Infection Prevention and Control

A guide for health professionals in low-resource settings

“Thorough and informative” Prof Eugenio Panieri
“Empowers nurses and offers a practical approach” Dr Herbert Cubash

Learn together

IPC programmes, risk management and surveillance

Angela Dramowski
Infection Prevention and Control

A guide for healthcare professionals in low-resource settings

Written by Angela Dramowski

Edited by Dave Woods and Shaheen Mehtar
We have taken every care to ensure that drug dosages and related medical advice in this book are accurate. However, drug and disinfectant dosages can change and are updated often, so always double-check dosages and procedures against a reliable, up-to-date formulary and the given drug’s documentation before administering it.

_Infection Prevention and Control: A guide for healthcare professionals in low-resource settings_

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About the book

This publication is part of the Bettercare series which addresses the need for continuing education by providing self-managed learning opportunities to health professionals. This book was developed to expand access to education in Infection Prevention and Control for all categories of healthcare workers, especially those working in low-resource settings. The content of the book is broadly based on a five-day introductory course run by the Unit for Infection Prevention and Control at Stellenbosch University and Tygerberg Hospital in Cape Town, South Africa.

Funding for development of this book was generously provided by the Stellenbosch University Rural Medical Education Partnership Initiative (SURMEPI) project. SURMEPI is funded by the US President’s Emergency Plan for AIDS relief (PEPFAR) through HRSA under the term T84HA21652.

We gratefully acknowledge the input and contribution of clinical cases and multiple choice questions from Infection Prevention and Control and Infectious Diseases practitioners around the globe. Many of these colleagues have been recognised as leaders in IPC in their home countries by the Society for Healthcare Epidemiology of America’s (SHEA) International IPC Ambassador programme.

All royalties from the sale of this book will be donated to the Infection Control Africa Network (ICAN).

We hope that you will find learning from this book enjoyable and that it will be valuable in your daily healthcare practice.

Angela Dramowski, Dave Woods and Shaheen Mehtar
About the author and editors

Dr Angela Dramowski is a paediatric infectious diseases specialist with a passion for improving infection prevention and control practices and an interest in the education of healthcare professionals.

Prof Dave Woods is a retired neonatologist and the editor-in-chief of the renowned Perinatal Education Programme. He is passionate about self-empowered distance learning for all health professionals. His work is funded by Eduhealthcare.

Prof Shaheen Mehtar is a retired Infection Prevention and Control expert, who remains actively involved in the field as the chair of the Infection Control Africa Network (ICAN). She also serves as an adviser and committee member on several World Health Organisation (WHO) working groups.
Reviews

‘Despite being one of the most cost-effective health interventions available, infection prevention and control has long been neglected in resource-limited settings – the very place where it is needed most.

This pragmatic guide offers a comprehensive overview of key knowledge elements and management principles required by healthcare workers. It is packaged in a user-friendly format that facilitates in-service training and adult learning.

A book of this kind is long overdue and should appeal to a wide audience in both the developed and developing world.’

—Professor Ben J Marais, Marie Bashir Institute for Infectious Diseases and Biosecurity, University of Sydney, Australia

‘This excellent guide on infection prevention and control is clearly written in simple and understandable language and is suitable for healthcare workers at all levels. It provides an explanation of terms and practices which are then nicely demonstrated by practical case reports. Finally the reader can test their understanding and knowledge gained with multiple choice questions.

The book is comprehensive and covers every important aspect of infection prevention and control in different healthcare settings. It is an easy guide for healthcare workers dealing with IPC issues to refer to on a daily basis.

In my opinion it is not only a must-read for all undergraduate nursing and medical students, but also for all qualified nurses and doctors. Although for the latter it may be obvious things, it is often the obvious that is most often neglected and this book will reinforce the basic IPC measures that we ALL in healthcare should know and be practicing.’

—Professor Simon Schaaf, Paediatric Infectious Diseases, Stellenbosch University, South Africa

‘This book highlights a critical dimension of quality in healthcare: SAFETY. In the current South African healthcare context, challenged with resource constraints and limited related technical expertise, this book offers a much needed knowledge guide with a difference. Its comprehensive scope,
detailed, easy-to-understand narrative and practical focus reflects an insight and understanding of the status quo and operational challenges of infection prevention and control practices within our local healthcare industry. It also highlights infection prevention control as a key management function to drive quality improvement and safety for all.

If coordinated effectively, the utilization of this critical resource will have far-reaching benefits, especially in low resource healthcare settings. I am excited at the prospect of having this book available as a resource for healthcare workers in district health services.'

—Zulfa Francis, Quality Manager, Metro District Health Services, Western Cape Department of Health

‘Infection prevention and control is one of those facets of healthcare that everyone acknowledges is vital, but always seems to be ‘someone else’s job’. Infection control is everyone’s responsibility and it is incumbent on all healthcare professionals to have an understanding of basic IPC principles.

This book is a well-written, well-structured resource that could be used by both undergraduate and qualified clinicians, nurses and allied health professionals.

The chapters all contain concise learning points, backed up with case studies, and with a self-assessment tool at the end of the book. The important aspects of infection prevention and control in healthcare facilities are all covered, as well as a section on antimicrobial stewardship.

I would recommend this book to any health care professional with an interest in infection prevention and control.'

—Professor Andrew Whitelaw, Head of Department of Medical Microbiology, National Health Laboratory Service, Cape Town, South Africa

‘This excellent and invaluable guide on infection prevention and control is well written in a simple, accurate, understandable and user-friendly format suitable for all healthcare workers. I find it comprehensive, demonstrative and covering most, if not all, basic and critical aspects of infection prevention and control.

It is a practical guide that offers a comprehensive overview of key concepts, essential knowledge and management principles required by infection prevention and control professionals as well as all healthcare workers.'
It is one of the must-read texts for all medical and nursing undergraduate students, in addition to medical, nursing and support services staff in different healthcare settings.’

—Professor Ossama Rasslan, Vice-Chair, Infection Control Africa Network (ICAN), President, APIC/Egypt Chapter (Egyptian Society for Infection Control ESIC)

‘This book is a valuable and timely contribution to the global effort to strengthen infection prevention and control, as well as the management of disease outbreaks, in healthcare settings. It is bolstered both by the contributors’ first-hand experience of clinical practice in low-resource settings and their deep understanding of the subject under consideration. The application of modern adult learning principles has resulted in an innovative learning resource on evidence-based infection prevention and control that will prove to be invaluable companion for health workers working in LMIC’s.’

—Professor Jimmy Volmink, Dean, Faculty of Medicine and Health Sciences, Stellenbosch University

‘An essential guide for infection prevention and control for all health practitioners working in resource- limited areas. It is comprehensive, easy to follow, beautifully illustrated and contains very practical case studies. This guide covers not only the more conventional IPC topics but has excellent chapters on the critical areas of antibiotic stewardship and tuberculosis transmission.’

—Professor Lucille Blumberg, Deputy Director, National Institute for Communicable Diseases (NICO), Division of Public Health Surveillance and Response, Johannesburg, South Africa

‘This is a very comprehensive and clearly-written infection prevention and control manual applicable to all healthcare workers.

Practical and clearly laid out, this manual covers all aspects of infection prevention and control in a systematic way. The practical case studies at the end of each chapter assist in understanding the contents of the chapter and bring theory closer to practice. They also enable the readers to establish how much they have understood. The multiple choice questions are an ideal way to test the knowledge of the reader.'
In my opinion it is an excellent manual for self-study for all healthcare workers and an ideal tool for use in in-service training.’

—Briëtte du Toit, Infection Prevention and Control Specialist, Mediclinic Southern Africa

‘An excellent guide for healthcare professionals working in infection prevention and control.

Written in clear, simple and understandable language for healthcare workers, it provides all basic information and skills with practical examples and case reports. This book is not only helpful for students, junior nurses and doctors in the field but also for senior personnel at all levels of healthcare. A book like this should be read by those working in infection prevention and control in both the developed and developing world.’

—Professor Moustafa Abdennasser, Al-Azhar University, Egypt
Acknowledgements

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Introduction

About the Bettercare series

Bettercare publishes an innovative series of distance-learning books for healthcare professionals, developed by the Perinatal Education Trust, Eduhealthcare, the Desmond Tutu HIV Foundation, the Desmond Tutu TB Centre, the Perinatal Mental Health Project, the Academic Unit for Infection Prevention and Control at Stellenbosch University, and the Infection Control Africa Network, with contributions from numerous experts.

Our aim is to provide appropriate, affordable and up-to-date learning material for healthcare workers in under-resourced areas, so that they can learn, practise and deliver excellent patient care.

The Bettercare series is built on the experience of the Perinatal Education Programme (PEP), which has provided learning opportunities to over 60 000 nurses and doctors in South Africa since 1992. Many of the educational methods developed by PEP are now being adopted by the World Health Organisation (WHO).

Why decentralised learning?

Continuing education for health workers traditionally consists of courses and workshops run by formal trainers at large central hospitals. These courses are expensive to attend, often far away from the health workers’ families and places of work, and the content frequently fails to address the biggest healthcare challenges of poor, rural communities.

To help solve these many problems, a self-help decentralised learning method has been developed which addresses the needs of professional healthcare workers, especially those in under-resourced regions.
Books in the Bettercare series

Adult HIV

*Adult HIV* covers an introduction to HIV infection, management of HIV-infected adults at primary-care clinics, preparing patients for antiretroviral (ARV) treatment, ARV drugs, starting and maintaining patients on ARV treatment and an approach to opportunistic infections. *Adult HIV* was developed by doctors and nurses with wide experience in the care of adults with HIV, in collaboration with the Desmond Tutu HIV Foundation.

Birth Defects

*Birth Defects* was written for healthcare workers who look after individuals with birth defects, their families, and women who are at increased risk of giving birth to an infant with a birth defect. Special attention is given to modes of inheritance, medical genetic counselling, and birth defects due to chromosomal abnormalities, single gene defects, teratogens and multifactorial inheritance. This book is being used in the Genetics Education Programme, which trains healthcare workers in genetic counselling in South Africa.

Breast Care

*Breast Care* was written for nurses and doctors who manage the health needs of women from childhood to old age. It covers breast examination, the assessment and management of benign breast conditions, the diagnosis and management of breast cancer and palliative care.

Child Healthcare

*Child Healthcare* addresses all the common and important clinical problems in children, including immunisation, history and examination, growth and nutrition, acute and chronic infections, parasites, skin conditions, and difficulties in the home and society. *Child Healthcare* was developed for use in primary-care settings.
**Childhood HIV**

*Childhood HIV* enables nurses and doctors to care for children with HIV infection. It addresses an introduction to HIV in children, the clinical and immunological diagnosis of HIV infection, management of children with and without antiretroviral treatment, antiretroviral drugs, opportunistic infections and end-of-life care.

**Childhood TB**

*Childhood TB* was written to enable healthcare workers to learn about the primary care of children with tuberculosis. The book covers an introduction to TB infection, and the clinical presentation, diagnosis, management and prevention of tuberculosis in children and HIV/TB co-infection. *Childhood TB* was developed in collaboration with the Desmond Tutu TB Centre.

**Ebola Prevention and Control**

*Ebola Prevention and Control* was written for all healthcare workers and administrators managing, preventing and controlling viral haemorrhagic diseases. Chapters cover virology and epidemiology, patient management, protection of healthcare workers, support services and documentation, and communication and community engagement. There is a strong emphasis on the protection of healthcare workers in the field, particularly in resource-limited settings.

**Infection Prevention and Control**

*Infection Prevention and Control* was written for nurses, doctors and health administrators working in the field of infection prevention and control, particularly in resource-limited settings. It includes chapters on IPC programmes, risk management, health facility design, outbreak surveillance and antimicrobial stewardship.

**Intrapartum Care**

*Intrapartum Care* was developed for doctors and advanced midwives who care for women who deliver in level 2 hospitals. It contains theory and skills chapters adapted from the labour chapters of *Maternal Care*. Particular attention is given to the care of the mother, the management of labour and
monitoring the wellbeing of the fetus. *Intrapartum Care* was written to support and complement the national protocol of intrapartum care and the essential steps to manage obstetric emergencies (ESMOE) in South Africa.

**Maternal Care**

*Maternal Care* addresses all the common and important problems that occur during pregnancy, labour, delivery and the puerperium. It covers the antenatal and postnatal care of healthy women with normal pregnancies, monitoring and managing the progress of labour, specific medical problems during pregnancy, labour and the puerperium, family planning, and regionalised perinatal care. Skills chapters teach clinical examination in pregnancy and labour, routine screening tests, the use of an antenatal card and partogram, measuring blood pressure, detecting proteinuria, and performing and repairing an episiotomy. *Maternal Care* is aimed at health workers in level 1 hospitals or clinics.

**Maternal Mental Health**

*Maternal Mental Health* was written for doctors, nurses and social workers caring for women before and after birth. It includes an introduction to maternal mental health and illness, making referrals for maternal mental illness, helping mothers with mental health problems and special issues in maternal mental health. It includes a resource section for assessing, referring and supporting mothers in the perinatal period.

**Mother and Baby Friendly Care**

*Mother and Baby Friendly Care* describes gentler, kinder, evidence-based ways of caring for women during pregnancy, labour and delivery. It also presents improved methods of providing infant care with an emphasis on kangaroo mother care and exclusive breastfeeding.

**Newborn Care**

*Newborn Care* was written for health workers providing special care for newborn infants in level 2 hospitals. It covers resuscitation at birth, assessing infant size and gestational age, routine care and feeding of both normal and high-risk infants, the prevention, diagnosis and management of
hypothermia, hypoglycaemia, jaundice, respiratory distress, infection, trauma, bleeding and congenital abnormalities, as well as communication with parents. Skills chapters address resuscitation, size measurement, history, examination and clinical notes, nasogastric feeds, intravenous infusions, use of incubators, measuring blood glucose concentration, insertion of an umbilical vein catheter, phototherapy, apnoea monitors, and oxygen therapy.

Perinatal HIV

Perinatal HIV enables midwives, nurses and doctors to care for pregnant women and their infants in communities where HIV infection is common. Special emphasis has been placed on the prevention of mother-to-infant transmission of HIV. It covers the basics of HIV infection and screening, antenatal and intrapartum care of women with HIV infection, care of HIV-exposed newborn infants, and parent counselling.

Primary Maternal Care

Primary Maternal Care addresses the needs of health workers who provide antenatal and postnatal care, but do not conduct deliveries. It is adapted from theory and skills chapters from Maternal Care. This book is ideal for midwives and doctors providing primary maternal care in level 1 district hospitals and clinics, and complements the national protocol of antenatal care in South Africa.

Primary Newborn Care

Primary Newborn Care was written specifically for nurses and doctors who provide primary care for newborn infants in level 1 clinics and hospitals. Primary Newborn Care addresses the care of infants at birth, care of normal infants, care of low-birth-weight infants, neonatal emergencies, and common minor problems in newborn infants.

Saving Mothers and Babies

Saving Mothers and Babies was developed in response to the high maternal and perinatal mortality rates found in most developing countries. Learning material used in this book is based on the results of the annual confidential
enquiries into maternal deaths and the Saving Mothers and Saving Babies reports published in South Africa. It addresses the basic principles of mortality audit, maternal mortality, perinatal mortality, managing mortality meetings, and ways of reducing maternal and perinatal mortality rates. This book should be used together with the Perinatal Problem Identification Programme (PPIP).

**Well Women**

*Well Women* was written for primary health workers who manage the everyday health needs of women. It covers reproductive health, family planning and infertility, common genital infections, vaginal bleeding, and the abuse of women.

**Format of the courses**

**Objectives**

The learning objectives are clearly stated at the start of each chapter. They help the participant to identify and understand the important lessons to be learned.

**Pre- and post-tests**

There is a multiple-choice test of 20 questions for each chapter at the end of the book. Participants are encouraged to take a pre-test before starting each chapter to benchmark their current knowledge, and a post-test after each chapter to assess what they have learned. Self-assessment allows participants to monitor their own progress through the course.

**Question-and-answer format**

Theoretical knowledge is presented in a question-and-answer format, which encourages the learner to actively participate in the learning process. In this way, the participant is led step by step through the definitions, causes, diagnosis, prevention, dangers and management of a particular problem.
Participants should cover the answer for a few minutes with a piece of paper while thinking about the correct reply to each question. This method helps learning.

Simplified flow diagrams are also used, where necessary, to indicate the correct approach to diagnosing or managing a particular problem.

Each question is identified with the number of the chapter, followed by the number of the question, for example 5-23.

**Important practical lessons are emphasised like this.**

**NOTE**

Additional, non-essential information is provided for interest and given in notes like this. These facts are not used in the case studies or included in the multiple-choice questions.

**Case studies**

Each chapter closes with a few case studies which encourage the participant to consolidate and apply what was learned earlier in the chapter. These studies give the participant an opportunity to see the problem as it usually presents itself in the clinic or hospital. The participant should attempt to answer each question in the case study before reading the correct answer. Case studies without the correct answers are also used at the start of some chapters to identify common clinical problems that need to be addressed.

**Practical skills**

Some Bettercare books include chapters on practical skills that need to be practised, preferably in groups. These skills chapters list essential equipment and present step-by-step instructions on how to perform each task, often with pictures. If participants are not familiar with a practical skill, they should ask an appropriate medical or nursing colleague to demonstrate the clinical skill to them. In this way, senior personnel are encouraged to share their skills with their colleagues.
Final examination

On completion of each course, participants can take a 75-question, self-managed multiple-choice examination.

All the exam questions will be taken from the multiple-choice tests from the book. The content of the skills chapters will not be included in the examination.

Participants need to achieve at least 80% in the examination in order to successfully complete the course. Successful candidates will be sent a certificate which states that they have successfully completed that course. South African doctors can earn CPD points on the successful completion of the CPD test at the end of each chapter.

Contributors

The developers of our learning materials are a multi-disciplinary team of nurses, midwives, obstetricians, neonatologists, and general paediatricians. The development and review of all course material is overseen by the Editor-in-Chief, emeritus Professor Dave Woods, a previous head of neonatal medicine at the University of Cape Town who now consults to UNICEF and the WHO.

Perinatal Education Trust

Books developed for the Perinatal Education Programme are provided as cheaply as possible. Writing and updating the programme is both funded and managed on a non-profit basis by the Perinatal Education Trust.

Eduhealthcare

Eduhealthcare is a non-profit organisation based in South Africa. It aims to improve health and wellbeing, especially in poor communities, through affordable education for healthcare workers. To this end it provides financial support for the development and publishing of the Bettercare series.
The Desmond Tutu HIV Foundation
The Desmond Tutu HIV Foundation at the University of Cape Town, South Africa, is a centre of excellence in HIV medicine, building capacity through training and enhancing knowledge through research.

The Desmond Tutu TB Centre
The Desmond Tutu TB Centre at Stellenbosch University, South Africa, strives to improve the health of vulnerable groups through the education of healthcare workers and community members, and by influencing policy based on research into the epidemiology of childhood tuberculosis, multidrug-resistant tuberculosis, HIV/TB co-infection and preventing the spread of TB and HIV in southern Africa.

The Perinatal Mental Health Project
The Perinatal Mental Health Project of the Centre for Public Mental Health in the Department of Psychiatry and Mental Health at the University of Cape Town, South Africa, aims to improve the mental health of women during pregnancy and in the months afterwards. The project targets women in low-resource settings who are at risk of depression and anxiety.

The Infection Control Africa Network
The Infection Control Africa Network (ICAN) promotes and facilitates the establishment of infection control programmes. This includes promotion of surveillance for and reduction of healthcare-associated infections, and antimicrobial stewardship activities through education. ICAN works with infection prevention structures in Africa and other international health-related associations.

Updating the course material
Bettercare learning materials are regularly updated to keep up with developments and changes in healthcare protocols. Course participants can make important contributions to the continual improvement of Bettercare books by reporting factual or language errors, by identifying sections
are difficult to understand, and by suggesting additions or improvements to the contents. Details of alternative or better forms of management would be particularly appreciated. Please send any comments or suggestions to the Editor-in-Chief, Professor Dave Woods.

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Role and structure of infection prevention and control programmes

Objectives

When you have completed this chapter you should:

- Understand the role and structure of infection prevention and control (IPC) programmes
- Be able to describe key indicators of IPC programmes
- Know the basics of IPC audits
- Know how to draft IPC policies and reports
- Understand the relationship between IPC and occupational health and safety programmes.

Introduction to infection prevention and control programmes

1-1 What is infection prevention and control?

Infection prevention and control (IPC) is a discipline that aims to prevent or control the spread of infections in healthcare facilities and the community. IPC is a universal discipline with relevance to all aspects of healthcare.

It is part of every healthcare workers’ duty of care to ensure that no harm is done to patients, visitors or staff. All healthcare workers require at least a basic understanding of IPC principles and practice.
Infection prevention and control is a discipline that aims to prevent or control the spread of infections in healthcare facilities and the community.

1-2 What is an infection prevention and control programme?
IPC programmes include activities, procedures and policies designed to reduce the spread of infections, usually within healthcare facilities. The primary goals of an IPC programme are:

- To prevent susceptible patients acquiring pathogenic (disease-causing) micro-organisms
- To limit the spread of antimicrobial resistant infections.

1-3 What is included in infection prevention and control programmes?
There are several components that are common to IPC programmes worldwide including:

- Skilled IPC practitioners (usually nurses, occasionally doctors) who co-ordinate the IPC programme activities and develop, revise, audit and implement policies
- Accountability for IPC and integration of IPC as an essential part of healthcare with direct links to clinical services and non-clinical services (e.g. healthcare facility management and support services).
- A mandate to implement best-practice standards and guidelines
- A strong education component, involving all categories of healthcare workers
- Surveillance for healthcare-associated infections and outbreaks.

Although the basic principles of IPC apply globally, each country and individual healthcare facility will need to adapt and add to the core elements based on their specific circumstances, e.g. differences in patient population, infectious disease profiles, and type of healthcare services delivered.
1-4 Why are infection prevention and control programmes needed?

Healthcare facilities are places where sick people congregate, creating many opportunities for micro-organisms to spread between patients, visitors and healthcare workers. Medical care is also becoming increasingly complex, with multiple, invasive procedures increasing the risk of developing healthcare-associated infections (HAI). Many of these infections (up to 70%) are preventable. Research has proven that IPC programmes can make healthcare safer and more affordable by preventing the suffering, loss of life and cost caused by healthcare-associated infection.

**IPC programmes can make healthcare safer and more affordable by preventing the suffering, loss of life and cost caused by healthcare-associated infection.**

1-5 Why are infection prevention and control programmes especially important in low-resource settings?

Many low-resource settings have a high burden of infectious diseases, including HIV and tuberculosis. IPC has a critical role to play in these settings to enhance patient safety and to avoid the use of scarce resources for the treatment of healthcare-associated infection.

1-6 What are the main activities of an infection prevention and control practitioner?

The main activities performed by the IPC practitioner include:

- Organising surveillance for healthcare-associated infections
- Providing advice and leadership in outbreak investigation
- Developing and delivering training on IPC to healthcare workers
- Developing and implementing IPC-related policies and procedures
- Auditing the quality and effectiveness of healthcare facility environmental cleaning
• Auditing the quality and effectiveness of disinfection and sterilisation practices
• Implementing local, national or international best-practice guidelines for prevention of infection transmission in clinical care.

In many countries, the IPC practitioner has other duties such as seeing to occupational health or quality management. The term ‘quality management’ refers to all activities related to quality planning, assurance, quality control and improvement. In some cases, this may hamper their ability to perform all the required IPC activities. Since the aim is to prevent harm to patients and staff, IPC programmes often form part of a healthcare facility’s quality management programme.

1-7 What are the key indicators for infection prevention and control programmes?

There are three key indicators that can be used to report on the impact of an IPC programme.

1. Compliance indicators: these rate how well local or national Department of Health guidelines are being followed, e.g. the percentage of handwash basins in a facility with soap, water and towels available.

2. Process indicators: these rate how well individuals follow facility-based guidelines, but may also include how many individuals were trained on local IPC policy implementation, e.g. the percentage of hand hygiene compliance; the number attending training on tuberculosis (TB) infection control.

3. Outcome indicators: these measure the outcome that IPC programmes are trying to prevent, healthcare-associated infection, e.g. the facility’s infection rate from surgical site infections, urinary tract infections in catheterised patients and rates of antibiotic-resistant infections.

The key indicators of IPC programmes address compliance, process and outcome.
1-8 What is the structure of infection prevention and control programmes at different levels?

The structure of IPC programmes varies from country to country. Many programmes have a central co-ordinating body situated within the national Department of Health or within the provincial (regional) healthcare administration. Each facility (both primary care clinics and hospitals) are then required to implement and adhere to the prescribed national or provincial IPC guidelines and policies. At individual facility level, the IPC programme should involve the facility management, the IPC committee and the IPC practitioner.

1-9 Who should take responsibility for the infection prevention and control programme?

Every healthcare worker (under the Duty of Care law) has responsibility for preventing harm to themselves, fellow staff, visitors and patients. However, the final authority and responsibility for IPC lies with the facility management. They may delegate this role to the IPC team, but must ensure that the right support structures are in place to ensure a functional and effective IPC programme.

Every healthcare worker has responsibility for preventing harm to themselves, fellow staff, visitors and patients.
1-10 What is an infection prevention and control team?

Ideally, an IPC team is made up of an IPC doctor and one or more IPC nurse practitioners, however, in some countries the IPC nurse practitioners function on their own. Preferably, an IPC doctor should be trained in infectious diseases, medical microbiology, public health or related specialities. The IPC nurse practitioner should be formally trained in IPC. The duties of the IPC team generally include:

- Performing and reporting on surveillance for healthcare-associated infection
- Investigating and advising on outbreak management
- Providing a clinical advisory service for infection prevention-related issues
- Revising and formulating policies
- Providing regular in-service training in IPC for all healthcare workers
- Auditing quality of care, high-risk procedures, and occupational injuries
- Reporting to and advocating for improved standards of care with facility management
- Liaising with all role players, e.g. laboratory, engineering, nursing, clinicians, sterile services, pharmacy, cleaning services, and the procurement division.

1-11 How many infection prevention and control nurse practitioners are needed?

Many countries provide guidance on how many IPC nurse practitioners (IPCNP) are required in order to deliver an effective IPC programme. This is reported as the beds per IPC nurse practitioner ratio. In well-resourced settings this is often one IPC nurse practitioner per 100 hospital beds, but in low-resource settings may be as low as one IPC nurse practitioner per 250 hospital beds. Owing to a lack of skilled staff, many countries may have only one IPC nurse practitioner per facility or per district. In low-resource settings, nursing staff in clinical units can be trained to fulfil some IPC practitioner functions (known as IPC link nurses).
In low-resource settings, the ratio of IPC nurse practitioners may be as low as one practitioner per 250 hospital beds or per facility.

1-12 What is an infection prevention and control committee?

An IPC committee is a multi-disciplinary group of healthcare facility staff who advise and assist with:

- Management of the IPC programme
- Policy development
- Procurement issues
- Patient safety
- Risk identification
- IPC training and education
- Antimicrobial and disinfectant use
- Surveillance of healthcare-associated infections.

The IPC committee usually consists of representatives from:

- Facility management
- Nursing management
- Clinicians
- The IPC practitioner or team
- Quality management
- Occupational health
- Pharmacy
- Cleaning services
- Sterile services
- Engineering department.

IPC committee meetings are usually held monthly or quarterly, with circulation of reports and meeting minutes to management and all other stakeholders in the facility.

1-13 What legislation supports infection prevention and control programmes?

Each country has its own legislation (laws) governing IPC. In South Africa these include: the Occupational Health and Safety Act; the National Health
Act including the National Core Standards for Healthcare Establishments and the Healthcare Waste Act. There are several international documents that provide recommendations for IPC programmes, including those available from the World Health Organization (WHO) and Centers for Disease Control (CDC), amongst others (see addendum).

Education of healthcare workers

1-14 Why should healthcare workers be educated about infection prevention and control?

In many countries, there is insufficient emphasis on IPC in the undergraduate training of medical, nursing and allied health professionals. In addition, the clinical training facilities and senior staff often provide poor examples of IPC best practice to students. New guidelines, equipment, procedures and even new diseases result in a need for regular updates to the healthcare workers’ IPC knowledge. Education is also important to address workers’ concerns, fears, stigmas and incorrect assumptions regarding transmission or prevention of healthcare-associated infections.

1-15 Which categories of healthcare workers should be trained in infection prevention and control?

All healthcare workers require at least a basic understanding of IPC principles. Since different categories of workers may have different information needs, it is recommended that IPC training sessions be tailored to the specific target audience, e.g. medical staff versus cleaning services staff. Critical information to include is training on standard and transmission-based precautions (see chapter 3).

All healthcare workers require at least a basic understanding of IPC principles.
1-16 When and how often should healthcare workers be trained in infection prevention and control?

Ideally all new employees should receive induction (pre-employment) training in IPC. Annual refresher courses or short in-service training updates are recommended for all categories of healthcare staff.

1-17 Which education methods can be used to train staff in infection prevention and control?

The simplest and often most well-accepted format for training is face-to-face, small group teaching. This is, however, the most time-consuming teaching method, and may limit the number of staff that the IPC practitioner can educate. Incorporating short sessions into the weekly clinical schedule and utilising other staff for IPC education may be effective, e.g. using the sister-in-charge of a ward to give a demonstration on hand hygiene techniques at the morning ward handover rounds. Alternative methods include formal IPC courses, distance learning (including small-group, self-study and collaborative learning, video demonstrations and e-learning (online short courses).

1-18 Who should provide training of healthcare workers in infection prevention and control?

The responsibility of providing training in IPC usually falls to the IPC practitioner or IPC team. However, involvement of other senior healthcare workers is important as staff members are more likely to follow the advice of respected clinical leaders and colleagues. There may also be additional nursing staff appointed for clinical training at some facilities (called clinical co-ordinators). These clinical co-ordinators, as well as IPC link nurses, may be able to provide some IPC training to their colleagues.
Audits in infection prevention and control

1-19 What is an infection prevention and control audit?

An audit is an assessment of practice based on pre-determined criteria. Audits are used as a quality management tool to improve patient safety and standards of care. In IPC, audits are used to monitor and evaluate how well a facility or clinical area is complying with specified standards of good IPC practice. Before an audit can be started, each facility must decide which standards or policies their performance will be measured against. South Africa has introduced the National Core Standards for Healthcare Establishments document to be used as a reference for IPC and other quality of care audits.

Audits monitor and evaluate how well a facility or clinical area is complying with specified standards of good IPC practice.

1-20 What is the purpose of infection prevention and control audits?

The purpose of performing an audit is to check how real-life observed practice in a facility or clinical area compares with accepted best-practice or standards of care. After the audit is completed, feedback with suggestions of how to improve practice is given to all stakeholders. This important step must not be forgotten. After the suggested changes or improvements have been implemented, the facility or clinical area should be re-audited. This process is similar to a quality improvement cycle.

1-21 Who should conduct infection prevention and control audits?

The people performing the audit should preferably be very experienced in the practices that they will be auditing. IPC practitioners are well-placed to perform such audits, but need to be impartial when evaluating practice in their own facility. For national audits, it is better to get auditors who do not work at the facility being assessed, as they are more likely to notice problems with practice than an IPC practitioner who works in the facility.
All audits should have the approval and support of facility management. Staff at the facility or clinical area being assessed should be informed prior to performing the audit, but the auditor should attempt not to interrupt clinical work or influence clinical practice during the assessment.

1-22 What is needed to conduct an audit on infection prevention and control practice?

Several elements must be considered before starting with an audit:

- The reference standard against which the audit will be conducted must be accepted.
- Permission to conduct the audit must be obtained.
- An experienced auditor or audit team must be identified.
- The stakeholders to whom the report will be presented must be identified.
- An audit tool or questionnaire must be designed and approved.
- The scoring system for audit results must be decided on.
- Management should agree to a reasonable period of time for the audit recommendations to be implemented before requesting a re-audit of the facility or clinical area concerned.

1-23 How and to whom should the audit findings be reported?

The audit outcome should be presented to stakeholders both in written and oral format. The written document should provide clear and understandable feedback with itemised and prioritised recommendations for improvements. It is best to give suggested timelines and assign individuals responsible for the implementation of the audit recommendations, as this keeps the facility or clinical area managers accountable. The various practices audited can be divided into categories for ease of reading. Compliance should be evaluated as shown below. The final outcome of the audit may be reported as a percentage score or a symbol.
Table 1-1: An infection prevention and control audit tool

<table>
<thead>
<tr>
<th>Practice category</th>
<th>Non-compliant (0)</th>
<th>Partially compliant (1)</th>
<th>Fully compliant (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental cleaning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. There is a written policy for general cleaning of the ward</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Cleaning equipment is appropriately stored on the ward</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. All cleaning staff are trained in IPC</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Hand hygiene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Running water is available at all hand-wash basins</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Soap is available at all handwash basins</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Paper towels are available at all hand-wash basins</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tally the scores</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Sub-total score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual score of 6 out of possible score of 12 = 50%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1-24 What infection prevention and control audit tools are available?

There are many well-designed tools available online for a variety of IPC audits, from comprehensive IPC programme audits, to hand hygiene, environmental cleaning, antibiotic usage and sterilisation and disinfection audits.
Policy development in infection prevention and control

1-25 What is a policy?

A policy is a document that records ‘a plan or a course of action intended to influence and determine decisions and action’. The purpose of a policy is to provide standard guidance on a particular topic, e.g. the National Department of Health policy on Tuberculosis-Infection Prevention and Control (TB-IPC); the facility policy on needlestick injury (NSI) management, the facility policy on isolation room usage.

1-26 When is a policy needed?

Circumstances and practices in healthcare settings change often. There are several reasons for drafting or revising a policy including:

- If no policy exists
- If a policy is outdated
- If there is a change in clinical practice, facilities, equipment or a new disease
- If legislation has changed or new laws have been introduced
- If there is a need to establish practice standards.

1-27 How are policies helpful in improving infection prevention and control?

From an IPC perspective, policies are useful for:

- Assisting healthcare workers to understand practices (as an educational tool)
• Supplying an agreed method of dealing with mishaps, e.g. needlestick injury or blood spills
• Ensuring healthcare workers are held accountable for their actions (since policies explain the minimum standard of care expected).

1-28 Who should be involved in drafting IPC policies?

Policies are usually drawn up by the IPC team, on behalf of a facility’s IPC committee or facility management. It is essential that all role players are consulted when the policy is being drafted. This ensures that staff have a sense of ownership of the policy and increases the chance that they will actually follow the policy recommendations.

1-29 What is involved in the process of drafting IPC policies?

Drafting or revising a policy should follow a specified process to ensure that the policy will be both evidence-based and acceptable to the facility staff. The steps involved in policy development include:

• Decide who will be involved (the policy working group).
• Critically review any existing policy documents.
• Remove any elements that are no longer applicable or are not based on evidence.
• Add new elements as needed, e.g. if new evidence has emerged or a test method has changed.
• Share the draft policy widely and give stakeholders a deadline to respond.
• Modify the draft based on the suggestions and re-circulate for final changes.
• Present the policy to the IPC committee or facility management for approval.

1-30 Which components should be included in a policy?

Every policy requires certain components including:

• A title (stating the content and intention of the policy)
• A rationale (the reasons why the policy was written)
• A scope (the target audience or geographical area covered)
• The principles (refers to the laws/legislation, research evidence and infection control principles that the policy incorporates)
• A body (the actual recommendations or steps to be implemented)
• Dates (date of policy adoption and date that renewal is required – usually every two years)
• Contact information (include the names of the people who were involved in drafting the policy).

1-31 How should new IPC policies be communicated and implemented?

The process of communicating a new policy is much simpler if all stakeholders were consulted during the policy drafting process. Before launching the policy:

• Make sure the policy is written in simple, understandable language
• Ensure that all the resources are available to implement the policy
• Pilot or test the draft policy before wide implementation.

Once the policy is finalised and approved, send out the final policy to all role players with a stated date for policy implementation. Call a meeting to go through the policy with all relevant role players.

Arrange for staff to be trained on the policy. Monitor the outcome of the new policy, providing opportunities for staff to report difficulties or request support for the implementation process. Make sure the policy is included in the infection control manual and that the document is easily accessible to staff.

1-32 What is a standard operating procedure (SOP)?

A standard operating procedure (SOP) is a written explanation of how to perform a practical task, e.g. how to clean a laryngoscope after use. SOPs are written using verbs or action words to describe the process, e.g. put on gloves and an apron, disassemble the laryngoscope, unscrew the light bulb, scrub the blade with soap and water. The instructions and steps should be very specific so that there is no uncertainty or confusion. The draft SOP should be produced after wide consultation with stakeholders. Once finalised and approved, the SOP should be prominently displayed in the
appropriate place, e.g. hand hygiene posters at wash basins; urine testing SOP in sluice rooms.

A standard operating procedure (SOP) is a written explanation of how to perform a practical task.

1-33 When is a standard operating procedure needed?

Most SOPs are written for high-risk tasks where the potential negative consequences for an incorrect practice are serious. SOPs can also be used to simplify complicated processes by breaking a task down into steps. SOPs are also useful for induction training of new staff members.

1-34 What is a guideline?

Guidelines are usually written to provide standard recommendations for:

- the treatment of a clinical condition, e.g. guidelines for the treatment of syphilis
- management of a particular circumstance, e.g. guideline for the management of needlestick injuries.

The format resembles that of a policy or SOP.

Report writing in infection prevention and control

1-35 What is an infection prevention and control report?

Reports in IPC are used to document findings and facts about a particular situation (e.g. outbreaks), services (e.g. the IPC programme) or practices (e.g. hand hygiene compliance). The purpose of an IPC report is to share factual information and to provide recommendations for improvement.

The purpose of an IPC report is to share factual information and to provide recommendations for improvement.
1-36 What should be included in the report?

An IPC report may be simply written but should provide sufficient detail (both written and in graphs/figures) to allow the reader to understand the content. The following components are included in most reports:

- Summary (a concise version of the report)
- Background (why the investigation or audit was undertaken)
- Aims (what should be accomplished)
- Methods (the steps used in the investigation or the audit checklist/tool used to measure compliance)
- Findings (what was observed or discovered, reported as numbers and percentages, or statistics)
- Discussion (includes the recommendations for changes required to improve IPC practice or avoid further outbreaks)
- Date of the report and the names of parties involved in drafting the report.

Occupational health and safety programmes

1-37 What is an occupational health and safety (OHS) programme?

