, low-temperature laundry with chemical rinse is just as safe as high-temperature laundry and can save both energy and money.

A typical laundry cycle consists of a pre-wash to remove gross soil, main wash, and then rinse. The settings of the laundry cycle are determined by the quality of the water, the size of the load, and the laundry chemicals used.[10] Apart from washing with water and a laundry detergent, further decontamination of linen is achieved by the temperature of the wash water, the laundry additives, as well as the drying and ironing process. If warm water is available, the washing cycle temperature and duration must be at least 71°C (160°F) for a minimum of 25 minutes.[11] These parameters must be used in conjunction with the manufacturer's instructions for the washing machine. Heat-sensitive patient clothing and uniforms must be washed at a temperature of no more than 40°C. If warm water is not available, laundry can be washed with water at a temperature of 22°–25°C (71°–77°F), however it is recommended that a disinfecting agent such as chlorine (bleach, i.e., sodium hypochlorite) or hydrogen peroxide be added to the wash cycle. Laundry detergents and other chemicals added to the laundry cycle must be approved by the facility and they must be used according to the manufacturer's instructions.

7. *Disposable linens*

Both disposable and reusable linens are available in the healthcare setting. With economic improvements, even developing countries can afford disposable linen. Particularly small items, such as caps, masks, shoe covers, diapers and wrappers, may require high handling charges if reusable versions are used.

The change to disposable may sometimes be more cost-effective. However, when changing from reusable to disposable, necessary consideration should include not just cost but also accessibility, lifespan of reusable items, availability of laundry services, storage space, and the cost of disposal.

8. Storage of clean linen

Clean linen must be covered or wrapped for protection from contamination during transport. Protection of stored linen is recommended until the linen is distributed for individual patient use.

Hospital linen is often mistaken to be a major source of infection. Studies have shown that most outbreaks are not directly related to hospital linen. Therefore, proper management of hospital linen is critical and regular audit and feedback would certainly help to maintain and improve laundry services[12]. Expensive practices such as double bagging of infectious linen and high temperature laundering processes are wasteful. Rational approach to handling hospital linen should be cost-effectiveness and environmental friendliness. Thus, the use of reusable canvas bags for package of soiled linen and low-temperature washing with a chemical rinse is acceptable in the healthcare setting.

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CHAPTER 16

VENTILATION SYSTEM ISSUES

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OUTLINE

A. INTRODUCTION

Airborne microbes of concern as a source of healthcare associated infections (HAIs) include *Mycobacterium tuberculosis*, *Aspergillus* species, *Cryptococcus neoformans, Histoplasma capsulatum, Coccidiodes imitis,* measles and varicella viruses.

Emerging evidence suggests that *Pneumocystis carinii* may be spread by the airborne route. The type of ventilation system to install for a facility will, therefore, depend chiefly on the type of patients expected to be cared for and the surrounding air quality.

Heating, ventilation and air-conditioning systems in healthcare facilities are designed to maintain the air temperature and humidity, control odours, remove contaminated air, and facilitate air handling so as to minimize risk for transmission of airborne pathogens from infected patients.

Guidelines are available from reputable institutes, e.g., the American Institute of Architects (AIA) or the UK Health Technical Memorandum 03-01.[1] These address indoor air quality standards such as temperature levels, humidity levels, ventilation rates, pressure relationships, and minimum air-changes-per-hour (ACH) requirements specific to each zone or area in the healthcare facility (e.g., operating theatre, laboratories, patient care areas, etc).

B. INTENSIVE CARE UNIT

The contributing factors to HAIs are mainly reservoirs (patients, staff, and environment) and patient-care practices (PCPs). The role that design and ventilation of an intensive care unit (ICU) play in the control of HAIs is difficult to evaluate. However, most institutions advocate a controlled ventilation system for the ICU with air-conditioning as a minimum.

There are no standard guidelines as to the essential requirements for the ventilation system of an ICU. Although the decision to deliver 100% fresh air or to use re-circulated air is based largely on cost, the use of high-efficiency particulate air (HEPA) filters that can ensure delivery of good quality air to the ICU is essential. A minimum of six ACH will also ensure adequate clearance of airborne particles. If controlled ventilation by air conditioning is not possible, attention must be paid to PCPs that comply with good IPC principles.

C. ISOLATION ROOM

A negative-pressure ventilation system is required for the management of patients with infections that require airborne precautions, e.g., *M tuberculosis*, measles and varicella viruses. Negative-pressure ventilation is achieved by installing an exhaust exceeding supply by about 15% or by a 1.4m^3/min difference. The room air is exhausted directly outdoors. Re-circulation of air is permitted but requires

filtration through HEPA filters before entry into the room. A minimum of six air ACH is needed, but most facilities will try to deliver at least 12 ACH; there is a point of diminishing returns at about 12–15 ACH.

Some units may be thinking of installing a two-mode system where the ventilation system can be changed from negative to positive when required, and vice-versa. Although it may have the advantage of versatility and cost-containment, it unfortunately has the danger of being switched on the wrong mode and hence, not recommended.

The need for an anteroom may be controversial. However, it is easy to understand the rationale for a precautionary measure in helping to ensure a gradual change of pressure from one area to another. An anteroom may also function as an area where staff can put on the necessary protective apparel, e.g., gowns and masks; as well as acting as a buffer zone to have a better pressure differential control between zones.

Retrofitting or renovating an existing facility is a challenge. It requires meticulous attention to sealing all ducts, doors, walls and windows of the room, but the problem lies in creating directional airflow suction.

Failure to maintain the system may cause the air balance to change because of increased collection of lint and dust on filters impeding airflow and decreasing exhaust function. This may result in a change to a positive-pressure system. It is vitally important that all components are easily accessible for routine inspection and maintenance. The filter change must be carried out safely without dislodging the trapped contaminants. Newer filters that can be removed as a whole unit are available to meet this need. Manometers or gauges should be fixed to measure the drop in pressure across the filters, signalling the need for a change. Fans, cooling coils and condensate pans must also be readily accessible for cleaning and repairs. Plans and provisions must be made for emergency malfunction of the system or shutdowns for maintenance work.

Maintenance work must be a coordinated activity to ensure that the necessary precautions are taken to protect the health and well-being of both patients and staff.

In cases where it is impossible to retrofit an isolation room to a negative pressure room for the purpose of isolating patients with pulmonary tuberculosis, it is important to ensure that the room is not air-conditioned, and that the patient is nursed in a room ventilated instead by normal air currents from an open window. However, in cases where negative pressure is not a requirement and patients are isolated

for the purpose of preventing transmission to other patients, all which is required will then be a single-bedded room or a cohort area for isolation of patients with an identical medical condition.

Otherwise, the isolation room or area may be air-conditioned. The importance lies in good compliance with the appropriate barrier precautions, e.g., gloves, mask and good workflow processes.

D. ONCOLOGY AND BONE MARROW TRANSPLANT UNIT

Bone marrow transplant patients are often managed in laminar airflow rooms designed with one entire wall of HEPA filters. Such rooms usually provide more than 100 ACH, resulting in uncomfortable drafts and excess noise. The use of such rooms is limited by their high cost. Alternative practical ventilation control procedures include a sealed room with more than 15 ACH, HEPA-filtered air (supply of filtered air exceeds amount of air exhausted by 10%), positive pressure and directed airflow from the vulnerable patient to corridor. The air diffusers should be located in the ceiling and positioned to throw air downwards.

E. OPERATING THEATRE

Organisms that cause most surgical-site infections are endogenous in origin, i.e., they come from the patient's own microbial flora. Host factors, such as age, wound class, surgical technique, size of incision, duration of operative procedure, the patient's nutritional status and the presence or absence of diabetes, contribute to the acquisition of infection. Exogenous sources of infections are controlled with the application of appropriate practices (preoperative scrubbing, use of surgical masks, sterile gloves, caps and gowns, etc.) and a controlled ventilation system.

The operating suite should be independent of the general traffic and air movement in the rest of the hospital. The rooms should be so arranged that there is continuous progression from the entrance to the suite, through zones that increasingly reach sterility, to the operating and sterilizing rooms. The directions of airflow within the suite should always be from the cleaner to less clean areas. The heating and ventilation systems should ensure safe and comfortable climatic conditions for the patient, surgeons and staff.

