

A Handbook of

Infection Control

for the

Asian Healthcare Worker

3rd Edition

LING Moi Lin
CHING Tai Yin
SETO Wing Hong

A Handbook of
Infection Control
for the
Asian Healthcare Work
Third Edition

LING Moi Lin
Singapore General Hospital
Singapore

CHING Tai Yin
Queen Mary Hospital
Hong Kong Health Authority
Hong Kong

SETO Wing Hong
WHO Collaborating Centre for Infection Control
Hospital Authority
Hong Kong

Copyright © 2011, 2004 by Authors Ling Moi Lin, Ching Tai Yin and Seto Wing Hong. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any forms or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the authors.

This publication is sponsored by the Advanced Sterilization Products franchise of Johnson & Johnson Medical as service to the Medical Profession. The views expressed do not necessarily reflect those of the publisher or sponsor. Consult full prescribing information before issuing prescriptions for any products mentioned in this publication.

CONTENTS

Preface	Iv	
About the Authors	v	
CHAPTER 1	Initiating Nationwide Infection Control Programs in the Asian Context	1
CHAPTER 2	Emerging Infections	11
CHAPTER 3	Infection Control Issues for Regional Infectious Diseases	23
CHAPTER 4	Isolation Precautions and Practices	31
CHAPTER 5	Hand Hygiene	41
CHAPTER 6	Surveillance	49
CHAPTER 7	Management of an Outbreak	59
CHAPTER 8	Sterilization and Disinfection	63
CHAPTER 9	Clinical Waste Management	71
CHAPTER 10	Proper Management of Hospital Linen	75
CHAPTER 11	Ventilation System Issues	81
CHAPTER 12	Infection Control and Antibiotic Stewardship Program	91
CHAPTER 13	Employee Health Program	103
CHAPTER 14	Implementing Infection Control Guidelines	127
CHAPTER 15	Quality Improvement and Infection Control	137

PREFACE

Since the last edition, there have been many changes in the field of Infection Control. We are pleased to provide updates in this 3rd edition.

In Chapter 1, we have included mention of the WHO core components of an infection control program. A brief write-up on NDM-1 has been included in Chapter 2 as universally, we grapple with the issues of MDROs. Chapter 4 has been re-written to highlight recent changes in isolation precautions following the SARS and H1N1 outbreaks. With the successful WHO Global 1st Patient Safety Challenge, Clean Care is Safer Care, a new Chapter 5 is created to discuss “Hand Hygiene”. The many recent updates on Sterilization and Disinfection are highlighted in Chapter 8. Details on the use of the infection control risk assessment matrix are added to Chapter 11 for use during construction and renovation of healthcare facilities. Chapter 12 has been re-named to include antimicrobial stewardship program. Chapter 15 now includes details on use of checklists and the role of quality improvement in infection control programs.

We trust that this revised updated edition will be an excellent reference tool for your daily use in your work as an infection control professional.

Ling ML

Ching TY

Seto WH

ABOUT THE AUTHORS

Dr Ling Moi Lin, MBBS, FRCPA, CPHQ, MBA is the Director, Infection Control at Singapore General Hospital (SGH). She has 30 years of experience in the healthcare setting with sub-speciality experience in clinical microbiology for the past 15 years. During her secondment to Tan Tock Seng Hospital, she held the responsibility of Acting Head, Department of Pathology and Laboratory Medicine (1995 –1997).

She played a key role in the infection control program in Singapore and helped to establish the Infection Control Association (Singapore) in 1999, of which she is the President till today. She is also currently the President of the Asia Pacific Society of Infection Control (APSIC). She has been conducting training programs in infection control in China, South East Asia as well locally in Singapore since 1995. She has been one of the key faculty members of the APSIC Course in Infection Control since 2002. She is also a certified professional in healthcare quality (CPHQ) since 2000 and received training in healthcare quality from Dr Brent James of the Intermountain Health Care (IHC) in the United States in 2001.

She has played a key role as Director of Quality Management at the SGH for the past 5 years where she contributed to building-up and improving quality awareness and implementing clinical quality programmes in SGH. She was also the Director for Quality Management for 2 years at the corporate office of Singapore Health Services where she initiated the Health Management Programs for various chronic diseases and also contributed to building the quality movement in the cluster. She has special interest in quality improvement and is the key trainer for the quality improvement training program at SGH since 2001.

Her expertise in healthcare quality is recognized internationally and she was a Director on the Healthcare Quality Certification Board (HQCB) and its Asia Pacific representative from 2006 - 2007.

Ms Patricia Ching Tai Yin has been practicing infection control since 1985. She received basic nurse training and midwifery training from Hong Kong in 1967 and 1971 respectively and graduated with a Diploma in Nursing Administration in Hong Kong Polytechnic University in 1991. Besides infection control, she is also trained in intensive care and coronary care. Ms Patricia Ching is also the founding chairwoman of Hong Kong Infection Control Nurses Association, treasurer of Asia Pacific Society for Infection Control and was conferred the title of Honorary Professor in Infection Control by Military Postgraduate Medical School, Chinese PLA General 301 Hospital in Beijing, China, in October 1992.

Ms Patricia Ching has published a total of 56 publications and co-authored "Infection Control for the Asian Healthcare Worker" in 1999 and 2004. She has also written a chapter "Strategic Alteration of the Nursing Practice Models in Hong Kong: an Important Lesson from the SARS Epidemic", which was included in "Challenges of Severe Acute Respiratory Syndrome (SARS)" in 2006.

She was recognized for her contribution to healthcare and was awarded Outstanding Staff Award of Hospital Authority from Hong Kong Hospital Authority in 2002 and a Medal of Honour by Hong Kong Government in 2004.

Prof Seto Wing Hong played a key role in initiating Infection Control in Hong Kong and started the local training course for Infection Control Practitioners in 1985. He is involved extensively in Infection Control education throughout China and the region and is the Founding President of the Asia Pacific Society of Infection Control. Besides being Honorary Professor for the University of Hong Kong and the Hong Kong Polytechnic University, he is also a visiting professor for the University of New South Wales.

He was conferred honorary professorships by several universities in China including Honorary Professorship for Infection Control by the Military Postgraduate Medical College, PLA General Hospital (301) and the People's Liberation Army of China has in addition appointed him honorary consultant for Infection control in 1999.

He is also the Chairman of the Infection Control Scientific Committee of the "Centre for Health Protection" in Hong Kong. Presently he has authored over a hundred research papers including the book "Infection Control for the Asian Healthcare Worker". Many international societies had invited him to speak on Infection Control and they include the ICC, ICID, CDC (USA), ASM (USA), ICN (UK), Hospital Infection Society (UK), APIC (USA), SHEA (USA) and ICNA (Australia).

The WHO has also regularly assigned him as advisor for various projects in Infection Control, Antibiotics Resistance and a core group member for the WHO Hand Hygiene guideline. He is also a member of the Emergency Committee of the IHR of the WHO, member of the Infection Control International Network and Director of the WHO Collaborating Centre for Infection Control in Hong Kong. He was also awarded the "Bronze Bauhinia Star" in 2004 and "Silver Bauhinia Star" in 2011 from the Hong Kong Government for his work in Infection Control in Hong Kong.

In view of his years of involvement in Infection Control, he is also active in the related field of Quality Healthcare Management and is presently the President of the Asia Pacific Society of Quality Healthcare.

Initiating Nationwide Infection Control Programs in the Asian Context

The field of hospital infection control 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 infection control practice varies between countries. It is reassuring to know, however, that the movement is vibrant and active in many countries. A group of senior infection control 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.

Infection control 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 infection control 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 1997.⁴ 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 infection control program, and a brief overview of the infrastructure necessary for such a program.

STEPS IN IMPLEMENTING NATIONWIDE HOSPITAL INFECTION CONTROL PROGRAMS

Starting infection control 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

Infection control 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.⁵ 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.⁶ 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 infection control nurses (ICNs)

Even a stated national policy will not guarantee the implementation of infection control 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 Paulo, only a few had a well-organized infection control team (ICT).⁷ 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 ICNs 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 5 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 infection control 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 infection control, 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 ICN in the teaching team will considerably

enhance the value of the course. Such a course was organized in Hong Kong when 14 ICNs were initially deployed in a single year in 1985. The experience is fully described elsewhere,⁸ but the curriculum of that early course is shown in Table 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 infection control personnel.

Step Five: Initiate infection control programs at the local hospital level

The benefits of infection control 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 ICT 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 infection control 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 ICNs 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 ‘Infection Control 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: Curriculum for Infection Control Course

<p>a) Basic course — day release (20 weeks; 6 hours/week)</p> <ol style="list-style-type: none">1) Basic infection control: definitions, foundation and role of infection control nurse (ICN) and infection control officer (ICO); formation and function of infection control team (ICT)2) Basic microbiology and infectious disease3) Microbiology specimens: proper handling and interpretation of results4) Basic epidemiology I (definitions and methods)5) Surveillance techniques and options6) Practical prevalence survey in respective hospitals
<p>b) Advanced course — full-time (2 weeks)</p> <ol style="list-style-type: none">1) Administration skills for ICNs2) Infection control in major systems: urinary tract, lower respiratory tract, surgical wounds and infusion therapy3) Infection control for special pathogens: <i>Legionella</i> sp, multidrug-resistant <i>Staphylococcus aureus</i>, multidrug-resistant Gram-negative bacteria, hepatitis viruses, HIV4) Infection control in special areas: kitchen, renal unit, burn unit, nursery, operating theatre and the laundry5) The inanimate environment, ventilation, pest control, water in the hospital and waste disposal6) Sterilization, disinfectants and Central Service Department7) Staff health8) Principles and techniques of isolation9) Basic epidemiology II (simple statistics) and outbreak investigation10) Miscellaneous topics: the compromised host, education principles, understanding antibiotics, liaison with community health program.