OHS programmes aim to promote and protect the health and safety of all healthcare workers. In general the OHS programme should perform:

- Pre-employment screening
- Workplace safety and risk assessments
- Surveillance and medical evaluations for occupational injuries and diseases
- Immunisation for occupationally acquired diseases.

1-38 What is the link between infection prevention and control (IPC) and occupational health and safety (OHS) programmes?

The IPC and OHS services at a facility should have a close working relationship, ensuring the safety of patients, visitors (IPC) and staff (OHS...
Report: Investigation of an outbreak of Klebsiella pneumoniae sepsis on the Neonatal Unit

Summary
In January 2014, eight neonates were diagnosed with *Klebsiella pneumoniae* bloodstream infection. Molecular testing showed that the infections were related. Investigation of the outbreak revealed the source to be inadequately decontaminated ventilator tubing. Hospital management agreed to stop the practice of recycling used ventilator tubing. No further cases of Klebsiella pneumoniae sepsis have been reported to date.

Background
*Klebsiella pneumoniae* is a common neonatal pathogen which can cause bloodstream infections, pneumonia and meningitis. Outbreaks of *Klebsiella pneumoniae* sepsis in neonatal units are not infrequent. Poor hand hygiene, contaminated medication or equipment and inadequate environmental cleaning may be responsible for outbreaks with this pathogen.

Aims
To identify the cause of the outbreak.

Methods
Following identification of eight neonates with *Klebsiella pneumoniae* sepsis in the neonatal unit over four weeks an outbreak investigation was undertaken. The following methods were used:

- A line list and Gannt chart were drawn up
- Audits of hand hygiene compliance and environmental cleaning were conducted in the neonatal unit
- Microbiological cultures (swabs) from equipment, surfaces and ventilator tubing were taken
- Molecular analysis techniques (PCR sequencing) were used to determine if the bacterial isolates were related.
Findings
The line list revealed that ventilation was a common risk factor for all eight affected neonates.
Overall levels of hand hygiene were low (average 30%, 125 observations).
Environmental cleaning levels were acceptable (audit score 24/30 = 80% compliance).
Strain typing of the eight neonates and the six isolates from the ventilator tubing revealed a closely related strain, implying that the inadequately decontaminated tubing was the source of this outbreak. On inspecting the washer disinfector used to clean the ventilator tubing in the sterile services department, it was found to be outdated with a faulty temperature gauge.

Recommendations
1. The practice of recycling single-use items should be stopped with immediate effect.
2. The outdated washer disinfector in the sterile services department should be replaced.
3. Sterile services department staff should be re-trained on validation of decontamination.
4. Hand hygiene compliance in the neonatal unit should be reinforced.

Date of report: 21 February 2014

Investigation Team: Sr N Khumalo (IPC practitioner), Dr M Smith (Microbiology), Dr G Sithole (Neonatal Unit)

and IPC). In some low-resource settings, the responsibility for IPC and OHS are combined in a single IPC/OHS practitioner post. IPC and OHS work together to monitor for and prevent transmission of hazardous biological agents, e.g. tuberculosis (TB), blood-borne diseases (HIV, hepatitis B and C), among others.

Infection prevention and control and occupational health and safety services work together to ensure the safety of patients, visitors and staff.
1-39 Which diseases and activities of the occupational health and safety programme have relevance to infection prevention and control?

Particular programmes where IPC and OHS services should combine their efforts are:

- Needlestick injury monitoring and prevention programmes
- Tuberculosis occupational disease monitoring and prevention programmes
- Immunisation of healthcare workers, e.g. hepatitis B and influenza
- Policy and guideline development with relevance to IPC and OHS
- Education and training of healthcare workers about occupationally acquired diseases and injuries.

1-40 How should needle-stick injuries be handled?

Every healthcare facility should have a needlestick injury (NSI) policy that is familiar and accessible to all staff and is regularly updated (at least every two years). Training on the NSI policy should be mandatory for all healthcare workers at pre-employment training or staff induction. The general procedures and principles that should be addressed in a NSI policy include:

- Perform first aid (remove the sharp, wash the affected area with soap and running warm water, do not suck the wound).
- For eye or mouth splashes, rinse out with lots of water (use eye washout kits if available).
- Report the injury to a supervisor and to the occupational health service immediately.
- Establish (where possible) the HIV, hepatitis B and C status of the source case.
- Establish the injured healthcare worker’s immunity to hepatitis B.
- Establish the injured healthcare worker’s HIV status and if HIV-positive, establish whether their CD4 and HIV viral loads have been checked within the last six months.
- Provide post-exposure prophylaxis for HIV as soon as possible (preferably within 1–2 hours of the injury) and if necessary for hepatitis B.
• Provide pre- and post-test counselling for the source patient and injured healthcare worker.
• Provide regular follow-up, support and testing for HIV and hepatitis sero-conversion to healthcare workers exposed to blood-borne viruses.

Every healthcare facility needs a needlestick injury policy that is familiar and accessible to all staff.

1-41 How can needlestick injuries be prevented?
• Healthcare workers should be educated never to recap used needles.
• Used needles should be immediately discarded in a puncture-proof sharps box.
• Sharps boxes should be located within arm’s reach of a procedure.
• Sharps boxes must be replaced when more than two-thirds full.

Case study 1

A new 1000-bed hospital is being built in a community with a high burden of tuberculosis (TB) and HIV. The hospital manager is busy recruiting staff to run the infection prevention and control programme.

1. What should the main goals of the IPC programme be?

The primary goals of the new hospital’s IPC programme should be:
• To prevent susceptible patients acquiring pathogenic (disease-causing) micro-organisms
• To contain the spread of antimicrobial resistant infections.

2. How many IPC practitioners will the new hospital need?

Since this will be a large 1000-bed hospital with a heavy burden of infectious diseases, the hospital manager should allocate sufficient human resources to IPC. Ideally he should appoint an IPC team, including an IPC doctor and at least four IPC nurse practitioners (that is one for every 250 beds).
3. What activities should the hospital manager add to the job description of the IPC practitioners?

The daily duties of the IPC practitioners would include:

- Organising surveillance for healthcare-associated infections
- Providing advice and leadership in outbreak investigation
- Developing and delivering training on IPC to healthcare workers
- Developing and implementing IPC-related policies and procedures
- Auditing the quality and effectiveness of healthcare facility environmental cleaning
- Auditing the quality and effectiveness of disinfection and sterilisation practices
- Implementing local, national or international best-practice guidelines for prevention of infection transmission in clinical care.

4. What other structure should the hospital manager create to assist the IPC team?

The manager should ensure that an IPC committee is formed as soon as possible after the hospital opens. An IPC committee is a multi-disciplinary group of healthcare facility staff who volunteer or are elected to advise and assist with management of the IPC programme. The manager should ensure that IPC committee meetings are held regularly with circulation of reports and meeting minutes to management and all other stakeholders in the facility.

Case study 2

A newly appointed IPC practitioner notices that staff at her clinic have limited understanding of and poor implementation of airborne isolation precautions for prevention of tuberculosis transmission. On questioning different categories of staff, she realises that they have had very little IPC education during their training and none at all since they started working at the clinic.
1. Why do these healthcare workers need training in IPC?

In many countries, there is insufficient undergraduate training in IPC for medical, nursing and allied health professionals. In addition, once they enter the workplace, healthcare workers often follow the poor or incorrect practices of senior colleagues. Over time new guidelines, equipment, procedures and even new diseases may arise, resulting in a need for regular in-service IPC training for healthcare workers.

2. Who should the IPC practitioner train?

All healthcare workers require at least a basic understanding of IPC, including TB-IPC principles. Since different categories of workers may have different information needs, it is recommended that IPC training sessions be tailored to the specific target audience. In the case of training on airborne isolation precautions for TB, every staff member who comes into contact with patients will need training, including cleaners, porters, nurses, doctors, radiographers and clinic reception staff.

3. When should staff members receive IPC training?

Ideally all new employees should receive induction (pre-employment) training in IPC. Annual refresher courses or short in-service training updates are recommended. In this case, the IPC practitioner may need to prioritise who is most at risk and then start training for this group first.

Case study 3

The facility manager requests the IPC practitioner to provide copies of all policies developed, audits performed and reports written in the last year. The IPC practitioner has to explain to the manager’s secretary which documents to file under policies, audits and reports.
1. What is a policy and what are some examples of documents that could be included?

A policy is a document that provides standard guidance on a particular topic. The IPC practitioner submitted a new policy and several policies that were updated in the last year, including:

- The facility policy on tuberculosis infection prevention and control (TB-IPC)
- The facility policy on needlestick injury (NSI) management
- The facility policy on isolation room usage.

2. What is an audit and what are some examples of audit reports that could be included?

An IPC audit is an activity performed to evaluate how well a facility or clinical area is complying with IPC standards. Examples of IPC audit reports that could be supplied to management include:

- Annual facility-wide audits of hand hygiene compliance
- Audits of compliance with healthcare waste management
- Audits of environmental cleaning.

3. What is an IPC report and what are some examples of reports that could be included?

Reports in IPC are used to document findings and facts about a particular situation (e.g. outbreaks), services (e.g. the IPC programme) or practices (e.g. hand hygiene compliance). The IPC practitioner could submit reports on the following:

- Outcome of outbreak investigations
- Reports of healthcare-associated infection rates
- Reports on training and education of staff in IPC.

Case study 4

A porter is carrying a sharps container and the lid which was loosely placed on top of the container falls off. All the sharps fall out and one needle and
syringe which appears unused jabs him on the lower leg. The sharps container had been placed next to a patient who was having a fingerprick glucose test taken.

1. **What steps should he take immediately after the accident?**

The porter should call his superior and report the incident immediately. He should then report to the occupational health department or officer, with the needle and syringe that caused the accident. The spillage should be cleared up by an experienced person in full protective equipment and with the appropriate brush and pan.

2. **What should the occupational health officers do for him as a staff member?**

Check his immunisation record and immune status. Take blood from the porter and from the source patient for HIV, hepatitis B and C and send for testing. If his immunisation is inadequate, fast track hepatitis B immunisation and start on HIV post-exposure prophylaxis (PEP) within two hours. If the source blood is HIV-negative then the PEP can be stopped. If the member of staff is HIV positive then his CD4 count and viral load should be checked.

3. **What is the expected risk from this accidental needle stick injury?**

This needle and syringe did not appear to have blood in it therefore the risk is less than if there had been blood in the needle and the barrel of the syringe. Nonetheless, it is essential that full precautions as described above be taken.
Micro-organisms of relevance to infection prevention and control

Objectives

When you have completed this section you should be able to:

- Understand the basic structure and physiology of micro-organisms
- Know how micro-organisms are transmitted
- Understand the basic host defences against micro-organisms
- Describe different types of healthcare-associated infections
- Know how to use laboratory services effectively
- Know the basics of communicable disease control.

Introduction

2-1 What are micro-organisms?

Micro-organisms are very small life forms that are not visible to the naked eye. They include bacteria, viruses, fungi and microscopic parasites. Micro-organisms are found everywhere (on our bodies, in food, in soil, water and plants). Most micro-organisms are not harmful to humans and many actually colonise and protect us by preventing growth of pathogens.

2-2 What are pathogens?

Pathogens are micro-organisms that can cause disease (infection) and are potentially harmful to humans. To cause disease, these pathogenic micro-
organisms must first be passed on (transmitted) to a person and then overcome the body’s defence systems.

Pathogens are micro-organisms that can cause disease (infection) and are potentially harmful to humans.

Pathogenic micro-organisms

2-3 Which types of micro-organisms can cause disease?

- Bacteria are single-celled organisms with a rigid cell wall that can survive outside the human body and can multiply on their own (replicate) without the help of the human ‘host’ cell.
- Fungi and moulds are made up of many cells, each with a rigid cell wall, which allows survival and replication outside of the human body.
- Viruses are made up of genetic material (either DNA and/or RNA) and they cannot survive or multiply outside the living cells of their hosts.
- Parasites include the groups helminths (worms and flukes) and protozoa (amoebas, ciliates, flagellates, and sporozoans). They can also survive and multiply outside of the human host.
- Prions are tiny protein particles which can cause infections if introduced into the central nervous system (brain and spinal cord).

2-4 How can micro-organisms be seen?

Micro-organisms are usually not visible to the naked eye:

- Bacteria, fungi, moulds and parasites can be seen under a microscope which enlarges (magnifies) by 100–1000 times. Bacteria range in size from around 1 to 5 microns (micrometres).
- Viruses are much smaller, ranging in size from 30 to 400 nanometres. Viruses can only be seen using an electron microscope, which magnifies the image by up to 10 million times.
Basic anatomy and physiology of bacteria

2-5 What do bacteria look like under the microscope?
Most bacteria are easily recognisable because they have particular shapes, staining characteristics and follow particular grouping or clustering patterns.

2-6 How can bacteria be classified by their shape?
The shape of the bacteria varies for different families, for example they can appear round (c cocci), rod-like (bacilli), spiral (spirochetes) or curved (vibrios).

![Diagram of bacteria shapes and grouping patterns]

2-7 How can bacteria be classified by their staining pattern?
Bacteria can also be classified based on their staining pattern. The Gram stain is the most commonly used laboratory method to identify the staining pattern of bacteria. A smear is made on a glass slide of a fluid, either directly from a clinical sample (e.g. pus) or from a culture of growing bacteria (in
liquid broth or on solid agar plates). The slide is allowed to dry and then stained with violet (blue) dye, decolourised and then stained with pink dye. Those bacteria that keep the blue dye stain are called Gram positive and those that lose the blue dye (decolour) will appear pink and are referred to as Gram negative. The staining of bacteria also allows identification by shape, such as round cocci or long bacilli, and grouping pattern.

Table 2-1: Bacteria as classified by their staining pattern (adapted from S Mehtar: Understanding Infection Prevention and Control, Juta, 2010)

<table>
<thead>
<tr>
<th>Gram stain</th>
<th>Shape</th>
<th>Grouping pattern</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Cocci</td>
<td>Clusters</td>
<td>Staphylococci</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chains</td>
<td>Streptococci</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pairs</td>
<td>Pneumococci</td>
</tr>
<tr>
<td></td>
<td>Bacilli</td>
<td>Spore-forming</td>
<td>Clostridium species</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-spore-forming</td>
<td>Listeria</td>
</tr>
<tr>
<td>Negative</td>
<td>Cocci</td>
<td>Pairs</td>
<td>Neisseria species</td>
</tr>
<tr>
<td></td>
<td>Bacilli</td>
<td>Random</td>
<td>Klebsiella, E. coli</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Curved</td>
<td>Vibrio, Campylobacter</td>
</tr>
<tr>
<td>Poorly or not staining</td>
<td>Spiral</td>
<td>None</td>
<td>Treponema</td>
</tr>
</tbody>
</table>

2-8 How can bacteria be classified by their grouping patterns?

The grouping pattern that the bacteria take up when seen under the microscope after staining, can also help to identify the bacterial species. For example some bacteria (staphylococci) are clustered together (appearing like a bunch of grapes) and others occur in chains (streptococci, enterococci). Most of the gram-negative rods (bacilli) have no particular grouping pattern.

2-9 What do mycobacteria look like under the microscope?

Mycobacteria form a group of bacteria causing diseases like tuberculosis (Mycobacterium tuberculosis) and leprosy (Mycobacterium leprae). They have a thick waxy layer that prevents the Gram stains from penetrating. Therefore a different staining technique called the Ziehl-Neelsen (ZN) stain is used, which allows a red dye (carbol fuchsin) to enter and stain the mycobacterial cells. Acid and alcohol are then applied to the slide which
removes colour from all other bacteria, but not the mycobacteria (which is why they are sometimes referred to as acid and alcohol fast).

2-10 How are bacteria grown (cultured) in the laboratory?
In microbiology laboratories, bacteria are grown on agar plates (essentially a jelly containing all the nutrients that bacteria need to grow). The laboratory can use other appearances (bacterial growth characteristics) on these agar plates to further identify the species. For example, colonies of Staphylococcus aureus bacteria growing on an agar plate have a characteristic golden yellow colour.

2-11 How can bacteria be classified by the need for oxygen or carbon dioxide?
Bacteria can also be classified by their growth requirements such as the need for oxygen or carbon dioxide. Bacteria can be classified as aerobic bacteria (oxygen dependent), anaerobic bacteria (can grow in the absence of oxygen) and facultative anaerobic bacteria (can grow in the presence or absence of oxygen).

2-12 What is the structure of bacteria?
Bacteria are single-cell organisms that have all the structures needed for their survival and replication. All bacteria are surrounded by a rigid outer cell wall, which gives them their shape (Gram-positive bacteria have thicker cell walls than Gram-negative bacteria). The cell wall allows some substances in and out of bacteria through tiny channels (porins). Some bacteria have projections from the cell wall called pili and flagella. Pili help with bacterial attachment to host cells, while flagella allow bacteria to move. A thin membrane called the cytoplasmic membrane runs inside the cell wall and holds together all the cell contents. Important cell contents include the bacterial genetic material (DNA) and ribosomes (which act as factories producing more genetic material).

2-13 What is the pattern of bacterial growth?
Bacteria will grow best when they are in an environment that provides the correct combination of nutrients, temperature and humidity. The time taken
to multiply (replicate) depends on the environmental conditions and bacterial species, but can be as fast as every 20 minutes. The growth cycle can be divided into four phases:

1. Lag phase: there is no growth (numbers remain static)
2. Log phase: there is a rapid increase in bacterial numbers
3. Stationary phase: numbers are maintained but there is no further growth (as the nutrient supply is used up)
4. Death: the number of bacteria starts to reduce.

Fungi, viruses and parasites

2-14 What is the structure of fungi?

Fungi are made up of many cells with a thick cell wall. Most fungi multiply by forming long string-like filaments (known as hyphae), some produce fungal spores (a type of resting form that fungi take up under unfavourable conditions) and others (yeasts) grow by budding. Fungi can be commonly
found in the environment and can also cause a variety of diseases in humans. Candida is the most commonly encountered fungal infection in healthcare settings. Fungal infections can be superficial (affecting the skin and subcutaneous tissue) or deep (affecting organs) or systemic, (spreading throughout the body). Deep and systemic fungal infections usually occur in hosts with weakened immune systems.

2-15 What is the structure of viruses?

Viruses can only survive within host (human, animal or plant) cells, usually cells of the immune system. Once inside the host cells, viruses are relatively protected from the host’s defence mechanisms and can use the host structures to replicate. The intracellular location of viruses makes it difficult to produce drugs that kill the virus without causing damage to the host cell.

Viruses are categorised both by their genetic make-up (single- or double-stranded, RNA or DNA) and their shape. The virus’ shape (icosahedral, helical and complex) is determined by its nucleocapsid structure, which is a combination of viral nucleic acid and capsid (the outer shell). In some viruses the nucleocapsid is covered by an outer membrane (known as an envelope), whereas others are ‘naked’ or non-enveloped. Viruses without an envelope are more difficult to destroy or remove by disinfection.
2-16 How are parasites classified?
Parasites include the sub-groups protozoa and helminths. Protozoal parasites are divided into four main types, grouped by their form (structure) and how they move (motility).

1. Protozoa:
   - Sporozoa: these parasites can only exist inside host cells (intracellular), e.g. malarial parasites
   - Flagellates: move using tail-like projections (flagellae), e.g. *Giardia lamblia* (causes giardiasis)
   - Amoebae: move using special rounded projections (pseudopods), e.g. *Entamoeba histolytica* (causes amoebiasis)
   - Ciliates: move by beating many tiny hair-like projections on the surface of their cells, e.g. *Balantidium coli* (causes balantidiasis).

2. Helminths: The helminths are divided into worms and flukes. There are many different types of worms that can cause human infestations, including:
   - Round worms (*Ascaris lumbricoides*)
   - Pin or thread worms (*Enterobius vermicularis*)
   - Hook worms (*Necator americanus, Ankylostoma duodenale*).

   These worms are spread mainly by ingestion (swallowing) of the eggs. Certain helminths can be spread by insects (so-called vector-borne helminths which can infect blood and/or human tissues), e.g. *Loa loa* (onchocerciasis) and *Wuchereria bancrofti* (elephantiasis). The sub-group of helminths, known as flukes, include the parasites that cause bilharzia (*Schistosoma haematobium*) and gastro-intestinal diseases (*Schistosoma mansoni* and *japonicum*).

Transmission of micro-organisms

2-17 How are micro-organisms transmitted?
There are five main routes by which micro-organisms can be spread (see table 2-2).
Table 2-2 The main routes by which micro-organisms can be spread

<table>
<thead>
<tr>
<th>Main transmission route</th>
<th>Types of transmission</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact</td>
<td>Direct</td>
<td>Hands of healthcare workers</td>
</tr>
<tr>
<td></td>
<td>Indirect</td>
<td>Equipment, e.g. thermometers, bedpans</td>
</tr>
<tr>
<td></td>
<td>Sexual</td>
<td>Sexual transmission of HIV or syphilis</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Droplet</td>
<td>Influenza, many other respiratory viruses</td>
</tr>
<tr>
<td></td>
<td>Airborne (aerosols)</td>
<td>Tuberculosis, measles, chickenpox</td>
</tr>
<tr>
<td>Ingestion</td>
<td>Water</td>
<td>Contaminated water, e.g. cholera</td>
</tr>
<tr>
<td></td>
<td>Food</td>
<td>Contaminated food, e.g. salmonella</td>
</tr>
<tr>
<td></td>
<td>Faecal matter (faeco-oral)</td>
<td>Hepatitis A</td>
</tr>
<tr>
<td>Inoculation</td>
<td>Injection, trauma, surgery, blood products</td>
<td>Needlestick injury transmitting HIV, hepatitis B or C</td>
</tr>
<tr>
<td></td>
<td>Insects / Vectors</td>
<td>Mosquitoes transmitting malaria</td>
</tr>
<tr>
<td>Transplacental</td>
<td>Mother-to-child infections</td>
<td>HIV, syphilis, rubella, etc</td>
</tr>
</tbody>
</table>

**Contact**

There is physical contact, which can be direct or indirect, between the host and the person or surface carrying the micro-organism.

**Respiratory**

The host breathes in micro-organisms which have been exhaled by an infectious person, in the form of respiratory droplets or aerosols.

**Ingestion**

The host either eats or drinks food or water that is contaminated by the micro-organism or touches a surface or person contaminated with faeces containing the micro-organism and then transfers the micro-organism into their mouth.
Inoculation

Micro-organisms can be introduced to the body through trauma, injections, surgical procedures or through the bite of an insect or vector carrying the micro-organism.

Transplacental

Micro-organisms circulating in the mother’s blood can cross the placenta during pregnancy causing infection in the fetus.

Contact transmission is the MAIN route of infection transmission in healthcare facilities.

2-18 What is the chain of infection?

For infection to develop the following are needed:

1. An infectious agent (the disease-causing or pathogenic micro-organism)
2. A susceptible host (a human with poor immune defences against the micro-organisms)
3. The right environment (the ideal conditions under which infection can be spread).

The sequence of infection transmission is sometimes called the ‘chain of infection’. It is the step-wise manner in which a micro-organism can be transmitted to a susceptible host.

The following steps are required to spread an infectious agent or micro-organism (see figure 2-4):

1. It leaves its reservoir.

A reservoir is the environment where the micro-organism is usually found, e.g. *Staphylococcus aureus* is commonly found in the nose; *Mycobacterium tuberculosis* (TB) is commonly found in the lungs.
2. It leaves through a portal of exit.
For example TB bacilli are coughed up from the lungs (respiratory tract) into the air.

3. It is transmitted by a route of infection.
For example, TB remains suspended in the air as aerosols (tiny particles containing the TB bacilli).

4. It gets into another person through a portal of entry.
For example, TB bacilli suspended in the air may be breathed into the lungs of a person in the same room as the TB patient.

Figure 2-4: The chain of infection

2-19 How do micro-organisms enter the human body?
There are two main ways in which micro-organisms are acquired and can cause disease:

- Exogenous acquisition: micro-organisms acquired from outside sources
- Endogenous acquisition: micro-organisms acquired from the host’s own collection of micro-organisms (known as flora).
It is important to know how an infection was acquired in order to prevent its spread to other susceptible people (hosts).

2-20 What is colonisation?

Once a micro-organism has been acquired, it must compete with the host’s local flora and withstand any host defences. Pathogenic micro-organisms that become established and persist on, or in, the host, are said to have colonised the host. Colonisation does not always result in infection or invasive disease in the host, but can be a potential source for transmitting the micro-organisms to other susceptible hosts.

Colonisation does not always result in infection, but can potentially transmit micro-organisms to other susceptible hosts.

2-21 How do micro-organisms cause disease?

To progress from colonisation to infection, a micro-organism must invade or penetrate through the host tissues and defences. Micro-organisms have a selection of ‘virulence factors’ which are mechanisms developed to overcome the body’s defences. Some pathogens also have special attachment mechanisms that allow them to find and enter specific host cells that will allow for survival and multiplication of the micro-organism.

Pathogenic micro-organisms can cause disease symptoms and signs by the following mechanisms:

- Changing the function of the target tissue or organ, e.g. gut pathogens causing diarrhoea by increasing intestinal contractions
- Releasing toxins (harmful chemicals) that damage the host’s organs or tissues and impair the normal function of cells, e.g. toxic shock syndrome toxin-1 released by Staphylococcus aureus or Streptococcus pyogenes causing rash, fever and circulatory collapse
- Bulk effect, e.g. intestinal obstruction caused by worm infestation.

Sometimes the symptoms or signs of disease are caused by the host’s own immune response to infection that is trying to remove the pathogen from the body, e.g. fever or a runny nose from the common cold (rhinovirus).
Defences against infection

2-22 What is the relationship between the invading micro-organism and the host?

Micro-organisms can be acquired (endogenously or exogenously), can become established (colonisation) and then may progress to infection (under favourable conditions) producing symptoms and signs of disease. The host has several ways of preventing micro-organism invasion in the first place or containing and/or destroying the micro-organisms once invasion has occurred. In hosts that have compromised natural defences or weakened immune systems (immune-compromise), progression from colonisation to infection is more likely. Immuno-competent hosts (with intact natural defences and immune systems), are able to overcome most minor invasions.

2-23 What are the host’s natural defences?

The host has three main defence mechanisms (see table 2-3), namely:

- Physical barriers: intact skin, mucous membranes, respiratory tract lining and normal flora
- Innate (or inborn) immunity: complement and white blood cells
- Acquired (or adaptive) immunity: B- and T-lymphocytes (a type of white blood cell).

Table 2-3: The main host defence mechanisms

<table>
<thead>
<tr>
<th>Main defences</th>
<th>Specific types of defence mechanisms</th>
<th>Explanation of defence mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical barriers</td>
<td>Intact skin</td>
<td>When skin is damaged it is easier for pathogens to invade, e.g. burn wounds, drips</td>
</tr>
<tr>
<td>Mucous membranes</td>
<td>Mucus can surround invading micro-organisms and prevent attachment</td>
<td></td>
</tr>
<tr>
<td>Respiratory tract</td>
<td>Larger pathogens can be trapped in mucus and expelled from the airways by movement of tiny hairs called cilia</td>
<td></td>
</tr>
<tr>
<td>Normal flora</td>
<td>Reduce the ability of pathogens to colonise and multiply by competing for space and nutrients</td>
<td></td>
</tr>
<tr>
<td>Main defences</td>
<td>Specific types of defence mechanisms</td>
<td>Explanation of defence mechanism</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Innate immunity</td>
<td>Complement cascade</td>
<td>A set of proteins that activate a chain of events causing inflammation, bursting of foreign and infected cells and removal by macrophages</td>
</tr>
<tr>
<td></td>
<td>Neutrophils and macrophages</td>
<td>Blood cells and immune cells of the liver, lungs, lymph nodes that activate a process (phagolysis) to destroy invading micro-organisms</td>
</tr>
<tr>
<td>Adaptive immunity</td>
<td>Immunoglobulin A (IgA)</td>
<td>This antibody is secreted from cells lining the gut and respiratory tract allowing for pathogen removal by other cells of the immune system</td>
</tr>
<tr>
<td></td>
<td>T-lymphocytes (cellular response)</td>
<td>These cells have special receptors that recognise bits of pathogens as foreign and can bind to infected cells</td>
</tr>
<tr>
<td></td>
<td>B-lymphocytes (humoral response)</td>
<td>These cells produce antibodies (specific anti-pathogen proteins) that trigger the complement cascade</td>
</tr>
</tbody>
</table>

2-24 What are normal flora?

Normal flora (sometimes called commensals) are micro-organisms that live on and in the human body (colonise) without causing infection. Normal flora are mostly bacteria, although fungi and protozoa are also included. The number of bacterial flora living on the body actually outnumber the total of all the cells in the human body! Normal flora are found on the skin, in the respiratory, gastrointestinal and genital tracts. However, normal flora microorganisms can cause infections if:

- They invade a body space where they do not belong (e.g. E. coli in the bladder causing urinary tract infection)
- They overgrow (e.g. normal bacterial flora can be destroyed by broad-spectrum antibiotics, which can lead to fungal overgrowth causing oral or vaginal thrush/candidiasis). This is called ‘opportunistic’ infection, where a normal flora organism can act as a pathogen under circumstances where the host’s defences are weakened for some reason.
Normal flora are micro-organisms that live on and in the human body without causing infection.

2-25 What is the difference between resident and transient flora?

- Resident flora, such as coagulase negative Staphylococci and Diphtheroids, are the commensal micro-organisms that are normally found on and in the human body (semi-permanently unless altered by antibiotic use).
- Transient flora, such as methicillin-resistant *Staphylococcus aureus* and *E. coli*, are micro-organisms that are transferred onto the human host by contact with a contaminated person or object. They usually remain on the skin for short periods of time and are easily removed by washing and drying the area. Transient flora can, however, cause healthcare-associated infections, highlighting the important role of hand hygiene in reducing transfer of pathogens. Over time, transient flora, can become well established at a site (colonisation) and are then considered to be part of a person’s resident flora, e.g. healthcare workers who over time have become nasally colonised with methicillin-resistant *Staphylococcus aureus* (MRSA).

2-26 How do normal flora protect us against infection?

Normal flora reduce the ability of pathogenic micro-organisms to colonise and multiply in the host by competing for space and nutrients. They can also produce chemical compounds (bacteriocidins) which kill other bacteria or make it difficult for other bacteria to grow by making the environment more acidic (lowering the pH). Normal gut and vaginal flora play a major role in preventing colonisation by pathogens.
Healthcare-associated infections (HAI)

2-27 Why are infections acquired in healthcare facilities?

There are many factors that increase the risk of acquiring an infection in a healthcare setting (see table below).

- Many sick individuals are nursed together in a confined space.
- Medical equipment, facilities and healthcare staff are often shared.
- Antibiotic use is common (reducing levels of protective normal flora and causing resistance in pathogens).
- Medical and surgical procedures may disrupt many natural defence mechanisms.
- In-dwelling devices can introduce pathogenic micro-organisms into the body.
- Staff shortages or lack of appropriate infrastructure (washbasins, cough rooms, isolation rooms) can lead to poor IPC practice that increases the risk of HAI.

Table 2-4 demonstrates in greater detail the many factors that increase the likelihood of HAI occurring.

Table 2-4: Factors increasing the likelihood of hospital acquired infections (HAI) (adapted from S Mehtar: Understanding Infection Prevention and Control, Juta, 2010.)

<table>
<thead>
<tr>
<th>Major factor</th>
<th>Specific factors</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>Staff shortages</td>
<td>Leads to shortcuts being taken which compromise IPC practice standards</td>
</tr>
<tr>
<td></td>
<td>Overcrowding of clinical areas</td>
<td>Increased risk of infection transmission by greater pathogen load and patients lying closer together</td>
</tr>
<tr>
<td></td>
<td>Lack of written IPC policies and structures</td>
<td>No formal guidance or practice standards that healthcare workers can be held accountable to</td>
</tr>
<tr>
<td></td>
<td>Lack of formal IPC training for staff; Use of untrained patient attendants</td>
<td>Staff and patient attendants who have not had any IPC training may be at risk of infection or may spread infections in a facility by incorrect or risky practices</td>
</tr>
<tr>
<td>Major factor</td>
<td>Specific factors</td>
<td>Explanation</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Inadequate equipment</td>
<td>Equipment will be shared by many patients, often without any form of cleaning or disinfection</td>
<td></td>
</tr>
<tr>
<td>Inadequate facilities; poor hospital or facility design</td>
<td>Lack of appropriate infrastructure (washbasins, cough rooms, isolation rooms) can lead to poor IPC practice that increases the risk of HAI</td>
<td></td>
</tr>
<tr>
<td>Poor communication of infection risk</td>
<td>If staff and visitors are not made aware of potential infection risks, they cannot take the necessary precautions to prevent spread of disease</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Antibiotic resistance</td>
<td>Most healthcare facilities harbour antibiotic-resistant organisms</td>
</tr>
<tr>
<td></td>
<td>Excessive use of disinfectants</td>
<td>Overuse of disinfectants can also contribute to the development of resistant organisms</td>
</tr>
<tr>
<td></td>
<td>Poor waste management</td>
<td>Can expose staff and visitors to infection and attract pests if not properly disposed of</td>
</tr>
<tr>
<td>Clinical</td>
<td>Overuse of antibiotics</td>
<td>Excessive use of antibiotics selects out the most resistant organisms which then become established</td>
</tr>
<tr>
<td></td>
<td>Poor levels of hand hygiene</td>
<td>Poor compliance with hand hygiene increases contact transmission of infections</td>
</tr>
<tr>
<td></td>
<td>Poor implementation of transmission-based precautions</td>
<td>Failure to institute and enforce transmission-based precautions contributes to spread of pathogens</td>
</tr>
<tr>
<td></td>
<td>Lack of personal protective equipment (PPE)</td>
<td>Stock-outs or shortages of essential protective equipment hampers healthcare workers' ability to adhere to standard and transmission-based precautions</td>
</tr>
<tr>
<td>Patient</td>
<td>Extremes of age</td>
<td>Neonates, infants and the elderly are particularly vulnerable</td>
</tr>
<tr>
<td></td>
<td>Immunocompromise</td>
<td>Certain diseases (HIV, immune-deficiencies) and medications (e.g. steroids and anti-cancer drugs) can weaken a person's immunity to infection</td>
</tr>
<tr>
<td></td>
<td>Broad-spectrum antibiotic use</td>
<td>Can destroy a person's normal flora that play an essential role in the body's infection defences</td>
</tr>
<tr>
<td>Major factor</td>
<td>Specific factors</td>
<td>Explanation</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Multiple invasive procedures</td>
<td>Any procedure, e.g. catheters, drips, mechanical ventilation, break the body's</td>
<td>increase susceptibility to infection</td>
</tr>
<tr>
<td></td>
<td>natural barriers and increase susceptibility to infection</td>
<td></td>
</tr>
<tr>
<td>Trauma and surgical procedures</td>
<td>The skin barrier is broken, resulting in easier entry for pathogenic micro-organisms</td>
<td></td>
</tr>
<tr>
<td>Prolonged hospital stay</td>
<td>The longer duration of stay exposes a patient to more pathogens</td>
<td></td>
</tr>
<tr>
<td>Pathogen</td>
<td>Primary invasive pathogens</td>
<td>Some organisms are by nature very invasive, e.g. <em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>Opportunistic pathogens</td>
<td>These are normal flora organisms that can act as a pathogen under circumstances</td>
<td>where the body's defences are weakened for some reason</td>
</tr>
<tr>
<td></td>
<td>where the body's defences are weakened for some reason</td>
<td></td>
</tr>
<tr>
<td>Bacterial invasion</td>
<td>Some bacteria invade more easily after a viral infection, e.g. pneumococcal</td>
<td>pneumonia after an influenza illness</td>
</tr>
<tr>
<td></td>
<td>pneumonia after an influenza illness</td>
<td></td>
</tr>
<tr>
<td>High infecting dose</td>
<td>An organism is more likely to cause an infection if the initial bacterial load</td>
<td>(inoculum) is large</td>
</tr>
<tr>
<td></td>
<td>An organism is more likely to cause an infection if the initial bacterial load</td>
<td>(inoculum) is large</td>
</tr>
</tbody>
</table>

2-28 What are the main types of infections transmitted in healthcare facilities?

The spectrum of HAI includes any infection that develops 48 hours or more after hospitalisation.

HAI include site-specific infections, e.g. bloodstream, surgical site, skin and soft tissue, urinary, respiratory and gastrointestinal tract infections. HAI can also occur related to medical devices (so-called device-associated infections), e.g. central-line associated bloodstream infections (CLABSI), ventilator-associated events (VAE) and catheter-associated urinary tract infections (CAUTI).

Types of healthcare-associated infections include site-specific infections and device-associated infections.
2-29 What are the main types of healthcare-associated pathogens?

The type of healthcare-associated pathogens (and their antibiotic susceptibility profile) will vary for each healthcare facility and will change over time. New pathogens can be introduced to a facility (e.g. with outbreaks) and will become more difficult to remove the longer they remain in the environment or on colonised patients or staff. Some facilities use a laboratory surveillance system for HAI, based on designated ‘alert organisms’. In such cases, a facility decides, based on the burden of HAI, which infection-associated organisms to monitor for and to investigate clinically when they are isolated. Typical examples of alert organisms include: methicillin-resistant *Staphylococcus aureus; Acinetobacter baumannii;* and *Pseudomonas aeruginosa.*

2-30 How can we prevent healthcare-associated infections?

The risk of transmitting infections in healthcare settings can be reduced by applying interventions and changing staff behaviour. IPC interventions to reduce the risk of micro-organism transmission include: standard precautions and transmission-based precautions.

2-31 What are standard precautions?

Standard precautions (previously called universal precautions) reduce the chance of infection transmission from both known and unknown (unrecognised) sources of infection. These precautions should be applied to all patients in all circumstances, whether or not they are known to pose an infection risk. Examples of standard precautions are safe injection practices, proper hand hygiene and use of appropriate personal protective equipment when exposed to blood and body fluids.

Standard precautions should be applied to all patients in all circumstances, whether or not they are known to pose an infection risk.
2-32 What are transmission-based precautions?

Transmission-based precautions (TBP) are interventions put in place to reduce the chance of infection transmission for particular pathogens, e.g. airborne precautions for TB. Remember that TBP are always applied in addition to standard precautions. Bear in mind too that many pathogens have more than one route of transmission, e.g. varicella (chickenpox) will need both airborne and contact precautions enacted.

