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InovSafeCare Project Extension

Capacitating Asia's Nursing Students on Innovative and Sustainable Prevention and Control of Healthcare-associated Infections

PREVINF E-BOOK FOR NURSING STUDENTS

2024

Programme Erasmus+ KA2

Cooperation for innovation and the exchange of good practices

Capacity Building in higher education

(Code: 618396-EPP-1-2020-1-PT-EPPKA2-CBHE-JP)

ISBN: 978-989-35129-6-8

Co-funded by the
Erasmus+ Programme
of the European Union

The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

SAVONIA
University of Applied Sciences

Escola Superior de
Enfermagem de Coimbra

E-BOOK COORDINATORS: João Graveto, Pedro Parreira, Anabela Salgueiro-Oliveira, Lurdes Lomba, Paulo Santos-Costa, Filipe Paiva-Santos, João Pardal, Marja Silén-Lipponen, Leena Koponen, Mikko Myllymäki, & Ulla Korhonen.

CHAPTERS AUTHORSHIP: All chapters were authored by the **PrevInf GROUP**, composed by:

- Nursing School of Coimbra (Portugal): João Graveto, Pedro Parreira, Anabela Salgueiro-Oliveira, Lurdes Lomba, Paulo Santos-Costa, Filipe Paiva-Santos, João Pardal

- Savonia University of Applied Sciences (Finland): Marja Silén-Lipponen, Leena Koponen, Mikko Myllymäki, Ulla Korhonen

- Bolyno Institute (Cambodia): Vannarith Nhem, Chhiay Song, Sovannarith Em, Sophon Sek, Mao Eam, Somnang Phai, Panha Pao, Bory Ouch

- Hai Duong Medical Technical University (Vietnam): Dinh Thi Dieu Hang, Pham Thi Cam Hung, Do Thi Thu Hien, Dinh Thi Xuyen, Dam Thi Thuy, Nguyen Thi Hue, Pham Thi Thanh Phuong, Do Thi Hue, Vu Thi Hai, Vu Thi Quyen

- Nam Dinh University of Nursing (Vietnam): Truong Tuan Anh, Ngo Huy Hoang, Vu Thi La, Mai Thi Lan Anh, Hoang Thi Minh Thai, Nguyen Thi Thanh Huong, Pham Thi Bich Ngoc, Le Van Cuong, Pham Thi Thuy Chinh

- International University (Cambodia): Sabo Ojano, Neth Barom, Nget Buntha, Vouch Phisith, Nget Manndy, Sokchhay Y, Toun Soksambat, Sath Mutta, Chhay Kry, Gnan Channoeurn, Kim Chantha, Dam Thida

E-BOOK LAYOUT: Nam Dinh University of Nursing (Vietnam)

EDITOR: Nursing School of Coimbra, Coimbra (Portugal)

CO-EDITORS: Savonia University of Applied Sciences (Finland), Nam Dinh University of Nursing (Vietnam), Hai Duong Medical Technical University (Vietnam), International University (Cambodia), and Bolyno Institute (Cambodia).

Any questions, comments or suggestions may be sent to previnf@gmail.com

previnf.com

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Acronyms List

ABHR	Alcohol-based Handrub
AGMPs	Aerosol-Generating Medical Procedures
AMR	Antimicrobial Resistance
ANTT	Aseptic Non-Touch Technique
ARIs	Acute Respiratory Infections
AS	Acute Sinusitis
^{o}C	Degrees Celsius
CABSI	Catheter-Associated Bloodstream Infection
CADVT	Catheter-Associated Deep Vein Thrombosis
CAUTIs	Catheter-Associated Urinary Tract Infections
CFU	Colony-Forming Unit
CLABSIs	Central Line-Associated Bloodstream Infections
CM	Centimeter
COVID-19	Coronavirus Disease 2019
CPE	Carbapenem-Resistant Enterobacteriaceae
CPE	Carbapenemase-Producing Enterobacteriaceae
E-BOOK	Electronic Book
ECDC	European Centre for Disease Prevention and Control
ESBL	Extended-Spectrum Beta-lactamase
ETO	Ethylene Oxide
^{o}F	Degrees Fahrenheit
FFP	Filtering Face Piece (respirators)
GI	Gastrointestinal
HAIs	Healthcare-Associated Infections
HAIs-PC	Healthcare-Associated Infections-Prevention and Control
HBV	Hepatitis B Virus

HCV	Hepatitis C Virus
HEIs	Higher Education Institutions
HIB	Haemophilus Influenzae Type B
HIV	Human Immunodeficiency Virus
HOB	Head of Bed
HWs	Healthcare Workers
ICU	Intensive Care Unit
IPC	Infection Prevention and Control
IPCT	Infection Prevention and Control Team
ISMP	Institute for Safe Medication Practice
IV	Intravenous
LMICs	Low and Middle-Income Countries
MDR	Multidrug-Resistant
MDROs	Multidrug-Resistant Organisms
MOH	Ministry of Health
MRGNB	Multidrug Resistant Gram-Negative Bacteria
MRSA	Methicillin-Resistant Staphylococcus Aureus
PBP	Penicillin-Binding Protein
PICC	Peripheral Inserted Central Catheter
PIVCs	Peripheral Intravenous Catheters
PPE	Personal Protective Equipment
QAC	Quaternary Ammonium Compound
RSV	Respiratory Syncytial Virus
SAL	Sterilization Assurance Level
SE	Southeast
SSI	Supplemental Security Income
SSIs	Surgical Site Infections
TBPs	Transmission-Based Precautions

TSM	Transparent Semipermeable Membrane
UNICEF	United Nations Children’s Fund
URIs	Upper Respiratory Infections
VAD	Vascular Access Devices
VAP	Ventilator-Associated Pneumonia
VMH	Vietnam Ministry of Health
VRE	Vancomycin-Resistant Enterococci
WHO	World Health Organization

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PREFACE

Dear Future Nurses,

As aspiring nursing professionals, you are embarking on a **journey of immense responsibility and opportunity**. One critical issue in healthcare that demands your attention is the prevalence of **healthcare-associated infections (HAIs**), especially in developing countries. It is not just a challenge, it is a call to action, and we believe you are uniquely equipped to answer it.

The World Health Organization (WHO) emphasized in its Global Action Plan on Antimicrobial Resistance (2015) that HAI prevention and control must be at the core of your education, training, and certification. It is not just about earning a degree; it is about shaping the future of healthcare.

Imagine making a difference in countries like Cambodia and Vietnam, where HAIs have had a significant impact on patient outcomes. That is what the PrevInf project consortium had in mind when we set out on a mission to empower nursing students across Asia.

And so the **PrevInf E-Book for Nursing Students** was born — a digital tool designed not only to impart knowledge, but also to ignite enthusiasm for **HAI prevention and control**, striving for evidence-based healthcare practices! This digital tool contains the PrevInf Model, a pedagogical framework developed based on the latest standards, recommendations, and scientific evidence. It is not just theory, but a practical guide tailored to the **unique context of your country.**

The PrevInf Model encourages you to be more than just healthcare professionals. It fosters your **entrepreneurial spirit**, challenging you to think innovatively. You will use the best practices and contribute to developing them, and in doing so, you will become part of the solution to a significant healthcare challenge in Asia.

Together, we will tackle HAIs and further improve the quality of nursing care. Get ready to embark on this exciting journey with the PrevInf E-Book for Nursing Students.

Your impact starts **now**!

INTRODUCTION

Introducing an E-book designed exclusively for nursing students like you!

Within the scope of the ERASMUS+ Program for Capacity Building in the field of Higher Education, and developed under the PrevInf project - *Capacitating Asia's Nursing Students on Innovative and sustainable Prevention and Control of Healthcare-Associated Infections* (618396-EPP-1-2020-1-PT-EPPKA2-CBHE-JP), this resource is packed with valuable information that will not only help you understand the theory behind healthcare-associated infections prevention and control (HAI-PC) but also equip you with the practical skills needed for your clinical placements and future career.

Get ready to dive into the world of nursing and discover the dos and don'ts in preventing and controlling healthcare-associated infections (HAIs). The PrevInf project consortium is on a mission to revolutionize nursing education in Asia by enhancing your competences in this critical area. They have revamped the nursing curricula of various partner higher education institutions (HEIs) across continents, ensuring you receive the most up-to-date and relevant training.

The PrevInf model takes a fresh approach, using the latest research studies and scientific evidence tailored to your country's needs. It's all about real-world application, with practice-based simulation scenarios that let you experience the challenges and triumphs of preventing HAIs first-hand. Who said learning can't be exciting?

But that's not all – this E-book is not just about mastering the basics. The PrevInf model encourages you to unleash your inner innovator!

You have a fundamental role in designing creative solutions to tackle the societal challenge of HAI-PC in Asia. Embrace the spirit of innovation and become a driving force in transforming healthcare practices for the better.

Ready to join the movement? Inside this E-book, you'll find the latest guidelines for good practices in HAI-PC, ensuring you stay at the forefront of nursing excellence. By embracing this capacity-building approach, not only will you modernize and internationalize

your nursing education, but you'll also champion the adoption of best practices in HAI-PC throughout Asia.

This E-book is packed with thrilling chapters that will take your understanding of HAI-PC to new heights. In Chapter 1, you will embark on a fascinating journey into the thematic world of HAIs. In Chapter 2, you'll explore the essential domains of HAI-PC in 11 engaging and informative modules

Get your hands on this captivating E-book today and unlock the path to becoming a reference nurse. It's time to make a difference in the world of healthcare!

CHAPTER 1. INTRODUCTION TO HAIS PREVENTION AND CONTROL

1. Definition of Healthcare-Associated Infections (HAIs)

HAIs are infections acquired by patients during their stay in a hospital or another healthcare setting. Although some of these infections can be treated easily, others may more seriously affect a patient's health, increasing their stay in the hospital and hospital costs, and causing considerable distress to these patients, families, and healthcare workers (European Centre for Disease Prevention and Control (ECDC), 2023). The U.S. Department of Health and Human Services (2021) has defined HAIs as "*infections people get while they are receiving healthcare for another condition. HAIs can happen in any healthcare facility, including hospitals, ambulatory surgical centers, end-stage renal disease facilities, and long-term care facilities.*"

2. Risk of Healthcare-Associated Infections

HAIs are the most common complication affecting patients in healthcare settings, especially in low-income countries. The literature suggests that at least 5.9% of hospitalized patients are affected by HAIs. Besides, patients, family members, visitors, and health workers (HWs) are all at risk of acquiring infections. HAIs are not limited to patients receiving care in a hospital - those receiving healthcare in community or home-based settings are also at risk (Clinical Excellence Commission, 2020).

There is a common misconception that HAIs are caused only by multidrug-resistant microorganisms (MROs), such as methicillin-resistant *Staphylococcus Aureus* (MRSA). However, potentially any microorganism, i.e., bacteria, fungi, viruses, parasites, and prions, can cause HAIs. Microorganisms that cause HAIs include *Pseudomonas* spp., *Enterobacterales* spp., *Clostridioides, difficile*, *Acinetobacter* spp., *Candida* spp., *norovirus,* and *influenza* virus. HAIs may occur in the presence or absence of an invasive procedure or device, and acquisition of a HAI is associated with greater risks of morbidity and mortality (Clinical Excellence Commission, 2020). The most frequent HAIs are urinary tract infections,

respiratory tract infections, surgical site infections, bloodstream infections, and gastrointestinal infections (ECDC, 2023).

HAIs are preventable, and HWs have an ethical and professional obligation to avoid harming patients. Implementing and adhering to HAIs-PC strategies is a crucial step in fulfilling this obligation. HAIs-PC programs are a core element in healthcare safety (Clinical Excellence Commission, 2020). HAIs can occur during hospital stay or after discharge, and no institution or country can claim to have solved this problem yet. HAIs represent the most frequent adverse event during healthcare delivery, threatening patient safety and healthcare efficiency (Haque et al., 2018).

3. Impact of HAIs in Low- and Middle-Income Countries (LMICs)

A study estimated that nearly 1.7 million hospitalized patients annually acquire HAIs while being treated for other health conditions and that more than 98,000 patients die due to these infections (Klevens et al., 2007). The World Health Organization (WHO) report shows that 7% of patients in acute-care hospitals in high-income countries and 15% in low- and middle-income countries acquire at least one HAI during their hospitalization. The report also shows that approximately 25% of hospital-treated sepsis cases and nearly 50% of all cases of sepsis treated in adult intensive care units are HAIs. The impact of HAIs and antimicrobial resistance on people's lives is incalculable. More than 24% of patients affected by healthcare-associated sepsis and approximately 52% of those patients treated in an intensive care unit (ICU) die each year. Deaths are increased two to threefold when infections are resistant to antimicrobials (WHO, 2022). However, it is estimated that up to 55% of HAIs could be prevented by systematically implementing evidence-based HAIs-PC strategies (Palmer, 2019).

In low-resource settings, surgical site infections occur in more than 30% of all surgical patients, nine times higher than in higher-income countries. Generally, it is the patients who pay for the additional cost for their healthcare. The risk of infection among women and newborns is 3 to 20 times higher compared to high-income countries. HAIs in ICU patients are

2 to 3 times higher than in high-income countries, and device-associated infection densities are up to 13 times higher than in the United States (Curless et al., 2018).

The impact of HAIs is a serious concern in low and middle-income countries (LMICs) because it requires additional resources that could be used for other patients. Several studies showed that increased length of stay due to HAIs varied between 5 and 29.5 days. HAIs increase the use of antibiotics, other supplies and laboratory and diagnostic testing, which drive up the costs of care. They also cause emotional and financial distress to patients and families and lead to disabling conditions that may reduce the quality of life (Curless et al., 2018).

A systematic literature review and meta-analysis of the burden of HAIs in South-East Asia was performed on 41 studies. The pooled prevalence of overall HAIs was 9.0%, whereas the pooled incidence density of HAIs was 20 cases per 1,000 intensive care unit-days. The pooled incidence density of ventilator-associated pneumonia, central line-associated bloodstream infection, and catheter-associated urinary tract infection was 14.7 per 1,000 ventilator-days, 4.7 per 1,000 catheter-days, and 8.9 per 1,000 catheter-days, respectively. The pooled incidence of surgical site infection was 7.8%. The attributed mortality and excess length of stay in hospitals of infected patients ranged from 7% to 46% and 5 to 21 days, respectively (Ling et al., 2015).

There is a consensus that urgent actions are needed to prevent and control the spread of antibiotic-resistant organisms because HAIs result in prolonged hospital stays, long-term disability, increased resistance of microorganisms to antimicrobials, massive additional costs for health systems and patients, and deaths (WHO, 2022).

WHO highlighted the importance of considering HAI-PC as a core component of professional education, professional training, and certification, continuing education and development in health, reinforcing the role played by academic institutions in generating such knowledge and translating it into clinical practice. The provision of high-quality education is essential for the acquisition and development of competences, knowledge and proper skills of students who will become health professionals, enabling them to provide excellent care (WHO,

2014). However, as nurses in low-income countries may not be aware and professionally trained to meet societal needs, HEIs should be assisted in improving their curricula to overcome these obstacles (WHO, 2016).

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CHAPTER 2. ESSENTIAL DOMAINS IN HAIS PREVENTION AND CONTROL

Module 1. Chain of infection

I. Overview

The implementation of HAI-PC measures in healthcare facilities help to stop the spread of infection and eliminate sources of infection, and in turn to protect both patients and HWs from infection. Patients in healthcare settings are more vulnerable to HAIs that occur as a result of healthcare interventions. Hospitals are hotspots for HAIs because the presence of HWs, patients, and surrounding factors facilitate the growth of a microbial population resistant to most antimicrobials. HAIs can be transmitted by healthcare staff via direct contact during healthcare delivery. Besides patients, nurses are also prone to infections because they contact with infectious materials and surroundings (Perry et al., 2014).