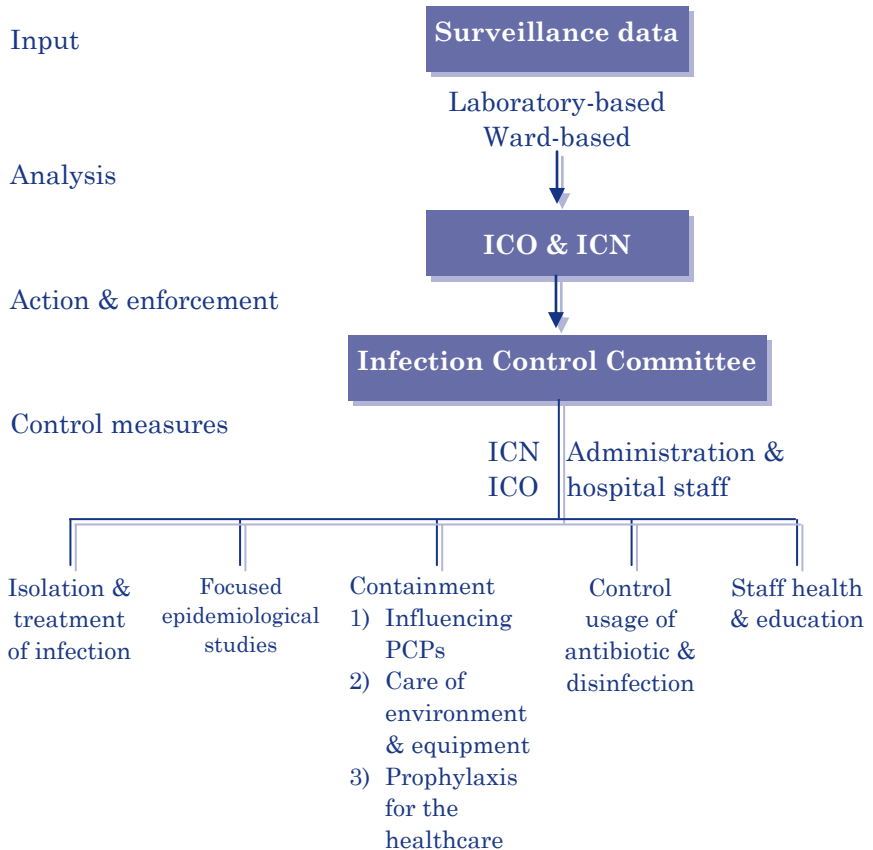
In this next section, the basic infrastructure of an infection control program will be described. The main components are described here, and further information on the control measures will be dealt with in the subsequent chapters.

Figure 1 shows the essential infrastructure for an infection control 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 ICT, which consists of one or more full-time ICNs and a doctor, who is generally given the title ‘Infection Control Officer’ (ICO) in Europe or ‘Hospital Epidemiologist’ in the USA. The ICO and the ICNs must work together as a team. Usually the ICO is only deployed part-time, while ICNs are the full-time personnel. Therefore, the ICNs would be expected to handle most of the ‘nuts and bolts’ operations of the infection control program and the ICO would only have a supervisory role. However, it is important to appreciate that they have differing roles in the infection control program and they must each fulfill their functional role. Only then can we expect optimal efficacy of the ICT.

The ICO — 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 infection control issues
- 7) Education in infection control, especially making it relevant to the doctors

Figure 1: Overview of Infrastructure of Hospital Infection Control



ICO = infection control officer (doctor)

ICN = infection control nurse

PCP = patient-care practice

The ICNs — 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 control, 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 infection control issues
- 7) Education in infection control, especially making it relevant to the nonmedical staff.

An infection control committee (ICC) must be established with the help of the hospital administration to oversee the entire infection control program. The ICC meets regularly to receive reports of surveillance data, and the plans and activities of the ICT. As the work of infection control involves the implementation of hospital-wide policies, the ICC will help by providing the necessary administrative authority for the ICT. The members of the ICC must, therefore, have sufficient seniority and breadth to ensure that the ICC has this authority.

Next, the ICT, 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 infection control 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 the Figure 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.⁹ 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 ICT, 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 for infection control 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 2008¹⁰. In the WHO, there are frequent requests to define the essential core components for the development of effective infection control 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 infection control 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".

REFERENCES

- 1) American Hospital Association. Prevention and control of Staphylococcus in hospitals. *Proceedings of the National Conference in Hospital-Acquired Staphylococcal Disease*. Chicago: Communicable Disease Centre, 1958:XXIII–XXVI.
- 2) Gaynes RP. Surveillance of nosocomial infections: a fundamental ingredient for quality. *Infect Control Hosp Epidemiol* 1997; 18: 475–8.
- 3) Rosales SP, Rangel-Frausto MS. Infection control in developing countries. In: Bennet JV, Brachman PS, Eds. *Hospital Infections, 4th ed*. Philadelphia: Lippincott-Raven, 1998: 291–8.
- 4) Seto WH. Implementing Nationwide Infection Control Programs. *Presented at the 20th International Congress on Chemotherapy*, Sydney, June 1997.
- 5) Scheckler WE, Brimhall D, Buck AS, et al. Requirements for infrastructure and essential activities of infection control and epidemiology in hospitals: a consensus panel report. *Infect Control Hosp Epidemiol* 1998; 19: 114–24.
- 6) Steering Group of the National Prevalence Survey. National prevalence survey of hospital acquired infections: definitions. *J Hosp Infect* 1993; 24: 69–76.
- 7) Pannuti C, Grinbaum R. An overview of nosocomial infection in Brazil. *Infect Control Hosp Epidemiol* 1995; 16: 170–4.
- 8) Yung WH, Seto WH. The training of infection control nurses in Hong Kong. *J HK Med Assoc* 1989; 3: 237–8.
- 9) Emori TG, Harley RW, Garner JS. *Technique and uses of nosocomial infection surveillance in US hospitals 1976–1977*. *Am J Med* 1981;70:933–40.
- 10) Seto, WH, Otaiza F, Pessoa-Silva CL, ,et al. Core Components for Infection Prevention and Control Programs: A World Health Organization Network Report. *Infect Control Hosp Epidemiol* 2010; 31(9): 948–950.

Emerging Infections

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 resistance¹

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 $\mu\text{g}/\text{mL}$. 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 control²

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.

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.

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 (Table).

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: Characterization of Vancomycin-resistant

Gene	MIC _{van} ($\mu\text{g}/\text{mL}$)	MIC _{tei} ($\mu\text{g}/\text{mL}$)	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
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

MIC_{van} = minimum inhibitory concentration of vancomycin;
MIC_{tei} = minimum inhibitory concentration of teicoplanin.

EXTENDED-SPECTRUM β -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.

NEW DELHI METALLOBETALACTAMASE-I (NDM-1)

Introduction

This was first detected in a *Klebsiella pneumoniae* isolate in 2008 from a Swedish patient of Indian origin¹³. 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.

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. The enzyme *bla*_{NDM-1} is carried on a plasmid that encodes resistance to all beta lactams except aztreonam.

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.

SEVERE ACUTE RESPIRATORY SYNDROME (SARS)

Introduction

This is a new severe febrile respiratory illness caused by the SARS-associated coronavirus (SARS-CoV).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.

REFERENCES

- 1) Jorgensen JH. Mechanisms of methicillin resistance in *Staphylococcus aureus* and methods for laboratory detection. *Infect Control Hosp Epidemiol* 1991; 12:14–9.
- 2) Boyce JM, Jackson MM, Pugliese G, et al. Methicillin-resistant *Staphylococcus aureus* (MRSA): a briefing for acute care hospitals and nursing facilities. *Infect Control Hosp Epidemiol* 1994; 15: 105–15.
- 3) Waldvogel FA. Treatment of infections due to methicillin-resistant *Staphylococcus aureus*. *J Hosp Infect* 1986;7 (Suppl A): 37–46.
- 4) Hiramatsu K. The emergence of *Staphylococcus aureus* with reduced susceptibility to vancomycin in Japan. *Am J Med* 1998; 104 (Suppl 5A): 7S–10S.
- 5) *Staphylococcus aureus* with reduced susceptibility to vancomycin, United States, 1997. *MMWR Morb Mortal Wkly Rep* 1997; 46: 765–6.
- 6) Update: *Staphylococcus aureus* with reduced susceptibility to vancomycin, United States, 1997. *MMWR Morb Mortal Wkly Rep* 1997; 46: 813–5.
- 7) Turco TF, Melko GP, Williams JR. Vancomycin intermediate-resistant *Staphylococcus aureus*. *Ann Pharmacother* 1998; 32: 758–60.