The role of the laboratory

2-33 What is the role of the laboratory in infection prevention and control?

A good working relationship between IPC and microbiology departments can contribute to better awareness of infection risks and improved IPC practices. In many settings accessing laboratory results is difficult, either because the laboratory is located far away or has insufficient staff to interact directly with clinical services. In such settings, the role of the IPC practitioner is critical to guide clinicians on how to contain potentially transmissible infections and to assist with outbreak investigation. A close relationship with the laboratory will help to gain access to urgent results with implications for management of patients (e.g. where isolation and/or transmission-based precautions are required).

2-34 How can infection transmission to laboratory workers be prevented?

Laboratory workers are at risk of acquiring infection through exposure to blood, body fluids, splashes and aerosols. Planning of laboratory design, safety features, work-flow and specimen handling techniques is essential to reduce this risk. In addition, laboratory workers should be fully immunised.

2-35 How can meaningful microbiology results be obtained?

When using a microbiology service, it is important to remember that the quality of the result obtained is often directly influenced by how well the
sample is taken and transported to the laboratory. The following basic tips will improve the outcome of your test:

- Label the request form in full with the patient’s details, the submitting clinician’s contact details, the ward or facility submitting the sample
- A clear indication of which tests are required
- A brief clinical history with (suspected) diagnosis; mention recent antibiotic therapy
- Obtain your sample using best practice techniques (e.g. aseptic technique for blood cultures; sample from the urine sampling port of urine bags)
- Ensure that you use the appropriate (leak-proof, unexpired) containers or tubes for the requested test
- Place the sample and request form in a clear leak-proof bag (preferably within separate pockets)
- Ensure the sample is delivered rapidly to the laboratory (some samples may require refrigeration).

The quality of the microbiology result obtained is often directly influenced by how well the sample is taken and transported to the laboratory.

2-36 Using and interpreting microbiology results

Decisions regarding antibiotic treatment should be made keeping in mind the clinical picture – microbiology results should be considered only as a guide to treatment. Antibiotics are usually started as a ‘best guess’ (empirical therapy) and then later modified depending on clinical response (improvement or deterioration) and taking into account laboratory findings.

Microbiology results are especially helpful in antibiotic stewardship, which aims to reduce excessive or inappropriate use of antibiotics. For example, where no organisms have been isolated (or a viral infection is proven) and the patient is improving, antibiotics may often be safely discontinued. If a pathogen is identified, the antibiotic choice can be targeted (matched) to the particular pathogen isolated.

Remember that microbiology results (especially where samples have not been properly obtained) may reflect contamination with skin flora or
pathogenic organisms that are only colonising the site, but not causing the infection.

Control of communicable diseases

2-37 How is infection prevention and control involved in managing communicable disease?

Communicable diseases are illnesses transmitted by a pathogenic microorganism from an infected person, animal, or reservoir to a susceptible host. IPC teams deal with patients hospitalised with communicable (infectious) diseases, as well as managing IPC practices in the community. Education of community-based healthcare workers, patients and caregivers in IPC is important in preventing spread of communicable disease and containing outbreaks.

2-38 What are the main routes of transmission of communicable disease?

Three main routes of transmission are recognised:

- Oro-faecal route: food or water contaminated with harmful microorganisms is ingested, e.g. cholera-contaminated water or *Staphylococcus aureus*-contaminated food.
- Inoculation route: involves introduction of infected blood or body fluids through medical devices (e.g. needles transmitting HIV, hepatitis B and C) or via vectors (insect ‘carriers’, e.g. malaria in mosquitoes; Congo virus in ticks).
- Respiratory route: where pathogens are transmitted via the air to a susceptible person. In addition to these major routes, sexual disease transmission (e.g. HIV, syphilis) and transplacental (in utero) disease transmission (e.g. HIV, rubella) should also be considered.
2-39 What public health measures are needed to manage communicable disease?

Several general public health measures can be used to reduce the occurrence of communicable disease or to contain communicable disease in an outbreak situation:

- Improving the quality of drinking water: through boiling or chemical disinfection with chlorine at 0.5 parts per million
- Providing adequate sanitation or safe disposal of human faeces
- Ensuring meticulous hand hygiene (especially in the preparation of food)
- Improving a population’s resistance to infection by promoting better nutrition and uptake of immunisation
- Control of vectors (e.g. indoor residual spraying for eradication of malaria-carrying mosquitoes)
- Use of education and awareness campaigns for communities
- Interrupting transmission of communicable disease by treating and isolating infected persons (e.g. TB case-finding and implementing basic IPC principles to reduce risk of household transmission).

Case study 1

A nine-month-old baby with a congenital heart defect is admitted to a paediatric ward in heart failure. He is placed in a cot next to a child recovering from adenovirus pneumonia. Four days later the baby with the heart defect develops breathing difficulty and requires admission to the intensive care unit. A tracheal aspirate isolates an adenovirus. Blood cultures show no growth.

1. How did the nine-month-old baby acquire the adenovirus infection?

Adenovirus is transmitted by the respiratory route (droplet infection). Respiratory droplets containing the virus can be inhaled or introduced to mucous membranes by direct or indirect contact (e.g. touching an adenovirus-contaminated surface and then placing fingers in the mouth).
2. Who is at risk of acquiring this infection?
Any person without previous immunity (antibodies) to adenovirus can become infected (including other patients, staff, parents and visitors).

3. How could transmission of this viral infection have been prevented?
The original patient who was known to be recovering from adenovirus pneumonia should have been isolated and placed under droplet precautions. The importance of hand hygiene should have been emphasised to the staff caring for these patients. Knowledge of duration of infectiousness of certain organisms is helpful.

Case study 2

A 25-year-old man who has recently returned from Zimbabwe presents to his local clinic with a short history of profuse, watery diarrhoea and severe dehydration. He lives in a shack with no access to running water or toilet facilities. He is referred to hospital for intravenous rehydration. Over the following week, several more adults and children from the same informal settlement present to the local clinic with watery diarrhoea and dehydration. Stool specimens confirm that the cause of this diarrhoeal outbreak is *Vibrio cholera*.

1. What is the route of transmission for this gastrointestinal pathogen?
*Vibrio cholera* is transmitted by the faeco-oral route through direct or indirect contact with contaminated water or an infected person’s body fluids (stool or vomitus).

2. How will you prevent transmission of this diarrhoeal disease in hospital?
Contact precautions should be implemented, ideally in a single room with en suite toilet facilities. If there are many affected patients, those with diarrhoeal disease (suspected to be cholera) could be nursed together
(cohorted) in one room. Ensure easy access to personal protective equipment (gloves, aprons) for staff caring for these patients. Make sure linen and waste from these patients are handled as potentially infectious.

3. How will you prevent transmission of this diarrhoeal disease in the community?

A clean water source will have to be supplied (if the water is cholera-contaminated) or the community must be shown how to safely decontaminate water by boiling or chlorination. Community members with gastrointestinal symptoms should be sent to a healthcare facility for management. Education regarding the importance of hand hygiene and clean water sources should be provided in all local languages.

Case study 3

A 56-year-old woman is admitted to hospital with 60% burn wounds to her body from a shack fire. She requires admission to ICU for ventilation and has a central line and urinary catheter inserted.

Her burn wounds have become infected with *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. She has had multiple courses of broad-spectrum antibiotics. The microbiology laboratory calls you to inform IPC that she has cultured a very antibiotic-resistant *Klebsiella pneumoniae* (a carbapenem-resistant Enterobacteriaceae) from her last urine sample.

1. How will you establish if this organism is colonising or infecting this patient’s urinary tract?

You will need to collect additional clinical and laboratory information on this patient. Review the clinical notes and speak to the attending doctor to establish if the patient has any symptoms and signs of a urinary tract infection. Check the urinalysis report for the presence of white cells (leucocytes) in the urine.
2. When considering infection transmission, does it matter if this organism represents colonisation or infection?

No, the risk of transmitting this highly resistant organism is just as great if the patient is colonised. The Burns Unit staff should be educated as to the potential for transmitting this organism to other patients.

3. How would you handle this situation from an IPC point of view?

The patient should be placed under contact precautions, and should ideally be put in a single room with en suite toilet facilities. Ensure easy access to personal protective equipment (PPE) (gloves, aprons) for staff. Try to provide dedicated equipment for this patient (to avoid the chance of carrying across this resistant bacteria to other patients). The Burns Unit staff should be educated as to the potential for transmitting this organism to other patients and the importance of excellent hand hygiene practice.

Case study 4

A severely ill eight-year-old boy is admitted to your casualty with a one day history of fever, exhaustion and muscle aches. He is noted to have extensive bruising. The doctor on call thinks that meningococcal septicaemia is the likely diagnosis.

1. How should this patient be managed from an IPC perspective?

The boy should be managed in isolation (away from other patients and visitors). The doctors and nurses caring for him should use contact and droplet precautions, since meningococcus can be spread through both these routes.

2. What public health measures should be in place?

According to national policy, this is a telephonically notifiable disease, which must be reported to the local health authority within 24 hours of presentation to hospital. The local health authority usually co-ordinates the investigation of community and household contacts, and provides antibiotic prophylaxis to close contacts.
3. How soon can the patient be de-isolated (removed from the single room)?

After 24 hours of appropriate antibiotic therapy, the patient can be de-isolated. It is very important to know (or to know where to find out about) the duration of contagiousness (infection risk) for different pathogens. This allows you (as an IPC practitioner) to make informed decisions on how long to recommend isolation of infectious patients.

Case study 5

A 26-year-old lady undergoes an emergency Caesarean section. Five days later her surgical wound looks infected and a wound swab grows a methicillin-resistant *Staphylococcus aureus* (MRSA).

1. **Is this a community acquired infection or a healthcare-associated infection?**

Since this is a site-specific infection (surgical site) caused by an ‘alert pathogen’ (MRSA), which developed more than 48 hours after admission, it is classified as a healthcare-associated infection.

2. **What is the most likely route of infection in this case?**

The most likely route or mode of infection is contact transmission (through the hands of healthcare workers). An important risk factor favouring the pathogen’s entry is the disruption of skin by the surgical incision.

3. **What steps are needed to contain this pathogen?**

All healthcare workers caring for this patient should use contact precautions (gloves and aprons). If possible, the patient should be placed in single-room isolation. Strict compliance with hand hygiene protocols should be enforced.
Case study 6

A 25-year-old recently married lady attends an outpatient clinic complaining of lower abdominal pain and painful micturition (passing of urine). The treating doctor requests urinalysis and a urine sample for laboratory microscopy and culture. Clear instructions are given to the patient regarding the sterile collection of a urine sample (to avoid contamination from the skin around the urethra).

1. Why is it important to give the patient instructions on urine collection methods?

The quality of the microbiology results will depend on how well the sample is collected. The chance of contaminating the urine sample (with normal flora from the skin in the genital area) is high. If the sample becomes contaminated at collection, it may be difficult to distinguish between growth of contaminants (skin flora) or true pathogens.

2. *Escherichia coli* is isolated from this patient’s urine culture. How was this infection acquired?

In this case, the patient developed the infection at home, so it is classified as a community-acquired infection. *E. coli* is a common cause of urinary tract infections and is usually considered an endogenous infection (acquired from the host’s own collection of micro-organisms, known as flora).
Risk management in IPC

Objectives

When you have completed this chapter you should:

- Understand how to perform a risk assessment
- Be able to stratify risk
- Understand how to manage risk
- Be familiar with standard and transmission-based precautions
- Understand when and how to use personal protective equipment
- Be familiar with injection safety initiatives and re-use prevention devices
- Be able to describe the purpose and types of care bundles.

Risk assessment in IPC

3-1 What is risk assessment in IPC?

Risk assessment (RA) is a process that:

- Identifies hazards (dangers)
- Evaluates the risk associated with that hazard
- Determines appropriate ways to eliminate or control the hazard.

In other words, RA is a detailed examination of potential or existing hazards in healthcare:

- To identify factors (policies, environment, practices, processes) that may cause harm to patients, staff and/or visitors.
To evaluate how likely the event is and how serious the hazard is.
Then decide what steps should be taken to prevent or control the harm from happening.

**Risk management in IPC**

3-2 What are the key steps in performing a risk assessment in IPC?
The following steps can be applied in RA for IPC:

1. **Identify a problem, hazard or threat**
   For example, a high rate of needlestick injuries (NSI) among staff

2. **Evaluate the problem (to establish the size and context of the problem)**
   For example, get data on the rate of NSI, the type of NSI, which staff were affected, when, where and how the injuries happened (in theatre, while recapping a needle).

3. **Identify infection risks (use a structured approach)**
   For example, identify all points of risk for NSI, e.g. when taking blood from uncooperative patients; when staff are tired (post-call); no eye protection in casualty, etc.

4. **Assess the likelihood of occurrence and consequences of infection**
   For example, NSI is a frequent occurrence at your facility and your patient population has a high HIV and hepatitis B prevalence, so consequences of infection would be severe.
5. Determine and implement priority interventions to manage the risk

For example, priority interventions for your facility: training of all staff in sharps management, sharps containers in all rooms or ensure eye shields available in casualty/obstetrics.

6. Continuously monitor the risk and evaluate the success of your interventions

For example, keep records of all NSI before, during and after the interventions, monitor how well the interventions were implemented, improve policies and re-train staff periodically.

![Figure 3-1: Risk assessment in IPC](image-url)

3-3 When should risk assessment in IPC be performed?

Risk assessment should be performed when:

- A new IPC service is established (looking specifically at standard precautions, transmission-based precautions, infection surveillance, cleaning, laundry and waste management, reprocessing of re-usable instruments, and renovation projects)
- A new piece of clinical equipment or instrument is procured
• A new procedure or diagnostic test is implemented
• A problem in IPC practice, policy or related issue is identified
• At least annually to re-evaluate the priorities for your facility’s IPC programme.

3-4 Who should perform risk assessment in IPC?
Ideally RA in IPC is best performed by an experienced IPC practitioner. Input should be gathered from staff in the clinical area concerned (e.g. casualty and theatre staff for needlestick injuries). The IPC practitioner may need assistance from clinicians, laboratory staff or data managers, depending on the location and type of hazard being investigated.

3-5 How is risk categorised in IPC?
Risk can be categorised as high, medium or low risk depending on the severity of the consequences of any particular hazard. For example, not wearing gloves when obtaining a blood sample would pose a low risk of infection to a healthcare worker. Handling a patient’s central venous catheter without performing hand hygiene would be medium risk. A high risk of infection would arise if a clinician performed an aseptic procedure (e.g. surgery) without performing adequate hand antisepsis.

Risk management in IPC

3-6 What is Risk management in IPC?
Risk management (RM) is a structured method to identify, evaluate, avoid or reduce hazards in healthcare. RM assists with prioritising risks and is an essential part of the quality management programme.

Risk management is an essential part of quality management programmes in healthcare.
3-7 What is the purpose of performing risk management in IPC?

There are many reasons for performing RM in healthcare including:

- To improve clinical practices
- To increase safety of patients, healthcare workers and visitors
- To reduce rates of healthcare-associated infections (HAI).

3-8 Which elements are needed for successful risk management in IPC?

The following key elements will help to produce successful RM projects:

- An active IPC committee: assists with risk assessment and implementation of IPC measures
- Robust policies and procedures: lay the foundation for good institutional IPC practice
- Effective healthcare leadership: commitment, clinical role-models and the provision of the resources to implement RM interventions
- Clinician ownership: ensures that staff support RM processes and are accountable
- Education and in-service training: are essential parts of any RM intervention.

**Standard and transmission-based precautions**

3-9 Which IPC programmes exist to reduce risk of HAI?

There are several IPC programmes and interventions designed to reduce the risk of infection transmission in healthcare including:

- Standard precautions
- Transmission-based precautions
- Procedure-based precautions
- Injection safety and re-use prevention (RUP) programmes
- Care bundles.
3-10 What are standard precautions?

Standard precautions (previously called universal precautions) reduce the chance of infection transmission from both known and unknown (unrecognised) sources of infection. They protect healthcare workers, patients and staff from acquiring infection. Standard precautions should be applied to all patients in all circumstances, whether or not they are known to pose an infection risk. All healthcare workers should be trained in the application of standard precautions. Each of the standard precautions are addressed in more detail in the following chapters:

Table 3-1: Further details on standard precautions

<table>
<thead>
<tr>
<th>Standard precaution</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand hygiene</td>
<td>4</td>
</tr>
<tr>
<td>Personal protective equipment</td>
<td>3</td>
</tr>
<tr>
<td>Safe injection practice and sharps management</td>
<td>3</td>
</tr>
<tr>
<td>Waste management</td>
<td>6</td>
</tr>
<tr>
<td>Patient placement (isolation)</td>
<td>5</td>
</tr>
<tr>
<td>Cough etiquette (respiratory hygiene)</td>
<td>8</td>
</tr>
<tr>
<td>Linen handling and segregation</td>
<td>5</td>
</tr>
<tr>
<td>Occupational health</td>
<td>1</td>
</tr>
<tr>
<td>Decontamination of equipment and the environment</td>
<td>6</td>
</tr>
</tbody>
</table>

Standard precautions should be applied to all patients in all circumstances, whether or not they are known to pose an infection risk.

3-11 What are transmission-based precautions?

Transmission-based precautions (TBP) are interventions put in place to reduce the chance of infection transmission for particular pathogens, e.g. airborne precautions for TB. Remember that TBP are always applied in addition to standard precautions. Bear in mind too that many pathogens have more than one route of transmission, e.g. varicella (chickenpox) will need both airborne and contact precautions. The table below compares and
summarises the precautions needed for each of the three major routes of transmission.

*Table 3-2: Transmission-based precautions for the three major routes of transmission (adapted from S Mehtar: Understanding Infection Prevention and Control, Juta, 2010.)*

<table>
<thead>
<tr>
<th>Precaution type</th>
<th>Contact</th>
<th>Droplet</th>
<th>Airborne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication</td>
<td>Patients known to be colonised or infected.</td>
<td>Patients with infections spread by large respiratory droplets.</td>
<td>Patients with pathogens spread in small particles (known as aerosols).</td>
</tr>
<tr>
<td>Area of risk</td>
<td>Pathogens acquired by touching the patient or any surfaces/equipment that the patient has had contact with.</td>
<td>Pathogens (in respiratory droplets) spread less than 1 metre from the patient and settle onto the surrounding surfaces.</td>
<td>Pathogens (aerosols) spread from the patient and may also settle onto surfaces.</td>
</tr>
<tr>
<td>Precaution type</td>
<td>Contact</td>
<td>Droplet</td>
<td>Airborne</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Example diseases</td>
<td>Diarrhoeal disease; Skin/wound infections, many other bacterial infections and colonising bacteria.</td>
<td>Meningococcal meningitis; Influenza; mumps, Rubella, Diphtheria, other respiratory viruses, e.g. adenovirus, RSV, rhinovirus, and many others.</td>
<td>Tuberculosis; Measles; Chickenpox (varicella) – note also requires contact precautions.</td>
</tr>
<tr>
<td>Risk-prone procedures</td>
<td>Wound dressings, vaginal or rectal exams, contact with body fluids</td>
<td>Insertion and suctioning of endotracheal tubes, nasogastric tubes, bronchoscopy.</td>
<td>Insertion and suctioning of endotracheal tubes, bronchoscopy, sputum production. Consider obtaining sputum samples outdoors if possible.</td>
</tr>
<tr>
<td>Patient placement</td>
<td>Ideally single room, but cohort isolation* or ward placement if no options.</td>
<td>Ideally single room with en-suite bathroom or *cohort isolation. If not available, place on ward near open window with curtains closed around bed</td>
<td>Do not admit unless clinically indicated. Single room with door closed at all times. Cohort isolation if no single rooms. Preferably en suite</td>
</tr>
<tr>
<td>Precaution type</td>
<td>Contact</td>
<td>Droplet</td>
<td>Airborne</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------</td>
<td>----------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Equipment and Personal Protective Equipment (PPE)</td>
<td>• Contact precautions signage on door/bed • alcohol handrub • non-sterile gloves • disposable aprons • dedicated equipment or adequate cleaning of shared equipment.</td>
<td>• Droplet precautions signage on door/bed • alcohol handrub • non-sterile gloves and apron only if indicated for a procedure • surgical mask and eye protection when within 1 metre of patient.</td>
<td>• Airborne precautions signage on closed door • alcohol handrub • non-sterile gloves and apron for intubation, suctioning, bronchoscopy • N95 respirators for staff, patient to wear surgical mask when staff are in the room.</td>
</tr>
<tr>
<td>Ventilation</td>
<td>No special requirements</td>
<td>No special requirements.</td>
<td>Negative pressure ventilation with 6–12 air changes per hour. If negative pressure is not possible, explore all options to increase air exchange naturally, directing air flow away from other patients and staff.</td>
</tr>
<tr>
<td>Precaution type</td>
<td>Contact</td>
<td>Droplet</td>
<td>Airborne</td>
</tr>
<tr>
<td>----------------</td>
<td>---------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>Environment</td>
<td>Dedicated cleaning equipment or clean room last. Terminal cleaning indicated on patient discharge.</td>
<td>Dedicated cleaning equipment or clean room last. Terminal cleaning indicated on patient discharge.</td>
<td>Dedicated cleaning equipment or clean room last. Terminal cleaning indicated on patient discharge.</td>
</tr>
<tr>
<td>Discontinue precautions</td>
<td>Only if patient is proven to be clear of colonisation or infection, ideally only once patient is discharged.</td>
<td>When patient’s symptoms have resolved or once patient is discharged.</td>
<td>When patient’s symptoms have resolved, when they are no longer infectious or once patient is discharged.</td>
</tr>
</tbody>
</table>

* cohort isolation: placing two or more patients with the same disease (caused by the same micro-organism) together in isolation.

**Transmission-based precautions are applied in addition to standard precautions based on a pathogen’s route/s of transmission.**

3-12 **What are procedure-based precautions?**

This is the requirement for specific interventions, to reduce risk of infection, during a specified procedure. For example, in order to place a central line in a patient, the healthcare worker should apply hand hygiene, proper skin antisepsis, wear appropriate personal protective equipment, use maximal barrier precautions (drapes), use sterile instruments and perform the entire procedure aseptically.
Contact Precautions

ALL STAFF AND VISITORS

STOP !

REPORT TO NURSE IN CHARGE. ADHERE TO THIS INSTRUCTION BEFORE ENTERING THE ROOM

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HAND</strong></td>
<td>Use alcohol rub or wash hands before leaving the room</td>
</tr>
<tr>
<td><strong>Aprons Gloves</strong></td>
<td>Wear an apron when entering the room. Wear gloves for direct or indirect contact with the patient or excretions and secretions</td>
</tr>
<tr>
<td><strong>Door</strong></td>
<td>Keep door closed at all times if patient is in isolation</td>
</tr>
<tr>
<td><strong>Before leaving</strong></td>
<td>Decontaminate equipment when it leaves the room. Discard gloves and apron and carry out hand hygiene before leaving the room</td>
</tr>
</tbody>
</table>

Figure 3-3: Contact precautions (Adapted from *Infection Prevention and Control Manual*, Tygerberg Academic Hospital, Cape Town, South Africa, 2012)
Droplet Precautions

ALL STAFF AND VISITORS

STOP !

REPORT TO NURSE IN CHARGE. ADHERE TO THIS INSTRUCTION BEFORE ENTERING THE ROOM

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hand</strong></td>
<td>Use alcohol rub or wash hands before leaving the room</td>
</tr>
<tr>
<td><strong>Mask</strong></td>
<td>Wear water-resistant mask when working within 1 metre of the patient</td>
</tr>
<tr>
<td><strong>Aprons Gloves</strong></td>
<td>Wear an apron when entering the room. Wear gloves for direct or indirect contact with the patient or excretions and secretions</td>
</tr>
<tr>
<td><strong>Door</strong></td>
<td>Keep door closed at all times if patient is in isolation</td>
</tr>
<tr>
<td><strong>Before leaving</strong></td>
<td>Decontaminate equipment when it leaves the room. Discard gloves, apron and mask. Carry out hand hygiene before leaving the room</td>
</tr>
</tbody>
</table>

Figure 3-4: Droplet precautions (Adapted from *Infection Prevention and Control Manual*, Tygerberg Academic Hospital, Cape Town, South Africa, 2012)
### Airborne Precautions

**ALL STAFF AND VISITORS**

![Stop sign]

**REPORT TO NURSE IN CHARGE. ADHERE TO THIS INSTRUCTION BEFORE ENTERING THE ROOM**

<table>
<thead>
<tr>
<th>![Image of hand washing]</th>
<th>Hand</th>
<th>Use alcohol rub or wash hands before leaving the room</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image of mask]</td>
<td>Mask</td>
<td>Wear N95 respirator (FFP3) for PTB/MDR/XDR-TB patients. Aerosol generating procedures</td>
</tr>
<tr>
<td>![Image of apron and gloves]</td>
<td>Aprons Gloves</td>
<td>Wear an apron when entering the room. Wear gloves for direct or indirect contact with the patient or excretions and secretions</td>
</tr>
<tr>
<td>![Image of door closed]</td>
<td>Door</td>
<td>Keep door closed at all times</td>
</tr>
<tr>
<td>![Image of person leaving]</td>
<td>Before leaving</td>
<td>Decontaminate equipment when it leaves the room. Discard gloves, apron and masks. Carry out hand hygiene before leaving the room</td>
</tr>
</tbody>
</table>

Figure 3-5: Airborne precautions (Adapted from *Infection Prevention and Control Manual*, Tygerberg Academic Hospital, Cape Town, South Africa, 2012)
Use of personal protective equipment

3-13 What is personal protective equipment?

Personal protective equipment (PPE) includes any item designed to protect healthcare workers from exposure to pathogens, e.g. gloves, aprons, face covers. It is important to note that the use of PPE does not replace the need for good IPC practices. For example, wearing gloves instead of washing hands is unacceptable as healthcare workers’ hands may still become contaminated through the gloves.

3-14 When is personal protective equipment required?

PPE is required for most clinical procedures and aseptic tasks. PPE is also required for domestic, waste management and sterile services department staff. The figure below indicates which PPE are required for certain commonly performed tasks and procedures.

Table 3-3: Appropriate use of personal protective equipment (PPE) for common procedures (Adapted from Z cards, S. Mehtar, 2010)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Hand hygiene</th>
<th>Gloves</th>
<th>Aprons</th>
<th>Masks</th>
<th>Eye covers</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV cannulation</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound dressing</td>
<td>✓</td>
<td></td>
<td>Aseptic technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion of NG tube</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion of airway</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dental procedures</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓ (High-speed drills)</td>
</tr>
<tr>
<td>Suturing</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
3-15 When is personal protective equipment not required?
No protective equipment is needed for routine patient care (e.g. turning, feeding or washing a patient), unless the patient is nursed under transmission-based precautions.

3-16 Where should personal protective equipment be available?
PPE should be easily available in all clinical areas. They should be located close to the point-of-care to encourage high rates of staff compliance. If certain items of PPE, e.g. N95 respirators are locked away or not easily accessible, staff will not make the effort to use them. Alternatively, if an item of PPE is in short supply, staff will re-use single-use items, e.g. plastic aprons, which increases the risk of infection transmission.

3-17 What should be considered when purchasing personal protective equipment?
Only good quality PPE should be procured (ideally after consultation with the IPC practitioner). The purchase of low-quality items often ends up costing healthcare facilities more, since several items have to be used for a single task, e.g. gloves that tear easily. A variety of sizes of each type of PPE,

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Hand hygiene</th>
<th>Gloves</th>
<th>Aprons</th>
<th>Masks</th>
<th>Eye covers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central line insertion</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓ Sterile gown</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Urinary catheter</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>insertion</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibre-optic procedures</td>
<td>✓</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Delivery (labour)</td>
<td>✓</td>
<td>✓</td>
<td>✓ Sterile gown</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Surgery (clean and dirty)</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓ Sterile gown</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Lumbar puncture</td>
<td>✓</td>
<td>✓ Sterile</td>
<td>✓ Sterile gown</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
e.g. gloves, N95 respirators, will be needed to ensure that all staff can find a product that fits correctly. Consideration must also be made for staff members with latex allergy (powder-free gloves and alternative products, e.g. neoprene or nitrile gloves should be available).

3-18 How should IPC be involved in personal protective equipment procurement?

Ideally when new PPE products are introduced, the procurement department should send product samples to the IPC practitioner and clinicians for evaluation. Based on the feedback from IPC and the clinical users, the procurement department should consider all factors (quality, ease of use, availability) and not only cost, before deciding on procurement and tenders. Where items already on tender are found to be defective or of poor quality, the IPC practitioner should report this to procurement and facility management.

Injection safety and re-use prevention devices

3-19 What is injection safety?

Injections are one of the most commonly used methods to deliver preventive or curative therapy, e.g. immunisations, intramuscular antibiotics and for obtaining blood samples for analysis. Injections can be given into several different spaces, e.g. intradermal, intramuscular, intravenous, intrathecal (by lumbar puncture) or into joint spaces. Injection safety is the over-arching term that refers to the prevention of infection transmission through elimination of unsafe injection practices.

Injection safety refers to the prevention of bacterial infection and blood-borne virus transmission through elimination of unsafe injection practices.
3-20 What is an unsafe injection?

An unsafe injection can include any of the following practices:

- Re-use of disposable (single-use) needles and syringes
- Drawing multiple doses into a syringe and injecting several patients consecutively
- Using a single syringe for multiple patients (changing the needle for each patient)
- Using multi-dose vials that are pierced by a single needle to draw up the contents
- Re-capping of needles
- Leaving contaminated sharps to be disposed of by someone else
- Separation of the needle and syringe before disposal
- Disposal of needles or syringes in general waste containers
- Attempted disinfection of needles or syringes (for re-use) with disinfectant, water or flames.

3-21 Which diseases are transmitted by unsafe injections?

The major infection risks from unsafe injections include:

- Bacterial or fungal infection (introduced from unsterile needles/syringes/fluids or through poorly cleaned skin prior to injection)
- Blood-borne virus infections, e.g. HIV, hepatitis B and C.

3-22 How large is the problem of unsafe injection practices?

The World Health Organization (WHO) estimates that globally up to four injections are administered per person every year. They estimate that up to 70% of injections given in low-income countries are unsafe. This leads to millions of exposures and infections especially with blood-borne viruses annually, most of which are undocumented.

Up to 70% of injections given in low-income countries are unsafe.
3-23 Which global programmes target the issue of injection safety?

The ‘Safe Injection Global Network’ (SIGN) is a WHO-affiliated partnership between multiple stakeholders worldwide that aims to achieve safe and appropriate use of injections. In the United States of America, the Centers for Disease Control (CDC) affiliated programme on injection safety is called ‘The One & Only Campaign’. These campaigns aim to promote the use of needles, syringes, and single-dose medication vials ‘only one time, for one patient’. Both the WHO and CDC have useful educational material and toolkits on injection safety available for download from their websites.

3-24 What are ‘safety-engineered’ and ‘re-use prevention’ devices?

Safety-engineered devices include:

- Devices designed to prevent re-use of needles or syringes
- Devices designed to prevent needlestick injury
- Devices designed to achieve both prevention of re-use and needlestick injury.

Safety-engineered devices reduce the risk of needlestick injury and re-use prevention devices discourage healthcare workers from recycling needles and syringes.

3-25 What types of safety-engineered and re-use prevention (RUP) devices are available?

Examples of safety-engineered devices for needlestick injury prevention include:

- Retractable lancets (the lancet disappears under a plastic hood after use)
- Retractable needles (the needle is pulled into injection chamber after use)
- Needle guards (a sleeve moves over the needle after use)
- Safety catheters (a metal cap moves over the tip of the stylet after the catheter is withdrawn).
Examples of RUP devices include:

- Fixed needles (the needle is permanently attached to the syringe, encouraging the user to discard them as a single unit)
- Auto-disable syringes (the plunger cannot be pulled out after use).

Care bundles

3-26 What is a care bundle?

Care bundles are a group of interrelated best practices used to prevent device- and procedure-related healthcare-associated infections, e.g. catheter-associated urinary tract and surgical site infections.

There is strong evidence of effectiveness for each element of a care bundle. Each bundle element can individually improve care, but when all elements are applied together, substantially greater reductions in infection rates are achieved. The focus of measurement is the completion of the entire bundle as a single intervention, rather than completion of individual elements, a so-called all-or-nothing approach.

In South Africa, the ‘Best Care Always’ campaign is involved in supporting bundle implementation in both public and private healthcare facilities.

A care bundle is a group of interrelated best practices used to prevent device- and procedure-related healthcare-associated infection.

3-27 What is the purpose of care bundles?

Care bundles provide a proven method to reduce specific types of healthcare-associated infections. These programmes are very effective in motivating, organising and encouraging communication among clinical teams around a specific problem, e.g. the staff of an intensive care unit or surgical ward.
3-28 Who should be involved in care bundle programmes?

When implementing a care bundle it is important to involve a multidisciplinary team, e.g. doctors, nursing staff, theatre staff, respiratory therapists (as appropriate to the specific bundle).

All stakeholders have to ‘buy-in’ to the process, as care bundles require the active participation and support of the entire healthcare team. Programmes built on team consensus are much more effective. It is very useful to identify a project champion, a recognised leader/expert who is actively involved in the clinical care of the individual ward or unit.

Implementation of a care bundle requires the active participation of the entire healthcare team on a particular ward or unit.

3-29 What types of care bundles exist?

The following bundles are commonly used in a variety of healthcare settings:

Device-associated bundles:

- Central line-associated bloodstream infection (CLABSI) bundle
- Ventilator-associated event (VAE) bundle
- Catheter-associated urinary tract infection (CA-UTI) bundle.

Procedure-associated bundles:

- Surgical site infection (SSI) bundle.

3-30 What is included in the central line-associated bloodstream infection (CLABSI) bundle?

The elements of the CLABSI bundle include:

1. Hand hygiene (during insertion and maintenance of the catheter)
2. Maximal barrier precautions upon insertion (the person inserting the catheter should wear a sterile gown, sterile gloves, hair cover and surgical mask with the patient covered with sterile drapes)
3. Optimal insertion site selection (the subclavian vein is the preferred insertion site, followed by jugular vein, with the inguinal vein being
least preferred because of microbial contamination of the surrounding skin)
4. Skin preparation with alcohol in 2% chlorhexidine gluconate (preferred over povidone iodine)
5. Daily review of line necessity (remove any line that is no longer needed)
6. Line maintenance (wear gloves when handling the line, swab the hubs with alcohol before accessing, change dressings as needed, change administration sets every 96 hours).

3-31 What is included in the ventilator-associated event (VAE) bundle?

The elements of the VAE bundle include:
1. Elevation of head of bed by 30–45 degrees (to reduce the risk of aspiration of secretions)
2. Periodic sedation vacations (stop sedatives intermittently to assess if the patient is ready for extubation)
3. Daily assessment of readiness to extubate
4. Peptic ulcer disease prophylaxis (not required in paediatrics)
5. Deep venous thrombosis prophylaxis (not required in paediatrics).

3-32 What is included in the catheter-associated urinary tract infection (CA-UTI) bundle?

The elements of the CA-UTI bundle include:
1. Avoid unnecessary urinary catheters
2. Insert urinary catheters using aseptic technique
3. Maintain urinary catheters based on recommended guidelines
4. Review urinary catheter necessity daily and remove as soon as possible.

Other important aspects of urinary catheter management (not part of the bundle) include:
- Using a single-use packet of sterile lubricant jelly for insertion
- Selecting the appropriate catheter size
• Securing the catheter well
• Maintaining a sterile closed system (do not allow the catheter bag to lie on the floor and do not lift the bag above the level of the bladder, otherwise urine will move back up the catheter).

3-33 What is included in the surgical site infection (SSI) bundle?

The elements of the SSI bundle include:

1. Antibiotic prophylaxis (administered in the hour before the first skin incision is made)
2. Skin preparation (ideally with alcohol in 2% chlorhexidine gluconate, preferred over povidone iodine)
3. Maintenance of postoperative normothermia (normal body temperature) and glucose control
4. Maintenance of normovolemia (normal hydration status).

Other important aspects in prevention of SSI (not part of the bundle) include:

• Get patients to do a chlorhexidine bath or shower before surgery
• Remove hair at the surgical site, only if necessary and preferably with clippers or depilatory agents. Razors should not be used for hair removal because they irritate or cut the skin and make it easier to develop an infection
• Thorough cleaning and sterilisation of surgical equipment (devices)
• Thorough cleaning and disinfection of the operating theatre environment between cases
• Traffic control in operating theatres
• Excellent adherence to hand hygiene (on the post-operative ward).

3-34 How is the bundle compliance rate measured?

Checklists are prepared for each bundle element. A witness verifies that each bundle element was complied with. The checklist is then scored as ‘compliant’ if all bundle elements were implemented or ‘non-compliant’ if any bundle elements were missing. Non-compliance to one element of the bundle means non-compliance to the whole bundle. The calculation of compliance is then performed as:
(Number of checklists that showed full compliance ÷ Total number of checklists) × 100

3-35 What is the effect of bundle compliance on infection rates?

As the bundle compliance rate increases, the healthcare-associated infection rate (for the specific infection event being monitored) should decrease.

Table 3-4: Example of bundle compliance (adapted from the Institute for Healthcare Improvement (IHI))

<table>
<thead>
<tr>
<th></th>
<th>March 2013</th>
<th>April 2013</th>
<th>May 2013</th>
<th>June 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTI bundle compliance (%)</td>
<td>30</td>
<td>23</td>
<td>68</td>
<td>88</td>
</tr>
<tr>
<td>CA-UTI rate</td>
<td>11.4</td>
<td>13.8</td>
<td>9.6</td>
<td>5.1</td>
</tr>
</tbody>
</table>

3-36 How are infection rates calculated for each care bundle?

A systematic surveillance system is needed for the specific infection type being targeted, e.g. surveillance for surgical site infections if the SSI bundle is being implemented. This will allow the clinical team to objectively measure the success of bundle implementation.

For device-related infections, a denominator (known as device days) must be counted and used in the calculation formula. The device days are counted as the number of patients with the indwelling device of interest (e.g. central catheters) in place for the period of interest (usually calculated monthly). For surgical site infections, the number of infections is usually divided by the total number of surgeries or type of surgeries during the chosen time period (month).