The presence of a microorganism does not mean that an infection will happen. An infection or colonization occurs as a result of a sequence of events that come together to transmit a microorganism or infectious agent to a susceptible host. This sequence of adverse events can occur within healthcare facilities or in the community. For a transmission to occur, the microorganism must leave the reservoir where it lives via a portal of exit, travel through a transmission mechanism, and enter a susceptible host via a portal of entry. This sequence of events and interactions is referred to as the chain of infection or chain of microorganism transmission (Pan American Health Organization [PAHO], 2018).

II. Learning objectives

At the end of this module, students will be able to

1. Identify and describe the most common microbiological agents that cause HAIs in Southeast Asian countries;

2. Describe the epidemiological chain and identify its links;

3. Know the mechanisms of prevention against infections, acting on the links of the epidemiological chain.

III. Major concepts

1. Chain of infection

Chain of infection describes the process of infection that begins when an infectious agent leaves its reservoir through a portal of exit, is transmitted by a mode of transmission, and enters a susceptible host to cause infection. It is the process through which an infectious agent spreads from one host to the next (Tyshenko, 2015). There are six steps in the chain of infection: an infectious agent, its reservoir, a portal of exit, a mode of transmission, a portal of entry, and a susceptible host (Figure 1).

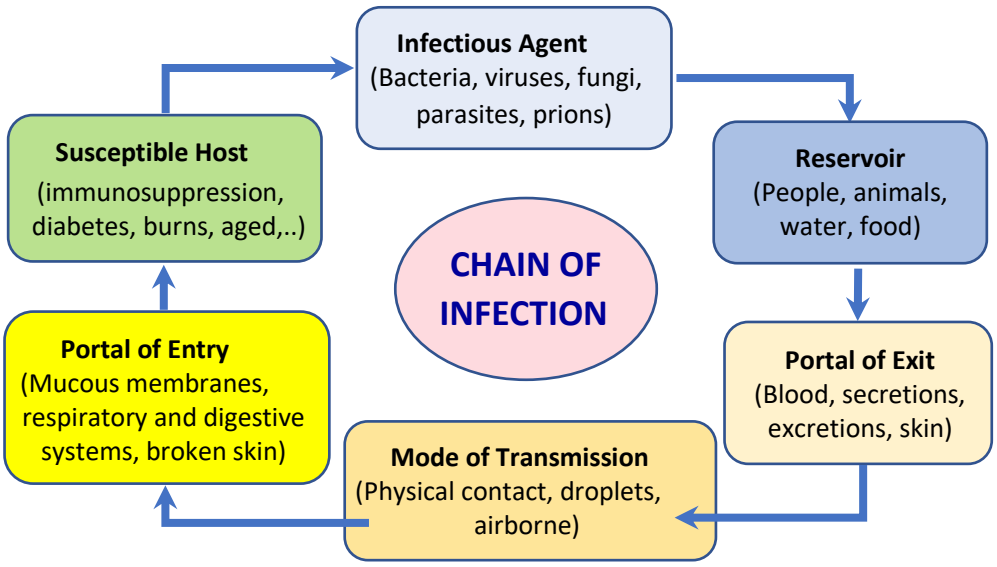

Figure 1: Chain of infection

(source: own elaboration)

1.1. Infectious agents

Infectious agents transmitted during healthcare services come mainly from human reservoirs, such as patients, healthcare personnel, and visitors. These carriers may be sick with symptoms of infection, may be infected and asymptomatic, may be in the incubation period, or may be temporary or chronically colonized with or without symptoms (National Health and Medical Research Council [NHMRC], 2019).

Infection results from a complex interrelationship between an infectious agent and a host. Individuals vary in their response to exposure to infectious agents:

- Some individuals never develop symptomatic disease, while others become critically ill or die;

- Some individuals may become temporarily or permanently colonized and remain asymptomatic;

- Some individuals progress from colonization to symptomatic disease either after exposure or following an asymptomatic period.

Infectious agent: A microorganism that can colonize or cause an infection in a host. Infectious agents may include bacteria, viruses, fungi, or parasites (Figure 2).

- Infection: presence of an infectious agent in the host's tissues, where it grows, replicates itself, and induces an immune response in the host that generates signs and symptoms;

- **Colonization**: presence of an infectious agent in the host's tissues, where it grows and replicates itself but without any signs or symptoms. Colonization may or may not induce an immune response.

For an infectious agent to cause an infection, the following characteristics must be present:

- Infective dose - the number of pathogens required to infect 50% of a population of hosts;

- Virulence - the microorganism's ability to cause severe disease or death, that is, to harm its host;

- Invasiveness - the microorganism's ability to invade the host's tissues and replicate;

- Pathogenicity - the microorganism's ability to cause disease through a variety of mechanisms (PAHO, 2018).

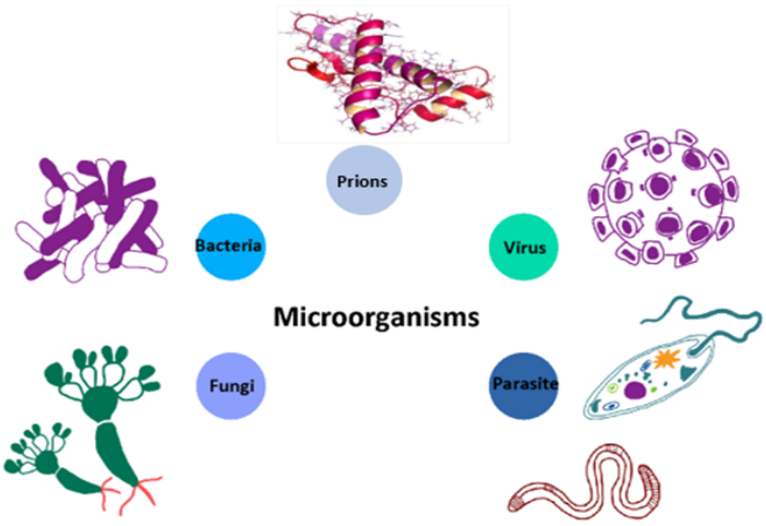

Figure 2: Types of microorganisms

(source: own elaboration)

Some of the most common HAIs, particularly low-resource countries, include:

- Catheter-associated urinary tract infections (CAUTIs): infections that occur when bacteria enter the urinary tract through a catheter;

- **Central line-associated bloodstream infections (CLABSIs):** infections that occur when bacteria enter the bloodstream through a central line;

- **Ventilator-associated pneumonia (VAP):** an infection that occurs in the lungs of patients who are receiving mechanical ventilation;

- **Surgical site infections (SSIs):** infections that occur at the site of a surgical incision (Centers for Disease Control and Prevention [CDC], 2023).

A recent systematic literature review and meta-analysis of the burden of HAIs in Southeast Asia found that the most common HAI pathogens were gram-negative bacilli, namely *Pseudomonas aeruginosa*, *Klebsiella species* and *Acinetobacter baumannii*. These findings are similar to those reported in many developing countries (Ling et al., 2015). Another systematic review with studies dated between 1st January 1990 and 12th May 2022 about the prevalence of HAIs in patients from both public and private hospitals found that specific microorganisms such as *Escherichia coli*, *Acinetobacter* species, *Pseudomonas aeruginosa*,

Staphylococcus aureus, and *Klebsiella pneumoniae* have a stronghold on HAIs in Southeast Asia and in other regions of the world (Goh et al., 2023).

1.2. Reservoir

A habitat that allows infectious agents to live, grow, and multiply. A reservoir can be an inanimate object, an animate being such as people or animals, and the environment (e.g., water or soil). The main reservoir of infectious agents responsible for HAIs is a patient infected or colonized by microorganisms, even if the infectious agent is sensitive or resistant to antibiotics. The host is often a healthy carrier of microorganisms who has no signs or symptoms of infectious disease, makings it more difficult to identify the reservoir (PAHO, 2018).

1.3. Portal of Exit

A portal of exit is the means by which the infectious microorganisms escape or leave the reservoir. The main portals of exit are the upper respiratory tract, the urinary tract, the lower digestive tract, and the wound areas in the skin that are infected or colonized. For example, pathogens that cause respiratory diseases usually escape through the respiratory tract (coughing and sneezing) (PAHO, 2018).

1.4. Mode of Transmission

Since microorganisms cannot travel on their own, they require a vehicle to carry them from the portal of exit to the portal of entry on the susceptible host. There are several modes of transmission such as direct contact, droplet transmission, and airborne transmission. HAIs are primarily transmitted via the following mechanisms of transmission:

1.4.1. Direct contact

The infectious agent travels from the portal of exit to the susceptible host directly. For example, it can occur through 1) direct contact with the contaminated source such as blood, body fluids, or skin lesions; 2) direct contact when healthcare workers without gloves provide care to patients; 3) a microorganism-contaminated drug that is injected into the bloodstream of a host.

1.4.2. Indirect contact

The infectious agent contaminates the susceptible host via an inanimate object such as clothes, surfaces in the room, and other fomites, or via an animate intermediary such as the hands of healthcare workers, mosquitos, or flies. Examples of transmission via indirect contact include:

1. Transmission of *Clostridioides difficile* spores from a symptomatic infected patient to a susceptible host via the hands of healthcare workers handling feces without using gloves;

2. Transmission of syncytial respiratory virus from a symptomatic patient via a contaminated toy;

3. Transmission of hepatitis C virus from an infected dialysis patient to other susceptible dialysis patient via a multidose syringe that was used in more than one patient.

- **Aerosols:** These particles are produced when an air current passes across the surface of a liquid, creating small particles at the interface of a liquid. Depending on the size of the particles, microorganism-bearing particles are classified as:

- **Droplets:** when an infectious patient transmits microorganisms within particles sized between 5 μm and 100 μm in diameter. Droplets usually come from the respiratory tract when coughing, sneezing, or speaking. They have no capacity to travel more than 1 meter from the person emitting them. As with contact transmission, droplets can be directly or indirectly transmitted.

- **Airborne transmission (droplet nuclei):** when infectious agents are transmitted through particles smaller than 5 μm in diameter, they can float in the air current for prolonged periods and travel longer distances than droplets when moved by air currents. Airborne particles can be inhaled into the alveoli of individuals who share the same room, even if they do not have direct contact with the infected patient. Airborne particles can be generated by coughing or sneezing (in the case of tuberculosis) or during medical procedures on patients such as tracheal intubation, non-invasive positive-pressure ventilation, invasive high-frequency ventilation, pre- and post-intubation airway aspiration, tracheotomy, fibro-bronchoscopy, sputum induction (PAHO, 2018).

1.5. Portal of Entry

It refers to the point at which the microorganism gets into a susceptible host, where infectious agents can survive and replicate as well as release its toxins and other pathogenic factors to act. Microorganisms can enter the body via inhalation (e.g., respiratory tract), ingestion (e.g., gastrointestinal tract), absorption (e.g., mucous membranes of eyes), breaks in skin (e.g., needle stick, cut), and medical procedures (e.g., catheterization). Infectious agents can also be transported to the body of susceptible hosts via invasive instruments (PAHO, 2018).

1.6. Susceptible Host

This is the final link in the chain. The future host is the person who is next exposed to the infectious agent. The microorganism may spread to another person and whether or not that person can be infected and ill will depend on a number of constitutional, genetic, immune-related, and other non-specific factors. They may however become 'carriers' without symptoms but be able to then transmit to other 'susceptible hosts'. Once the host is infected, she/he may become a reservoir for future transmission of the disease (PAHO, 2018).

Important factors that affect an individual's outcome after exposure include:

- Their immune status at the time of exposure (an immune status is compromised by medical treatment such as immunosuppressive agents or irradiation)

- Their age (e.g., neonates and older people are more susceptible to infectious agents)

- Their health status (e.g., a person who has an underlying disease or is a smoker is more susceptible to infectious agents)

- The virulence of the infectious agents

- Other factors that increase the risk of transmission (e.g., undergoing surgery, indwelling device such as a catheter, or prolonged hospitalization) (nhmrc, 2019)

2. Preventive intervention and control

In order to prevent HAIs, the HWs must understand the epidemiological chain and seek to interrupt the chain of transmission at one or more links. Two types of interventions should be implemented: standard precautions and transmission-based precautions:

2.1. Standard precautions

Standard precautions are measures implemented to protect both HWs and patients from the risk of transmission of microorganisms**.** These standard precautions are the minimum (IPC) measures that should always be implemented by all healthcare personnel during patient care and in all settings. When properly applied, these standard precautions can prevent contamination between patients, healthcare personnel, and the healthcare surroundings (WHO, 2022).

Key elements of standard precautions include:

- Risk assessment
- Hand hygiene
- Respiratory hygiene and cough etiquette
- Patient placement
- Personal protective equipment
- Aseptic technique
- Safe injection practices and sharps safety
- Environmental cleaning
- Handling of laundry and linen
- Waste management
- Decontamination and reprocessing of reusable patient care items and equipment (WHO, 2022).

2.2. Transmission-based precautions

These precaution measures are used with patients who are diagnosed with an infection or colonization by an infectious agent or its presence is suspected (PAHO, 2018).

For an infection or colonization to occur, each link in the chain of infection must be present; if one link is missing, the chain will be disconnected and there will be no transmission (PAHO, 2018).

Table 1: Measures to break the chain of infection

Link in the chain of infection	Breaking the Chain and Control
Infectious agents	- Clean contaminated objects. - Clean, disinfect, and sterilize.
Reservoir *(site or source of microorganism growth)*	- Control sources of body fluids and drainage. - Perform hand hygiene. - Bathe patient with soap and water. - Change soiled dressings. - Dispose of soiled tissues, dressings, or linen in moisture-resistant bags. - Place syringes, uncapped hypodermic needles, and intravenous needles in designated puncture-proof containers. - Keep table surfaces clean and dry. - Do not leave bottled solutions open for prolonged periods. - Keep solutions tightly capped. - Keep surgical wound drainage tubes and collection bags patent. - Empty and dispose of drainage suction bottles according to agency policy.
Portal of Exit	
***Respiratory Tract**:* Microorganisms leave the body of the infected person by means of droplets exhaled as a spray when coughing, sneezing,	- Wear a mask/respirator. - Do not talk directly into the patient's face. - Stay home if you are sick. - Cover your coughs and sneezes.

talking, singing, or just breathing. Microorganisms also get out through nose and throat secretions.	- Perform good hand hygiene.
Gastrointestinal Tract: Microorganisms that leave the body of the infected person by means of secretions (e.g., stool and vomit). For example, hepatitis A virus is shed in the stool of an infected person.	- Handle and dispose of body secretions properly. - Use personal protective equipment (PPE). - Perform good housekeeping. - Perform good hand hygiene.
Skin: Microorganisms that leave the body of the infected person by wound drainage or through skin lesions.	- Dispose of wound dressings properly. - Use personal protective equipment (PPE). - Perform good hand hygiene.
Blood: Infection may occur when someone's blood gets into another person's system.	- Safe handling of sharps. - Use gloves for procedures with risk of exposure to blood. - Use care in obtaining, transporting, and processing specimens. - Perform good hand hygiene.
Mode/Mechanism of Transmission	**Reduce microorganism spread by:** - Performing hand hygiene. - Using personal set of care items for each patient. - Avoiding shaking bed linen or clothes; dust with damp cloth. - Avoiding contact of soiled item with uniform. - Discarding any item that touches the floor.