Delivery of air is from diffusers on the ceiling causing downward displacement of air over the whole room to several exhaust outlets located on the walls just above the floor. The system should comply with the following guidelines:[2]

- Variable temperature range of 20–24°C
- Relative humidity between 50% and 60%
- Air pressure maintained positive with respect to any adjoining rooms by supplying 15% excess air

- Differential pressure-indicating device installed for air pressure readings in the rooms. Thorough sealing of all walls, ceilings and floor penetrations and tight-fitting doors are essential to maintain readable pressure
- Humidity indicator and thermometers located for easy observation
- Secondary filters of 2 μm or less with 95% efficiency placed inside an inlet grill; terminal HEPA filter of 0.3 μm with 99.7% efficiency in the case of ultraclean or orthopaedic theatres
- Air supply from the ceiling and exhausted or returned from at least two locations near the floor. Bottom of exhaust outlets should be at least 75 mm above the floor. Supply diffusers should be of the unidirectional type. Avoid high-induction ceiling or side-wall diffusers
- Minimum of 15 ACH for 100% fresh air system; minimum of 25 ACH for recirculating air system
- Air velocity of 0.1–0.3 ms^{-1}
- Positive pressure in relation to adjacent areas.

The commissioning test of a new or recently renovated operating room should include:

- Air quality check - air change rate, ventilation balance, bacteria-carrying particles
- Workmanship check - terminal cleaning, joint sealing, gaps around doors, temperature, humidity
- Acceptable bacteria-carrying particle counts (Table 16-1).

Table 16-1: Acceptable Bacteria-carrying Particle Counts[2]

Type of operating theatre	**Condition**	**Criteria (colony-forming units/m^3)**
Conventional	Empty	< 35
	During an operation	< 180
Ultraclean	Empty	< 1
	During an operation	< 20 at periphery, < 10 in centre
Reproduced with permission from the source		

It is now an established fact that laminar flow system is associated with higher risk for surgical site infections. Hence, they are no longer recommended for operating theatres.[3]

F. MAINTENANCE

A routine maintenance programme is essential to avoid failure in the ventilation system. The accumulation of lint and dust on filters will cause air imbalance, leading to decreased exhaust ventilation. This can change the negative air balance, resulting in the room becoming positively pressurized. Schedules should be drawn up for routine filter checks, air velocity checks, etc. Where there is to be a shutdown of the critical fan system, provisional plans must be drawn up to include back-up motors, portable systems, planned suspension of patient activities, etc.

All maintenance, repair, construction and renovation works should be coordinated to assure that precautions to protect the health of all patients and staff are implemented.

G. INFECTION PREVENTION MEASURES DURING CONSTRUCTION AND RENOVATION

The main objective of these measures is to reduce risk for healthcare associated *Aspergillus* infections in immunocompromised patients. A risk assessment matrix may be used to determine appropriate measures for the type of work activity in a clinical area (see Tables 16-2 – 16-4).

Table 16-2: IC Matrix - Class of Precautions – Project Type by Patient Risk

Construction Project Type

Patient Risk Group	TYPE A	TYPE B	TYPE C	TYPE D
LOW	**I**	**II**	**II**	**III / IV**
MEDIUM	**I**	**II**	**III**	**IV**
HIGH	**I**	**II**	**III / IV**	**IV**
HIGHEST	**II**	**III / IV**	**III / IV**	**IV**

Table 16-3: Type of Construction Project Activity (Dust Producing Activity)

TYPE A	Inspection and Non-Invasive Activities. Includes, but is not limited to: • Removal of ceiling tiles for visual inspection limited to 1 tile per 4.6 sq m (50 sq ft) • Painting (but not sanding) • Wall covering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
TYPE B	Small scale, short duration activities which create minimal dust Includes, but is not limited to: • Installation of telephone and computer cabling • Access to chase spaces • Cutting of walls or ceiling where dust migration can be controlled.
TYPE C	Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies Includes, but is not limited to: • Sanding of walls for painting or wall covering

	• Removal of floor coverings, ceiling tiles and casework • New wall construction • Minor duct work or electrical work above ceilings • Major cabling activities • Any activity which cannot be completed within a single work shift.
TYPE D	Major demolition and construction projects Includes, but is not limited to: • Activities which require consecutive work shifts • Requires heavy demolition or removal of a complete cabling system • New construction.

Table 16-4: Patient Risk Groups

Low Risk	Medium Risk	High Risk	Highest Risk
1. *Office areas* 2. *Non-patient areas*	1. *Cardiology* 2. *Echocardiography* 3. *Nuclear Medicine* 4. *Physiotherapy / Occupational Therapy / Speech Therapy Department* 5. *Radiology/MRI* 6. *Patient care areas not covered under high or highest risk groups* 7. *Public corridors (through which patients, supplies and linen pass)* 8. *Lab not specified as high or highest risk groups* 9. *Cafeteria* 10. *Kitchen*	1. *CCU* 2. *Emergency Medicine* 3. *Labour & Delivery* 4. *Laboratories (specimen)* 5. *Newborn Nursery* 6. *Ambulatory Surgery* 7. *Urology OT* 8. *Dialysis Centre* 9. *Haematology Centre* 10. *Endoscopy Centre* 11. *Paediatrics* 12. *Pharmacy* 13. *Surgical wards* 14. *Rehabilitation ward* 15. *Vascular and interventional radiology*	1. *Any areas caring for immuno-compromised patients* 2. *Oncology ward* 3. *Bone marrow transplant unit* 4. *Haematology ward* 5. *Neonatal ward* 6. *Burn Unit* 7. *Cardiac Catheterisation Laboratory / angiograph procedure areas* 8. *Central Sterile Supply* 9. *Intensive Care Units* 10. *Medical wards* 11. *Isolation wards and rooms*

	11. ***Material management department*** 12. ***Linen room***		12. ***Operating theatres including C-section rooms / labor OT*** 13. ***Pharmacy admixture***

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CHAPTER 17

IPC AND ANTIBIOTIC STEWARDSHIP PROGRAM

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OUTLINE

A. INTRODUCTION

It is now recognized that antibiotic resistance is a global problem and successful control must involve a concerted effort by the world's health community. The World Health Assembly in fact adopted such a resolution in 1998[1] and, increasingly, national governments of the world are taking responsible actions to reduce antibiotic resistance in their own localities. The WHO has also designated antibiotic resistance to be the focus for the World Health Day in 2011.

The problem of antibiotic resistance is naturally limited not only to the hospital environment but to all prescribers, and includes even non-medical applications outside the healthcare arena.[1] Nevertheless, the focus on hospital spread is important because resistance is generally a bigger problem in the hospital than in the community. This has been documented in many studies including analysis of fecal specimens of patients before and after admission, and the comparison or sewage micro flora from hospital and non-hospital sources.[2,3]

Many authorities now recommend that every hospital should organize an antibiotic stewardship program (ASP) to ensure proper use of antibiotics[4]. It is logical that the control of antibiotic resistance be recognized as one of the responsibilities for the IPC Team (IPCT). This is because many components of such a program including the collection of surveillance data and interactions with clinicians are already an integral part of infection control. Three categories of measures should be in place for the control of antibiotic resistance in the hospital. These are shown in Figure 17-1, which also indicates the functions of these three categories of measures. They must all exist together, just like a three-legged stool to be effective.

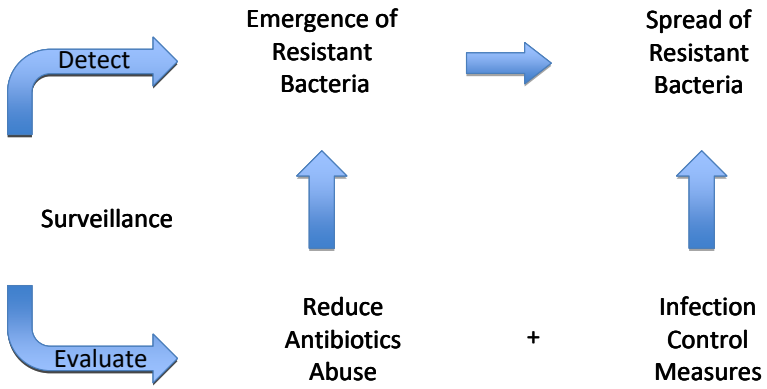
The first is the need for surveillance. Surveillance is needed to detect the presence of resistant organisms, but can also help us to evaluate the effectiveness of the control measures that are in place. We then need to control antibiotic abuse because it is the widespread abuse of antibiotics that provides the selective pressure for the emergence of resistant organisms. Finally, the actions that would prevent the spread of these resistant organisms are the infection control measures, which must be put in place for effective control. All three categories of measures are important, and they are mutually dependent on one another.