- CLABSI rate = (number of CLABSI events ÷ number of central line days) × 1000
- CA-UTI rate = (number of CA-UTI events ÷ number of urinary catheter days) × 1000
- VAE rate = (number of VAE events ÷ number of ventilator days) × 1000
- SSI rate = (number of SSI ÷ number of surgeries) × 1000

An example of a calculation of the CA-UTI rate for a Urology Ward in September 2013 follows.
Five patients developed a CA-UTI (physician and/or laboratory confirmed UTI were included in the surveillance programme). A total of 290 urinary catheter days were counted (30 patients had a catheter in for six days each, 20 patients had a catheter in for five days each, one patient had a catheter in for 10 days = 290). The formula to calculate the CA-UTI rate is:

\[
\text{CA-UTI rate} = \left( \frac{5 \text{ CA-UTI events}}{290 \text{ urinary catheter days}} \right) \times 1000 = 17.2 \text{ CA-UTI per 1000 catheter days}
\]

3-37 How successful are care bundles in reducing healthcare-associated infection rates?

In both high-income and low-resource settings, there is ample published evidence that properly implemented care bundles are very effective at reducing infection rates. The most common infection across all healthcare settings are CA-UTI, so improvements in this area can result in substantial cost savings for facilities. The infections associated with highest mortality are CLABSI and VAE, so implementation of these bundles, particularly in intensive care settings can improve overall patient outcomes and save costs.

Well-implemented care bundles can reduce infections, mortality and healthcare costs, even in low-resource settings.

3-38 What challenges may be encountered when implementing care bundles?

Implementing a care bundle is not an easy task and requires a team effort. Common challenges to programme implementation and sustainability are:

- Lack of accountability: there may be a gap between established guidelines and what is practised in reality in a particular unit or facility
- Fear of or resistance to change: staff are often reluctant to change existing practices
- Communication breakdown: implementation of such a project needs to be discussed with all stakeholders, and regular feedback to encourage staff efforts is essential
- Lack of staff commitment: care bundles take a lot of time and effort to sustain and some staff see these programmes as just an additional work burden
- Sustaining the new and additional practices: there is often an initial enthusiasm for the project, but as months pass it becomes more difficult to sustain the staff’s interest and commitment to the project
- Leadership for change: strong leadership and identified project champions (clinical and managerial) are important
- A culture of safety: staff need to realise that infection is not an inevitable consequence of care.

**Case study 1**

A child is admitted to the paediatric ward with gastroenteritis and a diagnosis of rotavirus infection is confirmed on stool analysis. The IPC practitioner is made aware of the situation and she advises the ward staff to follow strict standard and transmission-based precautions.

1. **Which type of precautions should be adopted in patients with rotavirus gastroenteritis?**

   Patient isolation, standard precautions, contact AND droplet precautions should be implemented for rotavirus gastroenteritis. Rotavirus is one of several communicable diseases that have more than one route of transmission.

2. **Which standard precautions should be implemented to prevent the rapid spread of infection in the paediatric ward?**

   Handwashing with soap and water or a sufficient amount of alcohol handrub may be used before and after touching the patient. Personal protective equipment (for contact and droplet transmission) should be worn. Terminal cleaning and disinfection of the environment and equipment will be required.
3. What are the key elements of contact precautions for such cases?

- Use clean, non-sterile gloves for all episodes of direct patient contact
- Change the gloves after each patient contact
- Use gowns (disposable or re-washable) or disposable aprons for each patient contact
- Use dedicated specific equipment for a single patient
- Limit patient contact with other patients by isolating the child OR
- Cohort the patient in a room with other patients who have rotavirus infection.

Case study 2

A nurse giving an injection to an ICU patient from a multi-dose vial is pricked while re-capping the needle. He washes the blood off his hand with soap and running water. He immediately tries to find out the patient’s HIV- and hepatitis B and C status.

1. Why is it essential to know the patient’s HIV- and hepatitis status?

The contaminated syringe might transmit blood-borne viruses including hepatitis B, C and HIV.

2. What precautions should the nurse have taken to avoid this incident?

Used needles should not be re-capped. They should be immediately disposed of in a puncture-proof sharps box located within arm’s reach of the procedure.

3. What are the prerequisites to make the healthcare workplace safer?

1. Plan for safe handling and disposal before beginning any procedure using needles
2. Modify the work practices that pose a needlestick injury hazard
3. Promote safety awareness in the work environment.

4. What precautions should be adopted to avoid contamination of multi-dose vials?
   - A new needle and syringe should be used every time the contents of a multi-dose vial are withdrawn.
   - The multi-dose vial cap (septum) should be disinfected with an alcohol swab prior to piercing.

Case study 3

An obstetric patient with obstructed labour had to undergo Caesarean section. After three days, a purulent (pussy) discharge was observed at the wound site. Bacteriological culture showed the growth of methicillin-resistant Staphylococcus aureus, which was successfully treated with antibiotics.

1. Which factors influence the risk of surgical site infection?
   - The duration of an operation
   - The patient’s pre-operative physical status
   - Pre-operative antibiotics within one hour of primary skin incision
   - Microbial contamination of the surgical site
   - Pre-operative skin preparation.

2. What can the healthcare workers do to reduce the risk of surgical site infection?

Comply with good surgical practice:
   - Take care to clean the hands and arms up to their elbows with an antiseptic agent just before the surgery
   - Wear personal protective equipment (PPE) consistently and properly – hair covers, masks, gowns, and gloves during surgery
   - Keep the surgery area clean
   - Practise good hand hygiene on the ward.
3. What additional precautions should be taken to prevent surgical site infection?

- Get patients to do a chlorhexidine bath or shower before surgery
- Clean the skin site with an antimicrobial agent
- Remove pubic hair at the surgical site, only if necessary and preferably with clippers or depilatory agents. Razors should not be used for hair removal because they irritate or cut the skin and make it easier to develop an infection
- Ensure diabetic patients have good blood glucose control in the peri-operative period.

4. What practices and policies should be followed to prevent surgical site infection?

- Thorough cleaning and sterilisation of equipment
- Thorough cleaning and disinfection of the operating theatre environment
- Traffic control in operating theatres
- Maintain operating theatre under positive pressure ventilation
- The operative site should be prepared and disinfected properly
- Adherence to hand hygiene should be strictly followed.

Case study 4

A patient admitted in the critical care unit with haemorrhagic stroke needed to have a urinary catheter inserted. After 48 hours he reports symptoms of a urinary tract infection. His doctor sends a urine sample for culture. A pathogen is cultured and the patient’s infection is successfully treated with antibiotics. The patient’s overall condition improves and his urinary catheter is later removed.

1. What could his healthcare workers have implemented to prevent the urinary tract infection?

The catheter-associated urinary tract infection (CA-UTI) care bundle should have been implemented to reduce the risk of catheter-related infections.
2. **What elements are included in the CA-UTI bundle?**
   - Avoid unnecessary urinary catheters
   - Insert urinary catheters using aseptic technique
   - Maintain urinary catheters based on recommended guidelines
   - Review urinary catheter necessity daily and remove promptly.

3. **What other factors are important for preventing CA-UTI?**
   - Practise hand hygiene immediately before insertion of the catheter
   - Practise hand hygiene before and after any manipulation of the catheter site or apparatus
   - Use gloves, a drape, and antiseptic solution for cleaning the urethral meatus
   - Use a single-use packet of sterile lubricant jelly for insertion
   - Select the appropriate catheter size and technique for catheter insertion
   - Secure the catheter well
   - Maintain a sterile closed system
   - Do not allow the catheter bag to lie on the floor and do not lift the bag above the level of the bladder (otherwise urine will move back up the catheter).

4. **Who is responsible for implementing the care bundles?**
   The IPC practitioner together with clinicians should provide education about the benefits of care bundles and the ward staff should ensure implementation and compliance with all bundle elements.
Hand hygiene

Objectives

When you have completed this chapter you should:

- Understand the importance of hand hygiene in infection prevention
- Be aware of different methods for performing hand hygiene
- Be able to describe the ideal facilities required for hand hygiene
- Understand the factors that impact on hand hygiene compliance
- Know how to measure hand hygiene compliance
- Be familiar with interventions to improve hand hygiene compliance rates.

Infection transmission via hands

4-1 What is the main route of infection transmission in healthcare?

The majority of micro-organisms causing healthcare-associated infections are transmitted to patients on the hands of healthcare workers. Indirect contact (with for example healthcare equipment and the patient environment) may also result in infection transmission. Respiratory transmission (both airborne and droplet) also occurs but much less frequently. However, respiratory pathogens can be transferred from contaminated surfaces to patients on healthcare workers’ hands.

The main vehicle for transmitting infectious pathogens in healthcare settings is the contaminated hands of healthcare workers.
4-2 What types of infections can be transmitted via hands?

Bacteria and fungi are the main micro-organisms transmitted to patients on the hands of healthcare workers. Certain viruses (for example influenza, rotavirus and chickenpox) can also be transmitted from person-to-person via hands (following transfer from contaminated surfaces). Parasites may occasionally be transmitted via contaminated hands (e.g. eggs from intestinal worms and scabies mites).

4-3 How long are bacteria carried on the hands?

Micro-organisms found on human skin are classified as transient or resident flora. Transient skin flora is found on the surface layers (epidermis). They are easily transmitted through physical contact between patients, healthcare workers and the healthcare environment. Transient flora is usually carried on the skin for a short time only and is easily removed by proper hand hygiene by the action of rubbing. Resident flora live in the deeper skin layers (dermis) and are more difficult to remove.

Introduction to hand hygiene

4-4 What is hand hygiene?

Hand hygiene is one of the most important ways to reduce the transmission of infections in healthcare settings. Included in the term hand hygiene is any activity that reduces the level of contamination with micro-organisms, for example handwashing, antiseptic handwash, alcohol-based handrub and surgical hand scrub.

4-5 When was hand hygiene first recognised as a way to prevent infection transmission?

In 1846 an Austrian obstetrician named Ignaz Semmelweis recognised that a type of maternal infection (puerperal sepsis) could be prevented if nurses
and doctors washed their hands in a chlorine solution before attending deliveries.

**4-6 How does hand hygiene reduce infection risk?**

The physical action of handwashing (friction, rinsing and drying) helps to remove and kill many transient flora from the superficial layers of the skin. The use of antiseptic handwash products, e.g. alcohol-based handrubs or medicated soaps, result in further chemical killing or inhibition of micro-organisms. By reducing the load of micro-organisms on a healthcare worker’s hands, the risk of infection transmission to the patient is reduced.

**4-7 Is hand hygiene as effective in healthcare workers who wear jewellery?**

No, it is not possible to perform adequate hand hygiene while wearing rings, bracelets or wristwatches. The skin under these items is very heavily colonised with micro-organisms that cannot be removed easily. Healthcare workers should be discouraged from wearing any of these items whilst on duty.

**4-8 Is hand hygiene as effective in healthcare workers who wear nail polish or artificial nails?**

The area around and under the fingernails has the highest concentration of micro-organisms and is also the most difficult to adequately clean during performance of hand hygiene. Long nails, nail polish and artificial nails all make it more difficult to perform adequate hand hygiene and probably increase the likelihood of transferring micro-organisms.

**Long nails, nail polish, artificial nails and the wearing of jewellery prevent the healthcare worker from performing proper hand hygiene.**

**4-9 How should healthcare workers care for their hands?**

In some settings (e.g. intensive care units), healthcare workers may be required to perform hand hygiene up to 20 times per hour! Frequent hand
washing and/or use of skin antiseptics may cause skin irritation or drying. To avoid skin irritation healthcare workers should use non-irritant hand hygiene products, avoid using excessively hot water, pat hands dry rather than rubbing and keep their hands well moisturised.

4-10 What precautions should healthcare workers take when they have skin lesions?

Damaged or broken skin (for example eczema or skin wounds) harbours much higher levels of micro-organisms and can more easily transmit infections. Ideally, healthcare workers with extensive skin damage should not provide patient care until their lesions are healed. Smaller lesions should be covered with a waterproof (occlusive) dressing.

Principles of hand hygiene

4-11 When should hand hygiene be performed in everyday life?

Routine (social) handwashing for all individuals is recommended before preparing food, before eating, and after using the toilet or changing babies’ nappies/diapers.

4-12 What are the ‘WHO Five Moments for Hand Hygiene’?

The World Health Organization (WHO) has identified five times when hand hygiene should be performed by healthcare workers. These times have been named the ‘WHO Five Moments for Hand Hygiene’ and form part of a global hand hygiene awareness initiative for healthcare workers. The five moments include:

- Before patient contact
- Before an aseptic task/procedure
- After exposure to body fluids
- After patient contact
- After contact with the patient’s surroundings.

The last of the five moments, after contact with the patient’s surroundings, is the hand hygiene opportunity that is most often missed or not clearly
understood by healthcare workers. The healthcare environment includes anything in the immediate patient’s surroundings (e.g. heart/saturation monitors, patient charts, bedside tables). Healthcare workers should take particular care to perform hand hygiene after touching these objects or surfaces.

The ‘WHO Five Moments for Hand Hygiene’ are a reminder of when hand hygiene should be performed by healthcare workers.

4-13 What methods of hand hygiene are available to healthcare workers?

Several methods are available:

- Routine handwashing with ordinary soap or antimicrobial soap and water for at least 40–60 seconds
- Alcohol-based handrub, applied over the entire hand surface area and remaining wet for at least 15 seconds and then allowed to dry completely (20–30 seconds altogether)
- Surgical hand decontamination with an antimicrobial soap and water for 3–5 minutes.

Alcohol-based handrubs are the most effective, quickest and most convenient method of hand hygiene available.

4-14 What are the advantages and disadvantages of different hand hygiene methods?

Routine handwashing with ordinary soap and water physically removes dirt, debris and transient micro-organisms, but has no ongoing bacterial killing activity. Antimicrobial soaps have limited residual bacterial killing activity. Both ordinary and antimicrobial soap require a handwash basin/sink, with running water and supplies for hand drying.

Alcohol handrubs have fast action and the greatest killing ability against a wide range of micro-organisms, but do not remove dirt/debris. The advantages of alcohol handrub include portability (small spray-bottles of
personal handrub can be carried by healthcare workers) and that it eliminates the need for handwash basins, water and hand drying supplies. A disadvantage of alcohol-based handrub is that it is flammable and can cause skin dryness. Allergies to particular alcohol handrubs can occur, but are infrequent.

4-15 What areas of the hand are most frequently missed during hand hygiene?

The fingertips, thumbs and little finger are commonly missed areas when performing hand hygiene. The correct technique for handwashing should be demonstrated to all new healthcare workers and reinforced for existing staff through the use of hand hygiene posters (available from the WHO website).

4-16 Why is it not acceptable to use gloves instead of performing hand hygiene?

Some healthcare workers use gloves to avoid having to perform hand hygiene. Besides the extra costs of using personal protective equipment inappropriately, micro-organisms can be transferred through microscopic perforations (holes) in the gloves onto the healthcare worker’s hands. If hand hygiene is not performed after glove removal, the healthcare worker’s contaminated hands can then transfer micro-organisms to the next patient or patient environment.

It is not acceptable to use gloves to replace hand hygiene since micro-organisms can still be transferred through pores in the gloves.

4-17 When should gloves be used?

Healthcare workers should use ordinary, clean gloves when direct contact with blood, body fluids, respiratory secretions, mucous membranes and non-intact skin is anticipated.

Sterile gloves should be worn for any aseptic task, e.g. inserting a urinary catheter or performing a lumbar puncture.
There is no need to wear gloves for routine patient care, e.g. turning, feeding or bathing a patient. All gloves are for single-use only and should never be washed or used while caring for multiple patients. Gloves should be changed between each patient, when dirty or contaminated and when moving from a contaminated body area to a ‘clean’ area of the same patient.

**Alcohol-based handrubs**

4-18 **When is it acceptable to use alcohol handrub instead of soap and water?**

In almost all instances it is preferable to use alcohol handrub, rather than soap and water. The entire handrub procedure is much faster than hand-washing, less drying to the skin and alcohol achieves better and faster bacterial killing. Alcohol handrub should not be used if hands are visibly soiled with dirt, blood or body fluids, or after potential exposure to spore-forming pathogens (e.g. *Clostridium difficile*). If one has washed hands with soap and water, it is unnecessary to use alcohol handrub in addition.

4-19 **How does alcohol handrub work?**

Alcohol penetrates the cell membrane of bacteria and fungi or the viral envelope, causing damage (denaturing) of the micro-organisms’ genetic material and thereby killing the micro-organism. It is important to note though that to achieve maximal killing, the alcohol must be in contact with the skin at sufficient concentrations, and must be allowed to dry.

4-20 **What strength of alcohol is needed?**

The WHO recommends alcohol formulations with at least 60–80% alcohol content, as this concentration is most effective at killing micro-organisms.

4-21 **What types of alcohol formulations are available?**

Several different types of alcohol can be used in the production of alcohol handrub, e.g. isopropanol (preferred), ethanol and n-propanol. Emollients (moisturising agents) such as glycerol should be added to reduce the drying
and damaging effect of alcohol on the skin. The use of additional disinfectants added to alcohol (e.g. alcohol with chlorhexidine gluconate) is only recommended for skin antisepsis of patients prior to a procedure or surgery.

4-22 When can you NOT use alcohol handrub?

Alcohol handrub should not be used if hands are visibly soiled with dirt, blood or body fluids. In addition, alcohol is not effective at killing bacterial spores and less effective at killing certain types of viruses (non-enveloped viruses, e.g. noro- and rotavirus). In patients with Clostridium difficile infection (a spore-forming bacterium that causes severe gastrointestinal disease), staff should wash hands with soap and water. There is evidence that alcohol handrubs (with concentrations above 60% alcohol) are still better than soap and water for killing gastrointestinal, non-enveloped viruses.

**Facilities for optimal hand hygiene**

4-23 Where should alcohol handrub be made available?

Alcohol handrub should ideally be provided at the point of care – in other words at the place where hand hygiene needs to be performed. This could be at the patient’s bedside, next to the examination couch, at the entrance/exit to the room or carried on the healthcare worker himself/herself. The closer the handrub is to the point of care, the more likely the healthcare worker will be to use it.

4-24 Is it safe to decant or top-up handrub or handwash solutions?

No, the permanent ‘old’ bottles of soap at the sinks and alcohol handrub become contaminated with micro-organisms over time. New handrub
solution being poured into these bottles can then also be contaminated with micro-organisms.

4-25 Where should handwash facilities be placed?

The location of handwash facilities is also critically important to encourage hand hygiene compliance. The following are examples of where handwash basins are needed:

- At the entrance of all wards and clinical areas
- Inside each patient room (ideally one basin for every 4–6 beds)
- Inside all patient en suite bathrooms
- Inside treatment rooms and physical examination rooms
- Inside any room with a toilet
- Inside or close to each nursing station
- Inside each dirty utility room (in addition to sinks)
- Inside the dirty linen holding area
- Inside or close to the staff lounge
- Inside all isolation rooms
- Inside the medication room
- Inside any room where food is handled/prepared (hospital kitchen, ward kitchen, breast milk and baby formula handling areas)
- Close to each laboratory work station
- Inside each clinical laboratory and morgue
- In areas where hands are likely to be contaminated – storage and disposal areas.

4-26 What specifications are needed for the ideal handwash station?

The ideal handwash station should be located close to the point-of-care. Handwash stations should be dedicated for handwashing only and so should not have plugs (to discourage use of the basin for washing items). The water stream should not be aligned with the water outlet/drain so as to prevent splash-back. Lukewarm, running water should be provided preferably through elbow-operated or ‘no touch’ taps. Liquid soap and paper towels are preferred. Pedal-operated ‘no touch’ waste bins are ideal to prevent re-contamination of hands. A laminated poster with instructions on how to handwash effectively should be placed above the sink.
Hand hygiene compliance

4-27 Which factors increase hand hygiene compliance?
The following activities and strategies have been shown to be effective in increasing healthcare workers’ compliance with hand hygiene:

- Staff and patient education
- Routine observation and feedback
- Making hand hygiene possible, easy and convenient
- Making alcohol-based handrub available
- Reminders in the workplace (posters, campaigns)
- Administrative sanctions and rewards
- Maintaining an institutional patient safety climate (where all healthcare workers are individually accountable for adverse events like healthcare-associated infections).

Education, compliance monitoring and provision of acceptable hand hygiene products are the most effective ways to improve hand hygiene compliance rates.

4-28 Which factors reduce hand hygiene compliance?
Healthcare workers’ compliance with hand hygiene is reduced when there is patient overcrowding, understaffing and an excessive workload. In such circumstances, provision of personal alcohol handrub (to be carried by all healthcare workers) can make a substantial impact on hand hygiene compliance rates. The most common reasons cited by healthcare workers for poor compliance with hand hygiene are: being too busy, skin irritation caused by handwashing and preference for using gloves instead of handwashing.

4-29 What tools are available to monitor and measure hand hygiene compliance?
The best way to establish your healthcare facility’s overall hand hygiene compliance rates is to directly observe healthcare workers during routine
clinical care. There are many tools and forms available for monitoring and scoring hand hygiene compliance (see addendum). An alternative indirect monitoring method is to record and track the consumption of hand hygiene supplies, e.g. amount of alcohol handrub used in a month divided by the average number of staff members per ward.

4-30 How often should audits of hand hygiene compliance be performed?

Ideally each ward/clinical area should be audited six-monthly with the results of their hand hygiene compliance made available to the staff and facility managers. Some healthcare facilities run regular hand hygiene campaigns which include awards and incentives for areas with the highest average hand hygiene compliance scores.

4-31 How should healthcare workers be educated about hand hygiene?

The challenge in teaching healthcare workers about hand hygiene is that they often already believe they know everything about the topic! Infection control staff may have to be creative and innovative to find new ways of presenting the information to their colleagues. Although regular hand hygiene campaigns or awareness days are important, daily workplace reminders are also effective. These include posters, regular audit or spot checks with feedback to staff and managers. Finding senior, well-respected nursing and medical staff to act as hand hygiene ‘champions’ or ambassadors may also be fruitful. It is especially important to include medical staff (physicians/doctors) as a specific target group in hand hygiene campaigns, as this group has consistently lower hand hygiene compliance rates documented in the medical literature. Another useful strategy may be pairing up staff members in a so-called hand hygiene ‘buddies’ campaign, where individuals remind one another when they spot missed opportunities for hand hygiene.
Figure 4-1: 5 moments for hand hygiene (adapted for low-data access from WHO/World Alliance for Patient Safety materials.)

1. **Before Patient Contact**: When? Clean your hands before touching a patient when approaching them. Why? To protect the patient against harmful germs carried on your hands.

2. **Before Aseptic Task**: When? Clean your hands immediately before any aseptic task. Why? To protect the patient against harmful germs, including the patient’s own germs, entering their body.


5. **After Contact with Patient Surroundings**: When? Clean your hands after touching any object or furniture in the patient’s immediate surroundings, when leaving - even without touching the patient germs.
How to handwash?

HAND HYGIENE

WASH HANDS ONLY WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB!

Duration of the entire procedure: 40–60 seconds

0. Wet hands with water
1. Apply enough soap to cover all hand surfaces
2. Rub hands palm to palm
3. Right palm over left dorsum with interlaced fingers and vice versa.
4. Palm to palm with fingers interlaced
5. Backs of fingers to opposing palms with fingers interlocked
6. Rotational rubbing of left thumb clasped in right palm and vice versa
7. Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa
8. Rinse hands with water
9. Dry thoroughly with a single-use towel
10. Use towel to turn off faucet
11. And your hands are safe

How to handrub?

RUB HANDS FOR HAND HYGIENE! WASH HANDS ONLY WHEN VISIBLE SOILED!

Duration of the entire procedure: 20-30 seconds

1a Apply a palmful of the product in a cupped hand and cover all surfaces

1b Rub hands palm to palm

2 Right palm over left dorsal with interlaced fingers and vice versa

3 Palm to palm with fingers interlaced

4 Backs of fingers to opposing palms with fingers interlocked

5 Rotational rubbing of left hand with clamped fingers and vice versa

6 Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa

7 Once dry, your hands are safe

8


Figure 4-3: How to handrub (adapted for low-data access from WHO/World Alliance for Patient Safety materials.)
Case study 1

A doctor visits a patient’s room to perform a bedside examination. He opens the door, stands in front of the patient’s bed, leaning on the bed rails. He asks the patient if he feels pain and examines his abdomen. After completing the clinical examination he washes his hands in the sink with soap and water. He makes notes in the patient’s chart and then leaves the room.

1. Was the doctor compliant with good hand hygiene practice?
No, he missed several opportunities for hand hygiene.

2. Which of the ‘WHO five moments for hand hygiene’ did he miss?
He failed to perform hand hygiene before touching the patient and after contact with the patient environment (after he made notes in the patient’s chart).

3. Was the soap and water the most appropriate method of hand hygiene?
No, the most effective and fastest method of hand hygiene is alcohol-based handrub. It is also the friendliest method for the hands, as it is less irritating. Washing with soap and water is indicated only when hands are visibly dirty, contaminated, or soiled.

Case study 2

A nurse visits a patient to change the gauze dressing of the central catheter in his chest. Before she touches the patient she cleans her hands with the alcohol-based rub. She removes the old gauze and cleans the wound. She suddenly realises that she forgot to bring new gauze, so she leaves the room to fetch some from the nursing station. She enters the room again and places the gauze on the patient’s chest. She again cleans her hands with alcohol handrub, because she notices blood from the wound on her hands.
1. Which hand hygiene practices did the nurse perform appropriately?
She cleaned her hands with alcohol handrub before she touched the patient.

2. Which practices did the nurse perform incorrectly during this wound dressing procedure?

- She did not have all the necessary equipment with her, so she had to leave the room during the procedure, increasing the chance of contaminating other areas.
- She did not clean her hands before leaving the room.
- Wound dressing is an aseptic procedure. She should have cleaned her hands and then put on sterile gloves to clean the site and place the new gauze.
- When she noticed the blood on her hands she should have washed with soap and water instead of alcohol handrub.

Case study 3

It is family visiting time in the neonatal intensive care unit. Parents enter the room and wash their hands. One of the mothers washes her hands with soap and water. She can’t find paper towels, so she doesn’t dry her hands. She picks up her baby and starts to feed him.

1. Is it necessary to dry hands after washing and before touching a patient?
Hand drying is an essential part of the handwashing process, as wet skin helps spread bacteria. Bacteria are more likely to be transferred from wet skin making proper hand drying an essential part of preventing healthcare-associated infections.
2. What is the best way to perform hand hygiene if there are no paper towels available?

Handrubbing with an alcohol-based rub is microbiologically more effective, saves time, does not require paper towels for hand drying and generates better compliance rates than handwashing with soap and water.

Case study 4

In the oncology unit the nurses decant supplies from new alcohol handrub bottles into permanent containers placed at each handwash sink. They do this because the replacement bottle is too large to be placed at the sink.

1. Is this practice safe?

No. The permanent ‘old’ bottles at the sinks can become contaminated. New handrub solution being poured into these bottles can then also be contaminated with micro-organisms.

2. How is it possible that micro-organisms can grow inside containers of alcohols?

Alcohol is effective in killing most, but not all, micro-organisms. Spore-forming bacteria like Clostridium difficile and some non-enveloped viruses are not killed by alcohol.
Infection prevention and control considerations for healthcare facility design

Objectives

When you have completed this chapter you should:

- Understand why IPC practitioners should be consulted when designing or renovating healthcare facilities
- Understand the role of the IPC practitioner in design/renovation projects
- Be familiar with IPC requirements for general wards and clinics
- Be familiar with IPC requirements for isolation areas
- Be familiar with IPC requirements for specialised areas
- Be familiar with IPC requirements for support services.

Healthcare facility design

5-1 What aspects should be considered when designing a new healthcare facility?

The main considerations include:

- The disease profile of the local community (burden of infectious disease)
- Location of the healthcare facility within easy access of population
- The size of the catchment area (population) that the facility will serve
- The type of services to be provided (e.g. primary care; specialised care).
5-2 Why should IPC practitioners be involved in healthcare facility design and renovation projects?

In many parts of the developed world, it is required by law that IPC practitioners are consulted before and during all healthcare facility design, building or renovation projects. The IPC practitioner’s involvement is essential to reduce healthcare-associated infection transmission (through good planning and design).

**IPC practitioners should be involved in healthcare facility design and renovation to incorporate design features that reduce healthcare-associated infection.**

5-3 How should IPC practitioners be involved in healthcare facility design or renovation projects?

The IPC practitioner should be involved very early in the planning phase, so that necessary design changes can be implemented before construction starts. The IPC practitioner’s role is to give input on how the design of clinical areas can support IPC practices and thereby reduce the risk of healthcare-associated infection transmission. The IPC team should attend regular construction site meetings to ensure that their recommendations have been applied. Before the new facility or renovated area is opened to patients, the IPC practitioner should inspect and approve the project’s IPC aspects.

**The IPC practitioner should be involved very early in the planning phase, so that necessary design changes can be implemented before construction starts.**

5-4 Which specific design areas should IPC practitioners advise on?

The IPC practitioner should advise on the following elements:

- Size of wards/clinical areas and space between beds
- Layout and position of waiting areas
- Ratio of isolation rooms to multi-bed rooms
• Toilet facility requirements
• Placement of IPC provisions (handwash basins; sluice rooms, etc.)
• Ward layout (the workflow in an area directly affects IPC practices)
• Ventilation requirements (for prevention of airborne transmission)
• Selection of fittings (surfaces, floors, doors, windows)
• Provision for sterile, clean and dirty storage
• Precautions needed for renovations (to prevent fungi and mould exposures).

The IPC practitioner should advise on isolation rooms, ventilation, layout and fittings.

General wards and clinics

5-5 What are the IPC requirements for general wards?

The basic requirements to ensure good infection control practice on general wards are:

• Sufficient space between beds to accommodate equipment/staff (at least 2.5 metres, measured from the centre of one bed to the centre of the next bed)
• Beds separated by curtains (both for privacy and for infection control during cough-generating procedures)
• Good natural ventilation or regularly maintained mechanical ventilation
• Provision of some isolation rooms, preferably with en suite bathrooms (at least 20% of all beds, and up to 40% of all beds in settings with high burden of infectious diseases)
• Sufficient toilets and bathrooms with handwashing facilities
• One dedicated handwash basin per room or per six beds
• Provision of alcohol handrub at entrances/exits and after every two beds
• Sharps containers on portable procedure trolleys or in high-care areas wall-mounted next to each bed
• Readily accessible personal protective equipment (at the entrance to rooms)
• Easy to clean and seamless surfaces (floors, walls)
Dedicated storage spaces for sterile, clean and used equipment, sterile and clean supplies, clean and used linen, cleaning equipment, waste holding

Sluice rooms within easy reach of clinical areas (with handwash basins)

Space for administrative areas, staff rest rooms, consultation rooms, kitchens.

5-6 What are the IPC requirements for outpatient departments (OPD) and primary care clinics?

The main infection transmission risks encountered in the outpatient setting include:

- Respiratory infections (viruses and TB): infectious and non-infectious patients congregate, often in poorly ventilated areas.
- Inadequate decontamination of shared equipment and re-use of single-use items.

To reduce these risks, the following are required:

- Good natural ventilation (in warm climates outdoor waiting areas are preferred).
- A triage system for identifying and separating potentially infectious patients. Patients with communicable respiratory infections, diarrhoeal disease and skin rashes can be identified early, separated from non-infectious patients and moved through the clinic system as quickly as possible to minimise staff and patient exposures. Many facilities use ‘cough officers’ to identify coughing patients, direct them to a separate waiting area and provide them with information on cough etiquette and hand hygiene.
- A separate cough room where patients can go to produce sputum samples (indoors or outdoors). The area must be adequately ventilated and have provision for hand hygiene.
- Sufficient toilet facilities with proper provision for hand hygiene (soap, water, paper towels).
- Appropriate personal protective equipment for staff (where indicated) and surgical masks for patients with pulmonary TB.
• Provision for hand hygiene as close as possible to point-of-care (personal alcohol handrub, bottles of alcohol handrub and handwash basins – one per consultation room).
• A dedicated, separate area for cleaning and sterilization of instruments. This should ideally be done in the nearest hospital’s central sterile services department (CSSD). In some circumstances, instruments may be manually cleaned, disinfected or sterilized on-site (using a boiler or desk-top sterilizer).
• Written standard operating procedures for decontamination of commonly used equipment (thermometers, saturation monitors, blood pressure cuffs).

The main infection transmission risks in clinics include respiratory infections and inadequate decontamination of shared equipment.

5-7 What are the IPC requirements for dental clinics?

There is a high risk of blood-borne virus transmission in dental services. Infection transmission to healthcare workers and/or patients can occur through:

• Penetrating injuries (needle-stick injury, bites)
• Mucosal splashes and aerosols (spit, high-speed drills)
• Inadequate sterilization (instruments, equipment).

To reduce these risks, the following are required:

• Individual treatment rooms/cubicles with sufficient space to accommodate a chair, patient, dentist, assistant and equipment
• A handwash basin inside each cubicle
• Good natural ventilation
• Appropriate personal protective equipment for staff (eye protection, mask, gloves)
• A dedicated, separate area for cleaning and sterilization of instruments (at a minimum: a sink to wash instruments, cleaning cloths and brushes, separate storage for clean and used instruments, a desktop sterilizer)
• Sufficient dental syringes, needles and dental trays
• Sharps containers at the point of use
• Written standard operating procedures for decontamination and adequately trained staff
• All dental staff should be immunised against hepatitis B.

There is high risk of blood-borne virus transmission in dental services through penetrating injuries, mucosal splashes and inadequate sterilization of instruments.

Isolation areas

5-8 What is the purpose of patient isolation rooms?

Patient isolation areas or isolation rooms are designed to:

• Separate infectious patients from susceptible patients
• Protect immunocompromised patients from potential exposure to harmful pathogens
• Provide directional air flow to prevent airborne organisms from flowing into other areas (by using mechanical ventilation).

Patient isolation areas are used to separate infectious patients from susceptible patients OR to protect immunocompromised patients from potential exposure to harmful pathogens.

5-9 How many patient isolation rooms does a facility require?

This will depend on the disease profile of the community and the burden of infectious diseases, e.g. TB. For most low-resource settings (where infectious disease burden is high), at least 20% of all beds should be isolation rooms (up to 40% in settings with a high burden of infectious diseases).

5-10 What are the IPC requirements for patient isolation areas?

Many countries have laws or building recommendations that prescribe the minimum requirements for isolation rooms/cubicles. These should include:

• Adequate floor space (at least 18 m², excluding toilets, cupboards)
• Adequate ventilation (either natural or mechanical negative pressure at 6–12 air changes per hour
• A door that is kept closed at all times (preferably with a patient observation window so that the patient can be seen without the need to open the door)
• A clinical handwash basin inside the room
• An en suite toilet and bathroom (so the patient does not leave the room)
• Storage space for the patient’s personal items
• Easy to clean surfaces (no carpets, preferably no curtains)
• Space for provision of personal protective equipment at the entrance to the room
• Ideally isolation rooms should be located at the far end of a ward (this avoids heavy traffic passing the isolation room, and limits potential exposures).

Minimum IPC requirements for isolation areas are a single room, a door that can be closed, a hand washbasin inside the room or alcohol-based hand rub available and a window that can open.

Specialised areas

5-11 What infection transmission risks are encountered in operating theatres?

The following factors in operating theatres increase the risk of surgical site infections:

• Inadequate ventilation: skin scales and aerosols from both the operating staff and patient (containing micro-organisms) may contaminate the surgical field.
• Inadequate temperature control: in hot climates, sweat from the surgical staff may contaminate the surgical field.
• Inadequate decontamination of surgical equipment: poorly processed equipment poses a serious risk of infection transmission (including blood-borne viruses).
• Inadequate surgical site antisepsis or poor aseptic technique.
• Inadequate hand hygiene or surgical handscrub.

Inadequate ventilation, temperature control, equipment decontamination and antisepsis are the main risk factors for infections arising in the operating theatre.

5-12 What are the IPC requirements for operating theatres (OT)?

The design of an operating theatre complex should minimise the risk of surgical site infections (factors listed above).

• Ventilation: The operating theatre should be mechanically ventilated under positive pressure (all windows should remain closed). Air handling units should achieve at least 20 air changes per hour. The air supply should pass through a series of filters (to remove particles) before being delivered into the theatre. Certain types of surgery, e.g. implants or orthopaedics, require specialised ventilation (ultra-clean).
• Air-conditioning: For both patient safety and staff comfort, the temperature in the operating theatre should be kept between 18–24 °C.
• Decontamination: All surgical devices should be sterilized in a sterile services department with validated processes and controlled procedures in place.
• Zoning: the design and layout of the operating theatre complex should provide for easy access to hand hygiene in all areas and provide sufficient space to create a partial barrier between well-demarcated ‘clean’ and ‘sterile’ zones.

5-13 What are the IPC requirements for intensive care units (ICU)?

Intensive care units (ICU) admit patients requiring extensive medical or surgical supportive care. ICU’s usually record the highest rates of healthcare-associated infection (HAI) rates in a facility. This is because they care for immunocompromised patients, with many indwelling devices and invasive procedures and also use antibiotics extensively.
To reduce these risks, the following are required:

- Sufficient space between beds to accommodate equipment/staff (at least 3.5 metres, measured from the centre of one bed to the centre of the next bed).
- Good natural ventilation is preferred. Where available, mechanical ventilation with negative pressure or wall-mounted extractor fans may be used for isolation areas, neutral pressure for other areas).
- Provision of some isolation rooms (at least 10% of all ICU beds, more in settings with high infectious disease burden).
- One dedicated handwash basin per ICU bed (or at maximum one per four beds).
- Provision of alcohol handrub at entrances/exits and every bed.
- Sharps containers near each bed (within easy reach).
- Readily accessible personal protective equipment (at the entrance to rooms).
- Regular training of clinical staff on infection control techniques (hand hygiene, aseptic procedures).
- Proper decontamination of shared equipment.

ICUs have high healthcare-associated infection rates because they care for immunocompromised patients, with many indwelling devices, invasive procedures and high antibiotic usage.

5-14 What are the IPC requirements for emergency and trauma departments?

Most emergency units are very busy places, with frequent admission of patients requiring resuscitation:

- Provision of sufficient space around each bed (bay) is essential. Ward design or layout is also critical to ensure easy workflow.
- Easy access to handwash basins, alcohol handrub (preferred as it saves time), sharps containers and personal protective equipment is important.
• It is useful to have some dedicated isolation spaces (bays) for patients with suspected respiratory-transmissible illness.
• Negative pressure (mechanical) ventilation is ideal, but good natural ventilation is acceptable.