	- Following standard precautions or select transmission-based isolation precautions.
Portal of Entry	
Respiratory Tract: Small particles that result from evaporation of droplets from the respiratory tract of an infected person remain suspended in the air of poorly ventilated spaces for some time. Infectious microorganisms can be inhaled by a well person who may then become infected.	- Wear a mask/respirator. - Maintain good ventilation. - Isolate those with respiratory syndromes. - Good respiratory hygiene. - Perform good hand hygiene
***Gastrointestinal Tract*:** Pathogenic microorganisms enter the body of a new host when food or water contaminated by feces is ingested (fecal or oral route)	- Dispose of body excretions carefully. - Careful food handling. - Perform good housekeeping. - Use personal protective equipment (PPE). - Perform good hand hygiene.
***Mucous membranes*:** Absorption of microorganisms through exposed eyes, nose, and mouth.	- Protect eyes, nose and mouth with face shield during procedure likely to generate splashes or sprays. - Carry out good housekeeping. - Perform good hand hygiene.
***Skin*:** Microorganisms enter the body when a person comes into contact with wound drainage or skin secretions.	- Dispose of wound dressings carefully and properly. - Wear personal protective equipment (PPE). - Maintain healthy intact skin.

	- Perform good hand hygiene.
Susceptible Hosts	
- Children who are very young - People who are very old - People on inadequate diets - People who are chronically ill - People receiving medical therapy such as chemotherapy or steroids - People who are already ill - People with open wounds	- Separate high-risk individuals from persons with known or potential infections. - Provide nutritional supplements to persons on inadequate diets. - Vaccinate against vaccine preventable diseases. - Maintain proper sanitation of air and environment. - Diagnose and treat underlying disease.

(Perry, 2014; Department of Health, Nunvut, n.d).

IV. Post-test

1. How many links are there in the chain of infection?
   A. 10 links
   B. 5 links
   C. 4 links
   D. 6 links
2. A site where microorganisms live and grow.
   A. Reservoir
   B. Portal of exit
   C. Portal of entry
   D. Susceptible host
3. A means by which microorganisms leave the reservoir.
   A. Mode of transmission
   B. Portal of entry
   C. Outbreak
   D. Portal of exit
4. A means by which microorganisms gets from one place to another host.
   A. Infection
   B. Mode of transmission
   C. Reservoir
   D. Susceptible host
5. A means by which microorganisms enter the host.
   A. Infectious agent
   B. Portal of exit
   C. Portal of entry
   D. Mode of transmission
6. A person who becomes infected and ill due to a weak immune system.
   A. Infection

B. Susceptible host

C. Outbreak

D. Epidemic

7. A pathogen that can cause an infection.

A. Portal of exit

B. Susceptible host

C. Infectious agent

D. Portal of entry

8. The chain of infection is a model of:

A. How microorganisms multiply and mutate to become pathogenic.

B. How an infection affects the immune system.

C. How infections can be prevented.

D. How pathogens are transmitted from one host to another.

9. What is the single most effective way to break the chain of infection?

A. Handwashing

B. Sterilization

C. Cleaning surfaces

D. Nutrition

10. In any healthcare setting, the chain of infection can be interrupted most readily at this step:

A. Portal of exit

B. Portal of entry

C. Mode of transmission

D. Susceptible host

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Module 2. Additional precautions for specific transmission routes

I. Overview

Ensuring that hospitalized patients who are known or suspected to be infected or colonized with potentially pathogenic microorganisms are “isolated”, or barrier nursed, is an important component in preventing and controlling the spread of HAIs and communicable diseases. It can, however, be a challenging and sometimes distressing process for patients, their relatives, caregivers, and healthcare staff. This module covers the implementation of additional precautions for specific transmission routes.

II. Learning objectives

1. To understand the route of transmission
2. To understand the different routes of transmission
3. To learn how to apply appropriate precautions for specific transmission routes

III. Major concepts

1. Introduction

Additional precautions are implemented when the natural transmission characteristics of, or impact of, infection with specific microorganisms are not fully prevented by routine practices. Additional precautions may also be required when a medical procedure increases the risk of transmission of a specific agent (e.g., AGMPs) or because of the clinical situation (e.g., care of a young child, incontinent adult or cognitively impaired individual). The application of additional precautions is specific to the care setting: acute care, ambulatory care, prehospital care, long-term care, and home care.

Additional precautions are conventionally divided into:

- Contact Precautions, for microorganisms of low infective dose or situations where heavy contamination of the patient’s environment is anticipated.

- Droplet Precautions, for microorganisms primarily transmitted by the large droplet route.

- Airborne Precautions, for microorganisms transmitted by small particles through the air over extended time and distance.

Some infections can be transferred by more than one route and require a combination of additional precautions (Manitoba Health, Seniors and Active Living, 2019).

2. Route of Transmission

Routes of transmission of microorganisms are conventionally classified as contact, droplet, airborne, common vehicle and vector borne routes. The route of transmission varies with the microorganisms involved. For most microorganisms, transmission may primarily be by one route, such as direct or indirect contact (e.g., rotavirus or C. *difficile*), droplet route (e.g., pertussis), or airborne route (e.g., *Mycobacterium tuberculosis*). Some infectious agents, however, may be transmitted by more than one route (e.g., RSV can be transmitted by both the droplet and contact routes) (WHO, 2016a).

2.1. Contact exposure and Transmission

Contact exposure occurs when microorganisms are transferred through physical contact between an infected source and a host, or through the passive transfer of the microorganisms to a host, via an intermediate object. Hands can be contaminated by contact with an infected source, or by contact with contaminated inanimate surfaces, or objects in the immediate environment of an infected source.

Contact exposure includes both direct contact and indirect contact:

1. Direct contact exposure occurs when the transfer of microorganisms results from direct physical contact between an infected or colonized source and a host (body surface to body surface, without barriers) such as shaking hands.

2. Indirect contact is a passive transfer of microorganisms to a host via an intermediate object, such as contaminated hands not cleaned between moments of patient care, contaminated patient care equipment (e.g., commodes, wheelchairs, base of electronic thermometers, BP cuffs or monitoring equipment), surfaces such as bedrails that are not appropriately cleaned and disinfected between patients, or devices that have manufacturing

defects that impede appropriate reprocessing (Manitoba Health, Seniors and Active Living, 2019).

2.2. Droplet Exposure and Transmission

Droplet transmission may occur when droplets that contain microorganisms are propelled a short distance (within two meters) through the air and are deposited on the mucous membranes (eyes, nose or mouth) of a susceptible host, overcoming his/her defenses (Manitoba Health, Seniors and Active Living, 2019). Droplets may also contaminate the immediate environment when they settle on surfaces and may contribute to contact transmission.

2.3. Airborne Exposure and Transmission

Airborne transmission may occur when viable microorganisms contained in aerosolized secretions from an infected source are propelled a short distance (within two meters) through the air, are inhaled, come into contact with receptors in a susceptible host's airway, overcome host defenses, and cause disease. For transmission of infection to occur, the microorganisms contained in the particles must be capable of remaining viable in the air for a prolonged period and the susceptible host must be exposed to a sufficient concentration (infectious dose) of these viable microorganisms. Infection can result only if the appropriate receptors for the infectious agents are present at the site of exposure (WHO, 2016a).

3. Transmission-based precautions

Transmission-based precautions are designed to reduce the risk of contact, droplet and airborne transmission and are used in addition to standard precautions (Siegel et al., 2007).

3.1. Contact precautions

Contact precautions are intended to prevent transmission of infectious agents, including epidemiologically important microorganisms, which are spread by direct or indirect contact with the patient or the patient's environment (WHO, 2016b).

3.1.1. Patient placement

- For patients requiring contact precautions, a single room is recommended (facilitates cleaning and decontamination of the environment, provides an en-suite bathroom, can decrease the spread of multi-resistant organisms, and increases the availability of sinks or hand hygiene dispensers).

- If a patient requiring contact precautions shares a room with a patient who is not infected:

+ The patient should not be placed with patients with an increased risk of developing infection-related complications.

+ Healthcare professionals must change their personal protective equipment and perform good hand hygiene between contact with different patients sharing the same room.

+ Patient transport should be limited as much as possible (NHMRC, 2019)

3.1.2. Hand Hygiene and Personal Protective Equipment

- Perform hand hygiene.

- Put on gloves and gown upon entry to the patient-care area.

- If performing multiple tasks whilst in the patient-care area, apply the principles of standard precautions and remove gloves, perform hand hygiene, and apply clean gloves between tasks when required to minimize risk of infection transmission.

- Ensure that clothing and skin do not contact potentially contaminated environment surfaces.

- Remove gown and gloves and perform hand hygiene before leaving the patient-care area.

- A surgical mask and protective eyewear or face shield must be worn if there is the potential for generation of splashes or sprays of blood and body substances into the face and eyes (NHMRC, 2019).

3.1.3. Single-use or patient-dedicated equipment

Patient-dedicated equipment or single -se patient-care equipment should be used for patients who require contact precautions (NHMRC, 2019).

3.2. Droplet Precautions

Droplet precautions are intended to prevent transmission of pathogens spread through close respiratory or mucous membrane contact with respiratory secretions (Siegel et al., 2007).

3.2.1. Patient placement

- A single-patient room for patients who require droplet precautions can reduce the risk of transmission between patients.

- If patients requiring droplet precautions share a room with a patient with a different infection:

+ The patient, sharing a room with a patient who requires droplet precautions should not be at increased risk of developing infection-related complications or be someone who facilitated the transmission.

+ Ensure the necessary distance between patients.

+ In these cases, patients must follow respiratory hygiene and cough etiquette e.

- When transport is necessary, patients should wear a surgical mask and practice respiratory hygiene and cough etiquette (NHMRC, 2019).

3.2.2. Hand Hygiene and Personal Protective Equipment

- Hand hygiene is a key measure to avoid droplet transmission.

- Surgical masks should be worn when entering a patient care environment to prevent droplet transmission (NHMRC, 2019).

3.3. Airborne precautions

Airborne precautions prevent transmission of infectious agents that remain infectious over long distances when suspended in the air.

3.3.1. Patient placement

- Patients who require airborne precautions must be placed in a negative pressure room equipped with bathroom facilities or in a room with closed-circuit ventilation.

- When transport is necessary (outside the negative pressure room), patients should use surgical masks and practice reparatory hygiene and cough etiquette, as well as cover

condition-associated sensitive areas to minimize the risk of cross-transmission (NHMRC, 2019).

3.3.2. Personal Protective Equipment

Healthcare professionals should wear N95 respirator masks prior to entering the patient-care area when an airborne transmissible infectious agent is known or suspected to be present (NHMRC, 2019).

IV. Post-test

1. Which is the correct statement for contact transmission route?

A. Contact transmission route presupposes the direct transmission of microorganisms from an infected source to the host.

B. Contact transmission route refers to the infection of a host through an infected object.

C. Contact transmission route can be direct or indirect.

D. Contact transmission route can occur between two humans.

E. All options are correct.

2. Which is the correct statement for airborne transmission?

A. The microorganisms are expelled during coughing and fall on surfaces.

B. The expelled particles are < 5 µm in size.

C. The distance between people is irrelevant for infection transmission.

D. Air circulation can facilitate the spread of infections.

E. All options are correct.

3. Some infectious agents can be transmitted by different transmission routes. The main routes of transmission are…

A. Contact transmission (direct or indirect).

B. Wearing a protective mask.

C. Droplet transmission and airborne transmission.

D. Options a and c are correct.

E. Options a and b are correct.

4. Standard precautions consist of…

A. Performing hand hygiene and using personal protective equipment.

B. Following respiratory etiquette.

C. Performing the aseptic technique and ensuring proper patient placement.

D. Managing the environment.

E. All options are correct.

5. When the infection can be transmitted through respiratory droplets:

A. Healthcare workers should use FFP2/N95.

B. Patients should use a surgical mask if they have to leave the isolation room.

C. Patients should use a surgical mask even when they are bedridden.

D. Healthcare workers should use a surgical mask in the care unit.

E. All options are incorrect.

6. Which of the following additional measures to prevent infections should be used for patient placement?

A. Have a single-patient room in case of contact transmission.

B. Have at least 3 meters' distance between beds when there is risk of droplet transmission.

C. Place patients in negative pressure rooms in case of droplet transmission.

D. Rooms with closed-circuit ventilation as an alternative to positive pressure are important in the case of airborne transmission.

E. All options are correct.

7. Which is the correct statement for transmission-based precautions?

A. Transmission-based precautions are independent and applied separately from standard precautions.

B. Transmission-based precautions are applied to patients suspected or confirmed to be infected with agents transmitted by contact, droplet, or airborne routes.

C. A patient who is not infected should not be at an increased risk of developing infection-related complications.

D. Options a and b are correct.

E. Options b and c are correct

8. Which is the correct requirement for personal protective equipment in airborne precautions?

A. Using a surgical mask

B. Using gloves

C. Using goggles

D. Using an N95 respirator

E. Wearing a gown

9. What is the correct patient placement for droplet precautions?

A. A single-patient room for patients.

B. A double room for two patients.

C. A single-patient room for several patients.

D. A double room for two patients with distance between beds.

E. Options a and d are correct.

10. The negative pressure room is used for…

A. Contact precautions.

B. Airborne precautions.

C. Droplet precautions.

D. Standard precautions.

E. All options are correct.

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Module 3. Hand Hygiene

I. Overview

Hand hygiene is the single most important procedure for preventing the transmission of microorganisms. This module will provide information to the students on WHO guidelines on hand hygiene in healthcare; the identification of the five moments for hand hygiene; (WHO, 2009; WHO, 2005). Students will also be made aware that hand hygiene is a cost-effective strategy that can save lives and reduce illnesses by preventing the spread of infectious diseases (UNICEF & WHO, 2021; WHO, 2009; WHO, 2005).

II. Learning objectives

After completing this module, students will be able to:

1. identify hand hygiene techniques.
2. identify the 5 moments for hand hygiene.
3. demonstrate the correct way to wash hands with soap and water based on WHO-recommended handrub formulations.
4. perform hand hygiene with an alcohol-based handrub (ABHR) based on WHO-recommended method.
5. list the three purposes of surgical hand preparation.
6. describe the correct surgical hand rubbing technique.

III. Major concepts

1. Hand Hygiene

1.1. Hand hygiene as a health protector

The United Nations Children's Fund (UNICEF) and the WHO (UNICEF & WHO, 2021; WHO, 2020a; WHO, 2020b) argue that the simple act of cleaning hands can save lives and reduce illness by helping prevent the spread of infectious diseases. These diseases can be caused by bacterial, viral, or protozoan pathogens (germs) transmitted through the air or via surfaces, food, or human faces. People frequently touch their faces, food, and surfaces, so hands play a significant role in spreading diseases. It is estimated that half a million people

die each year from diarrhea or acute respiratory infections that could have been prevented with good hand hygiene. Acute respiratory infections, such as COVID-19 and pneumonia, are a leading cause of morbidity and mortality worldwide and the single largest infectious cause of death among children under 5 years of age in low- and middle-income countries. Estimates from 2016 show that 370,000 deaths caused by acute respiratory infections each year could have been prevented through basic hand hygiene. Diarrheal disease is a major public health concern and a leading cause of disease and death among children under 5 years of age in low-and middle-income countries. This includes cholera, an acute diarrheal disease that can kill within hours if left untreated. Based on estimates from 2016, it is estimated that 165,000 deaths caused by diarrhea each year could be prevented through basic hand hygiene. Stunting, which can be caused by repeated bouts of diarrhea, affects nearly one quarter of children under 5 years of age globally. Sepsis is a preventable, life-threatening condition characterized by severe organ dysfunction, and is often related to inadequate quality of care. Sepsis accounts for a significant proportion of neonatal and maternal deaths globally, as well as HAIs. Hand hygiene during labor, delivery and post-natal care is critical to reducing infection. HAIs, or nosocomial infections, are a leading cause of avoidable harm, jeopardize patient safety and represent a massive disease burden. The most common are surgical infections, hospital-acquired pneumonia, catheter-associated urinary tract infections, and bloodstream infections. Many are caused by antibiotic-resistant organisms. It is estimated that hand hygiene can reduce up to 50%of these infections. Hand hygiene also enables several additional indirect health benefits, including unlocking other hygiene practices. The basin, water supply and soap required for hand washing unlock additional beneficial hygiene practices (e.g., facial cleanliness to reduce trachoma transmission) (UNICEF & WHO, 2021; WHO, 2020b).