Surveillance and the implementation of infection control measures must be taken up by the IPCT. The third measure of antibiotic abuse control has to be a collaborative effort of the entire hospital, especially involving the pharmacy, frontline clinicians and hospital administration. This chapter will first discuss the work of surveillance and IPC, followed by the control of antibiotic abuse in the hospital.

B. SURVEILLANCE AND IPC MEASURES

Authoritative expert panels have recommended various infection control measures for the control of antibiotic resistance in the hospital, and these are summarized in Table 17-1.[5,6] Most of these measures have already been discussed in other sections of this handbook and will not be repeated here. The subject has also been dealt with comprehensively elsewhere.[7] It is important to remember that probably the most important factor in the development of antibiotic resistance is the usage of antibiotics in hospitals;[8] therefore, the rest of this chapter will focus on the third measure of antibiotic abuse control.

Figure 17-1: The Contribution of Surveillance, Reducing Antibiotics Abuse (Antibiotic Stewardship Program) and IPC in the Control of Antimicrobial Resistance



C. THE CONTROL OF ANTIBIOTIC USAGE IN THE HOSPITAL

The strong relationship between antimicrobial use and the development of resistance has been well demonstrated in the epidemiology of methicillin resistant *Staphylococcus aureus*, drug-resistant *Streptococcus pneumoniae* and, recently, vancomycin-resistant *Enterococcus*.

Table 17-1: IPC Measures for the Reduction of Antibiotic Resistance

IPC Measures	**Key Mechanisms**	**Healthcare Workers Involved**
Surveillance	Identify sources Identify outbreaks Feedback of data Monitor control measures	IPC team Microbiology laboratory staff
Implementation of correct patient care practices e.g.,	Reduce the spread of resistant organisms	IPCT implementation with frontline staff compliance

handwashing		
Disinfection and sterilization	General reduction of microbial contamination Central sterilization Eliminate common bacterial source	IPCT Frontline staff compliance
Isolation and barrier precautions	Contain source and reduce transmission	IPCT implementation with frontline staff compliance
Notification of host-risk profile (e.g., early removal of IV lines)	Reduce colonization and halt progression to infection	Physicians Nursing staff

Antimicrobial use by physicians and patients is influenced by various factors, e.g., knowledge, peer influence, advertisement, availability of antimicrobials, and cost. In attempts to devise strategies to control the development of antimicrobial resistance, the following factors need to be established for the prescription of antimicrobials:

- An understanding of the factors that promote overuse and the barriers to change
- The implementation of effective strategies for changing behavior

As research into these areas is embryonic, strategies and interventions that are consistently effective are still in the developmental stages.

Factors that contribute to antimicrobial overuse include lack of education, patient expectations, past experience, and economic factors that influence the degree of availability of antimicrobials. Hence, multifaceted strategies must be adopted in the planning as well as the implementation of an antimicrobial policy.

D. INTERVENTION FOR THE CONTROL OF ANTIMICROBIAL USAGE

Many studies have shown that abuse of antimicrobials is prevalent in hospitals, even in developed countries. In a recent review, it was reported that up to 50% of these drugs are inappropriately prescribed in US hospitals.[9] Hospitals should be committed to altering this state of affairs. Not only is the current situation a disservice to patients, proper usage would also result in substantial cost savings.

Furthermore, it has been shown that overuse of antimicrobials contributes to the development of resistant strains and this alone is ample reason for the IPCT to participate in the control of these compounds.

It is beyond the scope of this small handbook to review exhaustively all intervention methods proposed. The full spectrum of intervention methods has been reviewed elsewhere.[9,10] It is, however, widely recognized that for control to be successful, hospitals must be proactive and that some kind of 'Antimicrobial Stewardship Program' (ASP) must be instituted. This chapter aims to describe briefly such ASPs and how the IPCT can assist in the implementation of such programs.

E. ANTIMICROBIAL STEWARDSHIP PROGRAM

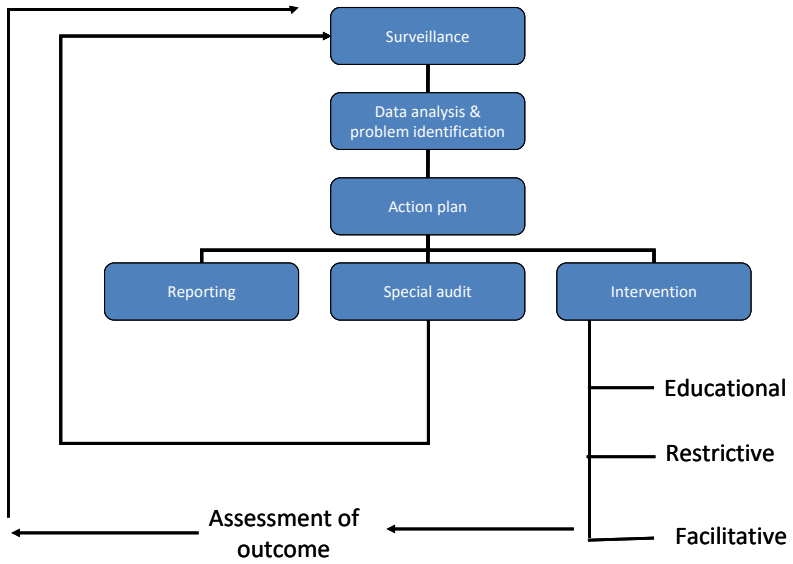
The infrastructure of an ASP is shown in Figure 17-2. A brief analysis will show many similarities to the IPC Program. The ASP, like IPC, begins with surveillance. As stated in Chapter 6, objectives and priorities must be clarified. Based on these objectives, data on antimicrobial usage will be collected. The data must then be analyzed, and the key problems identified.

From this, an action plan needs to be developed. This action plan generally includes three groups of activities:

1. ***Proper reporting of the data to the relevant prescribers and policy makers***
2. ***Design of special audits to further understand the problems identified in the general surveillance***
3. ***Intervention methods, which fall into three categories, namely 'educational', 'restrictive' and 'facilitative' methods.***

The efficacy of all intervention strategies must be evaluated by the ongoing surveillance program, which completes the loop in Figure 17-2.

Figure 17-2: Infrastructure of an Antimicrobial Stewardship Program



Educational methods

This is the traditional intervention and usually consists of lectures and/or written educational materials. The written material includes newsletters, manuals and even protocols. It is now widely reported that educational methods alone are ineffective,[11,12] and in this context, Kunin stated that "There is no concrete evidence [education] improves clinical practice".[13] The use of written guidelines alone also falls into this category. Similarly, it has been shown that guidelines by themselves are ineffective in altering doctors' behaviour.[14]

Restrictive methods

These are methods in which regulations and policies are enforced by the hospital, from the top down. They include the following:

1. ***Formulary restrictions Only drugs in the formulary may be prescribed***
2. ***Pharmacy justification A justification note or form must be written for certain drugs***
3. ***Automatic stop policies Antibiotics deemed inappropriate will be stopped automatically***
4. ***Mandatory consultation or endorsement by an infectious disease specialist***
5. ***Therapeutic interchange program A cheaper compound is automatically switched for an expensive equivalent***
6. ***Selective reporting of susceptibility tests by laboratory***
7. ***Restriction of interactions with pharmaceutical representatives.***

Although these methods are effective to a certain extent, John and Fishman noted that 'These strategies are probably the most onerous to prescribing physicians'.[9] The resentment may be so overwhelming that these methods may not be applicable in some hospitals.

Facilitative methods

These are methods in which the responsibility for correct prescription remains in the hands of doctors. There is, however, a proactive program to influence them or procure their cooperation. This usually involves the active feedback of inappropriate prescriptions or outcomes to doctors, which is usually in the form of a memo after evaluation by an audit team. A recent report shows that, if feedback is done immediately and while the patient is still in the hospital, thus giving the doctor an opportunity to correct his prescription, this feedback (known as 'Immediate Concurrent Feedback') can be extremely effective.[15] Feedback will be enhanced if it is based on an agreed guideline.[16,] Recently an effective Immediate Concurrent Feedback to control the expensive broad spectrum antibiotics has been successfully implemented resulting in savings of millions of dollars.[17] This program as described in the reference can be easily implemented and hopefully it will be widely adopted in hospitals.

An effective intervention strategy will generally comprise all three categories mentioned above. One method is probably not enough, and each hospital must use the right combination of methods for each particular problem identified.