5-15 What are the IPC requirements for burns wards?

Burns patients are at extremely high risk of wound colonisation and/or infection, owing to the disruption of skin integrity and transient immune-suppression. They are also at high risk of invasive infections, e.g. bloodstream infections or device-associated infections. Most burns infections are caused by direct or indirect contact with healthcare staff (hands), equipment and the environment.

To reduce these risks, the following are required:

• Isolation rooms for patients with multi-drug-resistant infections
• Mechanical ventilation is preferred in high-care areas, otherwise good natural ventilation
• Dedicated handwash basins close to each bed
• Written standard operating procedures (SOPs) for decontamination of equipment and environmental cleaning, with regular checks on adequacy of cleaning/decontamination
• Minimal clutter, separated ‘clean’ and ‘dirty’ areas of the ward, to minimise contamination of clean supplies
• Provision for wound cleaning procedures such as special shower/bath facilities or beds
• Sufficient personal protective equipment for staff (gloves, aprons, masks as indicated).

5-16 What are the IPC requirements for dialysis units?

The major risks for infection transmission in dialysis units arise from:

• Poorly maintained dialysis machines: depending on the type of machine, may require daily rinsing and disinfection or cleaning after each use. The filter or dialysis membrane (to prevent passage of pathogens) should be verified as intact before each use.
• Poor environmental cleanliness: all surfaces with body fluid spills or leakages should be appropriately disinfected. For the rest of the dialysis unit environment, standard cleaning protocols may be followed.
• Dialysis fluid contamination: many different types of fluids are utilised and sterility checks at prescribed intervals should be included in the dialysis unit’s standard operating procedures (SOP).
• Poor aseptic technique when the patients are linked to the machines.

5-17 What are the IPC requirements for neonatal wards?

Neonatal wards are generally busy, overcrowded units providing specialised care to very vulnerable (usually premature and low-birth-weight) babies. Healthcare-associated infections and outbreaks in neonatal units often result in high mortality and serious morbidity. For these reasons, clear protocols and sufficient provisions for infection control are needed. The following aspects should be considered:

• Hand hygiene: sufficient handwash basins and alcohol handrub (placed at point of care).
• Isolation: at least one isolation room for every 10 patients, preferably en suite (to prevent the baby’s mother, who may also be colonised or infected, from leaving the room).
• Spacing: adequate space for staff and parents to move between cots or incubators. Overcrowding and staff shortages are often contributing factors in neonatal ward outbreaks.
• Waiting area: for family members to wait in before being informed of the ward protocol.
• Protocols: clear explanations and training of staff on procedures such as decontamination of equipment, incubators/cots, milk feed preparation and management of expressed breast milk.
• Maternal screening protocols: in Kangaroo Mother Care (KMC) wards, where mothers remain in hospital with their babies, all mothers should be symptom screened for TB, diarrhoea/vomiting and flu-like illnesses.

Infections and outbreaks in neonatal units result in high mortality. Clear protocols and sufficient provisions for infection control are needed.
5-18 What are the IPC requirements for milk preparation areas (milk kitchens)?

In neonatal and paediatric wards, infant formula is often prepared on the ward or in a designated ‘milk kitchen’ nearby. This should be considered a high-risk area for microbial contamination during feed preparation, storage and sterilization of bottles. To reduce these risks, the following are required:

- Handwash basin with soap, water and paper towels
- Facilities to wash bottles and formula preparation equipment
- Provision for high-level disinfection and drying of bottles and teats (using either heat, microwave or chemical disinfection with hypochlorite at 125 parts per million available chlorine)
- Plastic aprons for staff preparing batches of formula
- Facilities to boil water
- Storage area for feed supplements, measures and mixing containers
- A dedicated, functional refrigerator for prepared formula feeds (stored at 4–6 °C and used within 24 hours of preparation)
- Facilities for waste disposal
- A register to document the patients receiving formula feeds.

Milk kitchens are considered high-risk areas for microbial contamination during feed preparation, storage and sterilization of bottles.

5-19 What are the IPC requirements for handling of expressed breast milk (EBM)?

In babies mistakenly fed EBM from an HIV-, hepatitis-B/C-infected mother, there is significant risk of blood-borne virus transmission. To avoid this unfortunate occurrence, strict procedures are needed for the management of EBM:

- The importance of hand hygiene should be emphasised and the correct hand hygiene technique should be demonstrated to new mothers
- Ideally a quiet, private room should be provided for mothers to express in
- A sterile plastic container or jar in which to express breast milk should be provided
After EBM is produced, the jar should be labelled (by a staff member in the presence of the mother) with the mother’s name, infant’s name and hospital number, the date and time EBM was produced.

EBM should be stored at 4–6 °C in a dedicated milk refrigerator and used within 24 hours (alternatively EBM can be stored frozen for up to one month).

In the case of HIV-infected mothers who wish to give EBM or where pooled breast milk is used, facilities for pasteurisation should be provided (pasteurisation involves exposing EBM to 75 °C for 3 minutes or 90 °C for 1 minute).

Strict protocols are needed for the management of expressed breast milk (EBM) in hospitals to avoid inadvertent blood-borne virus exposure to babies.

Support services

5-20 What are the IPC requirements for mortuaries?

Mortuary facilities should be designed to ensure the safety of mortuary staff. Exposure of mortuary staff to pathogens occurs through penetrating injuries (bone/sharp instruments), inhalation of pathogens (while cutting bone and lung tissue) and through mucosal splashes (blood and body fluids). To reduce these risks, the following are required:

- Refrigeration: for safe storage of bodies.
- Showers and change areas: for staff to remove their personal garments, dress, put on closed footwear and other protective equipment, and shower before leaving the mortuary.
- Ventilation: negative pressure ventilation is required, especially for TB-endemic settings.
- Personal protective equipment: to reduce exposure to blood and body fluids.
- Sharps containers at the point of use
- Provision for cleaning sinks to decontaminate equipment.
- Staff lockers for personal belongings.
5-21 What are the IPC requirements for ambulances?

Before transporting any patient, the ambulance staff should attempt to establish (from the patient and healthcare workers) if there is a known or suspected infection transmission hazard. In all cases, standard precautions should be used, with the addition of transmission-based precautions where needed. For example, staff transporting a patient known with pulmonary TB, should implement airborne precautions. This would include: a surgical mask on the patient, N95 respirators for the staff plus gloves and an apron (for anticipated contact with respiratory secretions). Strict adherence to the five moments for hand hygiene should be practised. Hand hygiene with alcohol handrub is sufficient unless hands are visibly contaminated.

Adequate natural ventilation may be difficult to achieve in the confined space of an ambulance, but where possible side windows should be kept open. After transport of a patient with a known pathogen, e.g. TB or drug-resistant bacterial infection, surfaces and equipment should be cleaned and wiped over with an appropriate disinfectant. Spills of blood and body fluid must be cleaned up immediately and the contaminated areas washed and disinfected with sodium hypochlorite.

Ambulance staff transporting a patient with known pulmonary TB should implement airborne precautions.

5-22 What are the IPC requirements for hospital kitchens?

The following features are recommended:

- Location of kitchen near main delivery areas, but with easy access to the wards
- Adequate changing, toilet, handwash and rest facilities for staff
- Separate area for receiving and storing food produce (frozen foods between -13 and -18 °C; meat and cold products below 4 °C)
- Separate preparation areas for raw and cooked food
- Separate areas for dry and fresh (wet) food supplies
- Adequate food storage areas
- Designated areas for utensil washing
- Uninterrupted supply of hot and cold water
• Provision of personal protective equipment (aprons, boots, hairnets, disposable gloves)
• Occupational health screening of kitchen staff for carriage of known intestinal pathogens and a mechanism for staff to report and receive treatment for concurrent illness
• Provision for safe storage and disposal of all kitchen waste
• A programme for regular audits and inspection of the kitchens.

5-23 What are the IPC requirements for other support services?

Support services include laundry and linen, waste management, housekeeping and engineering services among others. All support services staff are at increased risk of exposure to pathogens, and should be trained in job-specific infection prevention skills at employment and regular intervals thereafter. Hepatitis B immunisation is recommended because of the high risk of needlestick injuries among housekeeping, laundry and waste management staff. Appropriate personal protective equipment (PPE) should be readily available to support services staff and its use should be enforced by healthcare management.

Support services staff are at increased risk of exposure to pathogens, and require job-specific IPC training and immunisation against hepatitis B.

Case study 1

Owing to population growth and a greater demand for healthcare services, the community health centre in a rural town will be expanded and renovated. Additional consultation rooms will be added to accommodate a TB clinic, an antiretroviral treatment clinic, a midwife obstetric unit (MOU), an emergency treatment area, a paediatric clinic, a clinic for curative services and a dental clinic. The IPC team forms part of the renovation committee.
1. **What should be the main focus of the IPC team in this renovation project?**

The IPC team should consider the main risks and route of microbial transmission in each of the clinical areas being expanded or renovated. They will then be able to advise on specific design features, layout and ventilation requirements to reduce the risk of healthcare-associated infection.

2. **Which of the features in the design and layout of the clinic would be the most important to limit exposure to respiratory infections?**

Well-ventilated waiting areas and consultation rooms will be needed. Ideally, separate waiting areas for each clinic should be provided. A cough room or outdoor cough booth should be included in the renovated facility, so that patients can produce sputum samples safely.

3. **Why is a triage area close to reception an important design feature from an IPC perspective?**

Patients with communicable respiratory infections, diarrhoeal disease and skin rashes can be identified early, separated from non-infectious patients and moved through the clinic system as quickly as possible to minimise staff and patient exposures.

4. **What are the minimum requirements to facilitate proper decontamination of medical instruments used in the MOU, treatment clinic, and dental clinic?**

The facility will require dedicated cleaning rooms in each of these clinical areas. Each cleaning room should have: a sink to wash instruments, cleaning cloths and brushes, separate storage for clean and used instruments, a desktop sterilizer.
Case study 2

The emergency department of a large tertiary hospital is being revamped. The hospital’s IPC team is invited to be part of the renovation team and to give input on the layout of the department.

1. **Where in the emergency department would be the best place to have the sluice room?**

   The sluice room should be located close to the patient care areas to facilitate the prompt and safe disposal of body fluids and contaminated items.

2. **Where is the best place to put sharps containers in the emergency department?**

   Sharps containers should be wall-mounted next to each patient bed or attached to procedure trolleys, i.e. at the point of use (within easy reach).

3. **Is it necessary to have an isolation facility within the emergency department?**

   Yes, patients with suspected or known respiratory infections and other communicable disease must preferably be isolated.

Case study 3

A 40-bed medical ward in a resource-limited hospital has four single rooms that can be used as isolation rooms. These isolation rooms are mostly used for patients with active pulmonary tuberculosis and patients infected/colonised with multidrug-resistant organisms. Occasionally cases of meningococcal meningitis or viral respiratory infections are isolated here as well.
1. What factors will determine if the number of isolation rooms is sufficient?

The communicable disease profile of the community in which the hospital is located will determine how many isolation beds are needed. Generally 20% of the beds in each ward should be isolation beds.

2. What are the ideal requirements for each of these isolation rooms from an IPC perspective?

The isolation room should have the following features: a single room at the far end of the ward, a door that can be closed, patient observation panel in the door/wall, en suite bathroom, handwash basin inside the patient room, mechanical ventilation/window that can open and easy-to-clean surfaces.

3. What are the minimum requirements for each of these isolation rooms?

Minimum requirements are a single room, a door that can be closed, a handwash basin inside the room or alcohol-based handrub available and a window that can open.

4. If there is mechanical ventilation in the isolation rooms, what should the settings be?

Mechanical ventilation of isolation rooms requires regular maintenance (servicing) to maintain negative pressure ventilation at between six and 12 air changes per hour.

Case study 4

In a 30-bed neonatal ward for premature babies, some mothers are expressing breast milk (EBM) and others are feeding with formula milk. At the 2 am morning feed, one baby is mistakenly given EBM belonging to another baby’s mother. The EBM donor mother is known to be HIV-infected and nursing staff members have noticed that she is coughing a lot in the ward.
1. **What is the risk of giving another mother’s EBM to a baby?**

   In this case the source milk or donor EBM comes from an HIV-infected mother. There is a risk of transmitting HIV to the baby that was mistakenly given the EBM.

2. **What can be done to prevent this mistake from happening again?**

   After EBM is produced, the jar should be labelled (by a staff member in the presence of the mother) with the mother’s name, infant’s name and hospital number, the date and time EBM was produced. Before feeding a baby, the EBM or formula milk jar label should be checked by two staff members against the baby’s identity band.

3. **What should the nursing staff do about the coughing mother?**

   Ideally all mothers admitted to neonatal wards with their babies should complete a symptom screening questionnaire to identify potentially transmissible infections, e.g. TB, diarrhoeal disease. In this case, they should ask the medical staff to exclude the possibility of TB or other respiratory illness in this lady. While these investigations are being completed, the staff should ask the mother to wear a surgical mask while in the ward, and ideally move her and her baby to an isolation room.
Environmental cleaning, waste management and decontamination of medical devices

Objectives

When you have completed this chapter you should:

- Understand the importance of the environment in infection transmission
- Be familiar with common methods of environmental disinfection
- Know the difference between routine cleaning and terminal cleaning
- Be familiar with recommended healthcare waste management practices
- Understand the difference between cleaning and decontamination
- Understand the difference between decontamination, disinfection and sterilization
- Understand the difference between disinfectants and antiseptics
- Be aware of the risks associated with inadequate decontamination of medical devices
- Be familiar with common methods of decontamination
- Know which medical devices require decontamination.
Environmental cleaning

6-1 What is cleaning?
Cleaning (in the healthcare setting) refers to the removal of visible dirt, dust and debris. Cleaning alone results in large reductions in environmental contamination, including the removal of many pathogens.

6-2 What is the role of the environment in infection transmission?
A clean patient environment contributes to prevention of healthcare-associated infection. Cleaning in healthcare facilities aims to remove visible dirt and dust, reducing levels of harmful micro-organisms in the patients’ surroundings. Dust contains skin scales and micro-organisms, which can be spread in the environment and air by sweeping or dry dusting.

6-3 How often should healthcare facilities be cleaned?
Most areas of a healthcare facility will require at least daily cleaning. Other specialised clinical areas may require twice daily (outpatient areas) or more frequent cleaning (operating theatres).

6-4 Which cleaning methods should be used?
Any cleaning method that generates movement of dust, e.g. sweeping or dry dusting, should not be used. Damp dusting of surface and mopping of floors are the preferred method as these techniques do not generate dust movement. The routine use of disinfectants for all clinical areas is unnecessary and strongly discouraged as it contributes to the development of antimicrobial resistance.
6-5 What cleaning equipment is required?

- Cleaning cloths: these should ideally be colour coded to distinguish cloths used for ‘clean’ areas from those used for highly contaminated areas, e.g. toilets, baths and isolation areas. Where a colour coding system is used, it is important to ensure that all staff is aware of which equipment may be used for cleaning which areas.
- Cleaning buckets/carts: should be cleaned daily or whenever heavily soiled.
- Mops: flat mops are preferred to the ‘spaghetti’ mop type. Mopping water and detergent solution should be changed frequently. Proper storage of mops is important so that they can be allowed to dry thoroughly and without cross-contamination of the mop heads.
- Floor polishers: where these are used the machines should be emptied and cleaned daily.
- Storage area: each clinical area should have a dedicated cleaning store/closet. It is important to ensure that all equipment is stored dry, and inspected for damage prior to use.

6-6 What general principles apply to cleaning of healthcare facilities?

- A cleaning programme should be in place (including cleaning protocols, regular staff training and monitoring of adequacy of cleaning)
- A standard, institution-approved detergent should be used in all areas (unless otherwise specified by the IPC practitioner)
- The manufacturer’s instructions regarding dilution of cleaning solutions should always be followed
- Surfaces must be allowed to dry completely (as damp areas encourage growth of micro-organisms)
- A cleaning plan should be devised for each clinical area, working from areas of least contamination to areas of most contamination, e.g. from administrative areas to toilets to isolation rooms.
- All surfaces should be easy to clean, compatible with hospital detergents and disinfectants, smooth and nonporous.
- All carpets should be removed as these are very difficult to clean.
6-7 Which tasks should be given to the domestic or household staff?

The cleaning tasks assigned to the domestic staff may vary between institutions, but in most instances include the following:

- Cleaning of clinical areas and surrounding administrative areas
- Removal of waste and replacement of waste containers
- Removal of linen, replenishing stocks of fresh linen
- Replacement of hand decontamination solution
- Cleaning of ward-based washer-disinfectors
- Cleaning of non-clinical equipment.

It is, however, critical to establish who is responsible for cleaning what (between domestic and nursing staff) to ensure there are no items or areas that are overlooked.

6-8 What personal protective equipment should be used by cleaning staff?

For routine environmental cleaning staff should wear:

- Domestic rubber gloves that reach to at least mid-arm to protect the workers from exposure to chemicals and organic material. These gloves are re-usable but should be inspected for tears or leaks before each use. Rubber gloves that are re-used must be cleaned with detergent and allowed to dry before moving on to clean the next clinical area. Cleaning staff should not use the examination gloves provided for healthcare workers. If working with potentially dangerous chemicals, then heavy-duty rubber gloves are preferred.
- Plastic aprons should be worn during any activity that may result in splashes.
- If entering a room where transmission-based precautions are in place, the domestic staff should be made aware of the risk and instructed to put on the required personal protective equipment.
- Ideally all domestic staff should also be immunised against tetanus and hepatitis B as they are frequently exposed to sharps.
6-9 Which areas are frequently touched in the healthcare setting?

Items such as door handles, light switches, patient monitors and medical equipment buttons/knobs are frequently touched by healthcare workers and patients. These are high-risk surfaces for cross-transmission because they hold the micro-organisms that are transferred from people’s hands. Domestic staff should be specifically alerted to give extra attention to these frequently touched surfaces during their routine cleaning.

Frequently touched surfaces are a high risk for cross-transmission because they hold the pathogens that are transferred from people’s hands.

6-10 What is the difference between routine cleaning and terminal cleaning?

Routine cleaning is the standard, everyday procedure for cleaning of clinical areas, including mopping of floors, damp dusting of surfaces with detergent, etc. Terminal cleaning is performed when a patient with a transmissible illness is discharged (usually for isolation rooms), e.g. MRSA and other drug-resistant bacteria, tuberculosis, Clostridium difficile. The terminal cleaning process requires:

- Removal and discarding of all unused consumables and personal protective equipment (PPE) from the room
- Removal and laundering of all linen
- Removal and safe disposal of all waste
- Washing of all surfaces with detergent (including walls to a height of 2 metres)
- Wiping of all surfaces with an appropriate disinfectant (including bed frame, mattress and pillows). The IPC practitioner should be asked to advise on an appropriate disinfectant (usually alcohol-based or chlorine-based disinfectants at an appropriate strength or dilution). Remember that chlorine can be corrosive (causing damage to metal surfaces).
- Allowing all surfaces to dry before admission of a new patient.
Terminal cleaning is required when a patient with a transmissible illness is discharged (usually from an isolation room).

6-11 How should blood spills be managed?

The following principles should be applied:

- All blood spillages should be immediately cleaned up using domestic gloves
- Glass and solids should be removed using a brush and pan, and discarded in a sharps container or if too large, wrapped in newspaper before safely disposing
- The remaining fluids should be blotted using as many paper towels as needed; these should be discarded in the clinical waste
- Water and detergent should be used to remove all visible blood
- The area should be wiped over with a chlorine-based solution (at a concentration of 10 000 parts per million) and allowed to dry.

All healthcare facilities require a written, easily understandable and accessible standard operating procedure (SOP) for managing blood spills.

Waste management

6-12 What is clinical waste?

This is generally defined as waste from a healthcare facility that may contain hazardous pathogens. Examples include:

- Any material contaminated with patient blood or bloody body fluids (e.g. wound exudate, pus)
- Other body fluids (cerebrospinal fluid, amniotic fluid, semen, vaginal secretions).

Other special types of waste are generated from healthcare facilities including expired medication, chemicals and oils. These are also potentially...
hazardous and require a programme for disposal, separate from management of clinical and general waste.

Clinical waste is waste that may contain hazardous pathogens; non-clinical healthcare waste includes general rubbish, expired medications and chemicals.

6-13 What is waste management?

Waste management is the handling and safe disposal of infectious and non-infectious waste. The aims of waste management are to ensure safe and environmentally friendly destruction or reprocessing of healthcare waste.

6-14 What legislation and recommendations exist for waste management?

Most countries have legislation governing the disposal of healthcare waste. Ultimately the head of each healthcare facility is responsible for ensuring that proper policies and processes are in place for waste management. Each facility or group of facilities should have a designated waste manager responsible for implementation of the waste policy and procedures for protection of staff working with waste. Compliance monitoring for waste management is usually performed by the IPC practitioner. Training in healthcare waste management is required for all facility staff, including clinical staff, domestic staff, porters, radiographers, pharmacists and other allied health professionals.

The healthcare facility manager is responsible for ensuring that proper waste management policies and processes are in place.

6-15 What is waste segregation?

This is simply the separation of healthcare-associated waste at source into clinical (infectious waste) or non-clinical (domestic) waste. Waste segregation takes place at the point of generation (source) into different (colour-coded) plastic bags or containers for disposal. Separation of waste at
source (i.e. at ward or clinic room level) saves time, cost and eliminates the risk attached with sorting medical waste. Many healthcare facilities use colour-coded waste bags and posters/signs to indicate to healthcare workers and visitors where the disposal of different types of waste must take place. For example, red bags for clinical waste and black or clear bags for non-clinical waste and general rubbish. Sharps are disposed of at source in robust solid containers to avoid accidental injuries.

Waste segregation is the separation of healthcare-associated waste into clinical (infectious waste) or non-clinical (domestic) waste.

**Waste segregation**

*Healthcare waste should be segregated at source (point of generation)*

**Table 6-1: Waste segregation (Adapted from Infection Prevention and Control Manual, Tygerberg Academic Hospital, Cape Town, South Africa, 2012)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Recommended colour coding</th>
<th>Examples of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatomical tissues and clinical waste, any material which is visibly contaminated with blood or body fluid or infectious agents</td>
<td>Red: Clinical waste</td>
<td>Placentae, human limbs and tissue, excision products, used bandages and dressings, urinary catheter and drainage bags*, intravenous administration sets, abdominal swabs, theatre dressings, Infectious disease isolation area: gloves and aprons, linen savers with blood or body fluids</td>
</tr>
<tr>
<td>Sharps, sharp objects that are contaminated with blood or body fluid</td>
<td>Yellow: Sharps</td>
<td>Hypodermic needles, stylets, vials, syringes containing blood or body fluids, insertion ends of intravenous administration sets, trochars, cannulae, rigid guidewires</td>
</tr>
</tbody>
</table>
### Category | Recommended colour coding | Examples of items
--- | --- | ---
Non-clinical waste generated by patients but not contaminated with blood or body fluids, paper and packaging, packaging or wrapping, office and administration | Black: Non-clinical | Items used by patients but not contaminated with blood or body fluids, e.g. used gloves, linen savers, tissues, paper towels, packaging or wrapping from sterile items or processed items, babies' nappies, sanitary towels, Office paper, wrapping paper from SSD, surgical masks, overshoes, surgical disposable caps and gowns
SSD equipment, used single items sent to SSD for sterilization or high-level disinfection | Clear: For sterilization | Surgical instruments, vaginal speculae, respiratory equipment, masks, etc.
Storage of patient articles | Clear: For storage | Storage of patient articles

* IV fluid and wound drainage bags containing residual fluid should be emptied in the sluice room.

### 6-16 What is sharps management?

This is the risk management programme (part of standard precautions) that is implemented to reduce the risk of sharps (or needlestick) injuries. The following recommendations apply to waste management of sharps:

- Puncture-proof containers should be used.
- Sharps containers should be securely wall-mounted or fixed to procedure trolleys.
- All sharps containers should be labelled with the date and location.
- Sharps containers should be removed when filled to the indicated two-thirds full mark.
- Sharps containers should be securely closed and transported to a safe storage area until collected for final destruction.
6-17 How should medical waste be transported?

When removing waste from clinical areas, the domestic staff should ensure that:

- The waste containers have been properly sealed (i.e. by sealing waste boxes with tape, closing the lids of sharps containers securely, or by placing soiled linen in leak-proof bags).
- The waste boxes and sharps containers are labelled correctly with the date, institution name and name of the clinical area where the waste was generated.
- A waste cart or trolley that is leak-proof and clean is available to remove the waste.
- The domestic staff should wear appropriate personal protective equipment (PPE), e.g. heavy duty gloves, apron and closed shoes.

6-18 How should medical waste be stored?

Medical waste is often stored in a holding area in the wards/clinical area, until collected by the domestic staff for disposal. This area should be kept clean, dry, well-ventilated and secured. Depending on the clinical area concerned, waste may need to be collected as often as twice daily. Collected waste from the clinical areas is then transported to the facility’s wasteholding area, to await collection for final disposal at an incineration or waste destruction site. Similar to the requirements mentioned above, this wasteholding area should be securely locked, clean, dry, well ventilated and free from pests/rodents. The area should be inspected by IPC staff intermittently.

6-19 How should medical waste be disposed of?

There are several different methods available for destruction and disposal of medical waste. Non-clinical waste (e.g. paper towels, rubbish) is usually buried at a local municipal dumpsite or landfill. Clinical waste and sharps are ideally destroyed by incineration. This is the best way to ensure that there is no remaining risk for needlestick injury and no viable microorganisms. The heat generated by this process is often ‘re-cycled’ to generate steam or produce heat for the healthcare facility. Other newer technologies for waste disposal are available for example microwave or heat
sterilization, and shredding. If third parties are used for waste disposal, the facility must draw up contracts for this purpose. In parts of Africa, leftover food and/or kitchen waste are disposed of in compost heaps, which in turn produce compost for fertilising food crops.

Decontamination of medical devices

6-20 What is decontamination?
Decontamination is the process followed to ensure that re-usable medical devices are safe to use on the next patient. Examples are the decontamination of a vaginal speculum between patients or the decontamination of surgical instruments between operations.

Decontamination is a process that ensures that medical devices are safe to use on another patient.

6-21 Why is decontamination required?
Decontamination is required to destroy and remove micro-organisms before a medical device or piece of equipment is used on another patient. Micro-organisms can be transferred to patients (through direct or indirect contact with inadequately decontaminated devices/equipment) resulting in healthcare-associated infection.

6-22 Which steps form part of the decontamination process?
Decontamination includes some or all of the following steps:

- Cleaning (physical removal of organic material including micro-organisms)
- Disinfection (killing or destruction of most but not all disease-producing micro-organisms)
- Sterilization (destruction of all micro-organisms).
6-23 How difficult is it to kill different types of micro-organisms?

Different micro-organisms have differing levels of susceptibility to destruction. Some, like viruses, most bacteria and fungi are relatively easy to kill. Others, like mycobacteria (TB) and spores (Clostridium difficile) are relatively resistant to killing. That is why it is important to know which micro-organisms need to be destroyed when selecting the appropriate method for decontaminating a particular device.

![Figure 6-1: Most resistant to least resistant micro-organisms](image)

6-24 Which medical devices should be decontaminated?

Any medical device or piece of equipment that comes into direct contact with a patient or patient’s body fluids, can potentially be contaminated with micro-organisms. For example blood pressure cuffs, thermometers and saturation probes all pose a risk of infection transmission if not adequately decontaminated between patients.
6-25 How does one decide on the level of decontamination required?

The method of decontamination is determined by the level of risk for infection transmission. For example, devices that will be in contact with the patient’s bloodstream or sterile tissue/sterile body cavities must be sterilized. Items that will only be in contact with intact skin, can undergo low-level disinfection, which should remove most pathogens. The Spaulding classification gives guidance on how to determine the type of decontamination processes required.

The Spaulding classification determines the level of decontamination required based on the type of medical device and the potential for infection transmission.

**Table 6-2: The Spaulding classification**

<table>
<thead>
<tr>
<th>Instrument category</th>
<th>Examples</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical: enters directly into the bloodstream, sterile tissue or cavities</td>
<td>Surgical instruments, needles, intravenous catheters</td>
<td>Sterilization: no micro-organisms left, including spores</td>
</tr>
<tr>
<td>Semi-critical: contact with intact mucous membranes</td>
<td>Endoscopes, laryngoscopes, airway tubes, resuscitation masks and bags</td>
<td>High-level disinfection: no vegetative forms of bacteria left, few spores acceptable</td>
</tr>
<tr>
<td>Non-critical: Touches only intact skin</td>
<td>Blood pressure cuffs, stethoscopes, cervical collars, thermometers</td>
<td>Low-level disinfection: most pathogens removed</td>
</tr>
</tbody>
</table>

6-26 Which medical devices can be decontaminated on the ward?

Using the Spaulding classification as outlined above, non-critical devices and instruments can be decontaminated at ward level. This would include the cleaning and disinfection of commonly used items such as thermometers and stethoscopes. Other commonly used items such as urine jugs and bedpans are often cleaned at ward level. Cleaning of these items can be manual or automated. Staff responsible for manual cleaning should be provided with personal protective equipment including heavy-duty gloves,
plastic aprons, and eye protection. The use of an automated washer-disinfector is ideal, as this minimises handling of bedpans/urinals, saves time and achieves better disinfection than manual methods.

Non-critical devices and instruments can be safely decontaminated at ward level.

*Table 6-3: Methods of decontamination (adapted from S Mehtar, Understanding Infection Prevention and Control, Juta, 2010.)*

<table>
<thead>
<tr>
<th>Items or site</th>
<th>Preferred method of decontamination</th>
<th>Alternative methods/comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airways and endotracheal tubes</td>
<td>Single-use disposable</td>
<td></td>
</tr>
<tr>
<td>Ambu bags</td>
<td>Send to SSD for heat disinfection.</td>
<td>Ethylene oxide</td>
</tr>
<tr>
<td>Ampoules</td>
<td>Wipe with 70% isopropyl alcohol and allow to dry before opening.</td>
<td><em>Do not</em> immerse in disinfectant.</td>
</tr>
<tr>
<td>Baths</td>
<td>Clean with detergent and non-abrasive cream cleaner. Rinse and dry</td>
<td></td>
</tr>
<tr>
<td>Beds and cots</td>
<td>Wipe with warm water and detergent to remove all visible signs of dirt. Allow to dry.</td>
<td>Disinfection not necessary.</td>
</tr>
<tr>
<td>Bed lockers</td>
<td>Wipe with warm water and detergent. Dry.</td>
<td>Clean inside locker once patient has been discharged.</td>
</tr>
<tr>
<td>Items or site</td>
<td>Preferred method of decontamination</td>
<td>Alternative methods/comments</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Blankets and bed covers</td>
<td>Change after each patient has been discharged or when visibly soiled. Send to laundry to wash at 80 °C.</td>
<td>Do not allow bedding from home. These may be infected with bed bugs or carry scabies.</td>
</tr>
<tr>
<td>Bowls (patient wash)</td>
<td>Wash with detergent, rinse and store inverted to dry.</td>
<td>Modern ward washer disinfectors can also wash bowls.</td>
</tr>
<tr>
<td>Commodes</td>
<td>Wash seat daily with detergent and hot water and dry with disposable paper towel. Wipe the commode seat with a large alcohol wipe after each use.</td>
<td>If visibly contaminated, remove soil with tissue. Wash with warm water and detergent. Dry. For enteric diseases, wipe the commode with hypochlorite (1000 parts per million) after each use.</td>
</tr>
<tr>
<td>Computer and keyboards</td>
<td>Damp dust daily. Wipe keyboard carefully to remove visible dirt.</td>
<td>Use a keyboard cover which is changed frequently.</td>
</tr>
<tr>
<td>Crockery and cutlery</td>
<td>Wash at 80 °C in dishwasher. Manual cleaning: wear gloves and hand wash in detergent and hot water (60 °C), rinse and dry.</td>
<td>Wear domestic gloves for manual cleaning. Infected patients: unless as instructed by IPC team treat as routine. Disposable crockery is rarely indicated, e.g. rabies.</td>
</tr>
<tr>
<td>Curtains</td>
<td>Change curtains frequently. Isolation room curtains (infectious cases) should be changed with each terminal clean.</td>
<td>Blinds, both vertical and horizontal, are difficult to clean and wash regularly.</td>
</tr>
<tr>
<td>Dressing trolleys</td>
<td>Remove all items daily and wipe surface with warm water and detergent. Dry. Wipe over with 70–80% ethanol alcohol. Discard all previous contents of open jars and bottles. Replace with unopened containers.</td>
<td>If open jars are used, keep the volume small so that the containers can be heat disinfected when empty. <em>Do not top up open disinfectant containers.</em></td>
</tr>
<tr>
<td>Items or site</td>
<td>Preferred method of decontamination</td>
<td>Alternative methods/comments</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Endotracheal suction catheters</td>
<td>Disposable. Can be used for 24 hours on the same patient. Flush with sterile water after each use. Bowl is washed and dried after each suction and filled with sterile water only before use.</td>
<td>Decontaminate hands thoroughly before carrying out suction. Do not share suction catheters between patients. <em>Do not recycle suction catheters.</em></td>
</tr>
<tr>
<td>Feeding bottles (baby)</td>
<td>Heat sterilized in SSD</td>
<td>Wash thoroughly. Rinse and soak in fresh hypochlorite solution (125 ppm available chlorine) for 30 minutes. Remove, rinse and dry.</td>
</tr>
<tr>
<td>Humidifiers</td>
<td>Empty daily and heat disinfect after each patient use. Clean with warm water and detergent. Dry. Fill with sterile water only.</td>
<td></td>
</tr>
<tr>
<td>Infant incubators</td>
<td>Wash all removable parts and clean thoroughly with detergent. Dry with paper towel.</td>
<td></td>
</tr>
<tr>
<td>Laryngoscope blades</td>
<td>Wash blade with detergent, rinse and dry. Wipe over with alcohol.</td>
<td></td>
</tr>
<tr>
<td>Mattresses</td>
<td>Use a water impermeable cover. Clean with warm water and detergent. Dry thoroughly. Never admit patients to soiled, stained or damaged mattresses.</td>
<td>Major source of cross-infection. Replace torn mattress covers immediately. Wet mattresses should be discarded.</td>
</tr>
<tr>
<td>Scissors</td>
<td>Wipe over with 70% alcohol before and after each use.</td>
<td></td>
</tr>
<tr>
<td>Thermometer (oral)</td>
<td>Wash and dry after each patient use. Wipe with 70% alcohol and store dry.</td>
<td><em>Never soak thermometers in disinfectant.</em></td>
</tr>
<tr>
<td>Items or site</td>
<td>Preferred method of decontamination</td>
<td>Alternative methods/comments</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ultrasound probe</td>
<td>Disinfect with 70% isopropyl alcohol between each patient use. Intravaginal: cover probe with a condom for each patient.</td>
<td></td>
</tr>
<tr>
<td>Ventilators</td>
<td>These are complex and should be cleaned and disinfected according to the manufacturer’s instructions. Sometimes there are technicians in the healthcare facility who do the maintenance.</td>
<td>Remove tubing and send to SSD for heat disinfection (80 °C × 3 min) or chemical disinfection. Clean all inspiratory and expiratory connections. Change both sets of filters. Check efficiency of air movement. Reassemble. Clean the outside of the ventilator. Register in logbook.</td>
</tr>
<tr>
<td>Wash basins</td>
<td>Clean with warm water and detergent. Disinfectants are not recommended.</td>
<td></td>
</tr>
<tr>
<td>X-ray equipment</td>
<td>Damp dust only.</td>
<td>Wipe with 70% alcohol if disinfection required.</td>
</tr>
</tbody>
</table>

6-27 Why is prior cleaning of devices and instruments needed?

Cleaning is the first step towards disinfection, sterilization and making medical devices safe for re-use. Proper cleaning alone will remove approximately 80–90% of microbial contamination. It is vital that the cleaning process removes all visible organic matter such as blood, dirt or tissue. This then ensures effective disinfection or sterilization by allowing penetration of disinfectants and steam respectively.

Cleaning is the first step towards making medical devices safe for re-use, and will remove approximately 80–90% of microbial contamination.
6-28 What is the correct method of cleaning?

For medical devices and instruments that can be safely immersed in water, the following steps apply:

- Wear domestic gloves, aprons and visors to protect your mucous membranes
- Fill a sink or tub with warm water
- Add detergent according to the manufacturer’s instructions
- If applicable, disassemble the instrument fully
- Hold the item below the surface of the water
- Using a soft nylon brush, clean all surfaces, grooves and hinges of the instrument
- Inspect the instrument thoroughly to ensure all visible organic material is removed
- Prepare the item for disinfection or sterilization as needed.

6-29 What is the role of disinfection?

Disinfection is the killing or destruction of most pathogens, and is applied to inanimate (non-living)surfaces or instruments. This process will not kill all pathogens (especially spore-forming pathogens), but reduces the level of contamination to one that is not harmful. Microbial killing by disinfection can be achieved using chemicals, heat or both.

The use of heat for either disinfection or sterilization is the preferred method for making items safe for re-use. However, for heat-sensitive items (endoscopes/electrical equipment) or surfaces (mattress covers, worktops, etc.), chemical disinfection is an acceptable alternative.

6-30 What are the advantages and disadvantages of using disinfectants?

Disinfectants are generally inexpensive, have rapid action, can be used for processing at the point of use and are suitable for decontamination of heat-sensitive items. The negative aspects of disinfectants are that they are less effective than heat, require rinsing of items, may enhance antimicrobial resistance, may be harmful to the environment and can cause allergic reactions.
Disinfectants are cheap, act rapidly and can be used on heat-sensitive items, but are less effective than heat and can cause allergic reactions.

6-31 Why is it not acceptable or effective to soak instruments in disinfectants?

The following concepts about soaking are very important:

- No device or instrument can be effectively disinfected or sterilized unless it has been thoroughly cleaned.
- Soaking used medical devices in disinfectants is a waste because most disinfectants cannot penetrate organic matter. * The act of soaking gives healthcare workers a false sense of security, whereas in fact the device or instrument has usually not been adequately decontaminated.

6-32 Which disinfectants are most commonly used in low-resource settings?