1.2. Positive societal impacts of hand hygiene

In addition to the health benefits, good hand hygiene has positive societal impacts that are difficult to measure. For instance, access to improved wash services has been shown to reduce stress, particularly among women and people living with disabilities, by increasing

feelings of dignity, privacy, and safety, and decreasing feelings related to disgust, fear of violence, injury, and shame. The ability to maintain personal hygiene has an important role to play in this, as it is linked to feelings of dignity and pride (UNICEF & WHO, 2021; WHO, 2020b). Adverse effects of poor hand hygiene disproportionately affect people living with disabilities. Globally, it has been shown that the most vulnerable populations and those in resource-poor settings suffer the most from the negative impacts of poor wash. Improvements in hand hygiene, therefore, contribute to reducing inequality. The infectious diseases that hand hygiene can help control keep kids out of school and adults out of work, affecting the short- and long-term economic well-being of households. Because poorer households are more exposed to key factors that cause illness, a pattern of decline in health and socioeconomic status can be created (UNICEF & WHO, 2021; WHO, 2020b).

1.3. Why, how, and when is hand hygiene performed?

Thousands of people die every day around the world from infections acquired while receiving health care. Hands are the main pathways of germ transmission during health care. Hand hygiene is therefore the most important measure to avoid the transmission of harmful germs and prevent HAIs. The brochure below explains how and when to practice hand hygiene. Any HW, caregiver or person involved in direct or indirect patient care needs to be concerned about hand hygiene and should be able to perform it correctly and at the right time. Clean your hands by rubbing them with an alcohol-based formulation, as the preferred means for routine hygienic hand antisepsis if hands are not visibly soiled. It is faster, more effective, and better tolerated by your hands than washing with soap and water. Wash your hands with soap and water when your hands are visibly dirty or visibly soiled with blood or other body fluids or after using the toilet. If exposure to potential spore-forming pathogens is strongly suspected or proven, including outbreaks of *Clostridioides difficile*, hand washing with soap and water is the preferred means (WHO, 2009). Below, Figure 3 and Figure 4 demonstrate a step by step on how to handrub correctly with alcohol-based formulas and how to handwash with soap and water, respectively.

Figure 3: How to handrub with alcohol-based formulation

Source: Adaptation from WHO guideline on hand hygiene in healthcare (WHO, 2009).

Figure 4: How to handwash with soap and water

Source: Adaptation from WHO guideline on hand hygiene in healthcare (WHO, 2009).

2. Five Moments for hand hygiene

The 5 Moments for Hand Hygiene approach (figure 3) was designed by the WHO to minimize the risk of transmission of microorganisms between a HW, the patient, and the environment (WHO, 2009).

2.1. Moment 1: Before touching a patient

Hand hygiene is performed on entering the patient's zone before touching the patient. It intends to protect the patient against acquiring harmful germs from the hands of the healthcare worker (HCW) by touching a patient in any way such as shaking hands, assisting a patient to move, allied health interventions, touching any medical device connected to the

patient (e.g., an intravenous line pump or a urinary catheter). Hand hygiene is performed before any personal care activities, such as bathing, dressing, brushing hair, and putting on personal aids such as glasses. It should be performed before any noninvasive observations, such as taking a pulse, blood pressure, oxygen saturation, temperature, chest auscultation, abdominal palpation, applying electrocardiogram (ECG) electrodes, and cardiotocography. Hand hygiene should be performed before any noninvasive treatment, such as applying an oxygen mask or nasal cannula, fitting slings/braces, and application of incontinence aids (including condom drainage). It should be performed while preparing and administrating oral medications, nebulized medications, oral care, and feeding (e.g., feeding the patient, brushing teeth or dentures) (WHO, 2009).

2.2. Moment 2: Before a procedure

Hand hygiene should be performed immediately before a procedure. Once hand hygiene has been performed, nothing else in the patient's environment should be touched prior to the procedure starting. It is intended to protect the patient from potential pathogens (including their own) entering their body during a procedure. Hand hygiene should be performed before insertion of a needle into a patient’s skin, or into an invasive medical device such as venipuncture, blood glucose level, arterial blood gas, subcutaneous or Intramuscular injections, and intravenous line flush; before preparation and administration of any medications given via an invasive medical device and preparation a sterile field (e.g., intravenous medication, nasogastric tube (NGT) feeds, percutaneous endoscopic gastrostomy (PEG) feeds, dressing trolley set up); before administration of medications where there is direct contact with mucous membranes such as eye drop instillation, suppository insertion, vaginal pessary; before insertion of, or disruption to, the circuit of an invasive medical device such as procedures involving endotracheal tube, tracheostomy, nasopharyngeal airways, suctioning of airways, urinary catheter, colostomy/ileostomy, vascular access systems, invasive monitoring devices, wound drains, PEG tubes, NGT, and secretion aspiration; and before any assessment, treatment and patient care where contact is made with non-intact skin or mucous membranes such as wound dressings, burns dressings, surgical

procedures, digital rectal examination, invasive obstetric and gynecological examinations and procedures, and digital assessment of newborn palate (WHO, 2009; WHO, 2000a).

2.3. Moment 3: After a procedure or body fluid exposure risk

Hand hygiene should be performed immediately after a procedure or body fluid exposure risk as hands could be contaminated with body fluid. Even if you have gloves on you should still perform hand hygiene after removing them as gloves are not always a complete impermeable barrier. Hands may also have been contaminated in the process of removing the gloves. It is performed to protect yourself and the healthcare surroundings from becoming contaminated with potential pathogens. Therefore, hand hygiene is performed after any Moment 2 and after any potential body fluid exposure such as contact with a used urinary bottle/bedpan, contact with sputum either directly or indirectly via a cup or tissue, contact with used specimen jars/pathology samples, cleaning dentures, cleaning spills of urine, feces or vomit from patient surroundings, and after touching the outside of a drain; before contact with blood, saliva, mucous, semen, tears, wax, breast milk, colostrum, urine, feces, vomitus, pleural fluid, cerebrospinal fluid, ascites fluid, and organic body samples such as biopsy samples, cell samples, lochia, meconium, pus, bone marrow, and bile (WHO, 2009).

2.4. Moment 4: After touching a patient

Hand hygiene should be performed after touching a patient and before you leave the patient zone in order to protect yourself and the healthcare surroundings from becoming contaminated with potential pathogens (WHO, 2009).

2.5. Moment 5: After touching patient surroundings

Hand hygiene should be performed after touching a patient's surroundings even when the patient has not been touched. Always hand hygiene before leaving the room to protect yourself and the healthcare surroundings from becoming contaminated with microorganisms. Hand hygiene should be performed after touching the patient's immediate surroundings when the patient has not been touched. The patient´s surroundings include bed, bedrails, linen, table, bedside chart, bedside locker, call bell/TV remote control, light switches, personal

belongings (including books, mobility aids), chair, footstool, and pick up walker (WHO, 2009).

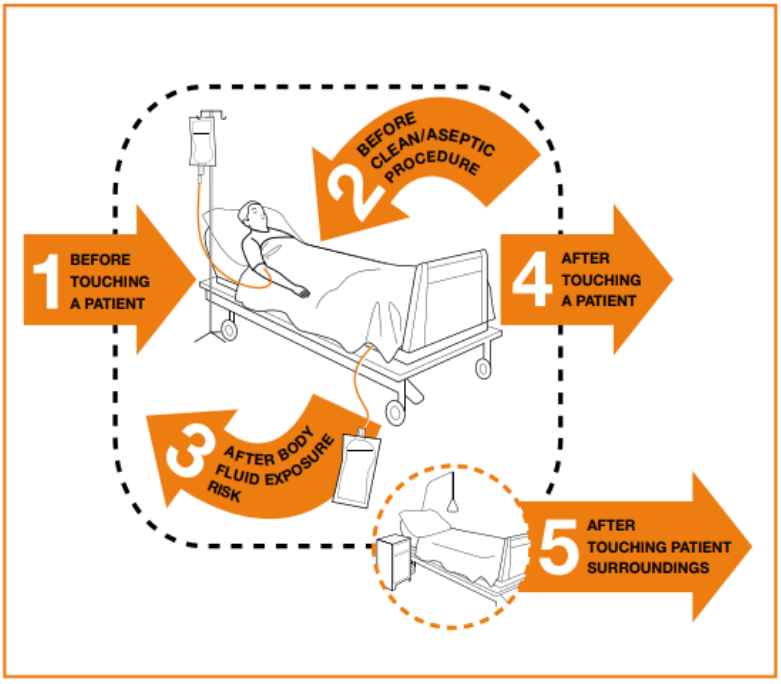

Figure 5: The 5 moments for hand hygiene

Source: Adaptation from WHO guideline on hand hygiene in healthcare (WHO, 2009).

3. Surgical hand preparation

3.1. Objective of surgical hand preparation

Surgical hand preparation should reduce the release of skin bacteria from the hands of the surgical team for the duration of the procedure in case of an unnoticed puncture of the surgical glove releasing bacteria to the open wound. In contrast to the hygienic handwash or hand rub, surgical hand preparation must eliminate the transient and reduce the resident flora. It should also inhibit growth of bacteria under the gloved hand. Rapid multiplication of skin bacteria occurs under surgical gloves if hands are washed with a non-antimicrobial soap, whereas it occurs more slowly following preoperative scrubbing with a medicated soap. The skin flora, mainly coagulase-negative staphylococci, *Propionibacterium* spp., and *Corynebacteria* spp., are rarely responsible for surgical site infection, but in the presence of a foreign body or necrotic tissue, even inocula as low as 100 CFU can trigger such infection. The virulence of the microorganisms, extent of microbial exposure, and host defense mechanisms are key factors in the pathogenesis of postoperative infection, risk factors that

are largely beyond the influence of the surgical team. Therefore, products for surgical hand preparation must eliminate the transient and significantly reduce the resident flora at the beginning of an operation and maintain the microbial release from the hands below baseline until the end of the procedure. The spectrum of antimicrobial activity for surgical hand preparation should be as broad as possible against bacteria and fungi. Viruses are rarely involved in SSI and are not part of test procedures for licensing in any country. Similarly, activity against spore-producing bacteria is not part of international testing procedures (WHO, 2009).

3.2. Surgical hand preparation with alcohol-based hand rubs

Several alcohol-based hand rubs have been licensed for the commercial market, frequently with additional, long-acting compounds (e.g., chlorhexidine gluconate or quaternary ammonium compounds) limiting regrowth of bacteria on the gloved hand. The antimicrobial efficacy of alcohol-based formulations is superior to that of all other currently available methods of preoperative surgical hand preparation.

With small amounts of QAC, hexachlorophene or chlorhexidine gluconate reduce bacterial counts on the skin immediately post-scrub more effectively than do other agents. The WHO-recommended handrub formulations were tested by two independent reference laboratories in different European countries to assess their suitability for use for surgical hand preparation. Although formulation I did not pass the test in both laboratories and formulation II in only one of them, the expert group is, nevertheless, of the opinion that the microbicidal activity of surgical antisepsis is still an ongoing issue for research as due to the lack of epidemiological data there is no indication that the efficacy of n-propanol (propan-1-ol) 60 % v/v as a reference in EN 12791 finds a clinical correlate. It is the consensus opinion of the WHO expert group that the choice of n-propanol is inappropriate as the reference alcohol for the validation process because of its safety profile and the lack of evidence-based studies related to its potential harmfulness for humans. Indeed, only a few formulations worldwide have incorporated n-propanol for hand antisepsis.

Considering other properties of the WHO-recommended formulations, such as their excellent tolerability, good acceptance by HCWs and low cost are of high importance for a sustained clinical effect, it is the consensus opinion of the WHO expert group that the two formulations can be used for surgical hand preparation. Institutions opting to use the WHO-recommended formulations (figure 6) for surgical hand preparation should ensure that a minimum of three applications are used, if not more, for a period of 3 to 5 minutes. For surgical procedures of more than a two hours' duration, ideally surgeons should practice a second handrub of approximately 1 minute, even though more research is needed on this aspect.

Figure 6: Surgical hand preparation technique with an alcohol-based handrub formulation

Source: Adaptation from WHO guideline on hand hygiene in healthcare (WHO, 2009).

The hands of the surgical team should be clean upon entering the operating room by washing with a non-medicated soap. While this handwash may eliminate any risk of contamination with bacterial spores, experimental and epidemiological data failed to demonstrate an additional effect of washing hands before applying handrub in the overall reduction of the resident skin flora. The activity of the handrub formulation may even be

impaired if hands are not completely dried before applying the handrub or by the washing phase itself.

A simple handwash with soap and water (Figure 7) before entering the operating room area is highly recommended to eliminate any risk of colonization with bacterial spores. Non-medicated soaps are sufficient, and the procedure is necessary only upon entering the operating room: repeating hand rubbing without prior handwash or scrub is recommended before switching to the next procedure (WHO, 2009; Eschweiler Nursing Academy, 2014).

Figure 7: Surgical hand preparation technique with an alcohol-based handrub formulation

Source: Adaptation from WHO guideline on hand hygiene in healthcare (WHO, 2009).

IV. Post-test

Choose the correct answer for each question below:

1. Good hand hygiene can prevent diseases that can be caused by:
   A. Bacterial pathogens.
   B. Viral pathogens.
   C. Protozoan pathogens.
   D. All of the above.
2. Which health conditions can be reduced through hand hygiene?
   A. Acute respiratory infections.
   B. COVID-19 and pneumonia.
   C. Diarrheal disease.
   D. All of the above.
3. Which infections are estimated to be reduced by 50%by hand hygiene?
   A. Catheter-associated infections.
   B. Hospital-acquired pneumonia.
   C. Urinary tract infections.
   D. All of the above.
4. In Figure 2, the appropriate duration of hand washing with soap and water is
   A. 10-15 seconds.
   B. 40-60 seconds.
   C. About one minute.
   D. At least 2 minutes.
5. Alcohol-based hand rub is the preferred mean for:
   A. Protecting from airborne microorganisms.
   B. Routine hygienic hand antisepsis if hands are not visibly soiled.
   C. Routine hygienic hand antisepsis if hands are visibly soiled.
   D. Killing all kinds of microorganisms on your skin flora.
6. When do you perform your hand washing with soap and water?

A. When hands are visibly dirty.

D. When hands are visibly soiled with blood or other body fluids.

C. After using the toilet.

D. All of the above.

7. When nurses are performing surgical hand hygiene, they must keep their hands

A. Above elbow.

B. Below elbow.

C. At a 45-degree angle.

D. In a comfortable position.

8. It is estimated that 165,000 deaths caused by diarrhea each year could be prevented through basic hand hygiene.

A. True (T) B. False (F)

9. The purpose of surgical hand scrub is to sterilize the hands prior to gowning and gloving.

A. True (T) B. False (F)

10. Alcohol-based hand rub is the preferred method of hand hygiene.

A. True (T) B. False (F)

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Module 4. Clinical Microbiology Actions and Antimicrobial Resistance in HAIs

I. Overview

Clinical microbiology is a discipline that encompasses different testing methodologies used to isolate and identify microorganisms (Chandler, 2013). It has a critical role in patient care management by identifying the cause of infection and the susceptibility to antimicrobials. Rapid identification of microorganisms is necessary for starting an effective antimicrobial administration and improving patient outcomes (Cho et al., 2015).

The rapid spread of antimicrobial resistance has become a global threat to the treatment of common infections, increasing hospital stay and imposing a significant economic burden on countries and families. Without effective tools for prevention and adequate treatment of drug-resistant infections, the number of patients for whom treatment is failing and who die of infections will increase (WHO, 2021).