- 8) Leclercq R, Corvalin P. Resistance to glycopeptides in enterococci. *Clin Infect Dis* 1997; 24:545–6.
- 9) Perichon B, Reynolds P, Courvalin P. VanD-type glycopeptide-resistant *Enterococcus faecium* BM4339. *Antimicrob Agents Chemother* 1997;41: 2016–8.
- 10) Recommendations for preventing the spread of vancomycin resistance. Recommendations of the Hospital Infection Control Practices Advisory Committee (HICPAC). *MMWR Morb Mortal Wkly Rep* 1995; 44 No. RR-12.
- 11) Philippon A, Labia R, Jacoby G. Extended-spectrum β -lactamases. *Antimicrob Agents Chemother* 1989; 33: 1131–6.
- 12) Meyer KS, Urban C, Eagan JA, Berger BJ, Rahal JJ. Nosocomial outbreak of *Klebsiella* infection resistant to late-generation cephalosporins. *Ann Intern Med* 1993; 119: 353–8.
- 13) Kumarasamy et al. Emergence of a new antibiotic resistance mechanism in India, Pakistan, and the UK: a molecular, biological, and epidemiological study. *The Lancet Infectious Diseases* 2010; 10: 597 – 602.
- 14) Centers for Disease Control and Prevention website: <http://www.cdc.gov/ncidod/sars/>

Infection Control Issues for Regional Infectious Diseases

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.

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.

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 work places 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.

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

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.

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.

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.

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.

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

Isolation Precautions and Practices

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 (the 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 5 μm . Three diseases transmitted by air are pulmonary tuberculosis (TB), chickenpox and measles. **Droplet Precautions** are used for infections transmitted by bigger droplets (> 5 μm) such as influenza and respiratory syncytial virus. **Contact Precautions** are used 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.

NEW GUIDELINES

Two international guidelines on isolation precautions are published after the SARS 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.

2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings- CDC³

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 scopes 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.

WHO Interim Guideline 2007 - Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases (ARD) in health care⁴

The purpose of this document is to provide infection control 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 and infection controls, including early detection, isolation and reporting, and establishment of infection control 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.

WHO guideline 2009 on Pandemic (H1N1) virus infection and influenza-like illnesses⁵

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.

GENERAL GUIDELINES FOR ISOLATION PRECAUTIONS

Handwashing / hand hygiene

Hands should be washed whenever they are suspected of being soiled and before the care of a new patient. 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 cleaning hands,⁶ but should only be substituted if running water and soap are not available.

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 handwashing, because gloves may be defective or torn during use. Gloves should be changed between patients; failure to do so is an infection control hazard.⁸

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.

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 washed. Putting on gowns on entering an isolation room before giving care is not proven to be effective in reducing infection.

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, 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 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. Doors should be closed at all times.

Disinfection of patient items

Critical reusable items are reprocessed either by 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.

Routine and terminal disinfection

Daily cleaning of the environment and bedside equipment is necessary to prevent the transmission of bacteria to other patients. Thorough cleaning and disinfection is useful in reducing the amount of equipment used. This is especially true for VRE, which can survive in the inanimate environment for a prolonged period of time.

Respiratory hygiene / Cough etiquette³

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 ≥ 1 metre, of persons with respiratory infections in common waiting areas when possible.

ENVIRONMENTAL DISINFECTION TO CONTROL MDRO

Hydrogen peroxide vapour (HPV) has been introduced for environmental disinfection for prevention of MDRO transmission. Studies showed that HPV is effective in eliminating bacteria from the environment but when colonized patients with MDROs are admitted, recontamination will occur. Consequently, HPV is not effective in controlling the environmental levels of MDROs especially in endemic areas of a particular organism such as MRSA.⁹

HOSPITAL BASED GUIDELINES

Throughout the years, different systems of isolation precautions have been developed after intensive systematic reviews. Each individual facility should select recommendations that are practicable and have written policies and regular audit to ensure consistent practices. These should include details practices such as when to wash hands, 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.

INEFFECTIVE RISK-REDUCTION PRACTICES

Infection control 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 for a period of time in the isolation room of patients with certain infections after the patients have been discharged, so that the air and surfaces are thoroughly disinfected.

‘Disinfection’ is a misnomer because there is no scientific evidence proving infected patients might disperse more microorganisms in the air than non-infected patients, or that airborne pathogens can be killed by fogging. Furthermore, formaldehyde is toxic. Thorough cleaning of the isolation room, however, is important between patients.

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 contaminate the outer surface of the bag. The use of a second bag would, therefore, reduce the number of organisms contaminating care givers. In fact, studies have shown that the inner bag has no more organisms than the outer bag,¹⁰ so double bagging is a waste of money and personnel time.

Routine culture of environment

Some countries in Southeast Asia still practice routine culture of environment. 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 isolation meal trays

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.

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 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 infection control 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.

REFERENCES

- 1) Lynch P, Jackson MM, Cummings MJ, Stamm WE. Rethinking the role of isolation practices in the prevention of nosocomial infections. *Ann Intern Med* 1987; 107:243–6.
- 2) Centers for Disease Control and Prevention (CDC) and Hospital Infection Control Practices Advisory Committee (HIPAC). Guideline for isolation precautions in hospital. *Am J Infect Control* 1996; 24:24–52.
- 3) Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the

- Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings <http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf>
- 4) Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care WHO Interim Guidelines 2007 http://www.who.int/csr/resources/publications/WHO_CDS_EPR_2007_6c.pdf
 - 5) Infection prevention and control during health care for confirmed, probable, or suspected cases of pandemic (H1N1) 2009 virus infection and influenza-like illnesses. Updated guidance. 16 December 2009 http://www.who.int/csr/resources/publications/cp150_2009_1612_ipc_interim_guidance_h1n1.pdf
 - 6) Larson E Guideline for use of topical antimicrobial agent. *Am J Infect Control* 1988; 16:253–66.
 - 7) Lynch P, Jackson MM, Preston GA, Soule BM. *Barrier Precautions: Reducing Risks for Transmission of Organisms: Infection Prevention with Limited Resources — A Handbook for Infection Committees*. Chicago: ETNA Communications LLC, 1997:87–93.
 - 8) Patterson JE, Vecchio J, Pantelick EL, et al. Association of contaminated gloves with transmission of *Acinetobacter calcoaceticus* var. *anitratus* in an intensive care unit. *Am J Med* 1991; 91: 479–83.
 - 9) Hardy KJ, Gossain S, Henderson N, Drugan C, Oppenheim BA, Gao F, Hawkey PM. Rapid recontamination with MRSA of the environment of an intensive care unit after decontamination with hydrogen peroxide vapour. *J Hosp Infect* 2007 Aug; 66 (4): 360-8
 - 10) Maki DG, Alvarado C, Hassemer C. Double-bagging of items from isolation rooms is unnecessary as an infection control measure: a comparative study of surface contamination with single and double bagging. *Infect Control* 1986; 7: 535–7.

Hand Hygiene

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. These days, hand rubbing with alcohol is preferred over handwashing with soap and water for the following reasons¹:

- 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 (H₂O₂) 0.125% v/v OR
- 2) isopropyl alcohol 75% v/v, glycerol 1.45% v/v, hydrogen peroxide 0.125% v/v:

FIVE MOMENTS OF 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)

STEPS IN HAND HYGIENE

Refer to Fig 2 and 3 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
- finger tips
- 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 Fig 4 and 5).

Figure 2¹**Hand Hygiene Technique with Alcohol-Based Formulation****C** Duration of the entire procedure: 20-30 seconds

Apply a palmful of the product in a cupped hand, covering all surfaces;



Rub hands palm to palm



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



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 3¹

Hand Hygiene Technique with Soap and Water

Duration of the entire procedure: 40-60 seconds



Flight 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;



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;



Rinse hands with water;



Dry hands thoroughly with a single use towel;



Use towel to turn off faucet;



Your hands are now safe.

Figure 4¹

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 procedure 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 5¹

Repeat the aboved-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.

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. The five components in the tool reflect the five elements of the WHO Multimodal Hand Hygiene Improvement Strategy:²

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

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

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 behaviour³.

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.

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.

Institutional safety climate

Leadership plays a key role towards success of the program. Their visible presence and support is 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.

REFERENCES

- 1) WHO Guidelines on Hand Hygiene in Healthcare 2009
- 2) Hand hygiene self-assessment framework 2010. <http://www.who.int/gpsc/5may/tools/en/index.html>
- 3) Whitby et al. Behavioural considerations for hand hygiene practices: the basic building blocks. *Journal of Hospital Infection* 2007; 65: 1-8.

Surveillance

Surveillance is generally recognized as essential to the practice of hospital infection control. 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 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 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 infection control, 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.

DEFINITION OF SURVEILLANCE

Surveillance has been defined as the “ongoing, systematic, collection, analysis, interpretation of health data essential to the planning, implementation, evaluation of infection control practices, closely integrated with timely dissemination of these data to those who need

to know”.³ Simply stated, surveillance is careful monitoring and relevant feedback.

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 infection control personnel to identify HAI outbreaks early and, hence, help them to control it promptly. The data collected will also prompt the implementation of appropriate infection control 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.

Infection control 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.

ESSENTIAL INFRASTRUCTURE REQUIREMENTS FOR SURVEILLANCE

A consensus report was recently 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.

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 infection control priorities of the hospital and it is important for the infection control team (ICT) 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,⁵ and if properly executed, it will ensure that the ICT 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.^{6,7}
- 2) ***Population under surveillance*** It is now recognized that the collection of hospital-wide infection rates are not as helpful as previously thought. These rates are not comparable between hospitals⁸ 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 ICT should identify the final consumers of the surveillance data and envisage the effect the data might have, even before the exercise begins.