Alcohol and chlorine-based disinfectants are the most widely available. Depending on the concentration used (see Table 6-4), these chemical disinfectants can achieve low to intermediate level disinfection. Chlorine may not be suitable for all types of disinfection, as it can be corrosive (causing damage to metal surfaces). Others types of disinfectants available include quaternary ammonium compounds (QACs) and phenolics. For semi-critical items like endoscopes, high-level disinfection is needed using aldehydes, peracetic acid or OPA.
Table 6-4: Concentrations for chlorine-releasing agents

<table>
<thead>
<tr>
<th>Item</th>
<th>Parts per million available chlorine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood spillage (HIV, HBV, HCV)</td>
<td>10 000</td>
</tr>
<tr>
<td>Pre-cleaned surfaces, cleaning equipment</td>
<td>1 000</td>
</tr>
<tr>
<td>Catering and infant feeding equipment</td>
<td>125</td>
</tr>
<tr>
<td>Drinking water</td>
<td>1</td>
</tr>
</tbody>
</table>

6-33 What is the difference between disinfectants and antiseptics?

Disinfectants are used for killing pathogens on inanimate surfaces or instruments. Antiseptics are chemicals used to kill pathogens on live tissue, for example alcohol hand-rub, chlorhexidine gluconate and povidone iodine for skin preparation prior to surgery.

Disinfectants kill pathogens on inanimate surfaces/instruments and antiseptics kill pathogens on live tissue/skin.

6-34 What legislation and recommendations exist for medical decontamination?

Any medical device or instrument that is re-usable should have a specified process for its decontamination, for example a standard operating procedure for re-processing of used vaginal speculae. Wherever possible, decontamination of devices/instruments should be performed in a dedicated sterile services department. This ensures that the items are handled by staff with the required skills, equipment and procedures to deliver safe medical devices. Most countries have legislation governing Patient and Occupational Health and Safety. In more developed settings, all decontamination processes require validation (a form of proof that the process was carried out to accepted standards).

Any re-usable medical device or instrument should have a specified process for decontamination. Wherever possible, decontamination should be performed in a dedicated sterile services department.
6-35 Which items or instruments should not be decontaminated?

Any item that is designated by the manufacturer as single-use, or any item that cannot be thoroughly cleaned, e.g. hypodermic needles and syringes, should be discarded after use.

Any item designated by the manufacturer as single-use should be discarded after use, because the risk of infection transmission after inadequate reprocessing is high.

The role of the sterile services department (SSD)

6-36 Which items should be sent to the sterile services department for decontamination?

Ideally all critical and semi-critical items (see Spaulding classification under 6-25) should be decontaminated in the SSD. In certain instances, where items are needed urgently for re-use on other patients, decontamination may be carried out at point of care. In such circumstances it is even more important to ensure quality management and proper oversight of the decontamination process. Examples would include cleaning and high-level disinfection of bronchoscopes or endoscopes at point of care.

All critical and semi-critical items should be decontaminated in a sterile services department (SSD).
6-37 What is the flow of items for decontamination through the sterile services department?

The SSD should be designed and laid out so as to streamline movement of items and to prevent contamination of processed, sterile items by ‘dirty’ items arriving in the ‘wash room’, cleaning area. Items and instruments for decontamination follow a specific flow or process through the SSD:

- Collection of used devices and instruments from wards, theatres, outpatients
- Disassembly of instruments
- Cleaning
- Disinfection
- Check that items are still functional
- Preparation and packaging of items for sterilization
- Sterilization of instruments, theatre trays and packs
- Storage of items and packs
- Dispatch and delivery of sterile items and packs to point of use.

6-38 What protective equipment and measures are required for staff in the sterile services department?

SSD staff should wear uniforms that cover their arms and neck area, to minimise skin contact with chemical products. Closed shoes should be worn. Industrial gloves and aprons are indicated for staff working in the ‘dirty’ areas or wash room. Eye protection may be needed where staff are rinsing items or using water jets through hollow bore instruments. All SSD staff should have received a full course of hepatitis B immunisation and 5-yearly tetanus boosters. Occupational health and safety training and access to an occupational health service is mandatory.

SSD staff require proper protective clothing/equipment, as well as hepatitis B and tetanus immunisations.
6-39 What form of sterilization is used in most sterile services departments?

The most widely used method for the final step in decontamination of heat-stable items is steam sterilization. Steam is a reliable, non-toxic and cost-effective method of sterilization. The machines used for steam sterilization are known as autoclaves, and can be downward displacement (gravity) or high-vacuum autoclaves. Items to be autoclaved must be wrapped in materials (cloth or paper) that allow penetration of steam. There are several validation methods used to ensure that the sterilization process is effective. Biological indicators measure the effectiveness of the autoclave in killing bacterial spores. Chemical indicators are used to verify that the items have been exposed to heat (e.g. autoclave tape) and that steam has penetrated the packs (e.g. the ‘Bowie Dick’ test). Records of validation testing should be kept in SSD in a logbook for at least five years. There is a variety of other methods of sterilization including flash sterilizers, dry-heat sterilization, irradiation, ethylene oxide and hydrogen peroxide gas plasma.

Steam (autoclaving) is a reliable, non-toxic and cost-effective method of sterilization.

6-40 Where should decontamination of specialised equipment be performed?

Endoscopy procedures are often performed in dedicated procedure rooms, with requirement of a rapid turnaround time for processing of equipment. For this reason, decontamination of endoscopes usually occurs at point of care. Several outbreaks and infections from poorly decontaminated endoscopes have been documented worldwide. Several pathogens can be transmitted by endoscopes including blood-borne viruses, gastro-intestinal bacteria and in some countries, intestinal parasites.

Reprocessing is the process followed to make a piece of shared equipment safe to use on the next patient. Endoscope reprocessing is a highly technical procedure and should only be undertaken by appropriately trained staff. The steps in endoscope reprocessing include: thorough cleaning of all channels, chemical disinfection, rinsing, drying and storage. Most endoscopes are heat-sensitive so cannot be autoclaved or heat sterilized. It is critical to
follow the manufacturer’s recommendations at every stage of the decontamination process. As the risk for cross-infection is high, users must ensure cleaning and high-level disinfection of endoscopes are tightly regulated (validated) and monitored.

Case study 1

A patient who has undergone a hernia repair presents to the outpatient’s department (OPD) after 14 days with a deep wound infection. The surgeon realises that this is the fifth case over the past eight weeks with an infected hernia repair. There is nothing out of the ordinary except that the operating theatre has been overloaded with work and has started decontaminating some surgical trays on site instead of sending them to the sterile services department (SSD) for reprocessing.

1. What are the possible reasons for deep-seated wound infections in these patients?

The operating theatre is not designed to reprocess a large number of surgical devices and only has equipment for reprocessing emergency instruments. Operating staff have not been adequately trained to clean and sterilize medical devices. They do not understand the validation process and how to deal with incorrect reprocessing cycles. There may not be adequate storage areas for the sterile packs.

2. What should the IPC team investigating this outbreak look for?

- Check the management of the patient including the antibiotic prophylaxis regimen – has it changed?
- Observe the reprocessing procedures to ensure these are correct. This information can be found in the registers and logbooks which ought to be present for each piece of equipment.
- Look to see if the medical devices have been soaked prior to cleaning; this increases the risk of antimicrobial resistance and is not recommended.
• The team should look for evidence of appropriate sterilization such as process indicators which should be present in the patient notes and also in the register.
• Make sure that the sterile packs remain sterile until they are ready for use.
• Review the early wound dressing practices on the ward.

3. What can be done to rectify the situation?

Move the sterilization of surgical devices back to the SSD as soon as possible. If this is not possible, train the operating theatre staff to clean and reprocess surgical devices correctly. The reprocessing equipment must have validation systems in place to check each step of the cycle and there must be a visible record of each kept for a minimum of five years.

Case study 2

A young enthusiastic surgeon goes to a conference and comes back with a very sophisticated state of the art flexible hepatoscope (a type of endoscope). As an IPC practitioner you are asked to work out a way of reprocessing this item.

1. How are you going to deal with this endoscope? What processes will you put in place to make sure it is safe for re-use?

Find out more about the endoscope, contact the manufacturer and get the necessary guidelines on cleaning and disinfection. Since it is an expensive and delicate piece of equipment, the exact cleaning and disinfection method must be obtained from the manufacturer. Then set up a standard operating procedure (SOP) which includes absolutely every step and where possible validation of each step. Train the staff who will be dedicated to handle this device so that they are confident to deal with it and will recognise any shortfalls in the decontamination process. If none of this is possible, arrange for the manufacturer to recommend a private contractor who knows how to reprocess this equipment.
2. What are the risks of using a poorly disinfected hepatoscope?
Consider blood-borne viruses, commonly HIV, hepatitis B and C but also other viruses that might affect the liver. In some countries parasitic diseases such as *Echinococcus granulosis*, liver fluke and others can be a problem. Healthcare-associated pathogens especially *Pseudomonas, Acinetobacter, Staphylococcus aureus* and *enterococci* must be considered. All these have to be dealt with in a clear and confident manner to make sure the equipment is safe to re-use.

3. What is the ideal method for reprocessing flexible fibre-optics and delicate endoscopes?
The device can be dealt with by low temperature chemical disinfection methods, but never a sterilizer which reaches above 90°C. It has to be thoroughly cleaned; making sure each channel (including the biopsy channel) has been cleaned. The final stage would be to disinfect with the appropriate chemical as per manufacturer’s recommendations. Automated systems for reprocessing are preferable to manual ones but both can be equally effective if the endoscope is exposed for the correct time and thoroughly rinsed after exposure to chemicals.

Case study 3
You walk into a healthcare facility and are met with a strong smell of a disinfectant in the outpatient’s department (OPD). It was discovered that the cleaners were using hypochlorite for routine cleaning of the environment including the floors and all surfaces including the bedpans, because of ‘all the germs in the hospital’ and because ‘we have been doing it for years’.

1. Is it necessary to use a disinfectant in the environment for routine cleaning?
No, by simply cleaning with warm water and detergent, 80-90% of organic matter will be removed and so will most pathogens. If the surfaces are visibly clean, then they are clean. No disinfectant is required for routine cleaning; only for terminal cleaning.
2. What is the impact of hypochlorite on the floors and surfaces?

Hypochlorite is highly corrosive to metal and other materials, and therefore should not be used in these situations. It is also non-biodegradable and can lead to enhanced antimicrobial resistance. It is inactivated by organic matter and so becomes ineffectual in the presence of it.

3. What are the indications for using disinfectant in the environment?

There are very clear indications for the use of hypochlorite such as terminal cleaning after a Clostridium difficile infection or spillage of blood (wiped over after cleaning up).

Case study 4

The Department of Health is contacted after several patients at a dental practice are diagnosed with hepatitis C infection. Further testing of all dental practice patients reveals that 53 people have contracted hepatitis C (all shown to be the same strain). The dentist’s rooms are visited by an IPC practitioner to review the on-site decontamination and sterilization procedures and equipment.

1. What should the IPC practitioner be looking for?

She should perform a risk assessment to identify possible means by which blood-borne viruses could be transmitted. The following specific areas and procedures should be assessed:

- The availability of standard operating procedures (SOP) for decontamination/sterilization
- The availability and use of personal protective equipment (PPE)
- Evidence that single-use items are being re-used, e.g. needles, syringes
- The facilities available for cleaning equipment
- The condition of the dental equipment itself
- The maintenance logbook of the bench-top sterilizer
- The area where sterile equipment is stored prior to use
- The adequacy of staff training in decontamination and sterilization.
2. The IPC practitioner finds that some of the dental instruments are rusty and that the sterilizer has not been serviced in more than five years. Why are these findings significant?

It is not possible to adequately disinfect or sterilize rusty equipment. Any item that has rust on it should be condemned and replaced. It is essential that all critical medical equipment (like sterilizers) be maintained regularly, at least annually. This should be documented in a service logbook so that the facility has a record.

3. On further enquiry, the IPC practitioner establishes that the dental nurse has never been formally trained on how to decontaminate and sterilize dental equipment. Why is training required?

Inadequately decontaminated equipment can transmit blood-borne viruses and bacterial pathogens. Patients undergoing procedures with unsterile equipment are at very high risk of infection. Decontamination and sterilization procedures can be complicated and staff may be unfamiliar with the proper technique. Induction and regular in-service training are needed, especially if new instruments or new sterilization equipment is purchased.
Surveillance and outbreak investigation in low-resource settings

Objectives

When you have completed this chapter you should:

- Understand the role and purpose of performing surveillance for healthcare-associated infections
- Be familiar with different types of healthcare-associated infection surveillance
- Be aware of the importance of communicating results of healthcare-associated infection surveillance
- Identify feasible targets for surveillance in low-resource settings
- Understand how to recognise an outbreak
- Understand the role and purpose of outbreak investigation
- Be familiar with the steps in outbreak investigation
- Understand the role of the IPC practitioner in outbreak investigation
- Know how to find resources or obtain help for outbreak investigation.

Surveillance of healthcare-associated infections (HAI)

7-1 What is surveillance?

Surveillance is an organised method for collecting, analysing and sharing information. For example, surveillance for needlestick injuries involves
collecting information (data) on when, how, why and in which staff categories these incidents occurred. An important part of surveillance is communicating the results of surveillance to people who can improve the outcome being measured, for example the facility manager, ward manager or head of department.

**Surveillance is an organised method for collecting, analysing and sharing information.**

**7-2 What is the purpose of surveillance?**

Surveillance produces ‘information for action’. In other words, the findings of surveillance activities or programmes should be used to understand the problem and then identify changes or interventions to prevent or manage the problem. There are many other reasons for performing surveillance, including:

- Establishing baseline data on rates of infection, before implementing a change or intervention.
- Identifying important pathogens to target with interventions.
- To detect increases in infection rates above baseline in order to identify groups (clusters) of people with infection (outbreaks).
- To detect cases of notifiable disease for reporting to the department or ministry of health.
- To monitor the effectiveness of IPC control measures or impact of changes in practice.

**Surveillance programmes help to understand a problem and then identify changes or interventions to address the problem.**
7-3 Why should surveillance of healthcare-associated infection be conducted?

Surveillance for HAI is an essential part of any IPC programme. Through tracking HAI, the IPC practitioner may be able to establish the following key information:

- Clinical areas with the highest infection rates (usually intensive care units)
- The most prevalent (common) types of infections, e.g. urinary tract infections
- The infection types that cause the most morbidity and mortality
- The most frequently performed invasive procedures, e.g. surgery, IV catheter insertion
- The types of patients with the greatest risk for infection, e.g. HIV-infected patients, diabetics.

This information will assist the IPC practitioner and facility manager in determining the important (priority) areas and clinical practices which require intervention to reduce infection rates.

7-4 Who should perform surveillance of healthcare-associated infection?

Surveillance is a team effort, ideally involving staff with training in data collection, surveillance methods, data analysis and interpretation. It is critical to involve all stakeholders or at least to make them aware of the surveillance process and results, e.g. facility management, clinical and IPC staff.

Surveillance is a team effort.

7-5 At which different levels is surveillance conducted?

Depending on the information required, surveillance can be conducted at many different levels:

- At individual unit or ward level, e.g. what is the rate of bloodstream infections in ward A?
• At facility or institution level, e.g. what is the overall rate of HAI at hospital B?
• At provincial or national level, e.g. how many measles cases were notified in country C this year?
• At global level, e.g. what is the rate of TB notifications per 100 000 population in each country that publishes annual TB data?

7-6 What resources are required for healthcare-associated infection surveillance?

Surveillance is a labour and resource-intensive activity that usually requires a dedicated person or team of people to achieve. Basic requirements for surveillance include:

• A clear purpose
• Standard definitions of infection (most use the Centers for Disease Control National Healthcare Safety Network definitions obtainable from the Internet)
• A central person or institution to standardise definitions and protocols, receive the data, assess data quality, standardise the approach to analysis, interpret and share the data.

7-7 What different types of surveillance can be performed?

The resources available for HAI surveillance will determine which surveillance method is most practical for an individual unit or facility.

The main HAI surveillance methods are:

• Continuous surveillance: e.g. for a period of at least six months of either total or targeted surveillance; total surveillance collects data on all types of HAI, whereas targeted surveillance identifies only a particular type of infection, disease or pathogen to survey.
• Periodic surveillance: is conducted intermittently, giving a ‘snapshot’ of infection rates at certain points in time, e.g. number of cases for one week every month. This is also known as a point prevalence survey.
• Laboratory-based surveillance: uses laboratory isolates of pre-selected pathogens, often called ‘alert organisms’ from specific types of samples or ‘alert sites’, e.g. blood cultures, urine, pus swabs to calculate HAI rates.

• Clinical surveillance: uses definitions of infection based on clinical parameters, with or without inclusion of laboratory results, e.g. a presumptive clinical diagnosis of lung infection would include fever above 38 °C, pneumonia on chest radiograph, and a raised white blood cell count.

The type of surveillance method selected is determined by the question to be answered and the resources available to carry out surveillance.

7-8 What is the difference between outcome and process measures?

Surveillance can measure:

• Outcomes (e.g. HAI rates, infection with specific pathogens or needlestick injuries)
• Processes (e.g. staff compliance with hand hygiene or uptake of influenza immunisation).

Surveillance can measure the outcome of a problem or the process which can prevent or correct a problem.

7-9 What is a surveillance plan?

Before starting with surveillance it is essential to have a well-thought out plan that includes the following steps:

• Over what period of time (continuous) or at what interval (periodic) will surveillance be performed
• Clear and easily understood case definitions of the HAI or event or practice being surveyed
• Who will collect the data?
• Who will check (verify) the accuracy of the data?
• How will the data entry be done?
• How will the data be analysed?
• Who will the results of the surveillance be shared with?

7-10 How are healthcare-associated infection rates reported?

The most common way of reporting on the frequency of HAI is by using a rate. Simply put, a rate is the number of times something happens during a particular period of time. To calculate HAI rates we divide the number of people who acquired infection (the numerator) by the total population at risk of an infection (the denominator), for example:

The Caesarean section infection rate at hospital X in 2013 = The number of women with Caesarean section wound infection in 2013 ÷ The total number of women who had a Caesarean section in 2013

It is essential to have the denominator data, as this allows for comparison of rates between different clinical areas or institutions.

Surveillance findings for healthcare-associated infection are usually measured and reported as a rate. A denominator is essential.

7-11 How is healthcare-associated infection surveillance performed in high-income countries?

The United States of America uses a sophisticated, centralised system for reporting of HAI, using the National Healthcare Safety Network (NHSN) criteria. Every institution country-wide is required to report their HAI data onto an Internet-based surveillance programme. The programme uses standardised case definitions and data-collection methods. This ensures that HAI data can be compared between institutions and regions (so-called benchmarking). The information is also made available to all stakeholders, to guide IPC programmes and identify priorities for intervention.
7-12 What is known about healthcare-associated infection rates in low-resource settings?

Many low-resource settings lack the resources (human, technical and laboratory) required to conduct accurate surveillance of HAI. HAIAs are the most common adverse event (complication) encountered in health care. The World health Organization (WHO) estimates that of every 100 patients hospitalised, seven in developed and 10 in developing countries will acquire a HAI. Rates of HAI in newborn infants in low-resource settings are up to 20 times higher, and in intensive care units up to three times higher than rates in developed countries. In low-resource settings, surgical site infections are the most common type of HAI, affecting up to one-third of all patients operated on.

Healthcare-associated infection rates are far higher in low-income countries than in wealthy countries.

7-13 Is it feasible for low-income countries to perform healthcare-associated infection surveillance?

In settings with very limited resources it may be very difficult to conduct even the most basic HAI surveillance. In such settings, it may be worthwhile doing once-off (only done once) or periodic point prevalence surveys of HAI as this requires fewer resources. Where diagnostic microbiology laboratory services are limited, clinical HAI surveillance can usually be conducted using standardised case definitions. In settings with good laboratory services and access to data, laboratory-based surveillance may be possible (without the need for additional human resources to do data collection).

7-14 How should healthcare-associated infection surveillance data be communicated to healthcare workers?

An essential part of the surveillance process is sharing the results with people who can improve the outcome, for example informing the obstetrics ward staff of the Caesarean section wound infection rate. The information should ideally be communicated verbally (to allow for discussion) and displayed in a prominent place (at the entrance to the ward) for all staff and visitors to see. The results should be graphically displayed in an
uncomplicated way, so that it is easily understandable. Ideally some interpretation or comparison of the results should be provided so that stakeholders know whether their performance for this surveillance measure was good, mediocre or poor. Suggestions on how to improve the outcome or process measure being surveyed are useful.

Surveillance findings should always be communicated to people who have influence over the outcome, e.g. ward staff and facility managers.

Outbreak investigation

7-15 What is an outbreak?

An outbreak is the occurrence of more cases of an infectious disease than would normally be expected for a particular time, place or population. For most outbreaks, two or more people with the same symptoms occurring in the same area and time, may be linked. In certain circumstances, even one case of a life-threatening disease is considered an outbreak, e.g. meningococcal meningitis or viral haemorrhagic fever.

An outbreak is the occurrence of more cases of an infectious disease than would normally be expected for a particular time, place or population.

7-16 Which other key definitions are used in an outbreak investigation?

When investigating or reading about outbreaks, you should be familiar with the terms in Table 7-1.
Caesarean section wound infection rates
Obstetrics Ward X, January 2013–April 2013

Criteria for wound infection include any of the following:

- Wound infection within 30 days of operation
- Purulent wound drainage
- Organisms isolated from wound swab
- Inflammation at wound site
- Doctor diagnoses wound infection

Figure 7-1: Caesarean section wound infection rates January–April 2013

Caesarean section wound infection rates have steadily increased in Ward X over the first four months of 2013. The infection rates have exceeded our target level of less than six infections per 100 Caesarean sections. Infection control has visited the operating theatre and ward to review all clinical practices. We recommend these measures to reduce the wound infection rates:

- Encourage all staff to practise adequate and regular hand hygiene
- Ensure that pre-operative antibiotics are given within one hour of surgery
- Ensure that all women for elective Caesarean shower before surgery.
### Table 7-1: Terms used in outbreak investigation

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endemic</td>
<td>The usual level of disease in a particular area</td>
</tr>
<tr>
<td>Epidemic</td>
<td>A level of disease above what is normally expected; more widespread or prolonged than an outbreak</td>
</tr>
<tr>
<td>Cluster</td>
<td>A group of cases in a certain place and time greater than would normally be expected</td>
</tr>
<tr>
<td>Vehicle</td>
<td>A non-living intermediary (factor) that can transmit pathogens (e.g. food or water)</td>
</tr>
<tr>
<td>Vector</td>
<td>A living intermediary (e.g. insects, arthropods) that can transmit pathogens</td>
</tr>
<tr>
<td>Reservoir</td>
<td>The usual place or area where a particular pathogen is found (e.g. humans, animals, the environment)</td>
</tr>
<tr>
<td>Modes of transmission</td>
<td>The way in which a pathogen is spread to infect humans; may be direct infection (MRSA transferred onto a patient by the healthcare worker's hands) or indirect (tick-bite fever caused by inoculation of Rickettsia from a tick bite)</td>
</tr>
<tr>
<td>Portal of entry</td>
<td>The way or site in which a pathogen enters a person to cause infection, e.g. swallowing contaminated food or water, or breathing in a pathogen</td>
</tr>
<tr>
<td>Common source outbreak</td>
<td>All victims acquire disease from a single point, e.g. cholera-contaminated water or Salmonella-contaminated food</td>
</tr>
<tr>
<td>Continuing source outbreak</td>
<td>Victims contract disease over multiple incubation periods (many people infected from others) e.g. chickenpox in a hospital ward</td>
</tr>
</tbody>
</table>

### 7-17 How are outbreaks usually recognised?

Outbreaks may be recognised in a variety of ways:

- Routine surveillance activities: in settings with good surveillance programmes, e.g. when outbreaks are detected early because the baseline infection rate is known. However, with all surveillance methods, you only find what you’re looking for. In other words, if your surveillance programme does not include all potential pathogens, you may fail to detect an outbreak with an unusual pathogen.
• Reporting by clinicians and laboratory staff: alert clinicians may notice an unusual increase in patients presenting with certain symptoms or infectious diseases. Similarly, a good laboratory service will phone clinicians or the IPC practitioner if they detect a cluster of a particular infection or identify a life-threatening pathogen. For this method of outbreak recognition to be effective, there must be good communication between all role players.
• Reports from individuals affected by a particular infectious disease: this is the way in which community outbreaks of disease, e.g. diarrhoeal or respiratory diseases, are often recognised. Communities should be aware of who to inform in the case of suspected outbreaks, e.g. the local health service, and in turn someone at district level should be responsible for investigation of outbreak claims.

7-18 What is the purpose of outbreak investigation?
The main aims of outbreak investigation are to identify the source of illness and to guide public health efforts to stop the spread of the outbreak. In addition, preventable risk factors for outbreaks can be identified and longer-term interventions can be planned, e.g. provision of safe drinking water to communities affected by cholera outbreaks. Outbreaks also provide opportunities to train healthcare workers about public health investigations and emergency response.

The main aims of outbreak investigation are to identify the source of illness and to guide public health efforts to stop the spread of the outbreak.

7-19 What is a pseudo-outbreak?
Several suspected outbreaks turn out to be ‘pseudo-outbreaks’ (false alarms). The impression of an increased infection rate may arise from:
• A change in the clinical or case definition of a disease
• An improved diagnostic method identifies more cases
• A change in the surveillance criteria.
To confirm an outbreak, you must analyse historical patient and/or laboratory data or sometimes consult published medical literature. You
should ensure that no changes in surveillance methods, diagnostic methods or case definitions have occurred.

7-20 What are the steps involved in outbreak investigation?

The steps (processes) are:

1. Prepare for investigation: all role players in outbreak investigation should be alerted, e.g. facility management, department of health, laboratories, clinicians, casualty and the community. A small core group of people (the outbreak team) should be formed to plan the investigation.

2. Confirm the existence of an outbreak: a case definition must be developed. This should ideally be clinical, e.g. the case definition for suspected measles would be fever, rash, cough and red eyes. This definition can be used to establish the size of outbreak, while laboratory confirmation of cases is awaited. The estimated numbers of cases can then be used to compare the present number of cases with usual rates of disease for that population and time period, to determine whether it is in fact an outbreak.

3. Establish the diagnosis: for each individual meeting the case definition, obtain and analyse clinical and laboratory data, to assist with identifying the suspected pathogen. For all cases, send appropriate clinical samples for laboratory investigation.

4. Search for additional cases: prepare a list of all individuals meeting the case definition in the facility or community (known as a line list). For hospital outbreaks, prepare a Gantt chart to track patient movements, procedures, samples submitted and disease outcome (see example in the case section).

5. Characterise (describe) the cases: use the demographic details from affected cases to build up a profile (description) of who is at risk of developing this infection. Where possible, draw the epidemic curve (this is a visual method of tracking when and at what rate new infections are occurring).

6. Put immediate control measures in place: support and intensify IPC measures, e.g. hand hygiene; and remove suspected sources of contamination, e.g. dirty drinking water.
7. Formulate a hypothesis (a possible explanation): analyse all the information collected to date and put together a theory (idea) that would explain the disease for most of the affected cases. Remember not all cases may be caused by the same pathogen and that it is possible for more than one outbreak to occur at the same time.

8. Test your hypothesis: most outbreak investigations do not reach this stage, as the intervention measures put in place often stop ongoing transmission. If this step is required, get help to perform further research on the problem.

9. Communicate your findings: identify a single member of the outbreak team to interact with the facility, the community and sometimes even the local media! It is vital to communicate progress and findings to all stakeholders and the public, as there is often a degree of panic and misinformation associated with outbreaks. Once the outbreak is over, summarise the investigation, make recommendations for prevention of future outbreaks and share the report widely.

7-21 What is the role of the IPC practitioner in outbreak investigation?

The IPC practitioner is a key person in outbreak investigation and should form part of the outbreak team. Additional activities that the IPC practitioner may help co-ordinate in an outbreak include:

- Collection of clinical specimens
- Evaluation and implementation of IPC measures
- Initiation of expanded disease surveillance into other areas
- Review of facility policies
- Education of healthcare workers regarding outbreak control measures.

7-22 What resources are available for outbreak investigation?

Outbreak investigation is a resource and time-intensive exercise. Ensure that the provincial or national communicable disease authorities have been alerted. Where local expertise in microbiology, virology and infectious disease is lacking, ask for assistance from larger institutions, the department of health and reference or national laboratories. In the case of large-scale or life-threatening disease outbreaks, the department of health may request
assistance from international bodies like the World Health Organization (WHO) or the Centers for Disease Control (CDC).

7-23 Where can healthcare workers obtain up-to-date information on outbreaks?

Most countries have communicable disease control programmes within their Health Departments or Ministries. In some countries, information on regional or national outbreaks may be made available from the national laboratory service. ProMED-mail (a programme of the International Society for Infectious Diseases) distributes a free email listserv with daily updates on outbreaks occurring throughout the world.

Case study 1

Your facility manager asks you to look into the problem of needlestick injuries (NSI) at your clinic. Many of the clinic’s staff who have had recent NSI are on sick leave, complaining of side-effects from their antiretroviral prophylaxis. You decide to start a surveillance programme for NSI at your workplace.

1. What is the purpose of this needle-stick injury surveillance programme?

Through starting the NSI surveillance you hope to better understand the problem and to establish the following:

• How prevalent (common) is the problem of NSI among the clinic staff?
• What factors increase the risk of a staff member having a NSI?
• What is the impact of staff having NSI on the clinic?
• What can be done to prevent NSI among staff members?

2. Who will you involve in the needle-stick injury surveillance programme?

Surveillance is a team effort, ideally involving staff with training in data collection, surveillance methods, data analysis and interpretation. It is important to involve all stakeholders or at least to make them aware of the
surveillance process and results. Given this information, you decide to invite the following people to be involved:

- The facility manager
- The IPC and occupational health nurse
- The nurse manager of casualty (where the highest number of NSI occurred)
- The facility data manager.

3. **What type of surveillance method will you use?**

You want to get an idea of how frequently NSIs in staff occur, as well as the circumstances surrounding each NSI incident. You decide that the best way to achieve this is to use continuous surveillance (ongoing for at least six months).

4. **What parts of the surveillance plan do you need to consider?**

Before starting your data collection, the surveillance team should plan and agree on the following:

- Over what period of time will the continuous surveillance be performed?
- What is your definition of a NSI? Will it include mucosal blood splashes?
- What information will you collect about each NSI incident?
- Who will be responsible for collecting and analysing the data?
- Who will the results of the surveillance be shared with?

5. **How will you report the findings of your surveillance?**

You could report on NSI at your clinic by using a rate (the number of times something happens during a particular period of time). To calculate the NSI rate you will divide the number of reported incidents of NSI (the numerator) by the total number of clinic staff at risk of a NSI incident. Using a denominator allows your data to be compared with data from other facilities or regions, regardless of the number of staff involved.
Case study 2

The IPC team at a hospital notice an increase in healthcare-associated infections (HAI) involving the pathogen Acinetobacter baumannii. They decide to conduct a point prevalence survey for the entire hospital to measure the burden of infections with Acinetobacter baumannii.

1. What is a point prevalence survey?

A point prevalence survey is a periodic surveillance method. Data is collected at a single time point giving a ‘snapshot’ of infection rates. Using the example above, the IPC team would survey all patients admitted to the hospital on a particular day. They could then establish how many patients have current infections with Acinetobacter baumannii.

2. The IPC team identified 10 patients with Acinetobacter baumannii infections. A total of 150 hospitalised patients were surveyed on that day. What is the point prevalence rate?

All patients with any site of Acinetobacter infection on the day of the survey: 10 ÷ Total number of hospitalised patients on that day: 150 = 10 ÷ 50 = 6.7% prevalence of Acinetobacter baumannii infections on that particular day.

3. Five of the affected patients are in the intensive care unit (ICU) and the remaining five are on the medical and surgical wards. How can the investigators determine if these infections are caused by a single strain of Acinetobacter baumannii?

Infections linked to a single strain of the organism are spread by cross-contamination. In other situations, infections may arise from different organisms or different strains of an organism and are spread from multiple sources. In this case, the infections may be linked, i.e. spread from a common source or from one patient to another. As a crude guide, outbreaks from a single-strain of a particular pathogen should have similar antibiotic susceptibility patterns from each of the different laboratory isolates.
4. After a thorough investigation, the IPC team conclude that possible factors responsible for this outbreak were inadequate disinfection of respiratory equipment and poor hand hygiene compliance. At what point in an outbreak investigation should IPC control measures be implemented?

Control measures should be implemented as soon as possible, based on the best available evidence.

5. In this case, what interventions could be implemented?

• Better adherence to hand hygiene
• Improved staff compliance with contact precautions on the wards
• Enhanced frequency of environmental cleaning on the affected wards
• Review of the cleaning procedure for respiratory equipment
• Refresher training for all cleaning staff and respiratory technicians
• Active surveillance for new Acinetobacter infections in the hospital.

Case study 3

On a Monday morning in April of 2012, the infection control department receives a phone call. The doctor in the neonatal intensive care unit reports that seven babies have developed sepsis over the weekend. Of the seven babies, four have laboratory confirmed bloodstream infection with Enterobacter cloacae. One baby has died and two others remain critically ill. The doctor is worried that this might be an outbreak.

1. When should an outbreak be suspected?

The following circumstances should alert you to the possibility of an outbreak:

• An increase in a particular type of infection in a ward or group of patients
• An increase in the number of device-associated infections, e.g. central line infections
• The occurrence of the same type of infection in healthcare workers and patients
• An increase in infections caused by an unusual pathogen or a highly drug-resistant bacteria.

2. Establishing a case definition is an important step in outbreak investigation. What case definition would you suggest for this case study?

When starting an outbreak investigation, the case definition used is usually broad, to include as many potential cases as possible. As more information becomes available, one can make the definition more specific, to include only cases with a strong link to the current outbreak.

The case definition may include several pieces of information: clinical criteria, e.g. fever, rash; laboratory criteria, e.g. positive stool culture for *Salmonella typhi*; epidemiological criteria, e.g. time, space, population. In this scenario a possible case definition could be: ‘Any newborn infant admitted to the neonatal wards after 1 April 2012 with clinical deterioration or raised infective markers.’

3. How will you confirm or disprove the doctor’s concern of an outbreak?

Several suspected outbreaks turn out to be ‘pseudo-outbreaks’ (false alarms). The impression of an increased infection rate may arise from:

• A change in the clinical or case definition of a disease
• An improved diagnostic method identifies more cases
• A change in the surveillance criteria.

To confirm an outbreak, you must analyse historical patient and/or laboratory data or sometimes consult published medical literature. You should ensure that no changes in surveillance methods, diagnostic methods or case definitions have occurred. Analysis of historical microbiology records showed that Enterobacter cloacae was an infrequently isolated pathogen on the neonatal wards.
4. What is a line list?

A line list is a method of summarising the personal and clinical information of all affected cases. It is one of the most important steps in outbreak investigation. It allows the outbreak team to compare all available data on the affected cases, to help with identifying common exposures, possible routes of infection and risk factors for infection. Below is the line list that was drawn up.

Table 7-2: Example of a line list

<table>
<thead>
<tr>
<th>Patient</th>
<th>Birth date</th>
<th>Date of positive blood culture with Enterobacter cloacae</th>
<th>Gestational age (weeks)</th>
<th>Weight at birth</th>
<th>Premature rupture of membranes</th>
<th>Parenteral nutrition</th>
<th>…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>03/25</td>
<td>04/03</td>
<td>28</td>
<td>910g</td>
<td>Yes</td>
<td>Yes</td>
<td>…</td>
</tr>
<tr>
<td>2</td>
<td>03/30</td>
<td>04/12</td>
<td>29</td>
<td>960g</td>
<td>No</td>
<td>Yes</td>
<td>…</td>
</tr>
<tr>
<td>3</td>
<td>04/01</td>
<td>04/14</td>
<td>31</td>
<td>1400g</td>
<td>No</td>
<td>Yes</td>
<td>…</td>
</tr>
<tr>
<td>4</td>
<td>04/14</td>
<td>04/14</td>
<td>28</td>
<td>1030g</td>
<td>No</td>
<td>Yes</td>
<td>…</td>
</tr>
<tr>
<td>5</td>
<td>04/08</td>
<td>04/16</td>
<td>30</td>
<td>1000g</td>
<td>No</td>
<td>Yes</td>
<td>…</td>
</tr>
<tr>
<td>6</td>
<td>04/05</td>
<td>04/17</td>
<td>36</td>
<td>1240g</td>
<td>No</td>
<td>Yes</td>
<td>…</td>
</tr>
<tr>
<td>7</td>
<td>03/15</td>
<td>04/18</td>
<td>26</td>
<td>1000g</td>
<td>No</td>
<td>Yes</td>
<td>…</td>
</tr>
</tbody>
</table>

5. A line list was drawn up with detailed information about the seven affected babies. What conclusions can you make regarding possible risk factors and the source of this infection?

An important step in outbreak investigation is to organise all the patient information by time, place, and person (a line list). This assists with identifying common risk factors and often identifies potential sources of infection. The time course of an epidemic can be plotted on graph showing the number of cases over time (the epidemic curve). In this case scenario,
the babies all became ill within the space of a few days (likely a point-source outbreak) and all were very low-birth-weight, premature infants. They all had a single common exposure to parenteral (intravenous) nutrition, which is a potential source of their bacterial sepsis.

**Case study 4**

In July 2013 the IPC practitioner in a government hospital identifies two patients with mediastinitis (infection of the tissue below the breastbone) after open-heart surgery. She starts an investigation to determine the cause of these infections and to establish if this is an outbreak. Together with the ward doctor and the microbiologist, she reviews clinical and laboratory information from these patients, establishes a case definition and starts surveillance for additional cases. In total, three patients hospitalised in July 2013 meet the case definition. There were no other cases of mediastinitis identified between January and June in that year. With all the information available she draws up the line list below.