This module consists of three units:

Unit 1. Role of microbiology laboratory diagnosis in HAIs

Unit 2. Antimicrobial Resistance in Healthcare-Associated Infections (AMR in HCAIs)

Unit 3. Methicillin-resistant *Staphylococcus aureus* (MRSA) in Southeast Asia

II. Learning objectives

1. To describe the role of microbiology laboratory diagnosis of HAIs.
2. To elaborate on the current epidemiology and causes of AMR in HAIs.
3. To elaborate on the current epidemiology and causes of MRSA in Southeast Asia.

III. Major concepts

1. Role of microbiology laboratory diagnosis in HAIs

1.1. The clinical role of the microbiology laboratory

Most HAIs are caused by bacteria and fungi that can be dangerous for patients, namely among those patients diagnosed with acute meningitis, sepsis, or severe pneumonia. The severity of HAIs is increasing due to the rise in antimicrobial resistance and the lack of

knowledge about the causative pathogens to treat the infections effectively and in a timely manner (Chandler, 2013).

The microbiology laboratory can contribute to the on-time diagnosis of the most common infectious pathogens, especially those causing HAIs. In addition, the laboratory is also able to perform antimicrobial susceptibility testing for bacteria and fungi that can improve treatment and prevent further transmission among patients. In addition, the microbiology laboratory staff can also assist in supporting and collecting the right specimens that are suspected of HAIs from patients within healthcare-associated pathogens. They play a very important role of supporting and providing any necessary training or education to other health staff on proper specimen collection techniques.

The laboratory staff has an important role in early pathogen diagnosis, smear collection, transportation, and pathogen isolation in order to identify the sources of infections in healthcare settings (Chandler, 2013).

1.2. The epidemiological role of the microbiology laboratory

The epidemiological role of the microbiology laboratory consists of investigating the occurrence of HAIs or any emerging pathogens from patients, health staff, or hospital settings. Finding of routes of transmission can help prevent the spread of HAIs. The laboratory is involved in collecting microbiology data, educating staff, and developing the antibiotic protocol and policy.

1.3. Roles in HAI-PC

The microbiology laboratory staff plays a crucial role in preventing and controlling HAIs. The microbiologist usually participates in the IPC team as the Infection Control Support Officer. The role of the laboratory in the HAI control plan includes identification of pathogens, provision of advice on antimicrobial therapy, provide advice on specimen collection and transport, provision of advice on antimicrobial susceptibility testing, report on antimicrobial resistance, identification of sources and mode of transmission of pathogens, microbiological testing of hospital personnel or environment to investigate a suspected outbreak, provision of support

for sterilization and disinfection of healthcare facilities, and provision of training for health staff involved in infection control programs (Cho et al., 2015).

1.4. Role in the surveillance of HAIs

The microbiology laboratory can assist the IPCT to produce routine periodic reports of isolates and to develop incidence graphs for any specific pathogens, wards, and groups of patients. They are also important because they demonstrate trends of specific pathogens and can be very useful in planning preventive measures for controlling HAIs.

1.5. The role of microbiology laboratory with IPCT and other department for HAIs Actions

The microbiology laboratory plays a significant role in identifying any healthcare-associated pathogens and informing clinicians to support a more effective diagnosis and treatment. In addition, it must report outbreak information and collaborate with IPC nurses in order to prevent the spread of HAIs by using standard precautions.

Based on ongoing HAI reports, a HAI prevention plan is developed and implemented by another IPC team within the healthcare setting, including doctors, nurses, pharmacists, quality managers, and patients. The work of the microbiology laboratory covers microbial isolation and identification, determination of antimicrobial susceptibility patterns, epidemiological surveillance and outbreak detection, education, and report of quality assured results (Kalenic, 2016).

2. Antimicrobial Resistance (AMR)

Antimicrobial resistance (AMR) has emerged as a major threat to human health. Southeast Asia has been identified as a region of increased spread of AMR. In Thailand, it has been estimated that 43% of deaths resulting from hospital-acquired bacteremia were due to multidrug resistance. Similarly, in Cambodia, community-acquired drug-resistant bacteremia in children is associated with increased mortality, and results in a doubling of hospital admission costs. Poor hygiene and infection control, lack of sanitation, weak or unenforced medicines regulation, and sub-standard quality drugs have been suggested as some of the main drivers of AMR in Southeast Asia.

In Cambodia, AMR levels were high, particularly among the gram-negative pathogens Klebsiella pneumoniae, Escherichia coli, and Acinetobacter baumannii, Enterobacteriacae. For the gram-positive pathogens, Streptococcus pneumoniae, Staphylococcus aureus, and Streptococcus pyogenes resistance to antibiotics was increasing (WHO, 2002).

Antimicrobials are medicinal products that kill or stop the growth of living microorganisms:

- Antibacterials (often called antibiotics, active against bacterial infections),
- Antimycobacterial drugs (which are antibacterials specifically active against tuberculosis and other mycobacterial infections)
- Antivirals (active against viral infections, e.g., influenza, HIV, herpes infections),
- Antifungals (active against fungal infections),
- Antiparasital drugs (active against e.g., malaria and other infections due to parasites).

Antimicrobial resistance (AMR) occurs when microbes change over time, usually through genetic changes, and no longer respond to medicines. Infections become harder to treat, increasing the risk of disease spread, severe illness, and death. Antimicrobial-resistant microorganisms, including multidrug-resistant types, are often responsible for HAIs. They are also responsible for infections in patients outside hospitals and can be found as part of the normal bacterial flora, in pet animals, and in the environment. Furthermore, they are responsible for infections and isolated from food-producing animals and sometimes isolated from foods. Humans and animals do not become resistant to antimicrobial treatments, but bacteria and other microorganisms can (Simões et al., 2016; Reed et al., 2019).

Multidrug resistance corresponds to resistance of a microorganism to multiple antimicrobials. This issue of multidrug resistance is relevant for all microorganisms, including bacteria responsible for HAIs.

Examples of common multidrug-resistant bacteria are:

- Methicillin-resistant *Staphylococcus aureus* (MRSA)

- Vancomycin-resistant *Enterococci* (VRE) Extended spectrum beta-lactamase (ESBL) producing *Enterobacteriaceae* (examples of common *Enterobacteriaceae* are *Escherichia coli* and *Klebsiella pneumoniae)*

- Carbapenem-resistant *Enterobacteriaceae* (CPE) *(i.e., Escherichia coli, Klebsiella)*

- Multidrug-resistant *Pseudomonas aeruginosa*

- Multidrug-resistant *Neisseria gonorrhoeae*

Multidrug resistant mechanisms are diverse. For example, the main mechanism of MRSA resistance is the production of an auxiliary penicillin-binding protein (PBP) that renders the isolate resistant to all β-lactams. PBP is encoded by mecA and mecC genes that are foreign to *S. aureus*. Most ESBLs are based on acquired enzymes, encoded by genes on plasmids. The acquired ESBLs are expressed at various levels and differ significantly in biochemical characteristics such as activity against specific β-lactams, such as cefotaxime, ceftazidime, and aztreonam (WHO, 2021).

The two major areas for prevention of AMR are the prudent use of antimicrobials (i.e., use only when needed) and hygienic precautions, including hand hygiene, screening, and isolation. AMR is a complex problem and needs coordinated actions such as policies, legislation, and research to attain better health outcomes. The Cambodia AMR policy recommends capacity building of health staff and professionals in several areas that influence AMR prevention such as laboratories, surveillance, clinical practice guidelines, IPC, and other areas that require microbiological skills. There is also a need for public awareness and advocacy on antibiotic use, AMR and basic practices on agriculture, disease prevention in animals and humans and basic healthcare (Simões et al., 2016; Reed et al., 2019).

3. MRSA in Southeast Asia

3.1. Overview of MRSA prevalence in Southeast Asia

Hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) associated with surgical wound infections is a serious threat due to its high mortality rates, particularly in the region of Southeast Asia. Southeast Asia countries have limited healthcare infrastructure,

limited capacity in the microbiological laboratory, and AMR stewardship, as well as other risk factors for the increase of MRSA (WHO, 2021).

In a study conducted at the Children's Surgical Center in Phnom Penh, Cambodia, between 2011 and 2020, 52.5% of the *Staphylococcus aureus* isolates collected from wound swab samples were MRSA positive. Between 2020 and 2022, MRSA rates in the Cambodian population have remained similar at 53.8%. Patients with wound infection due to trauma or orthopedic implants had greater propensity to yield MRSA (ECDC, 2022).

In Vietnam, the emergence and spread of multidrug-resistant (MDR) MRSA pose a serious problem in the treatment and control of staphylococcal infections in healthcare settings. In northern Vietnam, *Staphylococcus aureus* is observed in one-third of the nasopharyngeal carriage of the Vietnamese population. In southern Vietnam, the MRSA rates were 74.1% in hospitals and 30.1% in communities between 2004 and 2006. These rates were higher than in other Asian countries (Nguyen et al., 2019).

Nguyen et al. (2019) revealed that the MDR-MRSA with the highest rates were "ciprofloxacin-erythromycin-gentamicin-tetracyclines" (35.6%), followed by "erythromycin-tetracycline-chloramphenicol" (24.1%), and "ciprofloxacin-erythromycin-gentamicin" (19.5%), showing an accumulative total of 79.3%. The most susceptible antibiotics were rifampicin (100%) and vancomycin (100%), followed by doxycycline (94.0%), meropenem (78.0%), and cefotaxime (75.0%).

In 2019, a study was conducted to explore the prevalence of MRSA among HWs (physicians, nurses, and nursing assistants) who worked at the ICU in South Vietnam. In hospital settings, MRSA colonization among HWs is a huge problem nowadays because they may spread MRSA to their patients due to poor infection control measures. MRSA outbreaks in hospitals are usually epidemiologically associated with MRSA-colonized or MRSA-infected HWs, especially those who had exfoliated skin conditions, skin infections, or respiratory tract infections (Duong et al., 2022).

In 2006, an outbreak of severe community-acquired MRSA infections following routine immunization was reported in Ho Chi Minh City, Vietnam. The outbreak investigation found

that HWs' insufficient hand hygiene during routine injection had led to the transmission of MRSA among children (Nguyen et al., 2022).

The study revealed that, among 55 HWs, 16 (29.1%) carried MRSA in their noses or hands. MRSA intermittent hand carriage was documented in 2 (3.6%) HWs. Among 53 HWs undertaking nasal swabs, 13 (24.5%) were MRSA persistent and 3 (5.6%) were intermittent carriers. The MRSA carriage rate was highest among nursing assistants (50%, 4/8). More HWs with underlying diseases were found to be MRSA carriers (31.8%, 7/22) compared with those without comorbidities (27.3%, 9/33). The findings indicated that nurses have a higher risk of MRSA colonization because they have more hours of direct patient contact than physicians (Wong et al., 2023).

3.2. Measures to Prevent and Control MRSA in Healthcare Settings

To strengthen MRSA prevention and control practices in healthcare settings, the following measures are suggested:

- Screening for MRSA carriers among HWs who are suspected of MRSA colonization and MRSA infections.

- Examining the antimicrobial susceptibility profile of MRSA isolates and MRSA carriage rates among HWs.

- The IPCT should implement and regularly monitor standard precautions, namely hand hygiene among HWs.

- HWs who have underlying diseases such as skin infections or respiratory infections should be allowed to take a sick license.

- Whenever there is a suspected outbreak of MRSAs in healthcare settings, the MRSA profile of the hospital environment and health staff should be investigated.

- Infection control training should be provided to all HWs.

- The IPCT should have sufficient staff to implement the IPC Plan.

- The microbiology laboratory should collaborate with other healthcare professionals to prevent and control MRSA in healthcare settings.

IV. Post-test

Please choose the correct answer for each question below:

1. Which pathogens can cause the most HAIs?

A. Virus

B. Fungi

C. Bacteria

D. Pathogens

2. What is the key role of microbiology laboratory in HAI-PC strategies?

A. To detect on-time causes of infection transmission and help clinicians in treatment.

B. To help the IPCT prevent the spread of infections among patients.

C. To support and collect the right specimens that are suspected of HAIs from patients and identify environmental risks.

D. All options are correct.

3. Which is the most prevalent AMR in Southeast Asia?

A. Staphylococcus aureus and Streptococcus pneumoniae.

B. Escherichia coli.

C. Klebsiella pneumoniae.

D. All options are correct.

4. The risk for high prevalence of HA-MRSA infections is observed at:

A. Surgical and wound sites.

B. Injection skin sites.

C. The nasopharynx.

D. UTI sites

5. What is the most effective measure to prevent and control HAIs?

A. To applyuniversal precautions.

B. To establish an IPCT.

C. To surveil hospital environment pathogens.

D. All options are correct.

6. Which MRSA HAIs cause high mortality?

A. MRSA infections associated with surgical wounds cause high mortality.

B. MRSA infections associated with UTIscause high mortality.

C. Respiratory MRSA HAIs cause high mortality.

D. Skin MRSA HAIs cause high mortality.

7. Which of the following statements are correct?

A. AMR prevention measures required some interventions that include training for laboratory staff.

B. AMR prevention should strengthen the surveillance of HAIs.

C. AMR prevention should apply the clinical practice guidelines of antibiotic use and implement IPC precautions.

D. All options are correct.

8. In Cambodia and Southeast Asia, AMR levels were high due to HAIs caused by:

A. Klebsiella pneumoniae

B. *Escherichia coli and Acinetobacter baumannii*

C. *Enterobacteriaceae*

D. All of the above.

9. Who plays an important role in identifying HAI pathogens?

A. Administrative staff.

B. Microbiology laboratory staff.

C. Hospital management.

D. Physicians.

10. Which of the following pathogens cause AMR?

A. Methicillin-resistant *Staphylococcus aureus* (MRSA)

B. *Pseudomonas aeruginosa and Neisseria gonorrhoeae*

C. *Enterobacteriaceae included Escherichia coli and Klebsiella pneumoniae*

D. All of the above.

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Module 5. Use of Personal Protective Equipment and Safe Handling of Clinical Clothing

I. Overview

The use of personal protective equipment (PPE) by HCWs is important for HAI prevention and control. The main purpose of wearing Personal Protective Equipment (PPE) is to protect HCWs from contamination and prevent the transmission of microorganisms to patients within healthcare facilities. Healthcare facilities should ensure that healthcare personnel have adequate working conditions and access to PPE. The main components of PPE include goggles, face shields, masks (N95, FFP2, or FFP3 half-masks), surgical masks, gloves, disposable gowns, disposable coveralls, waterproof aprons, trousers and tops, head covers, waterproof boots and shoe covers (PAHO, 2018).

II. Learning objectives

After the completion of this module, students should be able to:

1. Identify the importance of following the correct procedures for PPE use.
2. Gain knowledge regarding the appropriate selection of PPE.
3. Gain knowledge and skills regarding PPE use and its safe handling.
4. Understand when gloves, aprons, and respiratory and facial protection should be worn.
5. Understand the implications of not wearing or disposing of PPE correctly.

III. Major concepts

1. Personal protective equipment and clinical clothing

Any infectious agent transmitted by the contact or droplet route can potentially be transmitted by contamination of HCW's hands, skin, or clothing. Cross-contamination can then occur between HCWs and patients or between HCWs.

PPE can be used alone or in combination to protect mucous membranes, airways, and skin from contact with infectious agents. PPE may include aprons, gowns, coveralls, gloves, surgical masks, protective eyewear, and face shields or a combination of several of these

items. PPE also protects patients from exposure to infectious agents during the procedures carried by HCWs (NHMRC, 2019).

1.1. Goggles and Face Shields

Goggles and face shields are used to protect the mucous membranes of the eyes, nose, and mouth. Contamination via mucous membranes is probably the most important mode of droplet transmission. Hence, wearing goggles or face shields could prevent the transmission through mucous membranes (PAHO, 2018).