F. PARTICIPATION OF THE IPCT

ASP is usually under the supervision of the Drug and Therapeutic Committee of the hospital. This ought to be a multidisciplinary team consisting of doctors, pharmacists and administrators. As there are so many similarities between the ASP and the IPC Program, there is ample opportunity for interface between these two programs. A substantial proportion of the data for the ASP can be collected by the IPC nurse (IPCN) in the course of IPC surveillance. If ample manpower is available, the IPCN can also participate in delivering the feedback memo and monitoring the response. The control of antimicrobials is a problem affecting most hospitals with no easy answers in sight. If the IPCT can constructively contribute to the ASP, it will be another opportunity to demonstrate the value of infection control in modern hospital practice.

G. GLOBAL ACTION PLAN

Antibiotics resistance is now firmly recognized as a global problem, requiring international collaboration for effective management. The WHO has released a "Global Action Plan" in 2015 and endorsed by all countries in the World Health Assembly[18]. It will be worthwhile to study this document and bring your own hospital ASP to be in line with these actions taken internationally.

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CHAPTER 18

EMPLOYEE HEALTH PROGRAM

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OUTLINE

A. INTRODUCTION

An employee health program is a program in which preventive strategies for infections known to be transmitted in healthcare settings are addressed.

These strategies include immunization, Isolation Precautions to prevent exposure to infectious agents, and post-exposure management of healthcare workers.[1]

B. OBJECTIVES

The objectives of an employee health program usually include the following:

1. ***To improve the safety of the hospital environment***
2. ***To maintain the well-being of healthcare workers***
3. ***To contain or reduce costs resulting from absenteeism and disability, potential medico-legal liability, and outbreaks.***

C. COMPONENTS

To attain these objectives, certain essential components are required:

1. ***Dedicated personnel***
2. ***Clear policies and procedures***
3. ***Support from administration***
4. ***Good coordination with other departments***
5. ***Immunization programs***
6. ***Post-exposure management of infectious diseases***
7. ***Counseling services***
8. ***Maintenance and confidentiality of medical records.***

D. PRE-EMPLOYMENT/PLACEMENT EVALUATION

This evaluation is done to ensure that a staff member is not placed in a job that would pose an undue risk of infection to other colleagues, patients or visitors.

The placement evaluation includes:

1. ***Immunization status***
2. ***Past medical history***
3. ***Current therapy/medications***
4. ***Physical examination***
5. ***Laboratory investigations***

- Chest x-ray

- Hepatitis b surface antigen (HBsAg)
- Anti-hepatitis b surface antigen antibody (anti-HBs)
- Varicella zoster virus (VZV) serology

E. EDUCATION

Early familiarization with the hospital's infection control policies and procedures (especially Isolation Precautions and hand hygiene) will benefit staff tremendously in complying with the hospital's program. Other important activities include ongoing education, campaigns and specialized education to increase awareness of illnesses, infection risks and preventive measures.

F. IMMUNIZATION PROGRAM

A mandatory immunization program is effective in ensuring that staffs are immune to vaccine-preventable diseases (Tables 18-1 and 18-2). This entails the following:

1. ***Immunization of new and currently employed staff***
2. ***Continual review of immunization status***

The decision on which vaccine to include in the program will depend on:

1. ***The staff member's risk of exposure to disease***
2. ***The staff member's nature of contact with patients***
3. ***Patient characteristics in the hospital***
4. ***Hospital budget***

In some instances, it may be more cost-effective to conduct serological tests to determine the immune status of the staff member prior to immunization, e.g., anti-VZV and hepatitis B screening. Good records of immunization should be kept by either a central source or by the respective managers/supervisors, so that reviews can be made periodically for necessary boosters to be given where required. Annual influenza vaccination with the appropriate strains is recommended in countries with winter outbreaks of respiratory diseases.

G. JOB-RELATED ILLNESSES AND POST-EXPOSURE MANAGEMENT

Prompt diagnosis and management is required to ensure an effective program (Tables 18-3 – 18-6). A hospital policy on reporting and management should be made freely available and known to all staff. This usually takes the form of a manual, while an on-going education program is essential not only to update staff on the details of diseases and the associated work restrictions upon exposure, but also to help in allaying fears and anxiety. The policy should, therefore, include:

1. ***Information on risk exposure***
2. ***Protocol for management and follow-up, if necessary***

3. ***Record keeping***

H. IMPLEMENTATION OF A PROGRAM

1. ***Needs assessment***

   This is necessary for a program to be implemented in the most cost-effective manner in the presence of the usual budget constraints. Questionnaire surveys may be done to establish the level of immunity to a particular disease. The information gathered may also be useful for planning the budget for serological tests and vaccines.

2. ***Program strategies***

   The calculation of the cost of a program is a necessary initial step to guide its implementation. This helps the administrators to understand the impact to their annual financial budget, and will ease discussion for approval of the program. Secondly, a well-thought-out comprehensive protocol for the identification of cases, provision of services, prophylaxis steps and the management of post-exposure cases helps not only in the smooth implementation but also in the success of a program, to the benefit and well-being of everyone. It also prevents unnecessary wastage that may arise from wrong management.

3. ***Working relationship***

   A good working relationship among infection prevention and control (IPC) personnel and administrators will help to facilitate the implementation of the program.

Confidence in the IPC Team (IPCT) will allay doubts in the minds of administrators as to the direction of the program. Both financial and moral support from hospital administrators is essential in ensuring an effective program. Free communication and continual collaboration with all sectors of the hospital is also important for the IPCT to identify early problems or noncompliance.

The necessary corrective measures can then be taken, thus preventing failures in the program.

I. IMPLEMENTING A PROGRAM IN A TIGHT BUDGET SITUATION

In a situation where it is impossible to implement all the possible IPC programs, the most important infectious disease that any healthcare worker should be protected from at his institution of practice is hepatitis B.

The incidence varies from country to country in the Asia Pacific region, but all healthcare workers are at high risk of contracting it as an occupational health hazard, if not protected. Hence, the minimum protection for any healthcare worker is a compulsory hepatitis B immunization program that includes

mass immunization and a follow-up check on anti-HBs titer following a completed course of the hepatitis B immunization.

This is best accompanied by a well-worked-out protocol for the management of blood and body fluid exposure via sharps injuries or splashes.

The protocol should include:

1. HBsAg, anti-HCV and anti-HIV testing of source patient
2. HBsAg and anti-HBs testing of healthcare workers
3. Prompt testing of respective serological tests
4. Prompt administration of hepatitis B immunoglobulin (HBIG) if the healthcare worker is deemed non-immune by serological test, i.e., within 72 hours of exposure
5. Hepatitis B vaccine booster administration, if required
6. Hospital coverage of all laboratory investigations and prophylaxis

Table 18-1: Immunizing Agents for Healthcare Workers (HCWs): Strongly Recommended[2]

Vaccine	**Primary schedule and booster(s)**	**Indications**	**Precautions and contraindications**
Hepatitis B recombinant vaccine	Two doses IM in deltoid muscle 4 weeks apart; 3rd dose 5 months after 2nd	HCW at risk of exposure to blood and body fluids	No apparent adverse effects to developing fetuses, not contraindicated in pregnancy; history of anaphylactic reaction to common baker's yeast
Varicella zoster live virus vaccine	Two 0.5 mL doses SC 48 weeks apart if 13 years of age	HCW without reliable history of varicella or laboratory evidence of varicella immunity	Pregnancy; mmunocompromised state; history of anaphylactic reaction following receipt of neomycin or gelatin. Avoid salicylate use for 6 weeks after vaccination
Influenza vaccine (inactivated, whole or split virus)	Annual single-dose vaccination IM with current vaccine	HCW in contact with high-risk patients or working in chronic care facilities; HCW with high-risk medical conditions and/or 65 years of age	History of anaphylactic hypersensitivity after egg ingestion
Measles live virus vaccine		HCW without documentation of receipt of two doses of vaccination with live vaccine, physician diagnosed measles or laboratory evidence of immunity	Pregnancy; immunocompromised state (including HIV-infected persons with severe immunosuppression); history of anaphylactic reactions after gelatin ingestion or receipt of neomycin; or recent receipt of immunoglobulin
Mumps live virus vaccine	One dose SC; no booster	Susceptible HCW	Pregnancy; immunocompromised state; history of anaphylactic reactions after gelatin ingestion or receipt of neomycin
Rubella live virus vaccine	One dose SC; no booster	HCW without documentation of receipt of live vaccine, or laboratory evidence	Pregnancy; immunocompromised state; history of anaphylactic reactions after receipt of neomycin