People

A useful guide to the number of infection control practitioners needed for surveillance and other infection control programmes is **one infection control practitioner to 250 beds** in the hospital.⁴ 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.

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 infection control practitioner for the analysis of data, e.g. ACCESS, EXCEL

Money 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 ICT is also important.

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 ICT 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 ICT initiates procedures to collect the data is recommended.⁴ 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 infection control 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 ICT 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 surveyor 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 ICT is expected to produce data on historical events.

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 nosocomial infections do occur and these usually present as a cluster of cases. The severe acute respiratory syndrome (SARS) 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 nosocomial infections constitute the minority of nosocomial infections. Wenzel et al reported in a 5-year study that only 10% of hospital infections presented as clusters and only 4% were subsequently confirmed to be epidemics.⁹ Early detection of these clusters is crucial because the outbreak could be spreading rapidly in the hospital. Therefore, infection control personnel should be screening for these clusters on a daily basis.

The ICN 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 ICN.

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

- 1) Any unusual results (e.g. SARS)
- 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. SARS associated coronavirus, Avian flu).

The ICN 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 ICT would have to formulate a cluster detection programme that is appropriate for their hospital.

REFERENCES

- 1) Goonan KJ. *The Juran Prescription*. San Francisco: Jossey-Bass Inc, 1995.
- 2) Haley RW, Culver DH, White JW, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infection in US hospitals. *Am J Epidemiol* 1985;121:182–205.
- 3) Gaynes RP. In: Bennet JV and Brachman PS, Eds. *Surveillance of Nosocomial Infections in Hospital Infections*, 4th ed. Philadelphia: Lippincott-Raven, 1998.
- 4) Scheckler WE, Brimhall D, Buck AS, et al. Requirements for infrastructure and essential activities of infection control and epidemiology in hospitals: a consensus panel report. *Infect Control Hosp Epidemiol* 1998; 19: 114–24.
- 5) Haley RW. Surveillance by objectives: a new priority directed approach to control of nosocomial infections. *Am J Infect Control* 1985; 13: 78–89.
- 6) Steering Group of the National Prevalence Survey. National prevalence survey of hospital acquired infections: definitions. *J Hosp Infect* 1993; 24: 69–76.
- 7) Garner JS, Jarvis WR, Emori TG, et al. CDC definitions of nosocomial infections. *Am J Infect Control* 1988; 16: 28–40.
- 8) Gaynes RP. Surveillance of nosocomial infections: a

fundamental ingredient for quality. *Infection Control and Hospital Epidemiology* 1997; 18: 475–8.

- 9) Wenzel RP, Thompson RL, Landry SM, et al. Hospital-acquired infections in intensive care unit patients: an overview with emphasis on epidemics. *Infect Control* 1983; 4: 371–5.

Management of an Outbreak

Outbreaks vary in extent and severity. It is the responsibility of the Infection Control Committee (ICC) 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 infection control doctor/officer (ICO) who is usually the person identified to take the leading role. Arrangements will have to be made by the ICO 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.

OUTBREAK CONTROL TEAM

Personnel

- 1) ICC representatives — ICO and infection control nurse
- 2) Medical director/administrator
- 3) Infectious disease doctor
- 4) Executive nurse director/senior nurse
- 5) Clinical head/senior doctor

Responsibilities

- 1) Ensure continual care of patients
- 2) Clarify resource implications
- 3) additional staff/supplies required
- 4) media handling
- 5) Agree upon and coordinate policy decisions
- 6) Review progress
- 7) Define the end of the outbreak

CHECKLIST OF ACTION

Investigation

- Confirm outbreak; provide case definition
- Demonstrate outbreak — compare current rates with pre-epidemic rates
- Analyze cases — line-listing with time, person and place
- Do literature search if indicated
- Conduct microbiology investigations to confirm reservoir and mode of transmission
- Conduct microbiological screening of patients and staff (if necessary)
- Conduct serological screening of patients, staff and other contacts, if necessary

- Follow-up contacts — patients, staff, visitors, etc

Communication

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

Management

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

Control

- Implement isolation policies
- Administer active/passive immunization where needed
- Administer antibiotic prophylaxis, where necessary
- Define patient admission, transfer and discharge policy
- Define visiting arrangements
- Evaluate control measures

End of outbreak

- Announce end of outbreak to relevant authorities informed earlier
- Compile report for ICC
- Change policies and practices, if necessary

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.

Sterilization and Disinfection

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 3 and 4).

Table 3: The Risks to Patients from Equipments

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	<u>Disinfection</u> High level disinfectant Pasteurization
Low	Contact normal intact skin	Wash bowls, toilet *MRSA patient	<u>Cleaning & drying</u> *disinfection
Minimal	Not in close contact with patients	Floor, wall, beds	Cleaning & drying

Table 4: 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°C	6 hours at 20°C	21 days	1 ppm TWA
Peracetic acid 0.2%	NA	12 mins at 50-60°C	Single use	None
Gluteraldehyde $\geq 2\%$	20-90 mins at 20-25°C	10 hours at 20-25°C	14-30 days	None
Ortho-phthalaldehyde (OPA) 0.55%	12 mins at 20°C 5 mins at 25°C In AER	None	14 days	0.05ppm
Hydrogen peroxide / Peracetic Acid (7.35% / 0.23%)	15 mins at 20°C	3 hours at 20°C	14 days	HP 1 ppm

STERILIZATION METHODS

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

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 exposure². 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 / 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 airtightness of the chamber, atmospheric pressure, the quality of steam. Preventive maintenance should be done regularly by the hospital bio-engineers.

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.

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 turn around 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.

DISINFECTION

There are three main methods of disinfection, namely cleaning, heating and chemical disinfection.³

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.

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.

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.⁴ Therefore, for effective usage of disinfectant; the following points need to be observed:

- 1) **Microbial sensitivity** Different organisms vary in their sensitivity to different disinfectants, e.g. phenolics (Printol™) possess limited virucidal effect, and chlorhexidine (Hibitane™) is not an effective tuberculocidal disinfectant.
- 2) **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.

- 3) **Incompatibility** Materials that are incompatible can neutralize the activity of disinfectants, e.g. soap, cork, rubber and plastics.
- 4) **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 Cetavlon™. 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.
- 5) **Hazards** 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.

High level disinfectant and low level disinfectant⁸

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 2 with list of HDL.⁹ 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), phenolics 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.

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.⁹

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.¹⁰ To achieve sterilization of such instruments, an ideal low temperature sterilant is needed, which should possess 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 Sterilization⁸

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 to 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.

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.

REFERENCES

- 1) Ayliffe GAJ, Coates D, Hoffman PN. *Chemical disinfection in hospital*. London: Public Health Laboratory Service, 1985.
- 2) Keene JH. Sterilization and pasteurization. In: *Mayhall CG, Ed. Hospital Epidemiology and Infection Control*. Baltimore: Williams & Wilkins, 1996: 913–36.
- 3) Rutala WA. Draft APIC guideline for selection and use of disinfectants. *Am J Infect Control* 1995; 23:35A–67A.
- 4) Rutala WA. Selection and use of disinfectants in health care. In: *Mayhall CG, Ed. Hospital Epidemiology and Infection Control*. Baltimore: Williams & Wilkins, 1996:937–46.
- 5) Alfa MJ, Sitter DL. In-hospital evaluation of orthophthalaldehyde as a high-level disinfectant for flexible endoscopes. *J Hosp Infect* 1994; 26:15–26.
- 6) Rutala WA, Weber DJ. Disinfection of endoscopes: review of new chemical sterilants used for high-level disinfection. *Infect Control Hosp Epidemiol* 1999; 20:69–76.
- 7) Walsh SE, Maillard JY, Russell AD. Ortho-phthalaldehyde: a possible alternative to glutaraldehyde for high level disinfection. *J Appl Microbiol* 1999; 86:1039–46.
- 8) Ontario. Ministry of Health and Long-Term Care and the Provincial Infectious Diseases Advisory Committee. *Best Practices for Cleaning, Disinfection and Sterilization in All HealthCare Settings*. November, 2009. Available at: http://www.health.gov.on.ca/english/providers/program/infectious/diseases/ic_cds.html.
- 9) Rutala WA, Weber DJ and the Healthcare Infection Control Practices Advisory Committee *CDC Guideline for Disinfection and Sterilization in Healthcare Facilities*, 2008
- 10) Rutala WA. *Low temperature sterilization technologies: Do we need to redefine ‘sterilization’?*

Clinical Waste Management

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.

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 demonstrate 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

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 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

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.

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.

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.

REFERENCES

- 1) Rutala WA. Disinfection, sterilization, and waste disposal. In: Wenzel RP, Ed. *Prevention and Control of Nosocomial Infections*, 2nd ed. Baltimore: Williams & Wilkins, 1996: 913–36.
- 2) Weinstein S, Kotilainen HR, Moore D, Gantz N. Microbiologic contamination of hospital trash from patients on isolation precautions versus standard care. *Am J Infect Control* 1988; 16: 76.
- 3) Rutala WA, Mahal CG, Society of Hospital Epidemiology of America. Position paper: medical waste. *Infect Control Hosp Epidemiol* 1992; 13: 38–48.
- 4) Lynch P, Jackson M, Preston GA, Soule BM. Cleaning, disinfection and sterilization. In: Pugliese G, Ed. *Infection Prevention with Limited Resources —a Handbook for Infection Committees*. ETNA Communications LLC, 1997: 61–74.