1.2. Face Masks

Masks and respirators can provide different levels of protection depending on the type of mask and how they are used. Loosely woven cloth products provide the least protection, layered finely woven products offer more protection, well-fitting disposable surgical masks offer even more protection, and well-fitting NIOSH-approved respirators (including N95s) offer the highest level of protection (CDC, 2022).

Surgical face masks

Surgical masks are single-use items that cover the nose and mouth. They are used as part of standard precautions to keep splashes or sprays from reaching the mouth and nose of the person wearing them. They also provide some protection from respiratory secretions and are worn when caring for patients on droplet precautions. Surgical masks can be placed on coughing patients to limit the potential dissemination of infectious respiratory secretions from the patient to others (NHMRC, 2019).

Considerations when using a surgical mask include:

- masks should be changed between patients and when they become soiled or wet.

- masks should never be reapplied after they have been removed.

- masks should not be left dangling around the neck.

- touching the front of the mask while wearing it should be avoided.

- hand hygiene should be performed upon touching or discarding a used mask (NHMRC, 2019).

Particulate Respirators

Respirators, known as filtering face pieces (FFP), are designed to protect the wearer from exposure to airborne contaminants (e.g., from inhaling infectious agents associated with inhaling small and large particle droplets). They are used to cover the mouth and the nose to filter the air and to protect healthcare workers from airborne pathogens. They should always be worn along with other PPE (gown, gloves, eye protection) when taking care of very contagious patients or when performing aerosol-generating procedures on patients with suspected or confirmed highly contagious respiratory diseases. They are also used in healthcare facilities where ventilation is known to be poor or cannot be assessed, or the ventilation system is not properly maintained (ECDC, 2020).

1.3. Gloves

Gloves are one of the main PPE components. They are used to prevent contact with contaminated sources such as the skin of patients colonized or infected with multi-resistant microorganisms, blood, or body fluids. Extended use of medical gloves is discouraged, and it is strongly recommended to change medical gloves between patients. The use of the same pair of gloves for multiple patients can lead to the transmission of pathogenic organisms from one patient to the next (PAHO, 2018).

1.4. Medical Aprons

An apron is made of waterproof material and covers the front of the body from the neck to the knees but not the arms. It is used to protect the front of the body. It should be used only as a second, waterproof barrier on top of the gown during procedures that generate a large volume of blood or body fluids. Special attention should be paid to how the apron fastens. It should be easy to put on and take off so that the user does not come in contact with fluids when it is being removed (PAHO, 2018).

1.5. Medical Gowns

A gown is made of textile material, plastic or paper. It covers the body from the neck to the knees and the arms down to the wrists. The purpose of using gowns is to keep the HCW's regular clothes from becoming contaminated or soiled during procedures that might create blood spatters, secretions, or excretions. Their use is also indicated when the procedure to be performed could place most of the HCW's clothing in contact with patients carrying specific microorganisms or with surfaces near patients (PAHO, 2018).

1.6. Coveralls

Coveralls are loose-fitting garments that cover the whole body except for the face, hands, and feet. Coveralls are commonly made from high-density polyethylene formed into a non-woven fabric that allows heat and sweat to leave the suit while preventing liquids and aerosols from entering it. They are reusable or disposable and can provide full body protection (PAHO, 2018).

1.7. Surgical Scrubs (Trousers and Tops)

Surgical scrub is a cotton or cotton/polyester wearing apparel, consisting of a short-sleeved shirt and drawstring pants, that is the universal uniform of surgeons. Scrubs are typically reserved for the operating room and used during bloody procedures. Surgical scrubs may be worn under protective clothing. These are considered regular on-duty wear, not PPE (PAHO, 2018).

1.8. Head Covers

A head cover provides protection to the hair and scalp from possible contamination when sprays or airborne exposure is anticipated, and it should be worn as part of full barrier precaution. A coverall usually has a head cover also known as hood. Those wearing gowns should use a separate head cover (Minnesota Department of Health, 2023). However, there

is no evidence to support the use of head covers for preventing contamination or transmission of infection, but medical head caps are ideal to prevent hair from falling down from surgical personnel (WHO, 2016).

1.9. Waterproof boots and closed shoes

Waterproof boots are preferred over closed shoes because they are easier to clean and disinfect and because they provide optimal protection when the floor is wet. In addition, rubber boots can protect you from sharp injuries (WHO, 2016).

1.10. Shoe Covers

Wearing shoe covers provides a barrier against possible exposure to airborne organisms or contact with a contaminated environment. Shoe covers should be worn as part of full barrier precautions. Shoe covers are commonly recommended for use in hospitals to protect healthcare workers from blood and bodily fluid contamination (Minnesota Department of Health, 2023).

2. Putting on PPE (Donning)

2.1. *Basic principles in donning*

There are many ways of properly donning PPE. The most critical aspects of the process are how to avoid secondary disease transmission to HCWs involved in patient care. Consequently, donning and doffing strongly benefit from active assistance by a team member, who has been trained in this process The type of PPE used varies based on the level of precautions required, such as droplet or airborne contamination precautions.

For building an integrated protection system to a high standard, PPE components have to be put on and off meticulously and in a systematic order. Checking the PPE components for potential damage before donning, at the end of donning and before doffing adds another layer of safety. The ability to wear and use personal protective equipment is crucial in HAI prevention. Failing to comply with the procedure might result in spreading viruses and bacteria,

which might constitute a health and life hazard. It is important to follow hand hygiene procedures (ECDC, 2014).

2.2. *Where to wear PPE*

PPE should not be worn outside the patient-care area. They must be used in areas where there is a high risk of contamination, and they must be removed before leaving the area. Even where there is a lower risk of contamination, protective clothing that has been in contact with patients should not be worn outside the patient-care area. Similarly, to reduce the risk of disease transmission between patients, PPE should be removed and replaced before attending to another patient. When providing patient care in a room where patients are cohort together, PPE should be changed when moving between patients in these rooms. The extended use of PPE items can increase the risk of cross-infection for patients and HCWs and the risk of environmental contamination (NHMRC, 2019).

2.3. *Donning sequence*

To reduce the risk of transmission, the following steps are recommended when putting on PPE:

1) Remove all personal items (jewelry, watches, cell phones, pens, etc.) (WHO, 2015).

2) Put on a scrub suit and rubber boots or closed shoes in the changing room:

Put on scrubs suit and hair cover- to ensure comfortable and safe working conditions, PPE users should wear hospital scrubs and a hair cover under protective clothing. These are considered regular on-duty wear and not PPE. The scrubs will absorb sweat, and hair covers prevent fluids from seeping in through individual strands of hair sticking out from the hood (WHO, 2015; ECDC, 2014).

Put on foot protection- Rubber boots can be used in situations where patients might have diarrhea, vomiting and hemorrhaging, leading to the contamination of floors and other surfaces. If boots are not available, use closed shoes or clogs and shoe covers. Closed shoes or clogs are less protective against liquids. Boot covers are not the preferred option as any extra components added to the PPE complicates the donning and doffing process.

Nevertheless, when boots are not available and coveralls do not have integrated foot sections, boot covers are necessary (WHO, 2015; ECDC, 2014).

3) Move to the clean area at the entrance of the isolation unit.

4) By visual inspection, ensure that all sizes of PPE sets are correct, and the quality is appropriate.

5) Put on PPE under the guidance and supervision of a trained observer (colleague).

6) **Perform hand hygiene -** follow the steps of hand hygiene in Module 3.

7) **Put on the first pair of gloves** (examination, nitrile gloves)- gloves should be used to prevent the risk of contamination by microorganisms (WHO, 2015).

8) **Put on disposable gown or coverall**

Put on disposable gowns- there are different types of gowns, and they should fully cover the torso from neck to knees, arms to end of wrists and wrap around the back. When using gowns with back closure, a second operator should assist in buttoning up. Full-body fluid-repellent gowns must be worn when there is a risk of extensive splashing of blood and body fluids onto the skin or clothing of healthcare personnel (WHO, 2015; Weston, 2013).

Put on coveralls- Do not use adhesive tape to attach the gloves. If the coverall sleeves are not long enough, make a thumb or middle finger hole in the coverall sleeves to ensure that your forearm is not exposed when making wide movements. Some coverall models have finger loops in sleeves (WHO, 2015).

9) **Put on mask or respirator**

After wearing the gown, the mask or the respirator should be worn to protect from the inhalation of droplets and particles. Different types of masks and respirators offer different levels of protection.

Surgical face masks protect the HW by providing a barrier to splashes and droplets of blood and body fluids that may enter the nose, mouth, and respiratory tract (WHO, 2015; Weston, 2013).

Respirators protect from the inhalation of droplets and particles. However, most respirators are not certified 'splash-proof', especially if they are provided with an exhalation valve. They require a fitness test. A splash-proof respirator is needed in settings where there is not only the exposure risk to secondary aerosolization but also to splashes from bodily fluids (WHO, 2015; Weston, 2013).

10) **Put on eye protection (face shield or goggles)**

Facial protection in the form of wrap-around goggles or face shields protects the conjunctiva and the inside of the eyelid from splashes and droplets of blood, body fluids and chemicals. They should be worn when any splashing of blood or body fluids is anticipated (WHO, 2015; Weston, 2013).

11) **Put on head and neck covering**

When the coveralls do not have integrated head covering sections, use surgical bonnet covering neck and sides of the head (preferably with face shield) or use hood (WHO, 2015).

12) **Put on disposable waterproof apron**

Aprons must be worn as single-use items for one procedure or one episode of care. Thus, they should be changed in between interventions on the same patient. Disposable plastic aprons must be worn when close contact with the patient, materials or equipment is anticipated and when there is a risk that clothing may become contaminated with pathogenic microorganisms or blood, body fluids, secretions, or excretions during healthcare interventions (WHO, 2015; Weston, 2013).

13) **Put on second pair of (preferably long cuff) gloves over the cuff**

The use of double gloves can decrease the potential risk of transmission of microorganisms to the HCW as a result of glove perforations or damage of gloves from disinfectants, such as chlorine. When wearing the second pair of gloves, it is important to extend the glove to cover the wrist over the gown's cuffs. Latex gloves have been popular because of their durability, elasticity, dexterity, and their low microbial and fluid penetration rate which offers all-important protection against blood-borne viruses (WHO, 2015).

3. Taking off PPE (doffing)

The knowledge and skills on how to correctly remove PPE and the knowledge on correct waste management after using PPE are crucial. Failing to comply with the procedure might result in the spreading of viruses and bacteria, which might constitute health and life hazards. It is important to follow hand hygiene procedures (WHO, 2015).

3.1. Basic principles in doffing

The type of PPE used will vary based on the level of precautions required, such as contact, droplet or airborne precautions. The procedure for removing PPE should be tailored to the specific type of PPE. After caring for the patient, the removal (doffing) of the PPE is a critical and important step that needs to be carefully carried out in order to avoid self-contamination because the PPE could now be contaminated. There are many different ways of removing PPE. The most critical aspects in the process are how to avoid secondary disease transmission to HCWs involved in patient care and avoid self-contamination while doffing. Consequently, the process of doffing should be assisted by a member of the team, who has received specific training. Doffing PPE without assistance is complex and increases the risk of PPE dysfunction or even secondary contamination. During doffing, the active assistant must wear a full-body PPE ensemble and perform glove disinfection and glove changes in accordance with the established procedure. For building an integrated protection system to a high standard, PPE components have to be put off meticulously and in a systematic order. There may not be time pressure or other kinds of distractions during the process (ECDC, 2014).

3.2. Where to remove PPE

Removal of PPE should be done at the doorway (before leaving the patient's room) or immediately outside the patient’s room. Particulate masks should be removed outside of the patient room or > 1 m from symptomatic patients. At a minimum, hand hygiene should be performed after the removal of gloves as well as after the removal of any other individual item of contaminated PPE (NHMRC, 2019).

3.3. Doffing sequence

The correct order of doffing PPE can be just as important as wearing PPE in the first place, particularly removing it in order to avoid contamination. Active assistance in doffing of HWs leaving the red zone is essential for preventing him or her from manipulating contaminated PPE without having direct sight. Therefore, active assistance is the preferred option for the doffing compared to guided assistance by a qualified observer or to mirror-assisted self-doffing (ECDC, 2014).

- Steps to take off (doffing) PPE including gown:

To take off PPE including gown, the WHO recommends taking the following steps:

1. Always remove PPE under the guidance and supervision of a trained observer. Ensure that infectious waste containers are available in the doffing area for safe disposal of PPE. Separate containers should be available for reusable items (WHO, 2015).

2. Perform hand hygiene on gloved hands (WHO, 2015).

3. Remove apron- to remove the apron, lean forward and take care to avoid contaminating your hands. When removing the disposable apron, tear it off at the neck and roll it down without touching the front area. Then untie the back and roll the apron forward (WHO, 2015).

4. Perform hand hygiene on gloved hands (WHO, 2015).

5. Remove outer pair of gloves - The gloves should be removed as follows:

*First, p*inch and hold the outside of glove with the gloved hand between the palm and wrist without touching the skin of the forearm. *Second,* peel the glove downwards, away from the wrist, turning the glove inside out. *Third,* hold the removed glove in the gloved hand and slide the fingers of the ungloved hand inside between the glove and the wrist, without touching the outer surface of the glove peel the glove downwards over the inside-out glove being held on other hand, and. *Fourth,* dispose of the gloves in a biohazard bin (WHO, 2015).

6. Perform hand hygiene on gloved hands (WHO, 2015).

7. Remove head and neck covering in case head and neck covering are used (WHO, 2015).

When removing head and neck covering, take precautions to avoid contaminating your face by starting from the bottom of the hood in the back and rolling from back to front and from inside to outside, and dispose of it safely (WHO, 2015).

8. Perform hand hygiene on gloved hands (WHO, 2015).

9. Remove the gown- Remove the gown by untying the knot first, then pulling from back to front rolling it from inside to outside and disposing of it safely (WHO, 2015).

10. Perform hand hygiene on gloved hands (WHO, 2015).

11. Remove eye protection- Removal of a face shield, protective eyewear can be performed safely by pulling the string from behind the head and disposing of it safely (WHO, 2015).

12. Perform hand hygiene on gloved hands (WHO, 2015).

13. Remove the mask- The front of a mask, protective eyewear or face shield is considered contaminated. Remove the mask from behind the head by first removing the bottom string above the head and leaving it hanging in front; and then the top string next from behind the head and dispose of it safely (WHO, 2015).

14. Perform hand hygiene on gloved hands.

15. Remove rubber boots - Remove the rubber boots without touching them. If the same boots are to be used outside of the high-risk zone, keep them on but clean and decontaminate them appropriately before leaving the doffing area. Appropriate decontamination of boots includes stepping into a footbath with 0.5% chlorine solution. At least once a day boots should be disinfected by soaking them in a 0.5% chlorine solution for 30 min, then rinsed and dried (WHO, 2015).

16. Perform hand hygiene on gloved hands (WHO, 2015).

17. Remove gloves carefully with the same technique as in step 5 and dispose of them safely (WHO, 2015).

18. Perform hand hygiene (WHO, 2015).

- Steps to take off (doffing) PPE including coverall:

To take off PPE including coverall, WHO recommends taking the following steps:

1. Always remove PPE under the guidance and supervision of a trained observer (colleague). Ensure that infectious waste containers are available in the doffing area for safe disposal of PPE. Separate containers should be available for reusable items (WHO, 2015).