Vaccine	Primary schedule and booster(s)	Indications	Precautions and contraindications
		of immunity	
Tetanus and diphtheria toxoid (Td)	Two doses IM 4 weeks apart; 3rd dose 6–12 months after 2nd dose; booster every 10 years	All adults; tetanus prophylaxis in wound management	First trimester of pregnancy; history of neurological reaction or immediate hypersensitivity reaction; HCW with severe local (Arthus-type) reaction after previous dose of Td vaccine should not be given further routine or emergency doses of Td for 10 years
IM = intramuscularly; SC = subcutaneously; immunocompromised state = persons with immune deficiencies, HIV infection, leukemia, lymphoma, generalized malignancy, or immunosuppressive therapy with corticosteroids, alkylating drugs, antimetabolites or radiation; MMR = measles-mumps rubella. *Table adapted from the source.*			

Table 18-2: Immunizing Agents for Healthcare Workers (HCWs): Special Circumstances[2]

Vaccine	Primary schedule and booster(s)	Indications	Precautions and contraindications	Special considerations
Hepatitis A	Two doses of vaccine: either HAVRIX® 6–12 months apart or VAQTA® 6 months apart	Persons who work with HAV-infected primates or with HAV in a laboratory setting	History of anaphylactic reaction to alum or the preservative 2-phenox-ethanol; vaccine safety in pregnant women has not been evaluated, the risk of vaccination should be weighed against the risk for hepatitis A in women at high risk for exposure to HAV	HCWS who travel internationally to endemic areas should be evaluated for vaccination
Polio	IPV two doses SC given 4–8 weeks apart followed by 3rd dose 6–12 months after 2nd dose; booster doses may be IPV or OPV	HCW in close contact with persons who may be excreting wild virus and laboratory Personnel handling specimens that may contain wild poliovirus	History of anaphylactic reaction after receipt of streptomycin or neomycin; because safety of vaccine has not been evaluated in pregnant women, it should not be given during pregnancy	Use only IPV for immunosuppressed persons or HCWs who care for immunosuppressed patients; if immediate protection against poliomyelitis is needed, OPV should be used

HAV = hepatitis A virus; IPV = inactivated poliovirus vaccine; SC = subcutaneously; OPV = oral poliovirus vaccine; IM = intramuscularly; ID = intradermally. *Table adapted from the source.*

Table 18-3: Post-exposure Prophylaxis[2]

Disease	Prophylaxis	Indications	Precautions and contraindications
Hepatitis A	One IM dose IG 0.02 mL/kg given within 2 weeks of exposure in deltoid/gluteal muscle	HCW exposed to feces of infected persons during outbreaks	Persons with IgA deficiency, do not administer within 2 weeks after MMR or within 3 weeks after varicella vaccine
Hepatitis B	HBIG 0.06 mL/kg IM as soon as possible after exposure (within 72 hours); if hepatitis B vaccine has not been started, give 2nd dose 1 month later	HCW exposed to blood or body fluids containing HBsAg and who are not immune to HBV infection	
Varicella zoster	Vaccine: immunocompetent sero-negative contacts will receive the varicella vaccine within 5 days of exposure VZIG: immuno-compromised sero-negative contacts with no IgG levels will receive VZIG (125 units/10 kg up to 625 units) as soon as possible and within 10 days of exposure.	HCW known or likely to be susceptible (especially those at high risk for complications e.g., pregnant women) who have close and prolonged exposure to a contact case or an infectious HCW / patient. Sero-negative pregnant staff contact should be reviewed by their obstetrician for VZIG and follow-up.	
Diphtheria	Benzathine penicillin 1.2 mU IM, single dose or erythromycin 1 g/day PO x 7 days	HCW exposed to diphtheria or identified as carrier	
Meningococcal disease	Rifampicin 600 mg PO every 12 hours for 2 days, or ceftriaxone 250 mg IM single dose or	HCW with direct contact with respiratory secretions from infected persons without the use of proper precautions (e.g., mouth-to-mouth	

Disease	Prophylaxis	Indications	Precautions and contraindications
	ciprofloxacin 500 mg PO single dose	resuscitation, endotracheal intubation, endotracheal management, or close examination of oropharynx)	
Pertussis	Erythromycin 500 mg qid PO or trimethoprim/sulphamethoxazole 480 mg bid PO for 14 days after exposure	HCW with direct contact with respiratory secretions or large aerosol droplets from respiratory tract of infected persons	Rifampicin and ciprofloxacin not recommended during pregnancy
IM = intramuscularly; IG = immunoglobulin; HCW = healthcare worker; MMR = measles-mumps-rubella; HBIG = hepatitis B immunoglobulin; HBsAg = hepatitis B surface antigen; HBV = hepatitis B virus; VZIG = varicella zoster immunoglobulin; PO = oral. *Table adapted from the source.*			

Table 18:-4: Post-exposure Prophylaxis for Healthcare Workers (HCWs) Exposed to Blood and/or Body Fluids with Hepatitis B surface antigen (HBsAg)[2]

Immune status of HCW	**Source patient HBsAg (+)**	**Source patient HBsAg (–)**	**Source not tested or unknown**
Unvaccinated	HBIG dose and start HB vaccine 1 series	Start HB vaccine series	Start HB vaccine series
Previously vaccinated			
Known responder (anti-HBs > 10 mIU/mL)	No treatment	No treatment	
Known non-responder	HBIG dose and start HB vaccine 1 series	No treatment	If known high-risk source, treat as if source were HBsAg (+)
Antibody response unknown	Check anti-HBs: If > 10 mIU/mL, no Treatment if <10 mIU/mL, HBIG 1 dose and vaccine booster	No treatment	Check anti-HBs: If > 10 mIU/mL, no Treatment if <10 mIU/mL, HBIG 1 dose and vaccine booster
HBIG = hepatitis B immunoglobulin; HB = hepatitis B; anti-HBs = anti-hepatitis B surface antigen antibody. *Table adapted from the source.*			

Table 18-5: Risk of transmission following exposure to HIV[4]

Exposure type	**Estimated risk of HIV transmission per exposure**
Percutaneous exposed to blood	0.227% (if source patient is not on antiviral treatment)
Mucous membrane exposed to blood	<0.1% (if source patient is not on antiviral treatment)
Non-intact skin or wounds exposed to blood	Estimated to be less than risk for mucous membrane exposure
Exposure to other body fluids i.e., not blood	Estimated to be lower than for blood exposure
Table adapted from source.	

Table 18-6: Post-exposure prophylaxis (PEP) when source patient is at high risk for being HIV positive[4]

Source status	**Actions**
Source patient's status for HIV is unknown	Offer PEP to HCW with significant exposure. This is started as soon as possible after the exposure, ideally within 24 hours. Starter pack with 3 days supply may include 2 or 3 anti-HIV agents but HCW will need review and assessment by Infectious Disease (ID) physician or HIV specialist before a 28-day course is

	recommended.
Source patient's status is known to be HIV positive	Starter pack of 2 or 3 anti-HIV drugs is prescribed within 24 hours; choice of therapy is determined by safety, tolerability, medical history of HCW and anti-HIV drug resistance information. HCW should be followed up by ID physician or HIV specialist within 72 hours.
High risk exposures e.g. • Deep needlestick or percutaneous injury with device visibly contaminated with blood • Source patients with following: ▪ Advanced HIV disease ▪ Recent testing shows high plasma viral loads ▪ Anti-HIV drug resistance seen in at least 2 drug classes	HCW should be started on starter pack of anti-HIV drugs within 24 hours; and then reviewed by ID physician or HIV specialist within 72 hours.
Table adapted from source.	