Proper Management of Hospital Linen

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.

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 cm² 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.

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.

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.

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:

- 1) the inner water-soluble bags are expensive;
- 2) there is tainting associated with hot-water washing;
- 3) re-washing adds to the cost; and
- 4) 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.

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.

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.

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 cm² are equal to complete pathogen

removal,⁷ while Christian et al proposed that a 10^6 – 10^7 reduction in viable counts is effective.⁸ Nonetheless, regular assessment of the microbial levels on laundered linen is unnecessary unless laundry-related outbreaks occur.

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, 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.

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.

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 services¹⁰. 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.

REFERENCES

- 1) Martin MA. Nosocomial infections related to patient care support services, dietetic services, central services department, laundry, respiratory care, dialysis and endoscopy. In: *Wenzel RP, Ed. Prevention and Control of Nosocomial Infections*, 2nd ed. Baltimore: Williams & Wilkins, 1994:101–3.
- 2) McDonald LL, Pugliese G. Laundry service. In: *Mayhall CG, Ed. Hospital Epidemiology and Infection Control*, 1st ed. Baltimore: Williams & Wilkins 1996: 805–8.
- 3) Blaser MJ, Smith PF, Cody HJ, et al. Killing of fabric-associated bacteraemia in hospital laundry by low-temperature killing. *J Infect Dis* 1984; 149: 48–57.
- 4) Weinstein SA, Gantz NM, Pelletier C, et al. Bacterial surface contamination of patients' linen: isolation precautions versus standard care. *Am J Infect Control* 1989; 17: 264–7.
- 5) Pugliese G. Isolating and double-bagging laundry: is it really necessary? *Health Facilities Management* 1989; 2: 16–21.
- 6) Taylor LJ. Segregation, collection and disposal of hospital laundry and waste. *J Hosp Infect* 1998;11(suppl A):56–63.
- 7) Walter WG, Schillinger JE. Bacterial survival in laundered fabrics. *Appl Environ Microbiol* 1975;29:368–73.
- 8) Christian RR, Manchest JT, Mellor MT. Bacteriological quality of fabrics washed at lower than standard temperatures in a hospital laundry facility. *Appl Environ Microbiol* 1983;45:591–7.
- 9) Smith JA, Neil KR, Davidson CG, et al. Effect of water

temperature on bacterial killing in laundry. *Infect Control* 1987;8:204–9.

- 10) Fijan S, Sostar-Turk S, Cencic A. Implementing hygiene monitoring systems in hospital laundries in order to reduce microbial contamination of hospital textiles. *J Hosp Infect.* 2005 Sep; 61(1):30-8.

Ventilation System Issues

Airborne microbes of concern as a source of nosocomial infections include *Mycobacterium tuberculosis*, *Aspergillus* species, *Cryptococcus neoformans*, *Histoplasma capsulatum*, *Coccidioides immitis*, and 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 2025. These address indoor air quality standards such as temperature levels, humidity levels, ventilation rates, pressure relationships, and minimum air-changes-per-hour requirements specific to each zone or area in the healthcare facility (e.g. operating theatre, laboratories, patient care areas, etc).

INTENSIVE CARE UNIT

The contributing factors to HAIs are mainly reservoirs (patients, staff, 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 air changes per hour 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 infection control principles.

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 50-ft³/min difference. The room air is exhausted directly outdoors. Recirculation is permitted but requires filtration through HEPA filters before entry into the room. A minimum of six air changes per hour is needed, but most facilities will try to deliver at least 12 air changes per hour; there is a point of diminishing returns at about 12–15 air changes per hour.

Some units prefer to install a two-mode system where the ventilation system can be changed from negative to positive when required, and vice-versa. This system has the advantage of versatility and cost-containment, but measures must be taken to prevent accidentally switching to the wrong mode.

The need for an anteroom is 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.

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.

The use of ultraviolet (UV) light is an additional optional feature to reduce the concentration of airborne bacteria. UV light fixtures must be mounted high on the walls away from the eyes of healthcare workers, i.e. 7 feet from the floor with at least one additional foot for air disinfection.

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 that is required will then be a single-bedded room or a cohort area for isolation of patients with an identical medical condition.

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

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 air changes per hour, 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 air changes per hour, 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.

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 wall, ceiling 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 air changes per hour for 100% fresh air system; minimum of 25 air changes per hour 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 5).

Table 5: Acceptable Bacteria-carrying Particle Counts²

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

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.

INFECTION CONTROL 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 6-8).

**Table 6: 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 7: Type of Construction Project Activity (Dust Producing Activity)

TYPE A	<p>Inspection and Non-Invasive Activities. Includes, but is not limited to:</p> <ul style="list-style-type: none"> removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet 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.
---------------	---

Table 7 (Cont'd)

TYPE B	<p>Small scale, short duration activities which create minimal dust</p> <p>Includes, but is not limited to:</p> <ul style="list-style-type: none">• installation of telephone and computer cabling• access to chase spaces• cutting of walls or ceiling where dust migration can be controlled.
TYPE C	<p>Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies</p> <p>Includes, but is not limited to:</p> <ul style="list-style-type: none">• 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	<p>Major demolition and construction projects</p> <p>Includes, but is not limited to:</p> <ul style="list-style-type: none">• activities which require consecutive work shifts• requires heavy demolition or removal of a complete cabling system• new construction.

Table 8: 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 11) Material management department 12) Linen room	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 Cath Lab / angiograph procedure areas 8) Central Sterile Supply 9) Intensive Care Units 10) Medical wards 11) Isolation wards and rooms 12) Operating theatres including C-section rooms / labor OT 13) Pharmacy admixtur

REFERENCES

- 1) Streifel AJ. Design and maintenance of hospital ventilation systems and the prevention of airborne nosocomial infections. In: Mayhall CG, Ed. *Hospital Epidemiology and Infection Control*. Baltimore: Williams & Wilkins, 1996: 955–64.
- 2) Holton J, Ridgway GL. Commissioning operating theatres. *J Hosp Infect* 1993; 23:153–60.
- 3) Guidelines for environmental infection control in health care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) 2003.

Infection Control and Antibiotic Stewardship Program

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 1998¹ 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,² and the comparison of sewage micro flora from hospital and non-hospital sources.³

Many authorities now recommend that every hospital should organize an antibiotic stewardship program to ensure proper use of antibiotics⁴. It is logical that the control of antibiotic resistance be recognized as one of the responsibilities for the Infection Control Team (ICT). 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 2, which also indicates the functions of these three categories of measures.

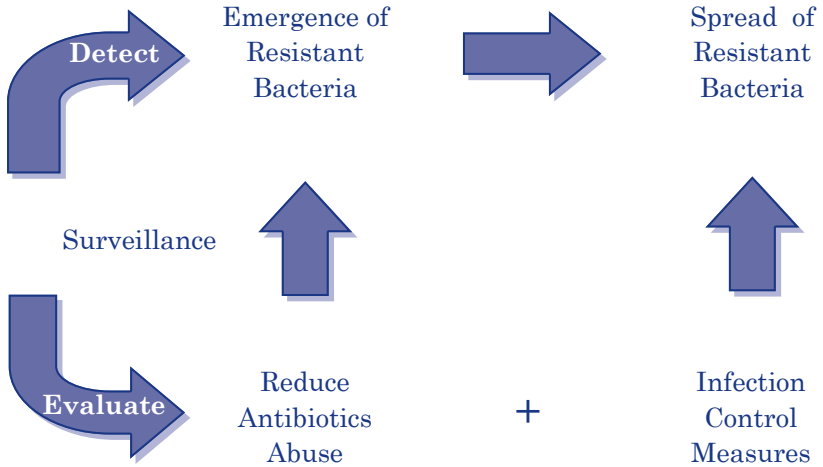
The first is the need for surveillance. Surveillance is needed to detect the presence of resistant organisms, but can also help us to evaluate the effectiveness of the control measures that are in place. We then need to control antibiotic abuse because it is the widespread abuse of antibiotics that provides 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 ICT. 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 infection control, followed by the control of antibiotic abuse in the hospital.

SURVEILLANCE AND INFECTION CONTROL MEASURES

Authoritative expert panels have recommended various infection control measures for the control of antibiotic resistance in the hospital^{5,6} and these are summarized in Table 8. 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 6: The Contribution of Surveillance, Infection Control, and Reducing Antibiotics Abuse in the Control of Antimicrobial Resistance



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 enterococci.

Table 9: Infection Control Measures for the Reduction of Antibiotic Resistance

Infection Control Measures	Key Mechanisms	Healthcare Workers Involved
1) Surveillance	<ul style="list-style-type: none"> Identify sources Identify outbreaks Feedback of data Monitor control measures 	<ul style="list-style-type: none"> Infection control team Microbiology laboratory staff
2) Implementation of correct patient care practices e.g. handwashing	Reduce the spread of resistant organisms	ICT implementation with frontline staff compliance
3) Disinfection and sterilization	<ul style="list-style-type: none"> General reduction of microbial contamination Central sterilization Eliminate common bacterial source 	<ul style="list-style-type: none"> ICT Frontline staff compliance
4) Isolation and barrier precautions	Contain source and reduce transmission	ICT implementation with frontline staff compliance
5) Notification of host-risk profile (e.g. early removal of IV lines)	Reduce colonization and halt progression to infection	<ul style="list-style-type: none"> 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.