2. Perform hand hygiene on gloved hands (WHO, 2015).

3. Remove the apron as described above in step 3 of doffing PPE, including gown (WHO, 2015).

4. Perform hand hygiene on gloved hands (WHO, 2015).

5. Remove head and neck covering as described above in step 7 of doffing PPE, including gown (WHO, 2015).

6. Perform hand hygiene on gloved hands (WHO, 2015).

7. Remove coverall and outer pair of gloves- Ideally, in front of a mirror, tilt your head back to reach the zipper, unzip completely without touching any skin or scrubs, and start removing the coverall from top to bottom. After freeing the shoulders, remove the outer gloves while pulling the arms out of the sleeves. With inner gloves, roll the coverall from the waist down and from the inside of the coverall, down to the top of the boots. Use one boot to pull off the coverall from the other boot and vice versa, then step away from the coverall and dispose of it safely (WHO, 2015).

8. Perform hand hygiene on gloved hands (WHO, 2015).

9. Remove eye protection as described above in step 11 of doffing PPE, including gown (WHO, 2015).

10. Perform hand hygiene on gloved hands (WHO, 2015).

11. Remove the mask as described above in step 13 of doffing PPE, including gown (WHO, 2015).

12. Perform hand hygiene on gloved hands (WHO, 2015).

13. Remove rubber boots as described above in step 15 of doffing PPE, including gown (WHO, 2015).

14. Perform hand hygiene on gloved hands (WHO, 2015).

15. Remove gloves carefully with appropriate technique and dispose of them safely as described above in step 17 of doffing PPE, including gown (WHO, 2015).

16. Perform hand hygiene (WHO, 2015).

IV. Post-test

Please choose the correct answer for each statement below:

1. Protective gloves should be worn when:

A. Undertaking any clinical procedure that involves patient contact

B. Contact with healthcare-related equipment such as walking frames, hoists, or wheelchairs is expected

C. Potential exposure to blood and bodily fluids is expected

D. Undertaking any clinical procedure that involves contact with the patient's surroundings

2. Personal protective equipment (PPE) refers to:

A. A physical barrier that prevents HWs from being contaminated with blood and other bodily fluids

B. Specially designed clothing that protects HWs from physical attack

C. A screen that separates HWs from patients who have infectious diseases

D. A personal alarm carried by HWs in case of physical attack

3. Which of the following precautions do not protect against infectious pathogens?

A. Universal precautions

B. Transmission-based precautions

C. Standard precautions

D. Basic precautions

4. What is the correct donning sequence?

A. Hand hygiene, goggles, protective mask, gloves, gown

B. Hand hygiene, protective mask, googles, gown, gloves

C. Hand hygiene, inner gloves, protective gown, protective mask, protective eyewear

D. Hand hygiene, gloves, protective mask, goggles, protective gown

5. A nurse is about to perform a procedure where gloves and an isolation gown are indicated based on risk assessment. She puts on her gown and her gloves and then:

A. Pulls the gloves under the cuff of the gown

B. Pulls the gloves up over the cuff of the gown

6. A patient becomes nauseated and vomits. The nurse wears PPE while cleaning up the patient and the patient's surroundings. What is the risk that indicates PPE for the nurse?

A. Transmission of infectious droplets from the nurse to the patient

B. Exposure to blood or bodily fluids

C. Occupational risk of sharps injury

D. Exposure to infectious droplets in the air

7. A patient is admitted to the pediatric ward with fever and diarrhea. What PPE should be used in the care of this patient?

A. No PPE is indicated

B. PPE indicated by standard precautions

C. PPE indicated by both standard and appropriate transmission-based precautions

D. PPE indicated by transmission-based precautions

8. Select the best purpose for glove use.

A. Protects workers from inhaling tiny microorganisms

B. Protects hands from contact with infectious materials

C. Provides a physical barrier that prevents contact with mucosal splashes

D. Provides a physical barrier for the eyes

Please state whether the following statements are true (T) or false (F):

1. One of the important elements of preventing the spread of viruses and microbes is following the correct doffing sequence. (T) (F)

2. Wearing gloves eliminates the need for hand hygiene. (T) (F)

Further reading

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Module 6. Individual assessment for infection risk during patient admission and placement/isolation

I. Overview

Healthcare-associated infections (HAIs) are infections acquired by patients during their stay in a hospital or another healthcare setting. Although some of these infections can be treated easily, others may more seriously affect a patient's health, increasing their stay in the hospital and hospital costs, and causing considerable distress to these patients (ECDC, 2023).

Ensuring that patients in hospitals who are known or suspected to be infected or colonized with potentially pathogenic microorganisms are isolated is an important component in preventing and controlling the spread of HAIs and communicable diseases. However, it can be a challenging and sometimes distressing process for patients, their relatives, and caregivers, as well as healthcare staff, and is not always appropriate, or easily achieved, in some settings (Weston, 2013).

HAIs are among the most frequent adverse events occurring in the context of health service delivery. These infections, many of which are caused by multidrug-resistant organisms, harm patients, visitors and HCWs, and place a significant burden on health systems, including the associated increased costs (WHO, 2022). These infections frequently include central line-associated bloodstream infections, catheter-associated urinary tract infections, surgical site infections and ventilator-associated pneumonia (Khan et al., 2017). The impact of HAIs and antimicrobial resistance on people's lives is incalculable. No country or health system can claim to be free of HAIs (WHO, 2022).

When an individual is found or thought to be suffering from an infection, it is necessary to consider the possible source and route of transmission in order to institute appropriate control measures. These may include isolating an individual from others within a healthcare facility, a care home, or community-based unit (NHS Education for Scotland, 2022). Patient placement is a two-step process that is informed by a risk assessment, followed by

prioritization of the seriousness of the infection and any competing patient needs (Australian Commission on Safety and Quality in Healthcare, 2020).

This module discusses patient risk assessment and isolation in the context of infection control standard precautions, along with different methods of isolation such as negative pressure facilities and cohort nursing, and the challenges of isolating patients in different care areas (Weston, 2013).

II. Learning objectives

After completing of this module, students should be able to

1. Understand the importance of individual assessment for infection risk during admission.

2. Be able to define the principles of individual assessment for infection risk during patient admission and placement/isolation.

3. Understand the different categories of isolation.

4. Understand what needs to be in place when patients are isolated, or cohort nursed.

5. Understand how to apply infection control standard precautions in settings where patients cannot be isolated in a single room or cohort area.

III. Major objectives

1. Patient infection risk assessment

1.1. Introduction

There are several factors that need to be taken into consideration before moving a patient into a single room or transferring him or her to an isolation ward, and, increasingly, risk assessments need to be undertaken by the IPCT in collaboration with the nursing staff and ward managers. These take into account the organism; its mode of transmission; the risk of cross-infection to healthcare staff and other patients; the implications of cross-infection; patient safety; and the facilities available (Weston, 2013).

The basic concept in the implementation of standard precautions is the maintenance of a physical, mechanical, or chemical barrier between microorganisms, the environment, and an individual, thus breaking the disease transmission cycle. The rationale is that, for

transmission to occur within the healthcare setting, all elements in the chain of infection must be present (Figure 1- Module 1). Whether it is a woman coming for antenatal care, a hospitalized patient, a HW caring for patients, standard precautions help prevent the spread of bloodborne pathogens, respiratory viruses (e.g., hepatitis B, hepatitis C, HIV, and influenza), and other infectious diseases in healthcare facilities (Curless et al., 2018).

Standard infection control precautions may be insufficient to prevent cross-transmission of specific infectious agents. Hence, additional Transmission-Based Precautions (TBPs) are required to be used by staff when caring for patients with a known or suspected infection or colonization. Clinical judgment and decisions should be made by staff regarding the necessary precautions. TBPs must be based on:

- The suspected or known infectious agent.
- The transmission route of the infectious agent.
- The care setting and procedures undertaken.
- The severity of the illness caused.

TBPs are categorized by the route of transmission of infectious agents (some infectious agents can be transmitted by more than one route). Application of TBPs may differ depending on the setting and the known or suspected infectious agent (NHS England, 2023).

To protect effectively against infection risks, standard infection control precautions must be used consistently by all staff. Patients must be promptly assessed on arrival at the care area, e.g., inpatient, outpatient, care home (if possible, prior to accepting a patient from another care area) and should be continuously reviewed throughout their stay. This assessment should influence placement decisions in accordance with clinical/care needs. Patients who may present a particular cross-infection risk should be assessed and appropriate clinical samples and screening undertaken to identify the causative pathogen. This includes but is not limited to those patients (Curless et al., 2018; NHS England, 2023):

- With diarrhea, vomiting, an unexplained rash, fever or respiratory symptoms.

- With a known (laboratory confirmed) or suspected infectious pathogen for which appropriate duration of precautions are not yet complete.

- Known or suspected to have been previously positive with a multidrug-resistant organism (MDRO), such as methicillin-resistant *Staphylococcus aureus* (MRSA) and carbapenemase-producing *Enterobacteriaceae*, usually referred to as CPE.

- Who have been an inpatient in any hospital in the country or abroad or are a known epidemiological link to a carrier of CPE (including those who received dialysis).

- Who have a known or suspected infection or colonization (NHS Education for Scotland, 2022; Curless et al., 2018; NHS England, 2023).

Confirmed risk: A 'confirmed risk' patient is an individual who has been confirmed by a laboratory test or clinical diagnosis, e.g. COVID-19, methicillin-resistant *Staphylococcus aureus* (MRSA), Multidrug-Resistant Gram-Negative Bacteria (MRGNB), Pulmonary Tuberculosis, scabies, seasonal influenza and enteric infections (diarrhea and/or vomiting), including *Clostridioides difficile* (Harrogate and District NHS Foundation Trust, 2023).

Suspected risk: A 'suspected risk' patient is an individual who is awaiting laboratory test or clinical diagnosis results to identify infections/organisms or who has been in recent contact/close proximity to an infected person. Patients at suspected risk include those with diarrhea, vomiting, an unexplained rash, fever or respiratory symptoms (Harrogate and District NHS Foundation Trust, 2023).

1.2. Assessment for infection risk

Prior to a patient's transfer to and/or from another healthcare provider, an assessment for infection risk must be undertaken to identify those who may present a cross-infection risk. This ensures both the appropriate placement of the patients and that appropriate precautions are taken.

This applies to all admissions, transfers and discharges to all healthcare facilities including:

- Admissions to hospital

- Transfers from or to another care facility

- Attendance for treatment or support in another healthcare setting

A transfer form must be completed for all transfers, internal or external, and indicate whether the patient presents an infection risk or not. When transferring a patient who has had diarrhea of any cause in the past 7 days, staff should ensure they include the infection risk, history of type of stool, and frequency of bowel movements during the past week. The history should be given in any verbal communication to the ambulance personnel and the receiving unit, to ensure that isolation facilities are identified. The completed transfer documentation should be supplied to the receiving provider and a copy filed in the patient's files (Harrogate and District NHS Foundation Trust, 2023).

Why this procedure? This procedure ensures that all healthcare personnel have a standard procedure to follow assessing a patient's risk of acquiring or transmitting infection. Healthcare facilities must have in place appropriate core policies/procedures, including procedures for prompt identification of people who have or are at risk of developing infection, so that they receive timely and appropriate treatment to reduce the risk of transmitting infection to other people. Implementation of this procedure will contribute to the achievement and compliance with the Standard Infection Control Precautions (NHS Foundation Trust, 2019).

Who does the procedure apply to? This procedure applies to all clinical staff who are working to care for patients as part of their role and job description (NHS Foundation Trust, 2019).

When should the procedure be applied? Effective prevention and control of HAIs must be embedded into everyday practice and applied consistently.

Patients must be promptly assessed for infection risk on arrival at the healthcare facilities and should be continuously reviewed throughout their stay. This assessment should influence patient placement decisions in accordance with clinical/care needs (NHS England, 2023).

Patients who may present a particular cross-infection risk should be isolated on arrival and appropriate clinical samples and screening undertaken to establish the causative pathogen. This includes but is not limited to patients:

- With symptoms such as diarrhea, vomiting, unexplained rash, fever, or respiratory symptoms.

- With a known (laboratory confirmed) or suspected infectious pathogen.

- Known or suspected to have been positive with a Multi-drug Resistant Organism, e.g. MRSA.

- Who have been in close contact with the infected individual in recent times.

- Who have been hospitalized in the last 12 months (NHS England, 2023).

1.3. Patient transfer

1.3.1. From other healthcare providers

- When patients are transferred from another healthcare provider, the transfer documentation must be checked for suspected or confirmed infection risks.

- The patient's current condition should be assessed on arrival to ensure appropriate isolation for infection risk minimization and to ensure appropriate infection prevention and control measures are in place (Harrogate and District NHS Foundation Trust, 2023).

1.3.2. To other healthcare providers

- If the patient is in the 'suspected or confirmed infection risk' group, the person completing the transfer documentation is responsible for advanced communication (e.g., by telephone) to the transport service at the time of booking and the receiving health or social care provider prior to the transfer, to enable them to make appropriate arrangements.

- Ensure that any leaking wounds are covered with appropriate dressing as advised by healthcare professionals (Harrogate and District NHS Foundation Trust, 2023).

1.4. Communication

The presence of some infectious conditions such as MRSA does not usually prevent patients' transfer to another ward or unit. However, good communication before transfer will ensure that correct management measures are taken to reduce the risk of spread. Good communication with the receiving facility will help to determine whether the patient needs isolation or not (NHS Foundation Trust, 2019).

Key principles

- All patients must have an infection risk assessment completed on admission within 24-72 hrs.

- Where any risks are identified staff must contact the IPCT for advice and include any control measures identified in the patient's care plans.

- Advice given by the IPCT must be implemented and all IPC policies/standard operating procedures followed.

- Whenever a transfer of any patient is arranged to another ward or hospital, the risk assessment must be repeated, and information exchanged with the receiving ward to ensure appropriate preventative measures can be taken as appropriate to reduce risk of acquisition or transmission of infection.

- Whenever a patient returns to another in-patient facility following an episode of care in another ward/hospital/care home or other institution, the patient risk assessment must be repeated/updated, and any identified risks discussed with the IPCT, and appropriate actions taken to reduce risk of acquisition or transmission of infection.

- For patients undergoing long-term treatment and in-patient care, the risk assessment should be regularly reviewed and updated monthly. Any new risks must be discussed with the IPCT and acted as advised.

- Environment risk assessment for HAIs must be completed for all new or redesigned services or premises as part of the planning refurbishment or development process – the IPCT must be involved from the outset (NHS Foundation Trust, 2019).

1.5. Suggested risk reduction methods

- All staff must attend infection control induction and mandatory updates about the IPC standard principles.

- Staff must be 'Bare Below the Elbows' when performing clinical duties.

- Hands must be decontaminated immediately before and after each episode of direct patient care or activity that could potentially result in hands being contaminated.

- Cuts and abrasions must be covered with a waterproof dressing.

- Fingernails must be short and free from false nails, nail art, nail polish, extensions, etc.

- PPE (e.g., gloves and aprons) must be used when exposure to blood, bodily fluids, excretions or secretions is expected.

- All non-disposable equipment must be decontaminated before/after use as per the manufacturer's instructions.

- Risk assessment for HAIs must be completed for all new or redesigned services or premises as part of the planning refurbishment or development process (NHS Foundation Trust, 2019).

2. Patient placement and isolating infectious patients

2.1. Introduction

Isolation is the segregation of infectious and potentially infectious patients to prevent transmission of highly contagious pathogens and those causing serious infection and those who are at particular risk of infection. It is integral to any infection prevention program but in some countries, isolation accommodation is in short supply, with competition from patients who are in critical conditions (Gould et al., 2018).

Isolation facilities should be prioritized depending on the known/suspected infectious agent. All patient placement decisions and assessment of infection risk (including isolation requirements) must be clearly documented in the patient's files. When single-bed rooms are limited, patients who have conditions that facilitate the transmission of infection to other patients (e.g., draining wounds, stool incontinence, uncontained secretions) and those who are at higher risk of acquired infections and adverse outcomes resulting from HAIs such as immunosuppression, open wounds, invasive devices, anticipated prolonged length of stay, total dependence on HWs for activities of daily living should be prioritized for placement in a single-bed room. Single-bed room prioritization should be reviewed daily, and the clinical judgment and expertise of the staff involved in a patient's management should be sought particularly for the application of transmission-based precautions (TBPs), e.g., isolation prioritization when single rooms are in short supply (NHS England, 2023).