Table 18-7: Work restrictions for Healthcare Workers (HCWs) Exposed to or Infected with Infectious Diseases[2]

Disease	**Work restrictions**	**Duration**
Conjunctivitis	Restrict from patient contact and contact with patients' environment	Until discharge ceases
Cytomegalovirus infection	No restriction	
Diarrheal diseases Acute stage Convalescent stage, *Salmonella* spp	 Restrict from patient contact, contact with patients' environment, and food handling Restrict from care of high-risk patients	 Until symptoms resolve
Diphtheria	Exclude from duty	Until antimicrobial therapy completed and two cultures obtained 24 hours apart are negative
Enteroviral infections	Restrict from care of infants, neonates or	Until symptoms resolve

Disease	Work restrictions	Duration
	immunocompromised patients and their environment	
Hepatitis A	Restrict from patient contact, contact with patients' environment, and food handling	Until 7 days after onset of jaundice
Hepatitis B HCW with acute or chronic hepatitis B surface antigenaemia who does not perform exposure-prone procedures	No restriction unless epidemiologically linked to transmission of infection, refer to state regulations, observe standard precautions	Until hepatitis B e antigen is negative
Hepatitis B HCW with acute or chronic hepatitis B surface antigenaemia who performs exposure prone procedures	Do not perform exposure-prone invasive procedures until counsel from an expert review panel has been sought; panel should review and recommend procedures the worker can perform, taking into account specific procedure as well as skill and technique of worker, refer to state regulations	Until lesions heal
Hepatitis C	No recommendation	
Herpes simplex Genital Hands (herpetic whitlow) Orofacial	 No restriction Restrict from patient contact and contact with patients' environment Evaluate for need to restrict from care of high-risk patients	
HIV	Do not perform exposure-prone invasive procedures until counsel from an expert review panel has been sought; panel should review and	

Disease	Work restrictions	Duration
	recommend procedures the worker can perform, taking into account specific procedure as well as skill and technique of worker, refer to state regulations; observe standard precautions	
Measles Active Post-exposure (susceptible HCW)	 Exclude from duty Exclude from duty	 Until 7 days after the rash appears From 5th day after first exposure through 21st day after last exposure and/or 4 days after rash appears
Meningococcal infections	Exclude from duty	Until 24 hours after start of effective therapy
Mumps Active Post-exposure (susceptible HCW)	 Exclude from duty Exclude from duty	 Until 9 days after onset of parotitis From 12th day after first exposure through 26th day after last exposure or until 9 days after onset of parotitis
Pediculosis	Restrict from patient contact	Until treated and observed to be free of adult and immature lice
Pertussis Active	 Exclude from duty	 From beginning of catarrhal stage through 3rd week after onset of paroxysms or until 5 days after start of effective antimicrobial therapy
Post-exposure (asymptomatic HCW) Post-exposure	No restriction, prophylaxis recommended Exclude from duty	Until 5 days after start of effective antimicrobial therapy

Disease	Work restrictions	Duration
(symptomatic HCW)		
Rubella Active Post-exposure (susceptible HCW)	Exclude from duty Exclude from duty	Until 5 days after rash From 7th day after first exposure through 21st day after last exposure
Scabies	Restrict from patient contact	Until cleared by medical evaluation
Staphylococcus aureus infection Active, draining skin lesions Carrier state	Restrict from patient contact, contact with patients' environment, and food handling No restriction, unless HCW is epidemiologically linked to transmission of the organism	Until lesions have resolved
Streptococcal infection, group A	Restrict from patient contact, contact with patients' environment, and food handling	Until 24 hours after adequate treatment started
Tuberculosis Active PPD converter	Exclude from duty No restriction	Until proven noninfectious
Varicella Active Post-exposure (susceptible HCW)	Exclude from duty Exclude from duty	Until all lesions dry and crust From 10th day after first exposure through 21st day (28th day if VZIG given) after last exposure
Zoster Localized in healthy person	Cover lesions, restrict from care of high-risk patients (those susceptible to varicella or at increased risk of complication of	Until all lesions dry and crust

Disease	Work restrictions	Duration
Generalized or localized in immunosuppressed person	varicella, e.g., neonates and immunocompromised persons) Restrict from patient contact	Until all lesions dry and crust
Zoster Post-exposure (susceptible HCW)	Restrict from patient contact	From 8th day after first exposure through 21st day (28th day if VZIG given) after last exposure or, if varicella occurs, until all lesions dry and crust
Viral respiratory infections, acute febrile	Consider excluding from the care of high risk patients or contact with their environment during community outbreak of RSV and influenza	Until acute symptoms resolve
VZIG = varicella zoster immunoglobulin; RSV = respiratory syncytial virus. *Table adapted from the source.*		

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CHAPTER 19

IMPLEMENTING IPC GUIDELINES

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OUTLINE

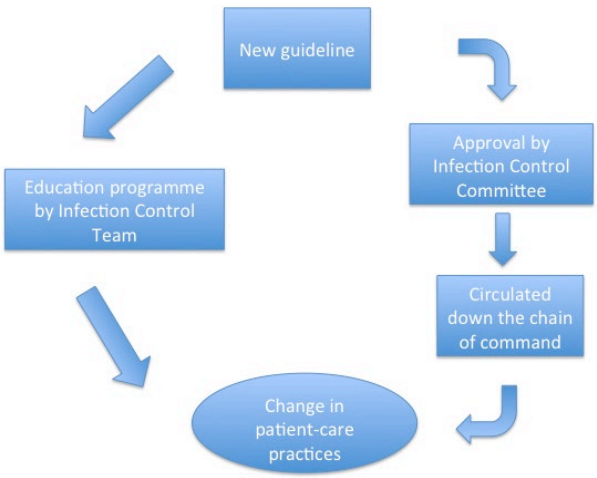
A. INTRODUCTION

IPC guidelines are now widely used in hospitals. Many authoritative institutions, such as the Centers for Disease Control and Prevention (CDC) in the USA, have taken it upon themselves to regularly introduce new, carefully drafted guidelines for the IPC community. This is laudable, because research has shown that they are well received by hospital staff and that guidelines are effective means of influencing behavior.[1] The Centre for Health Protection in Hong Kong also has IPC guidelines on its website which are regularly updated. On this website, guidelines for the four major systems, namely the urinary tract, surgical site, the vascular system and the respiratory tract are developed with the help of the authors. These can be downloaded and the web links are:

- urinary tract [http://www.chp.gov.hk/files/pdf/Recommendations_on_prevention_of_CAUTI.pdf]
- surgical site [http://www.chp.gov.hk/files/ pdf/recommendations_on_prevention_of_ssi.pdf]
- vascular [http://www.chp.gov.hk/files/pdf/Recommendations_on_Prevention_of_Intravascular_CABSI.pdf]
- respiratory tract [http://www.chp.gov.hk/files/pdf/Recommendations_on_prevention_of_VAP.pdf].

The WHO has recommended a basic set of guidelines and the list is available in the document on "Core Component" mentioned in Chapter 1.[2] As guidelines are now such an integral part of IPC, it is important that IPC nurses (IPCNs) understand how they can be effectively implemented in the hospital.

Figure 19-1: Implementation of a New Guideline



B. USUAL IMPLEMENTATION PROCESS

The usual implementation process is depicted in Figure 19-1. After a guideline is finalized, the IPC team (IPCT) will usually adopt a two-pronged implementation process. One of these 'prongs' consists of submitting the guideline to the IPC Committee (IPCC) for approval, and circulating it down the chain of command, with instructions for implementation.

The other is the education program given directly to frontline staff, conducted by the IPCT. It is important to realize that staff compliance can be extremely low (20%) when guidelines are simply circulated down the hospital hierarchy.[3] This underlines the importance of the education program: the success of the implementation process depends on the effectiveness of this program and careful planning is essential. In this chapter, guidance on the planning process will be given, and a new scheme for the development of an effective education program for guideline implementation will be presented.

C. REVIEWING GUIDELINES FOR IMPLEMENTATION

The central part of this scheme is a method for reviewing guidelines before implementation.[4] Following the review, the IPCT will obtain essential information for formulating the education program.

An IPC guideline generally consists of a list of recommendations on appropriate patient-care practices (PCPs). In the education program, instead of covering all the recommendations in a similar fashion for all categories of staff, a better strategy is to focus on the PCPs that require changing. The guideline should be reviewed to anticipate the educational needs of different staff, so that the IPCT can plan accordingly. All recommendations are categorized into the following:

1. ***Established practice***

   A policy for the practice is already present in the hospital or the practice is already standard. An example is the aseptic insertion of urinary catheters. Even without an official guideline for urinary catheter care, many hospitals will usually have such a practice in place.

2. ***Non-established practice (easy implementation)***

   The practice will be easily implemented by the usual educational program of in-service lectures or posters, as most staff will agree with the rationale. An example is the use of sterile water for inflating the balloon of the Foley catheter, as most staff will not object to such a reasonable practice.

3. ***Non-established practice (lack of resources)***

   For this category, implementation is anticipated to be difficult mainly because of the lack of resources. An example is the need for separate jugs for each patient during urine collection from

catheter bags. This is recommended because contamination by back splashing can occur if patients share collection jugs.