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 ICT 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 ICT can assist in the implementation of such programs.

ANTIMICROBIAL STEWARDSHIP PROGRAM

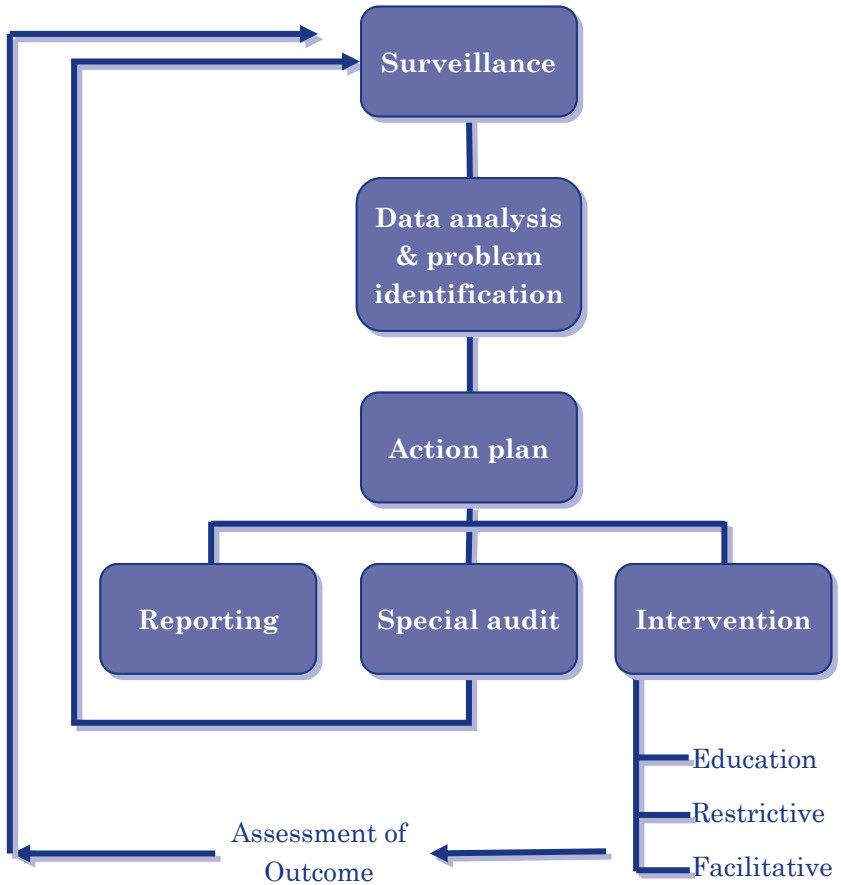
The infrastructure of an ASP is shown in Figure 7. A brief analysis will show many similarities to the Infection Control Program. The ASP, like Infection Control, begins with surveillance. As stated in Chapter 6, objectives and priorities must be clarified. Based on these objectives, data on antimicrobial 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 7.

Figure 7: 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')¹⁵ can be extremely effective. 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.

PARTICIPATION OF THE ITC

The 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 Infection Control 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 infection control nurse (ICN) in the course of infection control surveillance. If ample manpower is available, the ICN 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 ICT can constructively contribute to the ASP, it will be another opportunity to demonstrate the value of infection control in modern hospital practice.

REFERENCES

- 1) Containing Antimicrobial Resistance. *Review of the Literature and Report of a WHO Workshop on the Development of a Global Strategy for the Containment of Antimicrobial Resistance*. World Health Organization, Department of Communicable Disease Surveillance and Response, Geneva, Switzerland, 1999.
- 2) Datta N. *Drug resistance and R factors in the bowel bacteria of London patients before and after hospital admission*. *BMJ* 1969;2:407–11.
- 3) Linton KB, Richmond MH, Bewan R, Gillespie WA. Antibiotic resistance and R factors in coliform bacilli isolated from hospital and domestic sewage. *J Med Microbiol* 1974; 7:91–103.
- 4) Dellit TH, Owens RC, McGowan JE Jr, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America Guidelines for Developing an Institutional Program to Enhance Antimicrobial Stewardship. *Clin Infect Dis* 2007;44:159–77.
- 5) Shlaes DM, Gerding DN, John JF Jr, et al. Society for Healthcare Epidemiology of America and Infectious Diseases Society of America Joint Committee on the Prevention of Antimicrobial Resistance: Guidelines for the Prevention of Antimicrobial Resistance in Hospitals. SHEA Position Paper. *Infect Control Hosp Epidemiol* 1997; 18: 275–91.
- 6) Global Consensus Conference: final recommendations. Global Consensus Conference on Infection Control Issues Related to Antimicrobial Resistance. *Am J Infect Control* 1999;27:503–13.
- 7) Seto WH. Spread of Antibiotic Resistance: Impact of Infection Control Measures. *Nosocomial and Health Care Associated Infections in Urology, World Health Organization & International Union Against Cancer*, 2001:98–104.
- 8) Gaynes R. The impact of antimicrobial use on the emergence of antimicrobial resistant bacteria in hospitals. *Infect Dis Clin North Am* 1997; 11:757–66.
- 9) John JF, Fishman NO. Programmatic role of the infectious diseases physician in controlling antimicrobial costs in the hospital. *Clin Infect Dis* 1997; 24: 471–85.

- 10) Quintiliani R. Strategies for the cost-effective use of antibiotics. In: Gorbach SL, Bartlett JG, Blacklow NR, Eds. *Infectious Diseases*. Philadelphia: WB Saunders, 1998:417–22.
- 11) Schroeder SA, Meyers LP, McPhee SJ, et al. The failure of physician education as a cost containment strategy. *JAMA*. 1984; 252:225–30.
- 12) D'Eramo JE, DuPont HL, Preston GA, et al. The short- and long-term effects of a handbook on antimicrobial prescribing patterns of hospital physicians. *Infect Control* 1983; 4:209–14.
- 13) Kunin CM. Evaluation of antibiotic usage: a comprehensive look at alternative approaches. *Rev Infect Dis* 1981; 3:745–53.
- 14) Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet* 1993; 342:1317–22.
- 15) Seto WH, Ching TY, Kou M, et al. Hospital antibiotic prescribing successfully modified by 'immediate concurrent feedback'. *Br J Clin Pharmacol* 1996; 41: 229–34.
- 16) Kumana CR, Ching TY, Cheung E, et al. Antiulcer drug prescribing in hospital successfully influenced by 'immediate concurrent feedback'. *Clin Pharmacol Ther* 1998; 64:569–74.
- 17) Cheng VCC, To KKW, Li IWS, et al. Antimicrobial stewardship program directed at broad-spectrum intravenous antibiotics prescription in a tertiary hospital. *Eur J Clin Microbiol Infect Dis*, 2009; 28:1447–56.

Employee Health Program

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

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.

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.

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

EDUCATION

Early familiarization with the hospital's infection control policies and procedures (especially Isolation Precautions and handwashing) 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.

IMMUNIZATION PROGRAM

A mandatory immunization program is effective in ensuring that staffs are immune to vaccine-preventable diseases (Tables 9 and 10). 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.

JOB-RELATED ILLNESSES AND POST-EXPOSURE MANAGEMENT

Prompt diagnosis and management is required to ensure an effective program (Tables 11–14). 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

IMPLEMENTATION OF A PROGRAM

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.

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.

Working relationship

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

Confidence in the Infection Control Team (ICT) 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 ICT to identify early problems or noncompliance.

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

IMPLEMENTING A PROGRAM IN A TIGHT BUDGET SITUATION

In a situation where it is impossible to implement all the possible infection control 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 10: Immunizing Agents for Healthcare Workers (HCWs): Strongly Recommended²

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 bakers 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; immunocompromised 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

Table 10 (Cont'd)

Vaccine	Primary schedule and booster(s)	Indications	Precautions and contraindications
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 of immunity	Pregnancy; immunocompromised state; history of anaphylactic reactions after receipt of neomycin

Table 10 (Cont'd)

Vaccine	Primary schedule and booster(s)	Indications	Precautions and contraindications
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
<p>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;</p> <p>MMR = measles-mumps rubella.</p> <p>Table adapted from the source</p>			

Table 11: Immunizing Agents for Healthcare Workers (HCWs): Special Circumstances²

Vaccine	Primary schedule & 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-phenoxy-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

Table 11 (Cont'd)

Vaccine	Primary schedule & booster(s)	Indications	Precautions and contraindications	Special considerations
Polio	IPV two doses SC given 4–8 weeks apart followed by 3rd dose 6–12 months after 2 nd 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; OPV = oral poliovirus vaccine; Table adapted from the source.		IPV = inactivated poliovirus vaccine; IM = intramuscularly;		SC = subcutaneously; ID = intradermally.

Table 12: Post-exposure Prophylaxis²

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	VZIG: for persons < 50 kg, 125 u/10 kg IM; persons 50 kg, 625 u	HCW known or likely to be susceptible (especially those at high risk for complications eg, pregnant women) who have close and prolonged exposure to a contact case or an infectious HCW / patient	

Table 12 (Cont'd)

Disease	Prophylaxis	Indications	Precautions and contraindications
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 ciprofloxacin 500 mg PO single dose	HCW with direct contact with respiratory secretions from infected persons without the use of proper precautions (e.g. mouth-to-mouth 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

IG = immunoglobulin; IM = intramuscularly; HCW = healthcare worker; HBIG = hepatitis B immunoglobulin; HBsAg = hepatitis B surface antigen; HBV = hepatitis B virus; MMR = measles-mumps-rubella; VZIG = varicella zoster immunoglobulin; PO = oral.
Table adapted from the source.