*Table 7-3: Line list for mediastinitis cases*

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Admission date</th>
<th>Operation date</th>
<th>Diabetic</th>
<th>Surgical procedure</th>
<th>Perioperative blood sugar</th>
<th>Day of symptom onset</th>
<th>Organism on wound swab</th>
<th>Susceptibility profile</th>
<th>Surgeon</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>57</td>
<td>F</td>
<td>6 July</td>
<td>8 July</td>
<td>Y</td>
<td>CABG×3</td>
<td>Normal</td>
<td>Day 9</td>
<td>E. coli</td>
<td>Resistant only to ampicillin</td>
<td>A</td>
<td>died</td>
</tr>
<tr>
<td>2</td>
<td>61</td>
<td>M</td>
<td>25 June</td>
<td>27 June</td>
<td>Y</td>
<td>CABG×5; endarter</td>
<td>High</td>
<td>Day 22</td>
<td>Staph. aureus</td>
<td>Methicillin sensitive</td>
<td>B</td>
<td>ICU admission – alive</td>
</tr>
<tr>
<td>3</td>
<td>76</td>
<td>F</td>
<td>30 June</td>
<td>2 July</td>
<td>Y</td>
<td>CABG×2; Ao plasty</td>
<td>High</td>
<td>Day 15</td>
<td>Staph. aureus</td>
<td>Methicillin resistant</td>
<td>C</td>
<td>ICU admission – alive</td>
</tr>
</tbody>
</table>

*CABG = Coronary artery bypass graft*
1. **Do you think this is an outbreak?**

Yes, because the rate of mediastinitis in July (compared to the period January – June) is more than would be expected for this time, place and population.

2. **Do you think the three cases are linked?**

Looking at the line list there are some similarities in the three patients’ histories – all are diabetics and underwent the same operation in the same operating theatre. However, in all three cases the infections were caused by different organisms with different antibiotic susceptibility patterns. The cases are therefore not directly linked, but are part of a polyclonal outbreak.

3. **The investigators have so far not identified a source for this outbreak. What should they do next?**

Direct observation of clinical practices is often a very helpful exercise during outbreak investigation. One cannot rely on written procedures or interviews with healthcare workers – it is best to check and see for yourself. The IPC practitioner made the following observations after visiting the operating theatre and the post-operative ward:

- The operating theatre air conditioner was broken, with temperatures reaching up to 30 °C (much higher than the acceptable limit of 18–24 °C).
- Pre-operative hair removal was done using a razor.
- For surgical hand antisepsis, a three minute hand wash with antimicrobial soap was done.
- For pre-operative skin disinfection, 10% povidone iodine was used.
- Perioperative antibiotic prophylaxis was given within 30 minutes of skin incision.
- Hand hygiene compliance rates measured in the post-operative ward were poor (30%).

4. **What is the most likely cause of this outbreak?**

A possible contributing factor was the high temperatures recorded in the operating theatre, which could result in contamination of the operating field by the surgeons’ sweat. Poor hand hygiene in the post-operative ward may also have played a role. After fixing the ventilation system, no more wound
infections occurred. An active surveillance programme for surgical site infection was established in the cardiac surgery ward.
Tuberculosis infection prevention and control

Objectives

When you have completed this chapter you should:

- Understand how tuberculosis (TB) affects low-resource settings
- Understand which forms of TB pose a risk for TB transmission
- Be familiar with diagnostic tests for TB
- Know about the WHO 3I’s strategy for TB control
- Be familiar with the hierarchy of controls for prevention of TB transmission
- Know how to reduce the risk of TB transmission in healthcare facilities
- Know how to reduce the risk of TB transmission in households and communities
- Understand the influence of healthcare worker behaviour on compliance with TB prevention measures
- Be familiar with policies and surveillance for TB among health-care workers
- Be aware of the challenges posed by TB-infection prevention and control (TB-IPC) in low-resource settings.

Tuberculosis in low-resource settings

8-1 What is tuberculosis?

Tuberculosis (TB) is caused by a bacterial pathogen called Mycobacterium tuberculosis (the TB bacillus). In most people, TB affects their lungs. However, almost any bodily organ can be affected by TB, e.g. brain, spine, kidneys.
8-2 How is tuberculosis spread?

TB infection is spread to others mainly by the airborne route. Coughing releases the TB bacilli into the air from the lungs of an infected person. This TB-contaminated air can then be breathed in by others, who may go on to develop TB infection and/or disease.

Tuberculosis infection is spread by the airborne route.

8-3 What is the natural history of tuberculosis?

About one third of the world’s population are infected with TB bacilli. They have a condition known as latent TB infection (LTBI). In latent TB infection, a person has been exposed to and infected with TB bacilli, but there are very few TB bacilli in their lungs. As long as their immune system (body’s defences against infection) remains intact, the TB infection can be controlled and the TB bacilli are prevented from multiplying. In people whose immune system is underdeveloped (infants) or weakened (HIV, diabetes, malnutrition), the latent TB infection can progress to TB disease (i.e. tuberculosis). This happens when the body’s immune system is no longer able to contain the multiplying TB bacilli. The TB bacilli can then cause TB disease (tuberculosis) in the lungs or can spread via the lymph nodes or via the bloodstream to cause disease in other organ systems, e.g. abdomen, central nervous system. Most people with TB infection will never develop TB disease (tuberculosis).

About one third of the world’s population have latent tuberculosis infection (LTBI).

8-4 Who is at risk for acquiring tuberculosis?

Anyone who is exposed to TB (in close contact with an infectious TB case) can develop latent TB infection. For a person with latent TB infection, the lifetime risk of progressing to TB disease is about 10%. In people living with HIV, the risk of developing TB disease is much higher (up to 10% per year.) This risk can be reduced by ensuring HIV-infected people have access to antiretroviral treatment, which may partially restore the function of the
immune system. Other well-recognised risk factors for TB disease include extremes of age (young infants and the elderly), diabetes, steroids or cancer chemotherapy (which weaken the immune system), smoking and malnutrition.

In people living with HIV the risk of developing tuberculosis disease is up to 10% per year.

8-5 What is the global burden of disease caused by tuberculosis?

Although TB occurs globally, over 90% of TB disease is diagnosed in people living in low-middle income countries. About 9 million people are newly diagnosed worldwide with TB each year. The highest number of new TB cases are from countries in Asia and Africa. TB patients are often co-infected with HIV (14% worldwide, but up to 60% co-infection rates reported in some African countries). Worldwide, TB causes about 1.5 million deaths per year and is the second largest killer from a single infectious pathogen after HIV/AIDS.

Tuberculosis transmission

8-6 What forms of tuberculosis pose the greatest risk for transmission of disease?

People with pulmonary (lung) TB or laryngeal (throat) TB pose the greatest risk of transmission to others. TB is spread by the airborne route. When TB-diseased people cough they produce infectious ‘TB droplet nuclei’ or cough aerosols. These are tiny particles containing TB bacilli which may be suspended in the air for minutes to hours (in the absence of ventilation or air movement).

Pulmonary and laryngeal (throat) tuberculosis are the most infectious forms of disease.
8-7 When are tuberculosis patients most infectious?

People with undiagnosed pulmonary TB and those who have recently started treatment (less than two weeks) are most infectious. A person with untreated pulmonary TB can infect many people within their social and work environment. Once effective TB treatment is started, the number of live TB bacilli in the person’s cough aerosols drop dramatically, making them less infectious. This is why early identification of people with TB disease is so important to reduce TB transmission.

Other factors associated with infectiousness include:

- Cough (in patients with TB of the lungs and larynx)
- Lung cavities (which are filled with TB bacilli)
- Sputum smear positive TB (acid-fast TB bacilli on smear microscopy)
- Sputum culture positive for TB
- Patients undergoing procedures that may cause coughing (see below).

People with undiagnosed or newly diagnosed pulmonary tuberculosis are the most infectious.

8-8 When is tuberculosis transmitted?

TB can be transmitted whenever a person with TB disease of the lungs or throat coughs, shouts or sneezes (i.e. whenever there is forcible exit of air from the respiratory tract). In the healthcare setting, TB exposures occur most commonly when:

- Many people congregate in confined spaces with poor air flow, e.g. waiting areas or corridors outside consultation rooms.
- Exposure of healthcare workers to TB can occur during procedures such as sputum collection, nebulisation, suctioning, intubation, extubation and bronchoscopy.
- Infectious TB patients (diagnosed or undiagnosed) who are hospitalised also pose a hazard of TB transmission to fellow patients and staff if not appropriately isolated.
8-9 What factors influence the risk of tuberculosis transmission?

The two main factors that determine the risk of TB transmission are:

- The duration of exposure (how long)
- The degree of exposure (how much).

The longer one remains in close contact with an infectious TB case, the greater the chance that you will acquire TB. The degree of exposure is determined by many factors, e.g. the number of live TB bacilli in the air; the number of TB source cases in the room/ward; the infectiousness of the TB source case/s and how frequently the air in the environment/room/ward is exchanged (adequacy of ventilation.)

The risk of transmission is determined by the duration and degree of tuberculosis exposure.

8-10 Which areas in healthcare facilities have the highest risk for tuberculosis transmission?

In primary care clinics or community health centres, areas with high risk for TB transmission are waiting rooms, HIV clinics and sputum collection areas. In hospitals, adult medical wards, radiology departments, TB laboratories and paediatric wards are considered high-risk areas. In addition, any areas where aerosol-generating procedures occur (resuscitations, intubations, bronchoscopy areas) may be at higher risk for TB exposures to staff and other patients.

8-11 When are patients with tuberculosis considered to be non-infectious?

For patients not yet on anti-TB treatment, the following factors would make them less infectious:

- No coughing
- No lung cavities
- TB outside of the lungs (extra-pulmonary TB)
- Sputum smear negative for TB (no acid-fast bacilli on smear microscopy)
- Sputum culture negative for TB.
For patients who have started anti-TB treatment, the following criteria can be used to identify those who are no longer infectious (and could be safely de-isolated):

- At least two consecutive sputum smear microscopy samples negative for TB (sputum is usually submitted for repeat smear and culture after two months of treatment) AND
- Evidence of clinical improvement (resolution of cough/fever) AND
- Adherence to an adequate anti-TB treatment regimen for two weeks or more.

**Diagnosis of tuberculosis**

8-12 **When should the diagnosis of tuberculosis be suspected?**

Pulmonary TB is the most common form of TB disease. Symptoms of pulmonary TB can include any or all of the following:

- A chronic cough (more than two weeks)
- Unintentional weight loss
- Fever
- Night sweats
- Loss of appetite
- Chest pain
- Coughing up blood (haemoptysis)
- Failure of the respiratory symptoms to improve after an appropriate course of antibiotics.

TB in other organs can cause some of the above symptoms (fever, night sweats, weight loss) but in addition usually causes symptoms related to the organ system involved. For example, TB meningitis may cause symptoms like headache, confusion or decreased level of consciousness.

8-13 **How is tuberculosis usually diagnosed?**

In many low-resource settings, a method called sputum smear microscopy is still the main or only method used to diagnose TB. A microscope is used to magnify a sample of sputum placed on a glass slide. A trained laboratory
technician stains the sputum with various dyes that make it easier to see the acid-fast TB bacilli. Usually two to three sputum samples per patient are examined. A patient whose sputum contains TB bacilli is said to be ‘smear-positive’ for TB. The degree of infectiousness of a patient can also be estimated by counting the number of TB bacilli (called AFBs or acid-fast bacilli) under the microscopy field, e.g. grade 1, 2 or 3 smear positive. Although sputum microscopy can provide a quick diagnosis, the test does not detect patients with very few TB bacilli (pauci-bacillary disease), cannot differentiate easily other types of mycobacteria and cannot give any indication of TB drug-resistance.

**Although sputum TB microscopy is widely available, it cannot detect all patients with tuberculosis or give any indication of drug-resistance.**

**8-14 What other tests are available to confirm the diagnosis of tuberculosis?**

In very low-resource settings, TB smear microscopy may be the only laboratory diagnostic test available. Where a TB reference laboratory exists, TB smear microscopy is usually followed by TB culture. This process involves introducing the patient’s sputum sample (which may contain TB bacilli) onto a solid or into a liquid growth medium to support potential growth of TB under laboratory conditions. After between one to six weeks (depending on the type of growth medium used), the culture may become positive.

Further testing of the cultured bacilli allows the laboratory to confirm that the TB bacilli grown belong to the Mycobacterium tuberculosis complex (rather than other strains of mycobacteria). Additional testing can then be done to check for the anti-TB drug susceptibility of the strain (see below.) All of these tests are significantly more expensive and time-consuming than TB microscopy and require specialised equipment, highly trained laboratory staff and reliable access to water and electricity.

A new molecular test (GeneXpert or Xpert® MTB/RIF) has been made available in many countries to allow for rapid (less than two hours), point-of-care (on-site) testing for TB bacilli in sputum. This test can
simultaneously detect the presence of TB DNA, as well as mutations in the gene that determine the TB bacilli’s susceptibility to the anti-TB drug, rifampicin. The significance of this new test is that the TB diagnosis can be confirmed at the same visit. Even more importantly, drug-resistant TB (see below) can be identified at initial TB diagnosis (as compared with traditional testing methods for drug-resistant TB which take weeks to months, allowing a prolonged time for onward TB transmission).

A new molecular test (Xpert® MTB/RIF) can deliver rapid, on-site testing for tuberculosis and tuberculosis drug-resistance.

8-15 What is drug-susceptibility testing (DST) for tuberculosis?
Drug susceptibility (sensitivity) testing is done to determine if an individual patient’s strain of TB bacilli will be effectively treated by the standard first-line, or in some cases by second-line anti-TB drugs. The drug susceptibility of a particular TB strain can be tested by observing growth of TB bacilli in the presence of different anti-TB drugs, or using special techniques that identify mutations (changes) in the genes related to drug action.

Drug-resistant tuberculosis

8-16 What is drug-resistant tuberculosis?
Drug resistance develops when the standard drugs used to treat TB become less effective in killing the TB bacilli. Drug resistance can develop when TB patients stop taking their medication or take it infrequently (acquired resistance). However, drug-resistant TB (DR-TB) can also be transmitted directly (primary resistance). This happens when a person is directly infected with a resistant form of TB through contact/exposure to someone with DR-TB.

8-17 Why is drug-resistant tuberculosis a problem?
Drug-resistant TB is much more difficult and expensive to treat than normal, drug-susceptible (sensitive) TB. This is because in DR-TB the most
powerful anti-TB drugs have become ineffective through development of drug resistance. This means that DR-TB has to be treated with inferior drugs, that are less powerful at killing TB and often have many side-effects. To counteract for the fact that these drugs are less effective, more drug combinations are used (up to six different drugs). The DR-TB regimens also have to be given for much longer than the standard six-month TB regimen (for 24 months or longer).

Drug-resistant tuberculosis is much more difficult and expensive to treat.

8-18 How does tuberculosis become drug-resistant?

Drug-resistant TB can be acquired during the course of TB therapy under the following circumstances:

- When the full course of treatment is not completed (treatment defaulters)
- When patients take treatment infrequently (poor adherence)
- When patients have poor drug absorption (vomiting or intestinal disease)
- When the TB drug supply is erratic (drug-outs)
- When the wrong TB therapy combinations, dose or treatment duration is prescribed
- When the TB drugs are of poor quality.

8-19 What is multidrug-resistant tuberculosis?

Multidrug-resistant tuberculosis (MDR-TB) is TB that is resistant to at least the two most powerful first-line anti-TB drugs: isoniazid (INH) and rifampicin (RMP). There are estimated 650,000 patients with MDR-TB worldwide at any time.

Multidrug-resistant TB is TB that is resistant to isoniazid (INH) and rifampicin (RMP).
8-20 What is extensively drug-resistant tuberculosis?

Extensively drug-resistant (XDR-TB) is a form of TB which is resistant to at least four of the main anti-TB drugs: isoniazid (INH), rifampicin (RMP), any fluoroquinolones (e.g. ofloxacin or moxifloxacin) and to any of the injectable second-line drugs (amikacin, capreomycin or kanamycin).

The World Health Organization (WHO) states that about 9% of MDR-TB patients worldwide actually have XDR-TB, since in many sites advanced drug-susceptibility testing is not available.

8-21 Is drug-resistant tuberculosis more infectious than drug-susceptible tuberculosis?

DR-TB is spread from person to person as easily as drug-sensitive TB and by the same airborne route. In other words, DR-TB (MDR-TB and XDR-TB) is not more infectious; however, exposure to DR-TB may be prolonged for several reasons. In most cases the diagnosis of drug-resistance is delayed (by weeks or months). This is because many countries where TB is common lack molecular testing facilities for drug resistance. In addition patients with DR-TB take longer to smear conversion (i.e. remain smear positive and infectious for longer). They may also require more frequent and longer periods of hospitalisation resulting in greater exposure risk in healthcare facilities.

Drug-resistant tuberculosis is transmitted as easily as drug-susceptible tuberculosis and by the same airborne route.
Global tuberculosis control

8-22 What is the global tuberculosis programme?

The World Health Organization (WHO) has established the WHO Global TB Programme. This programme aims to advance universal access to TB prevention, care and control, guide the global response to threats, and promote innovation. Their core functions include:

- Provision of global leadership on TB
- Development of evidence-based policies, strategies and standards for TB prevention, care and control
- Provision of technical support and capacity building for Member States
- Monitoring the global TB situation measuring progress in TB care, control, and financing
- Shaping the TB research agenda with dissemination of valuable knowledge
- Facilitation of partnerships for TB action.

8-23 What is the 3I’s programme of tuberculosis control?

The World Health Organization (WHO) has developed the 3I’s strategy to help HIV and TB service providers to reduce the burden of TB among people living with HIV (PLWH).

1. Intensified case finding aims to identify undiagnosed TB among PLWH, to reduce the delay between infection, diagnosis and treatment. Up to a quarter of individuals initiating antiretroviral treatment (ART) may have undiagnosed active TB, underlining the need for increased TB screening efforts.

2. Isoniazid preventive therapy (IPT) for at least six months can reduce the TB disease burden in PLWH in whom active TB has been excluded. IPT is particularly useful for PLWH who are not yet on ART. IPT has been shown to be safe and well-tolerated.

3. Infection control both within household and healthcare (clinic/hospital) settings is the third intervention recommended by WHO to reduce the spread of TB.
8-24 What is the hierarchy of tuberculosis infection controls?

TB infection prevention and control includes a set of ranked interventions to reduce the risk of TB transmission, both in healthcare, community and household settings. These interventions are commonly known as the hierarchy of TB controls. They are ranked in order of importance:

- Administrative controls: to reduce the risk of TB exposure
- Environmental controls: to reduce the concentration of TB in the air and prevent spread
- Personal respiratory controls: additional risk reduction in high TB exposure settings.

These inter-connected control measures cut across programmes and disciplines, and require interaction and co-operation from multiple role-players in the healthcare context, including facility managers, healthcare workers, laboratory staff and patients/clients.

The hierarchy of tuberculosis infection controls are a set of ranked interventions to reduce the risk of transmission in healthcare, community and household settings.

8-25 Why is tuberculosis infection prevention and control needed in healthcare settings?

Poorly implemented or non-existent TB-IPC in healthcare settings can result in TB transmission to healthcare workers and patients alike. The 2005 outbreak of XDR-TB in Tugela Ferry, South Africa (52/53 patients who acquired XDR-TB died) should convince all healthcare workers of the need for TB-IPC. Recent research in South Africa has also reported very high rates of DR-TB (4–6 per 100 000 population) in healthcare workers compared with non-healthcare workers. In many low-resource settings, TB infection control measures are poorly implemented and occupational TB is common. Strengthening of TB-IPC is critical to prevent healthcare workers...
and patients from acquiring TB in the healthcare setting. However, ensuring that TB-IPC measures are adhered to requires involvement of all healthcare staff, as well as the co-operation of TB patients.

8-26 Who should ensure that tuberculosis infection prevention and control are implemented in healthcare settings?

It is usually the responsibility of the facility manager to ensure that the TB-IPC plan is implemented. The facility manager can delegate this responsibility to another member of staff, for example the IPC practitioner or the Occupational Health practitioner.

Every healthcare facility should have a named person responsible for implementing the tuberculosis infection control plan.

Administrative control measures

8-27 What is included in the administrative controls?

The administrative controls for TB infection control are placed at the top of the hierarchy. They are the most effective way to reduce the production of TB aerosols in the local environment. Early diagnosis of TB remains the most important intervention to reduce TB transmission. Several steps and role players are needed to ensure early diagnosis. These include:

- A patient-centred service
- Heightened clinical suspicion of TB
- Rapid specimen collection and processing
- Directed patient flows to avoid mixing of coughing adults with vulnerable patients (e.g. immunocompromised, young or elderly people)
- Implementation of strict cough triage and respiratory hygiene (separate coughing patients and provide them with surgical masks)
- Effective patient tracking and recall to commence treatment
• Treatment adherence by patients
• Active case-finding among household TB contacts (people who have been exposed to a TB case).

8-28 **Who should be involved in implementing the administrative controls?**

There are many people who should be directly involved in the implementation of administrative controls to prevent TB transmission in healthcare facilities, including:

- **Facility management:** to assign responsibility and accountability for TB-IPC; perform TB risk assessments with immediate corrective action when indicated; to develop, implement and evaluate the facility’s TB-IPC plan
- **Laboratory services:** to ensure timely processing and reporting of specimens
- **Clinicians:** to implement effective clinical management of TB patients (triage, isolation, treat promptly, discharge)
- **The IPC practitioner:** to train healthcare workers about TB-IPC, N95 respirators, supply appropriate signage for TB isolation areas, conduct TB surveillance and visit TB patients in wards
- **The Occupational Health practitioner:** to evaluate healthcare workers at risk for TB, monitor and report occupational TB statistics
- **All roleplayers (everybody):** to promote TB awareness and education for healthcare workers, patients, the community, encourage cough etiquette and respiratory hygiene and consider the possibility of TB as a diagnosis in all patients.

8-29 **What is a facility tuberculosis risk assessment?**

All healthcare facilities should assess and classify the risk of TB transmission in their setting once a year. The purpose of the risk assessment is to determine which of the components of the administrative, environmental and respiratory controls should be implemented. Risk classification also helps facilities decide if they need an occupational TB screening service. There are several tools available to assist facilities with the performance of TB risk assessments.
8-30 Which challenges do low-resource settings encounter with implementation of the administrative controls?

In low-resource settings there are multiple obstacles to full implementation of administrative controls for TB-IPC. Common areas where challenges are encountered include:

- **Laboratory diagnosis of TB:** there may be a lack of TB reference laboratories, limited TB diagnostic tests available, limited equipment and shortage of trained laboratory personnel, slow turnaround times (time between sputum sampling and return of laboratory results to healthcare practitioner) and inability to provide laboratory confirmation of drug-resistant TB.
- **Infection Control and Occupational Health:** many facilities lack IPC and/or Occupational Health-trained staff and services; there may be unfamiliarity with TB risk assessment protocols and insufficient capacity to train staff in TB-IPC.
- **Facility:** there may be a lack of leadership and accountability for implementation of TB-IPC plan; infrastructure problems may include lack of provision for separate waiting areas or triage of suspected TB; insufficient airborne isolation facilities and lack of cough rooms or cough booths for sputum sample production.
- **Healthcare workers:** may be unable to track TB patients when laboratory results are returned; may not have resources to perform active tracing of household contacts; may be reluctant to report occupational TB and may be unfamiliar with TB-IPC plans and the hierarchy of TB control measures.
- **The community:** may lack an awareness of how TB is transmitted and lack understanding of the principles of cough etiquette.

The administrative controls are the most important part of a tuberculosis control programme because they reduce exposure of susceptible individuals.
Environmental control measures

8-31 What is included in the environmental controls?

Environmental control measures for TB prevention are also sometimes referred to as engineering controls. They include the use of:

- Enhanced ventilation (natural)
- Negative pressure patient isolation rooms (mechanical ventilation)
- Ultraviolet germicidal irradiation (UVGI)
- High-efficiency particulate air (HEPA) filtration systems.

The aim of the environmental controls is to remove, replace or ‘clean’ contaminated air. By reducing or diluting (with fresh air) the concentration of TB bacilli in the air, the potential for TB transmission is decreased.

**The aim of the environmental controls is to remove, replace, dilute or ‘clean’ contaminated air.**

8-32 What is natural ventilation?

Ventilation is the provision of fresh air to a room or building. Natural ventilation is the process of supplying and removing air through an indoor space without the use of mechanical systems. Movement of air occurs on its own because of differences in temperature or pressure between locations. Natural ventilation is the preferred method of ventilation in low-resource settings and has many advantages over mechanical ventilation (see below). In its simplest form, natural ventilation can be achieved by opening windows and doors in healthcare facilities. Natural draughts (movement) of air replaces stale, stagnant and/or pathogen-contaminated air (TB or respiratory viruses) with fresh air from the outside environment. Fans can also be used to help direct the movement of air in a room.

The direction of air flow should be considered when setting up consultation rooms. The healthcare worker should sit closest to the fresh air source and the patient closest to the air outlet. This ensures that any air with potential pathogens (e.g. TB) is removed away from the healthcare worker.
Figure 8-1: Recommended layout of examination room for patients with TB or suspected TB

Natural ventilation is the preferred method of ventilation in low-resource settings.
8-33 What are the advantages of natural ventilation?
Natural ventilation requires no equipment, no electricity and no maintenance. In addition it does not generate any noise and in hot climates can be used to provide free cooling of the environment.

8-34 What are the disadvantages of natural ventilation?
The use of natural ventilation is dependent on the correct climate conditions (including wind direction, force and humidity). Natural ventilation may cause discomfort for patients as it often results in cooling of the environment. Another disadvantage is that staff and patients can close windows and doors thereby preventing air replacement by natural means.

8-35 What is mechanical ventilation?
Mechanical ventilation (or controlled ventilation) is the process of supplying and removing air through an indoor space with the use of mechanical systems. Mechanical ventilation is used in settings where a high risk of TB exposure is expected, for example airborne isolation rooms and TB clinics. There are two types of mechanical ventilation: local exhaust ventilation and general ventilation.

8-36 What is local exhaust ventilation?
Examples of local exhaust ventilation include window-mounted extractor fans and ceiling-mounted ‘whirlybirds’. These devices extract air from a small, confined space, e.g. cough room or isolation room and usually remove (exhaust) the air directly to the outside air. These devices (although more expensive than natural ventilation) are generally much cheaper, require less technical expertise to install and need less maintenance than general ventilation systems.

8-37 What is general ventilation?
General ventilation is usually achieved by the use of air-handling units that can control direction and rate of air movement over larger areas, e.g. waiting areas, TB wards. Air-handling units are effective in preventing TB transmission by: removing contaminated air; diluting TB by introduction of fresh air and controlling the movement of potentially contaminated air.
within a space. Air handling units used for reduction of TB transmission should achieve at least 6–12 air changes per hour. This means that the entire volume of air in the room/space should be removed and replaced with fresh air at least six times per hour. As with local exhaust ventilation, removed air is directed out into the environment. In situations where that air may re-enter a room or building, additional methods like filtration or ultraviolet radiation is needed to ‘clean’ the air. In most cases though, if the air is exhausted to the outside, it is rapidly diluted and no additional decontamination is required.

### Mechanical or natural ventilation for reduction of TB transmission should achieve at least 6–12 air changes per hour.

#### 8-38 What is negative pressure ventilation?

Negative pressure ventilation is used to prevent movement of contaminated air into areas with susceptible people. It is used in airborne isolation rooms or facilities where patients with TB, measles or varicella (chickenpox) infection are admitted. In this situation the amount of air extracted (removed) from the room is greater than the air supplied. To ensure that negative pressure is maintained, all windows and doors should be closed. The air extracted from contaminated areas should ideally be released into the outside atmosphere, and not re-circulated to other areas of the healthcare facility.

#### 8-39 What is a cough room?

A cough room or cough booth is a small confined space where a patient goes to produce a sputum sample. Coughing produces large amounts of infectious TB droplet nuclei which may remain suspended in the air for prolonged periods of time. For this reason, a designated area with good ventilation is needed to reduce the possibility of cross-infection in TB facilities. In addition to good ventilation, the ideal cough room should be situated away from clinical areas and patient waiting rooms, and should include handwashing facilities.
8-40 What other features should be included in the design of tuberculosis isolation facilities?

A single negative-pressure room (with en suite bathroom facilities) is preferred for isolation of newly diagnosed TB patients, especially if drug-resistant TB is suspected. In most low-resource settings, single room isolation facilities are limited, necessitating cohorting of patients. A cohort is a group of patients with the same infectious pathogen that are nursed together. For wards or patient bays that cohort TB patients, the following features are recommended: Bed spacing should be at least

- 2.5 metres (measured from the centre of one bed to the centre of the next bed).
- Each bed should have individual curtains, so that these can be closed to contain the spread of TB droplet nuclei during coughing or aerosol-generating procedures. These must be changed with the bed linen change on discharge of each patient.
- Surfaces should be easy to clean and keep dry.
- Sufficient handwash basins should be available to staff and patients.
- The room/ward should be well-ventilated (either naturally or mechanically) to achieve between six and 12 air changes per hour.
- Safe outdoor spaces for relaxation and visiting with relatives should be provided (e.g. central courtyards or verandas).

8-41 What is ultraviolet germicidal irradiation (UVGI)?

Ultraviolet germicidal irradiation (UVGI) can be used in addition to negative-pressure ventilation, in high-risk areas. Ultraviolet light at a specific wavelength (254 nanometres) kills TB bacilli (also viruses and other bacteria) that are suspended in the air. UVGI alters the DNA of the TB bacillus, leading to death of the bacillus given sufficient time and intensity of exposure to UV light.

The effectiveness of UVGI for TB prevention in low-resource settings is dependent on several factors:

- Regular monitoring and servicing of the UVGI lights are required
- The tubes require replacement after a certain amount of hours (consult suppliers)
- High levels of humidity may interfere with the UVGI
Excessive amounts of dust settling on the light tubes also reduce effectiveness.

Air circulation is required to bring the TB bacilli within close range of light tubes.

Skin damage, skin cancers and retinal damage are possible following prolonged exposure to improperly maintained UVGI.

8-42 Which challenges do low-resource settings encounter with implementation of the environmental controls?

Important challenges include:

- Lack of technical expertise: with a major shortage of skilled professionals and technicians for facility design, architectural planning, ventilation engineering and supply, maintenance of UVGI.
- Lack of knowledge: facility managers and healthcare workers may be unaware of the need for regular servicing and maintenance of ventilation systems and UVGI. This may give rise to a false sense of security, where the visible measures for environmental control may in fact be non-functional.
- Unsuitable facility design: many facilities do not have provision for patient separation, isolation rooms and cough rooms. New building or refurbishment planning projects may not take TB-IPC requirements into account.
- Financial: the provision of single room, en suite, negative pressure ventilation areas may be unaffordable in most low-resource settings.

Respiratory protection control measures

8-43 What is included in the respiratory controls?

The respiratory controls (also known as personal respiratory protection) are intended to provide additional protection in high-risk circumstances. It is important to remember that the administrative and environmental controls are far more effective in reducing TB transmission risk. Respiratory protection (if used correctly) can give additional benefit, especially for exposures to drug-resistant TB.
8-44 What is the difference between a face cover, a surgical mask and a N95 respirator?

A face cover is any piece of personal protective equipment designed to cover the nose and mouth of the wearer, e.g. surgical masks or N95 respirators.

To prevent release of TB bacilli when coughing, patients can be asked to use a disposable tissue or handkerchief to cover their cough or to wear a surgical mask. Although a surgical mask is effective in containing respiratory droplets, its filter efficiency is poor and short-lived. For this reason, surgical masks are not recommended for respiratory protection of healthcare workers.

N95 respirators should be worn when within 3 metres of an infectious TB source case. These respirators have very high filtering efficiency, preventing inhalation of over 95% of particulate aerosols. Particles from 0.1–10 microns in size are filtered out, including TB droplet nuclei which are about 2–5 microns in size.

N95 respirators should be worn by healthcare workers when in close contact with infectious tuberculosis patients.

8-45 What is a N95 respirator fit-test?

In order to be effective, it is essential that N95 respirators are properly fitted to the size and shape of an individual healthcare worker’s face. N95 respirators are available in different sizes and styles, e.g. cone- or cup-shaped; duckbill-shaped and others with built-in expiratory valves. This is to maximise the chance of finding a respirator that can provide a tight seal on the wearer’s face. Excessive facial hair or beards will prevent a proper seal being formed.

All healthcare workers should be fit-tested by an expert prior to using a N95 respirator. This involves formal testing of a particular size/style respirator’s ability to protect the wearer from inhaling particulate aerosols. At the time of fit-testing, staff should also be trained in the correct method of donning (putting on) and doffing (removing) the respirator.
N95 respirators are only effective at reducing risk of tuberculosis infection if worn correctly, consistently and stored appropriately.

8-46 How should N95 respirators be used and cared for?

In low-resource settings, N95 respirators are often re-used intermittently for up to one week or to a maximum of eight hours of use and then discarded. The proper care of the respirator is critical to ensuring its ongoing effectiveness. It should be stored dry (in an envelope marked with the healthcare worker’s name) because moisture reduces the filtering ability of the respirator. In addition, respirators should not be folded, crushed or torn. Respirators should be inspected for damage or surface contamination (by blood or body fluids) after every use.

If surgical masks are used by healthcare workers, these should be discarded immediately after use, as their filtering efficiency is limited to 10 to 15 minutes.
8-47 When should patients with tuberculosis wear face covers?

Patients with suspected TB or confirmed TB who are not yet sputum TB culture-negative should wear surgical masks in the following situations:

- During transportation between healthcare facilities
- While being moved about within a healthcare facility (e.g. going for X-rays)
- When present in patient waiting areas
- When other persons or patients are present in the room.

It is only necessary for TB patients to wear a face cover when in the presence of other people in a closed or a poorly ventilated environment. N95 respirators should never be used on patients as they are primarily designed to filter the air and can worsen shortness of breath in patients with lung damage.

8-48 Which challenges do low-resource settings encounter with implementation of the respiratory controls?

Important challenges include:

- Unavailability of personal protective equipment: N95 respirators are more expensive than surgical masks and may be unavailable or difficult to obtain; alternatively only selected shapes and sizes of respirators may be made available to staff.
- Lack of equipment and expertise to perform N95 respirator fit-testing: the N95 respirator fit-test kit is costly and the test solutions need to be replaced when used or expired; facilities may lack staff with the expertise and time to conduct the fit-testing assessments.
- Lack of staff adherence to respiratory controls: even when readily available, some staff members may refuse to use N95 respirators.
- Lack of understanding: staff may inappropriately insist that patients wear N95 respirators. This causes discomfort for patients, and takes away respirators that should be used for staff protection.
Healthcare worker adherence to tuberculosis control measures

8-49 How high is the risk to healthcare workers of occupational tuberculosis?

Rates of DR-TB (4–6 times higher than risk to the general population) have been reported in South African healthcare workers. In the group of healthcare workers described by this study, very few had been previously treated for TB. This implies that they were primarily infected with a DR-TB strain. The increased risk for development of TB (and DR-TB) among healthcare workers reflects substantial and unrecognised TB exposures in the workplace.

The increased risk for development of TB in healthcare workers reflects substantial and unrecognised TB exposures in the workplace.

8-50 What are the reasons for non-adherence to tuberculosis infection prevention and control measures?

Even though TB infection control policies and control measures are available, many healthcare workers disregard their risk of TB acquisition. Some of the reasons given by healthcare workers for not implementing TB infection control measures were:

- Not being bothered ‘very much’ by catching TB
- Feeling less susceptible to TB
- Fear of stigmatisation
- Discomfort from wearing N95 respirators.

TB infection control programmes need to take into consideration and address the reasons for non-compliance with intervention measures.
8-51 How can healthcare workers be encouraged to implement tuberculosis infection prevention and control measures?

This is a complex problem and requires actions at multiple levels of the healthcare system. Some suggestions to improve healthcare worker compliance with TB infection control programmes include:

- Institutional prioritisation of TB-IPC: there should be commitment from the healthcare facility manager to implement the facility TB-IPC plan; mandatory in-service training in TB-IPC for all healthcare workers; mandatory N95 respirator fit-testing of all clinical staff; annual TB risk assessments and sharing of results with staff and regular occupational TB awareness campaigns.
- Social proof and individual accountability: healthcare worker ‘champions’ for TB-IPC should be identified at each facility; senior clinical staff should ‘set the example’ for junior staff and facilities should consider the use of incentives and/or disincentives for adherence and non-adherence to TB-IPC controls.

Occupational health services for tuberculosis

8-52 When should healthcare workers be investigated for tuberculosis?

In some settings, healthcare workers may be offered a baseline (pre-placement) TB screening chest X-ray or annual blood tests to identify new latent TB infections (interferon gamma release assays – IGRA). Identification of new LTBI gives the opportunity to provide isoniazid (INH) prophylaxis where needed.

Any healthcare workers with possible symptoms of TB disease should be promptly referred for TB screening at their nearest staff clinic. Staff working
in high-risk areas for TB should be encouraged to determine their HIV status at regular intervals. Healthcare workers with known underlying immune-compromise (e.g. HIV, diabetes, steroid therapy), should be encouraged to disclose these conditions. This will allow occupational health services or facility managers to deploy such staff members in lower TB infection risk areas. Staff should also be discouraged from smoking, which may increase their risk of acquiring TB.

Symptom screening is another way to improve identification of staff with undiagnosed TB. Healthcare workers (in medium- to high-risk TB exposure settings) should undergo intermittent symptom screening with referral for investigation if any suspicion of TB disease.

**8-53 How should healthcare workers be investigated for tuberculosis?**

Healthcare workers with possible symptoms of TB should be referred to their nearest occupational health service for the following investigations:

- History and full clinical examination
- Chest X-ray
- At least two consecutive early morning sputum samples for TB microscopy, culture and sensitivity and/or
- Molecular testing (GeneXpert®) where available
- Voluntary counselling and testing for HIV (HIV rapid or ELISA)
- Other investigations (as determined by the clinical examination).

**8-54 What surveillance and reporting are required for occupational tuberculosis?**

In most countries, monitoring for workplace or occupational infection is required by law. Healthcare facility managers should be familiar with the requirements for healthcare worker protection. Each facility should conduct annual TB risk assessments and implement appropriate TB control measures. In many countries surveillance and reporting of TB infection and disease among healthcare workers are incomplete. For this reason, occupational TB is often not perceived to be a real threat to healthcare workers in countries where TB is most common.
Tuberculosis prevention in the community

8-55 What should newly diagnosed patients be told about preventing household spread of tuberculosis?

Wherever possible, a patient treated for TB should sleep in a separate room to other household members, particularly children under five years of age. The door to their room should be closed and the windows opened. All surfaces in the room should be kept clean and dust-free to avoid re-aerosolisation of TB droplets.

Good cough etiquette should be practised at all times: patients should use tissues or a handkerchief to cover their mouth and nose when sneezing or coughing; used tissues should be discarded immediately into a plastic bag, although a handkerchief may be re-used if good hand hygiene is performed. Hands should be washed with soap and water or cleaned with alcohol handrub. Caregivers should wash hands or use alcohol handrub immediately after each patient contact. If the patient goes outside, it is not necessary to wear a mask or face cover.