4. Non-established practice (staff resistance)

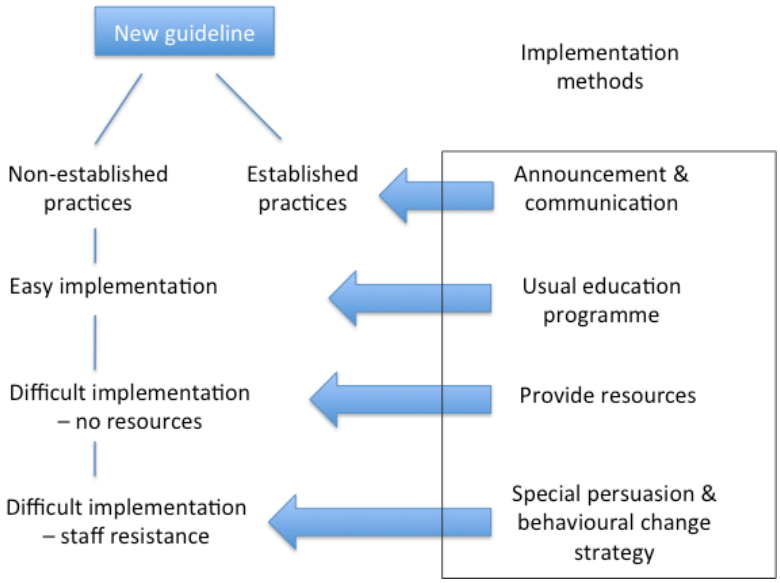
Implementation is difficult in this category because staff resistance is expected to be high. An example of this is the discontinuation of the practice of changing urinary catheters at arbitrary fixed intervals where this practice is in place.

It is recommended that a senior IPCN with at least 10 years of working experience in the hospital should conduct the initial review.[3] Other senior nurses in the hospital may also be co-opted for this exercise. Using this scheme, studies have shown that frontline nurses with more than 10 years of experience in the hospital are accurate in predicting actual practices in the wards. A survey comparing their predictions with practices reported in the wards showed a highly significant Pearson r of 0.9 ($p < 0.001$).[4]

Figure 19-2 shows the different implementation methods that can be used for each category of recommendations. Implementation of 'established practices' simply requires adequate communication and announcement, because hospital staffs are already practicing these recommendations. 'Non-established practices (easy implementation)' are recommendations in which a high level of agreement is expected. When there is agreement, the intent for practice is already present and attitude change is usually not required. Ajzen and Fishbein have shown that, under such circumstances, the desired behavior will often follow the intent.[5] Studies have shown that, for a PCP in which there is agreement, a standard educational program of lectures or posters will be effective.[2] In the next category, 'non-established practices (no resources)', the lack of resources is the limiting factor. A list of such resources should be compiled for the new guideline and the IPCN must ensure that these materials are in place before launching the implementation program.

The successful implementation of a new guideline usually hinges on the last category, 'non-established practices (staff resistance)'. Disagreement from staff is anticipated and a program of persuasion is needed to institute the required change. It will be worthwhile for the IPCN to understand the reasons for resistance, and both quantitative and qualitative studies may be required to elicit these factors. After understanding the reasons for resistance, a special behavioral change strategy may be needed to implement these practices. These strategies have been reviewed elsewhere by the author and will not be discussed further here.[6,7]

Figure 19-2: Scheme for Effective Implementation of IPC



D. STEPS IN GUIDELINE IMPLEMENTATION

Using the scheme just described, there are seven basic steps of implementation:

1. Formulate a final draft of the guideline. After obtaining various international guidelines on the subject from the literature, the IPCT needs to customize the recommendations according to the needs of the hospital.
2. Categorize all recommendations into the four types of practices described above with the help of a panel of experienced healthcare workers in the hospital.
3. Work with the hospital to provide the necessary resources for the 'non-established practices (no resources)' recommendations. The IPCT must ensure that these resources are in the wards when the guideline is introduced.
4. Conduct research for reasons for resistance for the 'non-established practices (staff resistance)' recommendations. The easiest method will be to convene a focus group consisting of staff from the relevant wards. This can be followed, if necessary, by a simple survey of the key issues identified by the focus group.
5. Measure baseline rates before introduction of the new guideline. This may include the infection rate, but by itself, it can be difficult to document improvement because large numbers are usually needed. It is more pragmatic to obtain practice rates for demonstrating change. This involves assessing the level of several key practices (e.g., spot check to see if separate jugs are used for emptying urinary catheters) before introduction of the guideline.
6. Formulate and execute an education program focus on the resistance factors for the 'non-established practices (staff resistance)'. Many techniques for persuasion, such as the use of opinion leaders and participatory decision-making have been described, and successful application

in the hospital context has been reported.[5,6,7] However, the use of persuasion strategies is time-consuming and they should only be reserved for programs requiring attitude change, i.e., 'non-established practices (staff resistance)' recommendations.

7. Evaluate and monitor progress. This is the last step, but of no less importance. The practices evaluated in step 5 should be re-evaluated. Even if improvement in these practices is documented, it is still worthwhile to survey the staff for feedback on the effectiveness of the whole guideline. With this information, further improvement can be made.

E. THE USE OF "BUNDLES" IN IPC GUIDELINES

A new strategy in IPC in recent years is the use of "bundles" which are integrated into the guidelines that are being implemented. This is a grouping of best practices that individually improve care, but when applied together results in even substantially greater improvement. The science behind each of the practices in the bundle should be so well established that it should be considered the standard of care. Bundle elements should if possible be dichotomous so that compliance can be easily measured and monitored. Using the bundle will prevent the piecemeal application of good practices in favor of an "all or none" approach. The use of bundles has been reviewed elsewhere and should be consulted[8]. In the implementation of any guideline, a search in the literature for bundles should be made and those with proven effectiveness should be integrated.

F. THE IPC LINK NURSE

Research has suggested that the implementation of IPC guidelines would be significantly improved when the frontline ward staff have been recruited to participate in an educational program on the guidelines.[9,10] The IPC Link Nurse (IPCLN) program is an attempt to apply this principle in practice and has been widely used to assist in the implementation of guidelines in the hospital.

In the IPCLN program, one nurse would be appointed in each hospital ward, from the pool of staff nurses presently working in that clinical area. This person would be the ward personnel assisting the IPCT in implementing new policies in the hospital. The position of the IPCLN is generally a voluntary assignment without monetary remuneration and the nurse is under no obligation to accept the appointment.

Their responsibilities include five aspects:

1. Facilitate the notification of notifiable disease.
2. Facilitate reporting of sharps injuries and mucosal exposure to blood and body fluids;
3. Facilitate monitoring of patient-care practices;
4. Facilitate cascading of IPC information to ward staff; and
5. Inform ward Managers regarding possible outbreaks of infectious diseases in the wards.

The nurses appointed would be given a 2-day training course; the curriculum of this course is shown in the Table 19-1. A random sample survey of 1,023 staff nurses from 23 hospitals in Hong Kong was conducted in 2001 to evaluate this curriculum. Respondents were requested to evaluate through a 5-point Likert scale whether the topics in the course as shown in the Table 19-1 were needed in the course; as shown, high scores were given to all seven topics (Table 19-1). A total of 79% of the respondents also agreed that they would be willing to be an IPCLN if appointed, indicating the readiness of ward staff to participate in facilitating the work of IPC.

The IPCLN program is perhaps just one of many innovations to enhance the implementation of IPC guidelines. Compliance to guidelines is so crucial that the development of innovative ideas and techniques ought to be encouraged. It is known that changing behavior is usually the ultimate barrier to guideline implementation and should be an area of IPC that is focused for research and study in the coming years. [11]

Table 19-1 Curriculum for IPC Link Nurses (IPCLNs) and the Results of a Hong Kong Survey of the 2-Day Course

IPCLN 2-Day Course Curriculum	**Agreement for Course Inclusion***
1. IPC for the four major systems (urinary, respiratory and vascular systems, and surgical wound infections)	4.28
2. Use of disinfectants and sterilization	4.28
3. Sharps injuries prevention	4.23
4. Microbiology specimen collection	4.17
5. Isolation techniques	4.33
6. Antibiotics usage control	4.05
7. Staff vaccinations	3.96

*Mean score on a 5-point Likert scale of 1,023 respondents in a 23-hospital survey

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CHAPTER 20

QUALITY IMPROVEMENT AND INFECTION PREVENTION AND CONTROL

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OUTLINE

A. INTRODUCTION

We aim to improve patient care at our hospitals via implementation of policies and practices that have proven to work in other places. Unfortunately, these evidence-based practices are not many. The infrastructure in each hospital is different and this is highly dependent upon available resources and expertise.