Table 13: 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; anti-HBs = anti-hepatitis B surface antigen antibody. Table adapted from the source.			

Table 14L Post-exposure Prophylaxis (PEP) for Healthcare Workers (HCWs) Exposed to Blood and/or Body Fluids with HIV.

PEP should be started as soon as possible, preferably within a few hours rather than days after exposure. Duration of PEP is 4 weeks. Counseling, follow-up and monitoring of HCW for seroconversion and PEP toxicity is essential³

Exposure	Source patient HIV(+)	Source patient unknown	Considerations
Mucous membrane or skin, integrity compromised	<i>Low titer:</i> source patient asymptomatic and high CD4 count may not need PEP, discuss with HCW	No treatment	Skin integrity is compromised if there is evidence of chapped skin, dermatitis, abrasion or open wound
Small (few drops or short duration)	<i>High titer:</i> source patient has advanced AIDS, primary HIV infection, high or increasing viral load or low CD4 count, consider prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd		

Table 14 (Cont'd)

Exposure	Source patient HIV(+)	Source patient unknown	Considerations
Large (several drops, major blood splash and/or longer duration, i.e. more than several minutes)	<i>Low titer:</i> source patient asymptomatic and high CD4 count, recommend prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd	If there is a possible risk for HIV exposure, consider prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd and either indinavir 800 mg every 8 hours or nelfinavir 750 mg tds	
Intact skin	<i>High titer:</i> source patient has advanced AIDS, primary HIV infection, high or increasing viral load or low CD4 count, recommend prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd and either indinavir 800 mg every 8 hours or nelfinavir 750 mg tds	No treatment	

Table 14 (Cont'd)

Exposure	Source patient HIV(+)	Source patient unknown	Considerations
Percutaneous exposure	<i>Low titer:</i> source patient asymptomatic and high CD4 count, recommend prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd	If there is a possible risk for HIV exposure, consider prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd	Combination of factors, e.g. large bore hollow needle and deep puncture contribute an increased risk for transmission if source patient is HIV(+)
Less severe, e.g. solid needle, superficial scratch	<i>High titer:</i> source patient has advanced AIDS, primary HIV infection, high or increasing viral load or low CD4 count, recommend prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd and either indinavir 800 mg every 8 hours or nelfinavir 750 mg tds		

Table 14 (Cont'd)

Exposure	Source patient HIV(+)	Source patient unknown	Considerations
More severe, e.g. large-bore hollow needle, deep puncture, visible blood on device, or needle used in source patient's artery or vein	<i>Low or high titer:</i> recommend prophylaxis with zidovudine 600 mg/day in two or three divided doses and lamivudine 150 mg bd and either indinavir 800 mg every 8 hours or nelfinavir 750 mg tds		
Table reprinted with permission from the source.			

Table 15: Work Restrictions for Healthcare Workers (HCWs) Exposed to or Infected with Infectious Diseases²

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	Restrict from patient contact, contact with patients' environment, and food handling	Until symptoms resolve
Convalescent stage, <i>Salmonella</i> spp	Restrict from care of high-risk patients	
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 immunocompromised patients and their environment	Until symptoms resolve
Hepatitis A	Restrict from patient contact, contact with patients' environment, and food handling	Until 7 days after onset of jaundice

Table 15 (Cont'd)

Disease	Work restrictions	Duration
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	No restriction	
Hands (herpetic whitlow)	Restrict from patient contact and contact with patients' environment	
Orofacial	Evaluate for need to restrict from care of high-risk patients	

Table 15 (Cont'd)

Disease	Work restrictions	Duration
HIV	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; observe standard precautions	
Measles Active	Exclude from duty	Until 7 days after the rash appears
Post-exposure (susceptible HCW)	Exclude from duty	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	Exclude from duty	Until 9 days after onset of parotitis
Post-exposure (susceptible HCW)	Exclude from duty	From 12th day after first exposure through 26th day after last exposure or until 9 days after onset of parotitis

Table 15 (Cont'd)

Disease	Work restrictions	Duration
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)	No restriction, prophylaxis recommended	Until 5 days after start of effective antimicrobial therapy
Post-exposure (symptomatic HCW)	Exclude from duty	
Rubella Active	Exclude from duty	Until 5 days after rash
Post-exposure (susceptible HCW)	Exclude from duty	From 7th day after first exposure through 21 st day after last exposure
Scabies	Restrict from patient contact	Until cleared by medical evaluation

Table 15 (Cont'd)

Disease	Work restrictions	Duration
<i>Staphylococcus aureus</i> infection Active, draining skin lesions	Restrict from patient contact, contact with patients' environment, and food handling	Until lesions have resolved
Carrier state	No restriction, unless HCW is epidemiologically linked to transmission of the organism	
Streptococcal infection, group A	Restrict from patient contact, contact with patients' environment, and food handling	Until 24 hours after adequate treatment started
Tuberculosis Active	Exclude from duty	Until proven noninfectious
PPD converter	No restriction	
Varicella Active	Exclude from duty	Until all lesions dry and crust
Postexposure (susceptible HCW)	Exclude from duty	From 10th day after first exposure through 21st day (28th day if VZIG given) after last exposure

Table 15 (Cont'd)

Disease	Work restrictions	Duration
<p>Zoster</p> <p>Localized in healthy person</p>	<p>Cover lesions, restrict from care of high-risk patients (those susceptible to varicella or at increased risk of complication of varicella, e.g. neonates and immunocompromised persons)</p> <p>Restrict from patient contact</p>	<p>Until all lesions dry and crust</p>
<p>Generalized or localized in immunosuppressed Person</p>	<p>Restrict from patient contact</p>	<p>Until all lesions dry and crust</p>
<p>Zoster</p> <p>Post-exposure (susceptible HCW)</p>	<p>Restrict from patient contact</p>	<p>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</p>
<p>Viral respiratory infections, acute febrile</p>	<p>Consider excluding from the care of high risk patients or contact with their environment during community outbreak of RSV and influenza</p>	<p>Until acute symptoms resolve</p>
<p>VZIG = varicella zoster immunoglobulin; RSV = respiratory syncytial virus. Table adapted from the source</p>		

REFERENCES

- 1) Diekema DJ, Doebbeling BN. Employee health and infection control. *Infect Control Hosp Epidemiol* 1995;16:292–301.
- 2) Bolyard EA, Tablan OC, Williams WW, et al and the Hospital Infection Control Practices Advisory Committee. Guideline for infection control in healthcare personnel, 1998. *Infect Control Hosp Epidemiol* 1998; 19:407–63.
- 3) Public Health Service guidelines for the management of health-care worker exposures to HIV and recommendations for postexposure prophylaxis. *Morb Mortal Wkly Rep, Recommendations and Reports* Vol 47 no. RR-7.

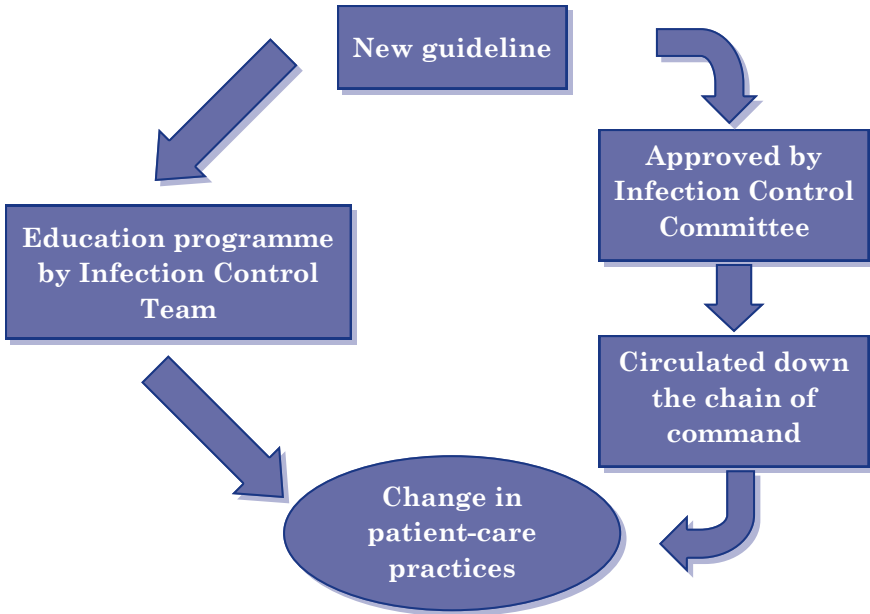
Implementing Infection Control Guidelines

Infection control 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 infection control 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 infection control 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](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](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](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](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 one.² As guidelines are now such an integral part of infection control, it is important that infection control nurses (ICNs) understand how they can be effectively implemented in the hospital.

Figure 8 Implementation of a New Guideline



USUAL IMPLEMENTATION PROCESS

The usual implementation process is depicted in Figure 8. After a guideline is finalized, the infection control team (ICT) will usually adopt a two-pronged implementation process. One of these ‘prongs’ consists of submitting the guideline to the Infection Control Committee (ICC) 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 ICT. 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.