Discourage visitors while the patient remains infectious. In cases of drug-susceptible TB, the infectiousness of the TB source case will decline dramatically within one to two weeks of starting treatment (assuming good treatment adherence). For this reason, it is usually not necessary for caregivers to wear a surgical mask or face cover when nursing the patient beyond two weeks, unless there is poor treatment adherence or suspected drug-resistant TB.

8-56 Which other settings pose a risk for tuberculosis transmission?

Outside of the traditional healthcare facility environment, there are several other settings where transmission of TB can occur, e.g. home-based care, long-term care facilities, correctional facilities (prisons), shelters for the homeless and emergency medical (ambulance) services. In all such settings where patients with TB disease may receive care, a TB infection control risk assessment should be performed and a TB-IPC plan implemented.
Case study 1

A three-month-old baby is admitted to hospital with coughing and severe shortness of breath. Tuberculosis is strongly suspected but the baby has no household TB contacts. The baby was born prematurely and spent his first three weeks of life in the Kangaroo Mother Care (KMC) ward. His mother remembers sharing a room with a lady who looked sick and coughed continuously. Doctors find the potential adult source/index case and confirm that she has smear-positive TB. Her M. tuberculosis culture strain is identical to the baby’s strain. A contact investigation is started for babies who shared the adult TB source case’s room in the KMC ward. Four of the eight babies (50%) have already been treated for TB. None had household TB contacts and therefore most likely acquired TB in the KMC ward after birth.

1. What factors make the transmission of tuberculosis more likely in this setting?

Patients at extremes of age (i.e. newborn babies) are very vulnerable to developing TB disease after being infected with TB (latent TB). The cramped and poorly ventilated environment in most Kangaroo Mother Care wards also increases the risk of TB exposure.

2. How could this situation have been prevented?

As part of the administrative controls, healthcare workers should consider the possibility of TB disease in all patients. A simple TB symptom screening checklist administered before admitting mothers to the kangaroo ward could have identified the TB source case mother. In addition, she should have been referred for TB investigations after staff had noticed her coughing in the ward.

3. Why are neonatal and paediatric wards a medium- to high-risk area for tuberculosis exposure?

The greatest burden of TB disease occurs in young adults, including women of child-bearing age. In many TB-endemic countries, HIV infection is also common. People living with HIV are at very high risk of TB disease (up to
10% risk of TB disease each year). Since parents often remain in hospital for prolonged periods with their sick children, they pose a great risk for TB transmission (if they have undiagnosed active TB disease).

Case study 2

AB is a 25-year-old male college student who comes to your clinic for evaluation of fever and cough. He has been coughing for about six weeks. He has consulted the college’s student clinic previously and was given a course of antibiotics, without improvement. He continued to have fever especially at night with sweats and chills. His appetite is poor and he has lost 5 kilograms in the last month.

1. What features should alert the physician to a possible diagnosis of pulmonary TB?

The presence of cough for more than two weeks along with fever, night sweats, poor appetite and weight loss are signs and symptoms suggestive of pulmonary TB. The lack of improvement after a course of antibiotics is also an important clue to the possibility of TB.

2. What investigations or tests should the healthcare worker send from this patient?

The student should produce at least two sputum samples to be sent for TB sputum smear microscopy and culture. If available, a chest X-ray may be helpful as additional evidence of TB.

3. The sputum test is smear positive for acid-fast bacilli (3+ AFB-positive) and the patient is started on anti-TB medication. What advice should be given to the patient regarding medication?

The importance of adherence to medication for the full duration of treatment must be emphasised. He should be made aware that even if he starts to feel better he should continue to take the medications for a full six months. Excellent treatment adherence may reduce the risk of relapse and development of drug-resistant TB.
4. What advice will you give the student regarding return to college?

The student should report his illness to the college’s student clinic and wait to return to classes until his repeat sputum tests are smear- and culture-negative for TB. Contact tracing should be done to identify persons exposed to the TB smear-positive student. If the student stays in shared accommodation (e.g. a college dormitory) he should be allowed to go home. His roommates should be screened for TB.

Case study 3

Mrs FG is a 35-year-old lady who has just delivered her second child. She was diagnosed with smear-positive pulmonary TB during the last month of her pregnancy and was put on anti-TB medicines. She, her husband, first children and in-laws live in the same household.

1. Mrs FG is really worried about passing the TB to her new baby. What can be done to prevent TB transmission to the baby?

The concern of transmitting TB to her baby is very valid. Children with TB are usually infected by adults around them with untreated or undiagnosed TB. Mrs FG should submit a repeat sample for sputum microscopy and culture at the end of the second month of treatment. She must wear a surgical mask while indoors and practise good cough etiquette until she is sputum-smear-negative. In the meantime she may care and breastfeed her baby as normal. The baby will need to be followed up at the clinic regularly in the first six months of life. The baby should receive INH prophylaxis if the mother is still infectious.

2. Who among the household members need to be screened for contact tracing purposes?

All household members should be screened, especially children under the age of five and people who share a room with the index case (the patient with pulmonary TB).
3. What advice should be given to households with an infectious TB patient?

Wherever possible, a patient treated for TB should sleep in a separate room to other household members, particularly children under five years of age. The door to their room should be closed and the windows opened. All surfaces in the room should be kept clean and dust-free.

Patients should use tissues or a handkerchief to cover their mouth and nose when sneezing or coughing. Used tissues should be discarded immediately into a plastic bag. Hands should be washed with soap and water. If the patient goes outside, it is not necessary to wear a mask/face-cover, but the person should still maintain good cough etiquette. Discourage visitors while the patient remains infectious. Family members may share crockery and cutlery. The household members should help in the treatment of the TB by being supportive treatment partners.

In cases of drug-susceptible TB, the infectiousness of the TB source case will decline dramatically within one to two weeks of starting treatment (assuming good treatment adherence). For this reason, it is usually not necessary for caregivers to wear a surgical mask/face-cover when nursing the patient beyond two weeks, unless there is poor treatment adherence or suspected drug-resistant TB.

Case study 4

Mr XY, a 40-year homeless man, is brought to the emergency unit because he is coughing up blood (haemoptysis). He was started on treatment for pulmonary TB eight months ago, but defaulted treatment after just two months. The doctor admitting him is concerned about the possibility of drug-resistant TB.

1. What immediate actions should the doctor take?

Mr XY should be placed in a single room with door closed or in an isolation cubicle with the curtains drawn. Any healthcare worker attending to him should wear appropriate personal protective equipment (i.e. N95 respirator, apron, gloves and eye shields, since he is coughing up blood). An airborne-
2. Once the bleeding has stopped, the doctor wants to get a sputum sample from the patient to send for smear microscopy, culture and GeneXpert® testing. Where should the patient go to produce the sputum sample?

If the patient is too unwell to leave his bed, he can produce a sputum sample with the bed curtains drawn. The curtains should remain closed for at least 15 minutes after the sputum sample is taken.

If he can walk, he should put on a surgical mask and walk to a well-ventilated outdoor area or to a cough room (if available). Patients should never be sent to the bathroom/toilet to produce sputum.

He should wash his hands well with soap and water after producing the sputum sample.

3. The patient is confirmed to have drug-resistant TB and is admitted for several weeks on the medical wards in an isolation cubicle. Despite the IPC practitioner’s best efforts, many ward staff are reluctant to wear their personal protective equipment. What are possible reasons behind these feelings of resistance?

Even though TB-IPC policies and control measures are available, many healthcare workers disregard their risk of acquiring TB. It has been shown (especially in countries with high TB burden) that healthcare workers are at increased risk of TB disease. Some of the reasons given for non-compliance with TB-IPC measures are: feeling less susceptible to TB, fear of stigmatisation and the discomfort of wearing N95 respirators. The IPC practitioner and hospital management should actively address the reasons for non-compliance with intervention measures.
Antimicrobial stewardship

Objectives

When you have completed this chapter you should:

- Be aware of the global problem of antimicrobial resistance
- Know how and why antimicrobial resistance develops
- Be familiar with the concept of antimicrobial stewardship
- Know some components of antimicrobial stewardship programmes
- Understand the role of IPC in antimicrobial stewardship programmes.

Antimicrobial resistance

9-1 What is an antimicrobial agent?

Antimicrobial agent is a general term used for drugs, chemicals or other substances that kill or slow down the growth of micro-organisms. Antimicrobial agents include antibacterial, antiviral, antifungal, antiparasitic drugs, disinfectants and antiseptic solutions.

An antimicrobial is a substance that kills or slows down the growth of pathogenic micro-organisms.

9-2 What is antimicrobial resistance?

Antimicrobial resistance is the ability of micro-organisms to grow in the presence of a chemical or drug that would normally kill them or slow their growth.
Antimicrobial resistance is the ability of pathogens to grow in the presence of a drug or chemical that would normally kill them or slow their growth.

9-3 What is the impact of antimicrobial resistance?
Antimicrobial resistance makes it more difficult to treat infections because the available drugs become less effective. There are many examples of old infectious diseases which have become more difficult to treat than in the past, e.g. gonorrhoea (a sexually-transmitted disease), malaria and TB (with evolving anti-TB drug resistance).

9-4 Why has antimicrobial resistance developed?
Micro-organisms evolve constantly and are able to survive difficult conditions by adapting to new environments. Factors contributing to the rapid development of antimicrobial resistance are the overuse and misuse of anti-microbial drugs, some disinfectants and related chemicals.

9-5 How does antimicrobial resistance develop?
Certain micro-organisms are naturally resistant to some types of antimicrobials.

But resistance can also develop (be acquired) in two ways: * By genetic mutation (a change in the micro-organisms’ DNA make-up) or * By acquiring resistance from another micro-organism (through sharing of genetic material).

In bacteria, these genetic changes may produce antibiotic resistance by:

- Altering the antibiotic binding site on the bacterial surface
- Destroying the antibiotic with enzymes produced by the bacteria
- Preventing the antibiotic from entering the bacterial cell wall
- Pumping the antibiotic out of the bacterial cell as soon as it enters.
9-6 How does the overuse of antibiotics encourage development of resistance?

Drug-susceptible (sensitive) bacteria are killed when an appropriate antibiotic is given at sufficient dose, frequency and duration. If there are any bacteria resistant to the antibiotic, they can survive, multiply and replace the drug-susceptible bacteria. Overuse of antibiotics (in humans and animals) creates ‘selective pressure’, selecting out drug-resistant strains. Misuse of antibiotics (e.g. underdosing or not completing a course of antibiotics) also selects out resistant bacteria.

9-7 How does antimicrobial resistance spread?

Once resistance develops, it can spread rapidly because bacteria multiply quickly. The drug-resistant strain is then spread through direct contact. Poor infection control practices (especially poor hand hygiene compliance) accelerate the spread of drug-resistant bacteria, particularly in hospitals and homes for the elderly. The increased usage of antibiotics in hospitals, vulnerable patients, invasive procedures and indwelling devices increase the likelihood of development and transfer of drug-resistant bacteria. Global travel and the widespread use of antibiotics as growth promoters in animals also contribute to the spread of resistance.

Good infection control practices can reduce the spread of drug-resistant micro-organisms in healthcare facilities.

9-8 Why is antimicrobial resistance a worrying development?

There are many reasons to be concerned about antimicrobial resistance (AMR):

- Patients with AMR infections are twice as likely to die or suffer prolonged illness when compared with infections caused by non-resistant bacteria
- Patients with AMR infections remain infectious for a longer time, increasing the chance of spreading resistant micro-organisms
Some AMR infections may be untreatable with currently available drugs, threatening the gains made in the antibiotic era. AMR infections cost more to treat and extend the length of hospital stay, increasing the overall cost of healthcare.

Antimicrobial-resistant infections cost more to treat and are more likely to result in death than infections with drug-susceptible micro-organisms.

Antimicrobial stewardship

9-9 What is antimicrobial stewardship?

The primary goal of antimicrobial stewardship is to improve patient outcomes while minimising the adverse effects of antimicrobial use, such as the development of antimicrobial resistance. Antimicrobial stewardship is any activity that promotes:

- The use of antimicrobials only when indicated
- The appropriate selection of antimicrobials
- The appropriate dosing of antimicrobials
- The appropriate route and duration of antimicrobial therapy.

Antimicrobial stewardship activities promote the appropriate use of antimicrobials thereby aiming to reduce antimicrobial resistance.

9-10 What does antimicrobial stewardship mean for individual patients?

When practising antimicrobial stewardship at an individual patient level, one should try to prescribe an antimicrobial that:

- Is indicated on clinical and/or microbiological grounds
- Is the best selection, dose, and duration for the patient and the specific infection
• Will ensure the best clinical outcome
• Will have minimal toxicity to the patient
• Will have minimal impact on subsequent development of resistance.

9-11 Why is antimicrobial stewardship needed?

Antimicrobial resistance (AMR) is developing faster than the pharmaceutical industry can produce new antimicrobial drugs. This means that some infections are becoming more difficult, more expensive and even impossible to treat. Although microbial evolution and resistance are inevitable, the situation is aggravated by overuse and misuse of antimicrobials. Antimicrobial stewardship is urgently needed to slow down the pace at which resistance is developing and to conserve our current antimicrobial agents for future use.

Antimicrobial stewardship is urgently needed to slow down the development of resistance and to conserve antimicrobials for future use.

9-12 In which ways can antimicrobials be misused?

Antimicrobials can be misused in the following ways:

• Overuse: animal husbandry uses tonnes of antibiotics per year as growth promoters
• Inappropriate use: unnecessary prescriptions of antibiotics for viral infections, e.g. the common cold, sore throats and influenza
• Underdosing: the use of a dose or duration of treatment that does not result in bacterial killing, but rather selects out drug-resistant strains, e.g. TB treatment defaulters.

9-13 What are the consequences of antibiotic misuse?

The negative, unintended consequences of antibiotic overuse or misuse are called ‘collateral damage’. These can include the following:

• Selection of drug-resistant micro-organisms
• Fungal super-infection, e.g. candida infections
• Selection of particularly dangerous micro-organisms, e.g. *Clostridium difficile* infections.

**Antimicrobial stewardship programmes**

9-14 What is an antimicrobial stewardship programme?

Antimicrobial stewardship is a co-ordinated programme of varied activities that aim to:

• Promote the appropriate use of antimicrobials (especially antibiotics)
• Apply appropriate IPC principles
• Improve patient outcomes
• Reduce antimicrobial resistance
• Decrease the spread of multidrug-resistant micro-organisms.

9-15 Who should be involved in an antimicrobial stewardship programme?

Antimicrobial stewardship is a team effort that should involve all parties delivering and managing clinical care, i.e. doctors, nurses, pharmacists, IPC practitioners and healthcare managers.

Antimicrobial stewardship is a team effort that should involve everyone delivering and managing clinical care.

9-16 What is the role of the antimicrobial stewardship programme (ASP) committee?

The ASP committee should perform the following functions:

• Raise awareness of the need for antimicrobial stewardship at their facility
• Consult institutional stakeholders on proposed projects and policies
• Discuss and develop facility-specific stewardship policies and activities
• Co-ordinate surveillance of antimicrobial usage at their facility
• Report back on ASP progress to facility management and stakeholders.

9-17 Who should be members of the antimicrobial stewardship programme (ASP) committee?

The ASP committee should comprise senior facility staff (to ensure the cooperation of all staff members) for example:

• The facility manager, superintendent or CEO
• A senior physician (if possible with training in infectious diseases)
• A pharmacist (if possible a clinical pharmacist with infectious disease training)
• A microbiologist (if available)
• An information system specialist or data manager
• An IPC practitioner.

The antimicrobial stewardship committee should include senior clinicians, management, microbiology, pharmacy and IPC staff.

9-18 Who should the antimicrobial stewardship programme committee report to?

The ASP committee should provide regular (6-monthly) feedback to the facility manager, and preferably also to all antimicrobial prescribers (doctors and nurse practitioners).

9-19 What data is needed for antimicrobial stewardship programmes?

It is very useful to have some baseline information about antibiotic usage at a particular facility before starting with an ASP intervention. Information may be available from the pharmacy service or may need to be collected by the ASP committee. The type of information needed includes:

• Most commonly used antibiotics (and where possible, the indication or reason for use)
• Volume of antibiotic usage
- Wards or clinical areas with the highest antibiotic usage
- Local or facility-specific antimicrobial prescribing guidelines (if they exist).

This information will help the ASP to identify which drugs and wards should initially be targeted in the intervention. The local antimicrobial guidelines assist the ASP to identify whether prescribers are adhering to recommended practices.

**Information from an institution’s pharmacy is very helpful in identifying which antimicrobials and which clinical areas should be targeted by the ASP.**

**9-20 What resources are needed for antimicrobial stewardship programmes?**

The most important resources needed are the time, enthusiasm and perseverance of the ASP committee. Changing prescriber attitudes and behaviours takes time and effort, and is unlikely to happen quickly. Access to information (data) on antibiotic usage is crucial for ASP committees to be able to track the effect of their interventions. Some financial resources will be needed, but the cost savings achieved by most well-functioning programmes will easily cover this.

**9-21 How do antimicrobial stewardship programmes save healthcare facilities’ money?**

Many research studies have shown that antimicrobial stewardship programmes are very cost-effective. Patient outcomes are improved, duration of hospitalisation is reduced, and unnecessary antibiotic usage is prevented. In the United States of America, stewardship programmes have shown annual savings to healthcare facilities of up to $400,000 each.

**Investment in antimicrobial stewardship saves lives and money.**
The role of IPC in antimicrobial stewardship

9-22 How does IPC practice impact on antimicrobial usage?

Antimicrobial stewardship is sometimes referred to as a ‘marriage’ between IPC and antimicrobial management. This acknowledges the primary role of IPC in preventing spread of drug-resistant pathogens in healthcare facilities. Without good IPC practices, any attempt at antimicrobial stewardship is unlikely to be successful (as the uncontrolled spread of drug-resistant pathogens will require more antibiotic treatment).

Good IPC practices at healthcare facility level are needed to ensure the success of antimicrobial stewardship programmes.

9-23 What is the role of the IPC practitioner in the antimicrobial stewardship programme?

The IPC practitioner can add value to the antimicrobial stewardship programme through activities that reduce spread of resistant pathogens (thereby reducing the need for antibiotic treatment):

- Performing surveillance for resistant pathogens
- Auditing hand hygiene compliance regularly
- Ensuring healthcare staff perform cleaning and decontamination of patient care equipment such as bedpans, urinals and bowls
- Ensuring appropriate isolation and transmission-based precautions are implemented
- Ensuring thorough environmental cleaning is performed, especially for rooms where the prior occupant had a drug-resistant infection
- Auditing IPC practices and healthcare-associated infection rates, with provision of feedback and support to clinical areas with poor performance
Encouraging healthcare workers to remove indwelling devices that are no longer needed, e.g. peripheral cannulae (drips), urinary catheters

Assisting with education and awareness programmes so that all clinical staff understand the importance of antimicrobial stewardship.

The IPC practitioner contributes to antimicrobial stewardship through activities that reduce the spread of resistant pathogens.

Tools for antimicrobial stewardship

9-24 What techniques or tools are used for antimicrobial stewardship?

There are many antimicrobial stewardship interventions and activities that are successful in reducing inappropriate antimicrobial usage including:

- Selective reporting
- Antimicrobial consultation
- Treatment de-escalation
- Intravenous to oral switch
- Therapeutic dose monitoring
- Antimicrobial restriction
- Antibiotic cycling
- Antimicrobial guidelines
- Antimicrobial prescription charts
- Antimicrobial stewardship ward rounds.

The basic principles of these stewardship tools are discussed below.

9-25 What is empiric antimicrobial therapy?

Empiric antimicrobial therapy is the prescription of an antimicrobial/s based on the treating physician’s ‘best guess’ at which pathogen/s are causing a particular infection. For example, a nurse practitioner sees a baby with a rash on the bottom that looks typical of candida infection (thrush). Her
empiric choice of antimicrobial for this infection is an antifungal that can kill candida.

In patients with severe and life-threatening infections, it is often unclear which pathogen/s may be causing the illness. Critically ill patients may need to be started on several powerful antimicrobials at once, until the cause of the infection is revealed. In such cases it is very important to obtain appropriate specimens for diagnostic microbiology, BEFORE starting antibiotics. Antibiotics given before specimens are taken may make it impossible to grow and identify the responsible pathogen(s) in the laboratory.

9-26 What is targeted antimicrobial therapy?

Once the pathogen causing the infection has been identified, antimicrobial therapy can be matched or targeted to the specific pathogen and its drug-susceptibility pattern. This means that other antimicrobials that will not treat the pathogen can be stopped. In most cases, targeted therapy will reduce the patient’s antimicrobial drugs from several agents to a single agent.

**Targeted antimicrobial therapy aims to match the antimicrobial to the pathogen causing the infection.**

9-27 What is a narrow-spectrum versus a broad-spectrum antibiotic?

A narrow-spectrum antibiotic will treat only a limited number of pathogens, whereas a broad-spectrum antibiotic is effective against a wide variety of pathogens. The disadvantage of using a broad-spectrum antibiotic is that it encourages selection of drug-resistant pathogens, by killing off normal flora and other sensitive bacteria living in and on the patient.

**Broad-spectrum antibiotics (effective against a wide variety of pathogens) encourage the selection of drug-resistant pathogens.**
9-28 What is selective reporting?
Selective reporting is a technique used by microbiology laboratories to encourage prescribers to use targeted therapy. Most microbiology laboratories will test each isolate against a wide variety of antibiotics that could be used to treat the infection. With selective reporting, only the most ‘narrow-spectrum’ antibiotics that the pathogen is sensitive to is displayed on the report.

9-29 What is microbiology consultation?
In some healthcare facilities (with well-established microbiology laboratories), a telephonic consultation service and microbiology ward rounds may be available to clinicians. Clinicians should be encouraged to discuss the antimicrobial management of complex clinical cases with the microbiologist. Microbiology consultation often helps to ensure prescription of antimicrobial therapy that is rational, effective and based on the principles of antibiotic stewardship.

9-30 What is de-escalation of antimicrobial therapy?
When a pathogen causing an infection is identified, broad-spectrum antimicrobial treatment can be de-escalated or targeted by changing to a narrow-spectrum agent. De-escalation ensures that the patient receives an effective treatment while at the same time avoiding harmful effects of broad-spectrum antimicrobials. In sick patients, it is essential to take appropriate clinical specimens for microbiological analysis, so that the causative organism can be identified and antimicrobial therapy de-escalated.

De-escalation of therapy ensures effective treatment while avoiding the harmful effects of broad-spectrum antimicrobials.

9-31 What is discontinuation of antimicrobials?
In many instances, antimicrobials (particularly antibiotics) are given for too long:

- Continued for much longer than is needed to treat a confirmed infection
- Continued inappropriately even when tests for infection are negative at 72 hours (e.g. blood cultures and septic markers)
- Prescription of surgical (pre-operative) prophylaxis for more than one dose or day.

Unnecessarily prolonged courses of antibiotics expose patients to greater risk of side-effects and encourage development of antibiotic resistance. Clinicians should be encouraged to review the need for ongoing antimicrobials 72 hours after starting treatment. When no longer indicated, antimicrobials should be discontinued promptly. Early discontinuation of antibiotics can have a significant effect in reducing overall antibiotic usage.

It is useful for each healthcare facility or district to develop standard treatment guidelines with recommended antimicrobial choices, doses and specific duration of treatment for different infections or clinical presentations.

**Unnecessarily prolonged courses of antibiotics expose patients to greater risk of side-effects and encourage development of antibiotic resistance.**

9-32 **What is meant by intravenous to oral switch?**

Once an ill patient’s condition has improved and they are able to tolerate oral feeds/fluids, clinicians should strongly consider switching antimicrobial therapy from the intravenous to the oral route. Most antimicrobials have both intravenous and oral preparations (with oral agents being substantially cheaper). Switching to the oral route (and removing the IV catheter) also has the advantage of reducing the risk of healthcare-associated bloodstream and soft tissue infections (thrombophlebitis).

9-33 **What is therapeutic dose monitoring?**

Therapeutic dose monitoring (TDM) is the taking of samples to estimate antibiotic concentration in a patient’s blood, while the patient is receiving a particular dose of the antibiotic. If the concentrations are too low, maximal killing of bacteria will not be achieved and the patient’s dose or dosing frequency will need to be increased. If the concentrations are too high, the patient may experience side-effects from the antibiotic, and the dose or
dosing frequency will need to be decreased. TDM is important for antibiotic stewardship because if the patient is under-dosed, there is a greater chance that antibiotic resistance will develop. TDM is usually required for aminoglycosides (gentamicin, amikacin) and glycopeptides (vancomycin).

9-34 What is antimicrobial restriction?

Antimicrobial restriction is a policy that limits clinician’s access to certain classes of antimicrobials, without the prior approval of a senior colleague, e.g. microbiologist, infectious diseases clinician or hospital manager. The aim of antimicrobial restriction is to decrease inappropriate usage of broad-spectrum agents, and thereby reduce further development of antimicrobial resistance. Such a policy must be agreed upon at healthcare facility level. The facility should have clinicians (telephonically available to prescribers) who are able to assess whether a request for a particular restricted antimicrobial is appropriate or not.

9-35 What is antibiotic cycling or antibiotic diversity?

Antibiotic cycling is the planned (scheduled) rotation or switching between different classes of antibiotics with similar spectrums of action (will treat similar groups of pathogens). In theory, switching between different types of antibiotics decreases the ‘selection pressure’ for particular patterns of antibiotic resistance. Antibiotic cycling can be practised at individual ward or ICU level or for an entire healthcare facility. The effectiveness of this strategy is still debated, since resistance to a particular class of antibiotics increases rapidly once they have been re-introduced.

9-36 What is an antimicrobial prescription guideline?

An antimicrobial prescription guideline can be implemented at healthcare facility, district, provincial or national level. It is crucial though, that antimicrobial recommendations are based on updated, local antimicrobial susceptibility patterns. The guideline should include recommended
antimicrobial choices, doses and specific duration of treatment for different infections or clinical presentations. The availability of a guideline is very helpful when implementing antibiotic stewardship, since prescribers can be encouraged to follow standard recommendations.

9-37 What is an antimicrobial prescription chart?

An antimicrobial prescription chart is a dedicated (stand-alone) chart that contains only prescriptions for antimicrobial agents (usually antibiotics). The chart is designed to encourage antimicrobial stewardship through the following design features:

- Space to document the indication for antimicrobial treatment
- Space to document patient’s weight and renal function (to accurately calculate doses)
- Space to document submitted microbiological specimens and results
- Prompts at day three, seven and so on, to review the need for ongoing treatment
- Local guidelines on antibiotic choice and standard treatment durations.

An example of the antimicrobial prescription chart used by the South African Antibiotic Stewardship Programme (SAASP) can be seen in Figure 9-1.
Figure 9-1a: Antimicrobial prescription chart, developed and produced by the South African Antibiotic Stewardship Programme (SAASP), reproduced by kind permission of Dr Marc Mendelson and the SAASP
Figure 9-1b: Antimicrobial prescription chart, developed and produced by the South African Antibiotic Stewardship Programme (SAASP), reproduced by kind permission of Dr Marc Mendelson and the SAASP
Figure 9-1c: Antimicrobial prescription chart, developed and produced by the South African Antibiotic Stewardship Programme (SAASP), reproduced by kind permission of Dr Marc Mendelson and the SAASP
**Send cultures BEFORE antibiotics are prescribed**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Blood Culture</th>
<th>Sputum Culture</th>
<th>CSF Culture</th>
<th>Urine Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Sepsis</td>
<td>x 2</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>x 3</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Pneumonia*</td>
<td>x 1</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Meningitis*</td>
<td>x 1</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>UTI</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pyelonephritis</td>
<td>x 1</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*If LP is not possible immediately, then do not delay antibiotic administration. Ensure blood culture is sent. *Consider TB/MCS in addition.

**Avoid using antibiotics with overlapping activity**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-anaerobic</td>
<td>Metronidazole, clindamycin, amoxicillin-clavulanate, Piperacillin-tazobactam, carbapenems</td>
</tr>
<tr>
<td>agents</td>
<td></td>
</tr>
<tr>
<td>Staphylococcal</td>
<td>Cloxacillin-sensitive Staphylococci are also covered by cephalosporins &amp; carbapenems</td>
</tr>
<tr>
<td>cover</td>
<td></td>
</tr>
</tbody>
</table>

**Antibiotics requiring therapeutic drug monitoring (TDM)**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Timing of blood collection and interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aminoglycosides (unstable &amp; ICU patients)</td>
<td>Check peak level after 1st dose – 1 hour after i.v or i.m bolus or 1 hour after infusion is commenced. Less vital when once daily dosing is employed. Trough levels are vital! Once adequate peak level achieved, monitor trough level twice per week provided renal function stable. Take trough level just before next dose.</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>Peak level not necessary, but loading dose required in severe infections. Measure 1st trough level before 4th dose.</td>
</tr>
</tbody>
</table>

**Recommended duration of definitive antibiotic therapy**

<table>
<thead>
<tr>
<th>Duration</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single dose</td>
<td>Uncomplicated Cystitis in healthy non-pregnant women ill for &lt;1wk (Quinolone ONLY), Trichomonas,</td>
</tr>
<tr>
<td>3 days</td>
<td>UTI (quinolone ONLY), Shigellosis (without bacteraemia, quinolone ONLY)</td>
</tr>
<tr>
<td>5 – 7 days (or 3 days after normalization of fever)</td>
<td>UTI (non-quinolone), Otitis Media, Pneumonia, Meningococcal meningitis, Tick bite Fever (7)</td>
</tr>
<tr>
<td>10 (~ 14 days)</td>
<td>Sinusitis, Pneumococcal meningitis, Pyelonephritis, pharyngitis (S. pyogenes), Complicated UTI, Prostatitis (acute), Shigellosis (with bacteraemia), Helicobacter eradication (14), Gonococcal arthritis</td>
</tr>
<tr>
<td>21 days</td>
<td>Meningitis (Listeria or Gram-negative)</td>
</tr>
<tr>
<td>4 weeks</td>
<td>Endocarditis (prosthetic valve 6 weeks), Osteomyelitis, Septic arthritis, Prostatitis (chronic), Brucellosis (6 weeks)</td>
</tr>
</tbody>
</table>

*See Western Cape Academic Hospitals Antimicrobial Recommendations for details

Developed for the South African Antibiotic Stewardship Programme (SAASP), MM 2012

Figure 9-1d: Antimicrobial prescription chart, developed and produced by the South African Antibiotic Stewardship Programme (SAASP), reproduced by kind permission of Dr Marc Mendelson and the SAASP
9-38 What is an antimicrobial stewardship ward round?

An antimicrobial stewardship ward round is a useful and non-threatening way to involve and educate prescribers (especially junior colleagues) about stewardship principles. The ASP committee members visit various clinical areas (usually one area per week) for a brief discussion of all patients on the ward currently receiving antimicrobials. The indication for treatment, dose, route, duration of therapy and need for dose monitoring (TDM) are discussed for each patient. The AS ward rounds also incorporate discussion of IPC implications, where relevant, e.g. need for patient isolation and contact precautions in a patient being treated for methicillin-resistant *Staphylococcus aureus* infection. Where possible, the AS ward round team makes recommendations for interventions which could include any of the following:

- Discontinuation of antimicrobial therapy
- De-escalation of targeting of antimicrobial therapy
- Intravenous to oral switch
- Removal of unnecessary indwelling devices, e.g. intravenous and urinary catheters
- IPC recommendations, e.g. isolation or transmission-based precautions.

9-39 Why do healthcare staff need education about antimicrobial stewardship?

It is crucial that the above tools for antimicrobial stewardship are implemented together with an ongoing education programme. Only when clinical staff understand the reasons for restriction of their prescribing choices, will they be likely to comply with stewardship recommendations. There is often passive resistance because they do not understand why the microbiology, infectious diseases and/or IPC team is being ‘unreasonable’.

Case study 1

A 15-year-old schoolgirl is taken by her mother to see her local general practitioner (doctor). She is complaining of a sore throat, fever and body aches. She is not particularly unwell but is worried because she has an exam
later that week. Her mother asks the doctor to prescribe a course of antibiotics, because she thinks this will get her daughter better faster.

1. **What is the best management for viral infections such as viral pharyngitis?**

Most viral infections present with fever plus other symptoms like tiredness, body aches and poor appetite. Since there is no effective treatment available for most viral infections, management includes supportive care with medicines to address the complaints of the patient. Antibiotics have no role in the management of viral infections.

2. **How should prescribers handle patients who insist on having antibiotics prescribed for a viral infection?**

Pressure from patients and their family members is one of the reasons for antibiotic overuse. Many patients expect a prescription of antibiotics every time they go to the doctor for various complaints like fever, sore throat or diarrhoea, even if these infections will not be helped by antibiotics.

Prescribers should take time to explain the diagnosis and reassure them that their condition does not require antibiotics. They could also educate patients about the potential harmful effects of giving unnecessary antibiotics.

3. **What problems can arise when a patient is given antibiotics unnecessarily?**

The patient may experience side-effects (adverse drug reactions) from antibiotics such as rash, diarrhoea (as in *Clostridium difficile* infection) and fungal infections (e.g. vaginal thrush). Antibiotics also cause changes in the flora of the gut, selective pressure and development of antibiotic resistance.

**Case study 2**

A 28-year-old healthy pregnant lady is scheduled to have her baby delivered by Caesarean section. She is given a dose of cefazolin as pre-operative prophylaxis four hours before the operation starts. The baby is delivered successfully without any complications. After delivery, the obstetrician
continues the patient on cefazolin 1 gram every eight hours for three more days.

1. **What are the main concerns regarding antibiotic stewardship in this case?**

The timing of the pre-operative antibiotic should be less than one hour before the first skin incision is made (operation starts). In uncomplicated, clean (non-infected) cases, a single dose of pre-operative antibiotics is sufficient.

2. **Why are patients sometimes given extra postoperative doses of antibiotics?**

Many doctors feel that additional doses of antibiotics will somehow ‘protect’ the patient from surgical site infection. This is especially true in training hospitals where doctors may be young and inexperienced. Many research studies have shown no benefit from giving extra doses of antibiotics postoperatively for routine surgical procedures. The extra antibiotic doses unnecessarily expose patients to side-effects and increase the chance of developing antibiotic resistance.

**Case study 3**

A 40-year-old lady is admitted to hospital complaining of headache and severe chest pain. After four days she develops fever and cough productive of yellow sputum. The doctors now diagnose her with hospital-acquired pneumonia. Sputum samples sent to the laboratory show *Klebsiella pneumoniae*. The bacteria is resistant to several antibiotics including cephalosporins, piperacillin-tazobactam and aminoglycosides. The patient is the wife of the hospital manager. The occurrence of this hospital-acquired infection (which is highly antibiotic resistant) has upset the manager. He orders the hospital staff to set up an Antibiotic Stewardship Programme.
1. Which hospital staff should be involved in the development of the Antibiotic Stewardship Programme?

The ASP committee should include senior facility staff such as:

- The hospital manager, superintendent or medical director
- A senior doctor (if possible an Infectious Diseases specialist)
- A pharmacist
- A microbiologist
- An information system specialist or data manager
- The most senior IPC practitioner.

2. What roles should the newly formed ASP committee take on?

The ASP committee has the following functions:

- Raise awareness among doctors, nurses and other hospital staff about the antimicrobial resistance problem in their facility and the need for an ASP
- Consult facility stakeholders on the ASP projects
- Collect and analyse data related to ASP
- Plan interventions, activities and goals of the ASP
- Make and submit reports to the facility administration.

3. Why is it important to include an IPC practitioner in the ASP committee?

The IPC practitioner is an essential member of the ASP committee. Without good IPC practices, any attempt at antimicrobial stewardship is unlikely to succeed. IPC ensures that policies and practices to control the spread of drug-resistant organisms are in place.

Case study 4

The Infectious Disease (ID) specialist doctor leads an ASP ward round with several medical students, junior doctors, nursing and pharmacy staff. The first patient is a 70-year-old male who has been on intravenous antibiotics
for ten days. The specialist asks why the patient is still on intravenous antibiotics even though his fever has settled and he is clinically better.

1. What should the ID specialist recommend for antibiotic management of this patient?
Since the patient is clinically well, the antibiotics should be stopped. Most infections require only five to seven days of antibiotics. For patients who need prolonged antibiotic courses, the intravenous antibiotic can often be switched to an oral formulation.

2. The next patient is a 65-year-old male with chronic kidney disease requiring haemodialysis. He has a permanent central catheter inserted in his right internal jugular vein. The patient is on antibiotics for a bloodstream infection with a methicillin-resistant Staphylococcus aureus (MRSA). What should the ID specialist recommend for antibiotic management of this patient?
The ID specialist doctor emphasises the need to submit adequate blood cultures specimens to the microbiology laboratory. Without appropriate specimens, the doctors cannot identify the micro-organism causing the infection or choose the correct antibiotic based on the susceptibility profile. He also recommends therapeutic dose monitoring of the antibiotic (vancomycin) to ensure that the patient (who has kidney failure) is getting the correct dosage. He also recommends that contact precautions be implemented.

3. The third patient is a 49-year-old female who has had a total hysterectomy three days ago. She still has intravenous prophylactic antibiotics boarded on her prescription chart. Her Foley’s catheter is still in place. What should the ID specialist recommend for management of this patient?
The ID specialist doctor recommends stopping the antibiotic immediately, since only a single pre-operative dose was needed. He also recommended removal of the Foley’s catheter as soon as possible to reduce the possibility of a catheter-associated urinary tract infection.
Addendum: Resources for infection prevention and control

Websites

World Health Organization (WHO): www.who.int
Centers for Disease Control and Prevention (CDC): www.cdc.gov
Infection Control Africa Network: www.icanetwork.co.za
Institute for Healthcare Improvement (IHI): www.ihi.org
Association for Professionals in Infection Control (APIC): www.apic.org
Society for Healthcare Epidemiology of America (SHEA): www.shea-online.org
Best Care Always: www.bestcare.org.za
Bettercare: www.bettercare.co.za
African Partnerships for Patient Safety (APPS) webinars: www.who.int/patientsafety/implementation/apps/en/
Teleclass Education in IPC: www.webbertraining.com
Pro-Med Mail (Outbreak reporting): www.promedmail.org

Guideline and policy documents