Deming and Juran have both shown clearly that systems and processes can be further improved if there are focused efforts on these to help people work better where they are. Eighty-five percent of an organization's problems are the result of inefficient processes or systems. Continuous quality improvement (CQI) is the science of process management. It focuses on streamlining, aligning and improving systems and processes with the ultimate results of eliminating inappropriate variation (process steps) and documenting continuous improvement (outcomes). These are usually cost saving measures and require process owners to give feedback, ideas, and time to work through the issues. Hence, quality improvement teams are effective solutions to practical problems faced by staff. These teams achieve significant process improvement when they use quality improvement tools (PDSA, LEAN, Six Sigma, etc.) in their analysis and design for improvement.[1,2,3]

B. EFFECTIVE TEAMS

The concept of an Infection Prevention and Control (IPC) Team was illustrated in *Initiating Nationwide Infection Control Programmes in the Asian Context*.

Many of us find this a workable model to handle daily issues. The IPC Nurses (IPCNs) meet their IPC Officer (IPCO) regularly to discuss and resolve ground issues rapidly. Together with appointed IPC Liaison Officers (IPCLOs), they work well in ensuring compliance to established policies and practices. However, the disadvantage is the exclusion of others, i.e., the process owners with the body of knowledge, who would have helped in coming up with more practical ideas on improving practices.

Behaviour change has always been a major challenge in IPC, especially in the practice of hand hygiene. The level of compliance will increase with more IPCLOs helping to ensure that it happens, but this is unreliable as the practice is artificially embraced out of fear or an awareness of being watched.

It will be more sustainable when practices are incorporated as part of the team's work process. This is where the involvement of process owners in quality improvement projects will help to provide reasonable answers that work.

The shift in paradigm for effective IPC in an organization is the incorporation of quality improvement principles in its programme. This will have to be translated in all aspects of the programme - review of surveillance data, implementation of guidelines, etc.

C. QUALITY IMPROVEMENT TECHNIQUES

Opportunities for improvement are best identified with proper analysis of surveillance data using statistical process control charts (SPCs). These quality tools help to discern random variation from special cause variation. These charts are easily produced using any statistical software, but their interpretation requires one to be trained in the use of SPC rules. The ability to discern the two types of variation is essential in saving us from expending unnecessary energy and resources, which can be well utilized in other quality improvement projects.

Managing a process means giving the right data in the right format at the right time and place to the right hands (the clinicians who operate the process). This feedback is critical as the process owners need to own the data and act on it.

The formation of multi-disciplinary teams is a basic start of a CQI project. A facilitator trained in use of quality tools (e.g., brainstorming, flowcharts, matrix prioritization, cause and effect diagrams, LEAN or Six Sigma tools etc.) can help the team to move along systematically towards achieving its goals. The close collaboration of the IPC unit with the quality improvement/management unit is essential and the partnership will certainly bring the organization to a higher level of improved patient care.

D. TOWARDS SAFER CARE

Patient safety is top priority and IPC is part of this (see Figure 20-1). We protect the patient by ensuring good patient care practices. We protect our staff through the implementation of an employee health policy. We protect the organization through the implementation of polices and guidelines. Healthcare associated infections are regarded as medical errors. The use of bundles of care or checklists have proven to be effective in helping the organization towards zero healthcare associated infections. Examples of these include:

I. Institute of Healthcare Improvement (IHI) VAP Bundle

a. Elevation of the head of the bed to between 30 and 45 degrees
b. Daily awakening: “sedation vacation”
c. Daily assessment of readiness for weaning
d. DVT prophylaxis (unless contraindicated)
e. Stress bleeding prophylaxis

II. IHI CLABSI Bundle

a. Hand hygiene
b. Maximal barrier precautions
c. Chlorhexidine skin antisepsis
d. Optimal catheter site selection, with avoidance of using the femoral vein for central venous access in adult patients
e. Daily review of line necessity with prompt removal of unnecessary lines

III. IHI MRSA Bundle

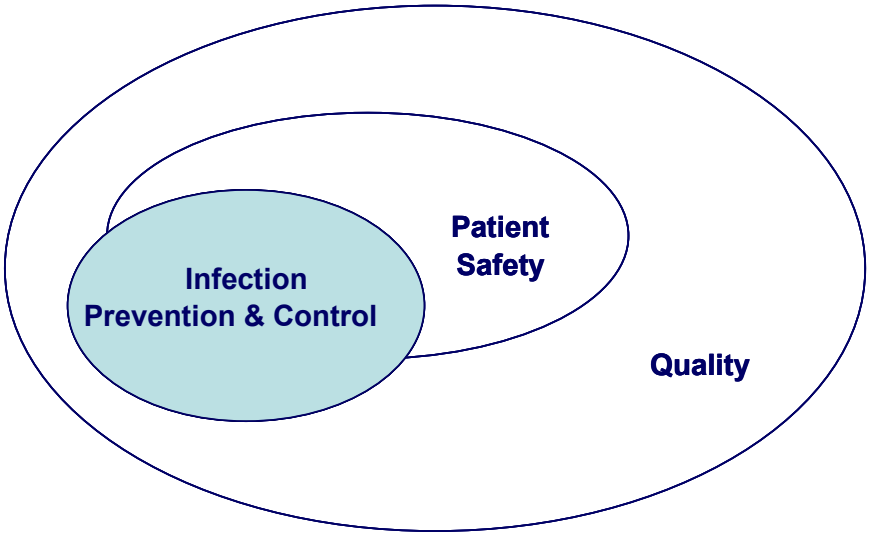
a. Hand hygiene
b. Decontamination of the environment and equipment
c. Active surveillance testing
d. Contact precautions for infected and colonized patients
e. Central Line and Ventilator Bundles

IV. IHI SSI Bundle

a. Appropriate use of prophylactic antibiotics
b. Appropriate hair removal
c. Controlled 6 a.m. postoperative serum glucose in cardiac surgery patients
d. Immediate postoperative normothermia in colorectal surgery patients

V. WHO Safe Surgery Checklist (http://www.who.int/patientsafety/safesurgery/en/)

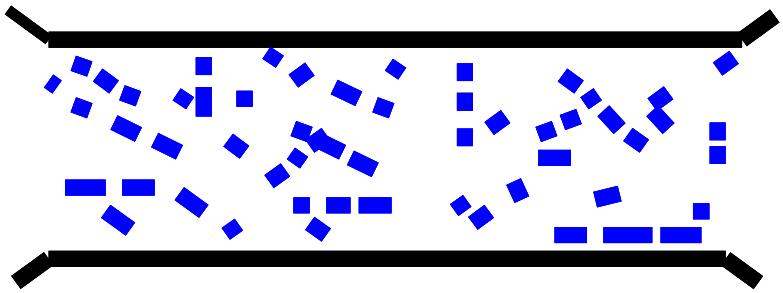
Figure 20-1: IPC shares inter-relationship with Quality and Patient Safety[1]



Through the use of quality improvement tools and techniques, we can certainly move patient care to another higher level of safety as processes and systems are ironed out to make it easy for everyone to do it right. Improvement comes with a change in the approach to any information received (see Figures 20-2 and 20-3). The learning-based approach, where one begins to ask why, what and how instead of the judgement-based approach of who, is necessary to create the ideal environment for improvement to take place positively. Incremental improvement will occur as one steadily moves on in the many rapid plan-do-study-act (PDSA) cycles required. Breakthrough improvement will occur as one chooses instead to use LEAN, Six Sigma or LEAN-Six Sigma methodologies.

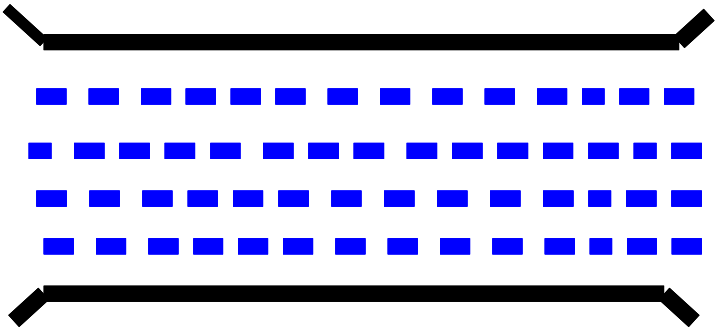
Figure 20-2 Problems in an organization's processes or systems[4]

Most organizations - systems not aligned



Deming 's & Juran 's 85-15 rule:
- 85% of organizations problems are the result of inefficient processes or systems

Figure 20-3: Focus of continuous quality improvement (CQI)[4]



The focus of CQI: to streamline, align and improve systems and processes.

E. REFERENCES

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4. *Ling ML. Patient Safety in Hospital Infections. Edited by Jarvis WR. 6th Edition 2014. Lippincott Williams &Wilkins, Philadephia, USA.*