REVIEWING GUIDELINES FOR IMPLEMENTATION

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

An infection control 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 ICT can plan accordingly. All recommendations are categorized into the following:

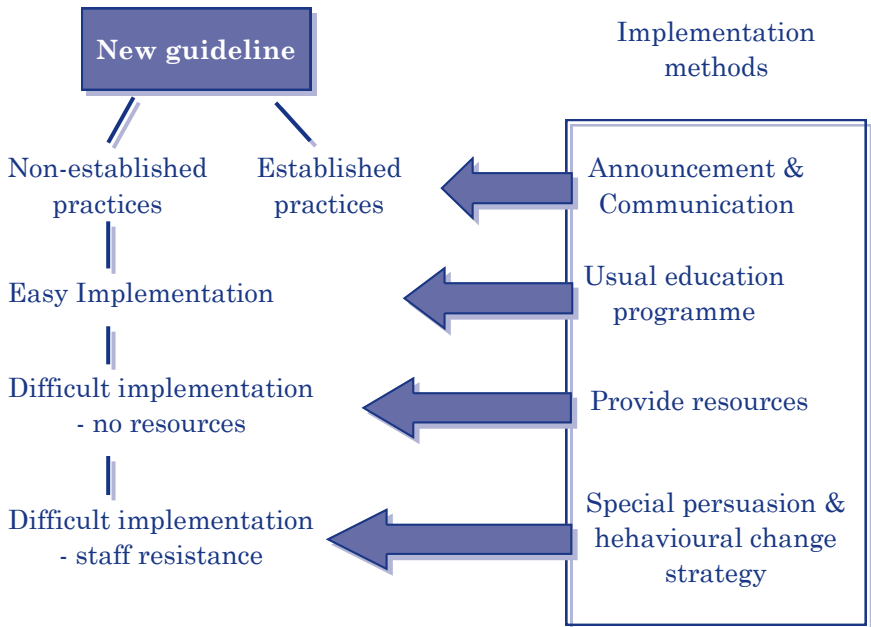
- 1) ***Established practice*** A policy for the practice is already present in the hospital or the practice is already standard. An example is the aseptic insertion of urinary catheters. Even without an official guideline for urinary catheter care, many hospitals will usually have such a practice in 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 ICN 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 9 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 ICN 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 ICN 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 9 Scheme for Effective Implementation of Infection Control



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 ICT 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 ICT 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,^{5,6} such as the use of opinion leaders⁷ and participatory decision-making have been described, and successful application in the hospital context has been reported.^{5,6} 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.

THE USE OF “BUNDLES” IN INFECTION CONTROL GUIDELINES

A new strategy in infection control 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 consulted⁸. In the implementing of any guideline, a search in the literature for bundles should be made and those with proven effectiveness should be integrated.

THE INFECTION CONTROL LINK NURSE

Research has suggested that the implementation of infection control 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 Infection Control Link Nurse (ICLN) 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 ICLN 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 ICT in implementing new policies in the hospital. The position of the ICLN 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 infection control 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. 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 Table 16 were needed in the course; as shown, high scores were given to all seven topics (Table 16). A total of 79% of the respondents also agreed that they would be willing to be an ICLN if appointed, indicating the readiness of ward staff to participate in facilitating the work of infection control.

The ICLN program is perhaps just one of many innovations to enhance the implementation of infection control 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 implementation¹¹ and should be an area of infection control that is focused for research and study in the coming years.

Table 16: Curriculum for Infection Control Link Nurses (ICLNs) and the Results of a Hong Kong Survey of the 2-Day Course

ICLN 2-Day Course Curriculum	Agreement for Course Inclusion*
1) Infection control 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.

REFERENCES

- 1) Seto WH, Ching TY, Chu YB, et al. Evaluation of staff compliance with influencing tactics in relation to infection control policy implementation. *J Hosp Infect* 1990; 15:157–66.
- 2) Seto, WH, Otaiza F, Pessoa-Silva CL, et al. Core Components for Infection Prevention and Control Programs: A World Health Organization Network Report. *Infect Control Hosp Epidemiol* 2010;31(9): 948–950.
- 3) Seto WH, Ching TY, Fung JPM, Fielding R. The role of communication in the alteration of patient care practices. *J Hosp Infect* 1989;14:29–38.
- 4) Seto WH, Ching TY, Ong SO. A scheme to review infection control guidelines for the purpose of implementation in the hospital. *Infect Control Hosp Epidemiol* 1990;11:255–7.
- 5) Ajzen I, Fishbein M. A theory of reasoned action — theoretical implications. In: Ajzen I and Fishbein M, Eds. *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs: Prentice-Hall, 1980:78–92.
- 6) Seto WH. Staff compliance with infection control practices: application of the behavioral sciences. *J Hosp Infect* 1995;30 (Suppl):107–15.
- 7) Seto WH. Training the work force — models for effective education in infection control. *J Hosp Infect* 1995;30(Suppl):241–7.
- 8) Marwick C, Davey P. Care bundles: the holy grail of infectious risk management in hospital? *Curr Opinion Infect Dis* 2009;22:364–369.
- 9) Seto WH, Ching TY, Yuen KY, et al. The enhancement of infection control inservice education by ward opinion leaders. *Am J Infect Control* 1991;19: 86–91.
- 10) Ching TY, Seto WH. Evaluating the efficacy of the infection control liaison nurse in the hospital. *J Adv Nurs* 1990;15:1128–31.
- 11) Seto WH. Infection control policies — learning from the behavioral sciences. *Asian J Infect Control* 1996;1:2–4.

Quality Improvement and Infection Control

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 (Figure) 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 (PDCA, LEAN, Six Sigma, etc) in their analysis and design for improvement

EFFECTIVE TEAMS

The concept of an Infection Control Team (ICT) was illustrated in Chapter 1, *Initiating Nationwide Infection Control Programmes in the Asian Context*.

Many of us find this a workable model to handle daily issues. The Infection Control Nurses (ICNs) meet their Infection Control Officer (ICO) regularly to discuss and resolve ground issues rapidly. Together with appointed Infection Control Liaison Officers (ICLOs), 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 infection control, especially in the practice of hand hygiene. The level of compliance will increase with more ICLOs 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 infection control 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.

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 infection control 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.

TOWARDS SAFER CARE

Patient safety is top priority and infection control is part of this (see Fig 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 policies 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:

- A) 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
- B) 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
- C) 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
- D) 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
- E) WHO Safe Surgery Checklist (see <http://www.who.int/patientsafety/safesurgery/en/>)

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 Fig 2). 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-check-act (PDCA) cycles required. Breakthrough improvement will occur as one chooses instead to use LEAN, Six Sigma or LEAN-Six Sigma methodologies.

Figure 10: Infection Control Shares Inter-relationship with Quality and Patient Safety

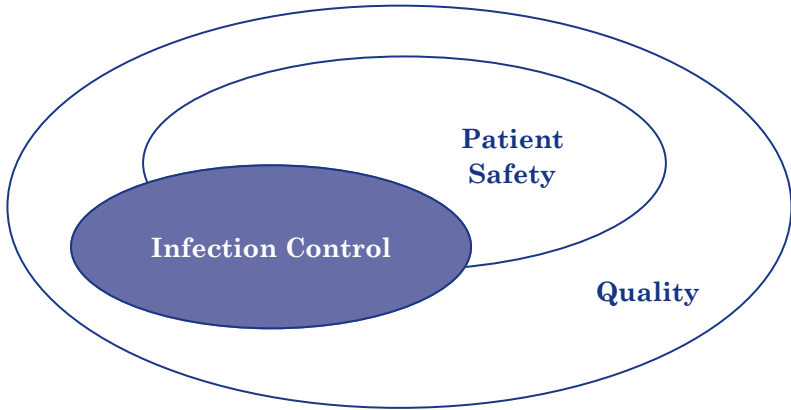


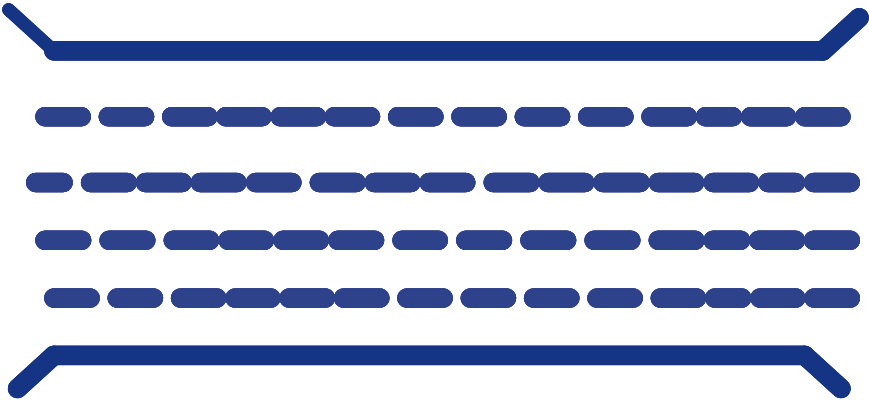
Figure 11(A): Problems in an Organization's Processes or Systems

Most organizations - systems not aligned
 Most organizations—systems not aligned



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

Figure 11(B): Focus of Continuous Quality Improvement (CQI)



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