Even where single rooms are the norm in general wards, patients who are sickest and on specialist units are often nursed in shared areas to facilitate observation. Single rooms are sometimes assumed to reduce infection risk but evidence of ability to contain spread is equivocal and a recent study in an all-single-room hospital has not demonstrated lower infection rates than hospitals where most care is in open bays (Cepeda et al., 2005). Possible reasons are breaches in isolation: doors left open, failure to cleanse hands or use PPE and patients leaving the room. Failure to identify infectious and potentially infectious patients and inefficient procedures to transfer them to isolation accommodation might also contribute to the contamination, although transmission from asymptomatic patients is possible (Landelle et al., 2013).

2.2. Patient isolation

The effectiveness of patient isolation depends on the pathogen concerned and HW adherence to isolation precautions once isolation has been initiated. Isolation involves much more than accommodating patients in single rooms. Unless identified before or on arrival, infectious patients may occupy common admission areas, use shared facilities, or receive treatment in common areas. Problems are compounded in asymptomatic patients (Gould et al., 2018).

The ward staff frequently identifies the need for isolation, but they are not always well equipped to identify infectious patients, placing others in the hospital environment at risk. Educating frontline staff is important but it is unrealistic to expect them to identify patients who have less commonly encountered pathogens. There is emerging evidence that those traditionally thought to be spread by contact are also transmitted by droplet and aerosol, while pathogens spread by airborne routes can also be spread by contact. Decision-making in relation to isolation should be a multidisciplinary activity with close liaison between clinical and specialist infection prevention teams, especially when it is necessary to prioritize isolation accommodation. Greater involvement of infection prevention teams could help avoid communication failures between the many departments for isolation (Gould et al., 2018; Gammon, 2018).

Isolation is intended to protect health service users, staff and the public. Isolated patients might experience more depression, anxiety, and adverse events than the general patient population. Isolation decisions should balance its benefits and risks for individuals against needs of the wider population. Patients should be informed of the risks and share responsibility for controlling them; of a causal evidence base on which to base isolation decisions; how to prioritize resources; and the extent that staff have an obligation to care for patients with potentially transmissible diseases (Gould, 2018; Gammon, 2018).

The facilities required for single-rooms might include en-suite sanitary facilities; a space for PPE and its disposal; basins for handwashing in the room and in the lobby; the ability to observe the patient; and facilities to improve the patient experience such as windows. For those with airborne infections adequate ventilation is also needed. Prioritization tools can enhance decision-making but must be quick and straightforward to apply. Other strategies might include cohorting of patients with the same infection, but this calls for a discrete cohort area and a relatively high level of decision making due to the resources involved such as potentially 'blocking' empty beds to new admissions (Gould, 2018; Gammon, 2018).

2.2.1. Single room isolation in hospital settings

If sufficient numbers of single rooms are not available for isolating patients, the following aspects should be considered:

- Prioritize single rooms for patients likely to be the most infectious. These patients might be the ones who are coughing, have active diarrhea, or have high fevers.

- Isolation of infectious patients can be in specialized isolation facilities, single room isolation, cohorting of infectious patients where appropriate, ensuring that they are separated by at least 3 feet (1 meter) with the door closed.

- If single rooms are not available, place the patient needing isolation in a low-traffic area, and maximize the distance from other patients. Indicate clearly that the patient is in isolation and use barriers, such as curtains, screens, or rope, to show the isolation area. Limit access to the isolation area and make hand hygiene supplies and PPE available right outside the isolation area.

- Isolation room doors should remain closed; if this is not possible (e.g., pediatrics), there should be a documented risk assessment.

- Signage should be used on doors/areas to communicate isolation requirements and prevent entry of unnecessary visitors, and non-essential staff. Patient confidentiality must be maintained.

- If single rooms are limited, infectious patients who have conditions that could increase the risk of transmission of infection to other patients, such as excessive cough or an MDRO should be prioritized for placement in a single room.

- Single room prioritization should be reviewed daily, and the clinical judgment and expertise of the staff involved in a patient's management and the IPCT should be sought particularly for the application of TBPs.

- For individual or group isolation, staff can be dedicated (cohorted) so that only a limited number of staff are exposed to isolation patients and those staff do not provide care to non-isolation patients. This reduces the opportunity of carrying infectious material from isolated patients to other parts of the facility. Cohorting of staff can also be based on factors such as immunity to an infection so that susceptible staff are not exposed. This can only be implemented if there are sufficient levels of staff available.

- Infectious patients should only be transferred to other departments if clinically necessary. If the patient has an infectious agent transmitted by the airborne/droplet route, then, if possible, the patient should wear a surgical face mask in communal areas during transfer.

- Receiving hospitals and transporting staff must be aware of the necessary precautions (Curless, 2018; NHS England, 2023).

2.2.2. *Cohorting in hospital settings*

Cohorting of infectious patients can be considered when single rooms are in short supply and if there are two or more patients with the same confirmed infection (NHS England, 2023).

2.2.3. *Infectious patients who must not be cohorted with others with different or multiple infections*

Those at increased risk of acquisition and adverse outcomes resulting from infection (e.g., immunosuppression) and the individuals who are unlikely to comply with TBPs (NHS England, 2023).

2.2.4. Primary care/outpatient settings

- Patients attending with suspected or known infection or colonization should be prioritized for assessment/treatment, e.g., scheduled appointments at the start or end of the clinic session.

- Infectious patients should be separated from other patients while awaiting assessment and during care management by at least 3 feet (1m).

- If transfer from a primary care facility to hospital is required, ambulance services should be informed of the infectious status of the patient. Patient confidentiality must be maintained (NHS England, 2023).

2.2.5. *Before discontinuing isolation*

Individual patient risk factors should be considered (e.g., there may be prolonged shedding of certain microorganisms in immunocompromised patients) (NHS England, 2023).

2.3. Patient transport

Limit patient transport to essential reasons only, i.e., diagnostic tests or therapeutic procedures that cannot be performed in the room. If the patient needs to leave the room for a test or procedure:

- Alert the department or facility where the patient is being transported so they can prepare to receive a patient on Transmission-Based Precautions.

- Cover wounds with appropriate dressings.

- Use PPE appropriately:

    + If applicable, remove and dispose of contaminated PPE and perform hand hygiene prior to transporting the patient.

    + Put on a clean PPE to transport the patient.

+ Remove PPE and perform hand hygiene once the patient has been transported.

- Clean and disinfect the wheelchair or gurney after transportation.

- Ensure that patients on droplet or airborne precautions wear a surgical mask while outside of the patient room (Curless, 2018).

2.4. Transmission-based precautions

Please check Module 2 of this E-book.

2.5. Setting with limited resources

Transmission-Based Precautions should be implemented wherever and whenever possible. However, there are situations where existing infrastructure and resources make the implementation difficult. In limited-resource settings, at a minimum, the following should apply:

- Always implement Standard Precautions at all healthcare facilities for all patients. \

- Use appropriate PPE based on the suspected route of transmission, clinical symptoms and signs, or laboratory results. Prioritize available PPE, at minimum, for all contacts while carrying out high-risk interventions on patients (e.g., suctioning a patient with acute respiratory illness, cleaning up stool from a patient with diarrhea).

- Limit visitors and non-essential staff contact with patients based on the clinical diagnosis, experience (empiric), or presence of a set of signs and symptoms (syndrome) until the final diagnosis, including laboratory investigations, is available.

- Limit patients' movements outside of designated areas, based on their empiric/syndromic symptoms, following appropriate guidelines.

- Clean and disinfect patient care environments and reusable equipment between each patient. (Curless, 2018).

2.6. Conclusion

Isolation has received the greatest attention in countries with under-provision of accommodation but there are many reasons for isolation failure that apply in all organizations regardless of availability. Isolation practices and procedures are an important facet of strategies aiming to prevent HAIs, reduce the threat of antibiotic resistance infections, and respond to new and emerging infectious disease threats globally. Important issues are the

moral and ethical dilemmas associated with segregating acutely ill and frail older people in the wider interests of health service users and society.

A significant number of HAI events are largely preventable and, as such, the use of single-room isolation standard precautions in addition to Transmission-Based Precautions, where necessary, has become a cornerstone of hospital IPC practices and procedures. It is imperative to educate patients and the public about their contribution to infection prevention and the risks of antimicrobial resistance (Gould, 2018; Gammon, 2018).

IV. Post-test

Multiple-choice questions: Please choose the correct answer(s) to each question below.

1. A patient is admitted to the emergency department with respiratory symptoms. It is influenza season in the community. As an IPC professional, what initial actions should you recommend? Select all that apply.

A. Wait until laboratory results come back to take any action.

B. Place the patient in a negative pressure room.

C. Allow the patient to sit together with other patients in the waiting room.

D. Encourage the patient to sit apart from other patients or at least one meter from other patients.

2. You are preparing an isolation area for a patient with seasonal influenza. Your facility does not have private or single rooms. Finding isolation areas has not been an easy task. What is the best isolation solution for this patient?

A. Place the patient in a general room and have them wear a mask.

B. Cohort the patient with a patient who has TB.

C. Cohort the patient with a patient who has confirmed influenza.

D. Place the patient in the facility's only airborne infection isolation room.

3. The correct diagnosis of an HAI is sometimes difficult for healthcare professionals. Identify the false statement.

A. The patients' susceptibility to infections may not be evident on admission in settings where individual assessment does not focus on this information.

B. HAIs refer to infections associated with different settings, namely hospitals and long-term care facilities, excluding community or ambulatory settings.

C. HAIs result from an adverse reaction to the presence of an infectious agent(s) or its toxin(s).

D. It is frequently considered an HAI if it appears ≥48 hours after admission.

4. Patients A and B are both on contact precautions. Can you use the same stethoscope on both patients?

A. Yes, the stethoscope can be used on both patients, but must be disinfected between uses.

B. No, you cannot use the stethoscope on both patients because they may be infected with different organisms.

C. No, you cannot use the stethoscope on both patients because a stethoscope cannot be cleaned.

D. Yes, the stethoscope can be used on both patients without cleaning it.

5. Which of the following are not major types of HAIs related to invasive procedures:

A. Catheter-associated urinary tract infection

B. Nasopharyngitis

C. Surgical site infection

D. Catheter-related bloodstream infection

6. Isolation may conflict with what patients consider to be their best interest, resulting in:

A. Ethical dilemmas

B. Legal issues

C. Impairment situations

D. Mental issues

7. Select one or more correct answers. When should the patient infection risk assessment be applied?

A. Patient infection risk assessment must be completed within 12 hours after admission.

B. Patient infection risk assessment must be completed on admission within 24-72 hours.

C. Patient infection risk assessment must be completed, at least, on admission and when transferring to another ward/department/healthcare facility.

D. Patient infection risk assessment must be completed whenever circumstances change.

Identify if the statements below are true (T) or false (F).

8. Focusing on main principles of patient placement/isolation, identify the following statements as true (T) or false (F):

i. The environment is an extrinsic factor that can affect the infectious agent and the patient and plays an important role in the relationship of factors in HAIs (T) (F)

ii. The animate environment of patients includes healthcare staff, other patients in the same, families and visitors (T) (F)

iii. The inanimate environment refers to medical instruments and equipment, diagnostic and therapeutic maneuvers, excluding environmental surfaces (T) (F)

iv. All disposable equipment must be also decontaminated before/after use as per the manufacturer's instructions (T) (F)

9. Initial contact and risk assessment include…

i. personal, clinical and epidemiological history of the patient (T) (F)

ii. known risk factors for infection (T) (F)

iii. the clinical presentation of the patient (T) (F)

iv. clinical history of the patient's family (T) (F)

10. Transmission-based precautions include….

i. Patients should always be placed in single rooms, despite the risk of infection identified (T) (F)

ii. Patients at airborne contamination risk must wear masks in any circumstance (T) (F)

iii. Patients at droplet contamination risk must wear masks when moving in common spaces (T) (F)

iv. In situations of droplet precautions, patients can be placed in the same room, if separated by at least 1.5 meters (T) (F)

Further reading

1. https://www.bcpft.nhs.uk/documents/policies/i/889-infection-prevention-control-assurance-sop-14-undertaking-a-patient-infection-risk-assessment/file
2. Global report on infection prevention and control (who.int)
3. https://www.jhpiego.org/wp-content/uploads/2020/03/IPC_M1_IPC_Introduction.pdf
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5. Patient Placement Guide – Infection Prevention and Control | Australian Commission on Safety and Quality in Healthcare

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Module 7. Global strategies to respiratory infection prevention and control

I. Overview

Respiratory illnesses are a significant contributor to morbidity and mortality. A variety of agents, including bacteria, viruses, fungi, and others, can cause these illnesses. Individuals with certain health conditions such as heart or respiratory problems or weakened immune systems, or young children, older adults (aged 65 and above), and pregnant women are at higher risk of developing respiratory complications such as influenza and pneumonia (Maryland Department of Health and Mental Hygiene [MDHMH], 2014).

This module has 3 main parts including:

- Basic principles to prevent respiratory infections
- Prevention of respiratory infections among older adults
- Nursing care of lower respiratory tract infection after abdominal surgery

II. Learning objectives

After the completion of this module, students should be able to:

1. Explain the basic principles to prevent respiratory infections.
2. Implement measures to prevent respiratory infections among patients.
3. Implement nursing care measures to prevent lower respiratory tract infections among patients after surgery.

III. Major concepts

1. Preventing respiratory infections

The principles of IPC for managing outbreaks include early and rapid recognition of patients, application of routine standard precaution for all patients, additional precaution in selected patients, and establishment of an IPC infrastructure for healthcare facility to support IPC activities. IPC strategies in healthcare facilities are commonly based on early recognition and source control, administrative controls, environments and engineering controls, and personal protective equipment (WHO, 2017).

1.1. Standard principle of preventing respiratory infections

The basic principle of preventing respiratory infections includes standard precautions and transmission-based precautions. Standard precautions should be always practiced by all staff with all patients. Transmission-based precautions are a set of infection preventions that should be implemented when patients are known or suspected, and include contact, droplet, and airborne precaution (WHO, 2017). (*see more in module 1 and 3*).

1.2. General measures to prevent respiratory illness

- Maintain an infection control program: Each facility must maintain an effective infection control program that promotes the prevention of communicable diseases and covers the investigation and control of cases and outbreaks (MDHMH, 2014).

- Monitor influenza activity: Health facilities should have mechanisms and policies to warn medical staff when an epidemic occurs in the community or in the hospital (MDHMH, 2014).

- Maintain a vaccination program for residents/patients and staff: All health facilities should offer influenza vaccine to staff and residents every year and offer influenza and pneumococcal vaccine to eligible patients when appropriate (MDHMH, 2014).

- Promote respiratory hygiene/ cough etiquette: Respiratory hygiene and cough etiquette are steps people can take to help contain their respiratory secretions and reduce the chance of spreading pathogens that cause illness to others (MDHMH, 2014).

Anyone with signs and symptoms of a respiratory infection should follow or be instructed to follow respiratory hygiene and cough etiquette as follows:

- Cover the nose/mouth with disposable single-use tissues when coughing, sneezing, wiping and blowing noses.

- Use tissues to contain respiratory secretions.

- Dispose of tissues in the nearest waste receptacle or bin after use.

- If no tissues are available, cough or sneeze into the inner elbow rather than the hands.

- Practice hand hygiene after contact with respiratory secretions and contaminated objects/materials.

- Keep contaminated hands away from the mucous membranes of the eyes and nose.

- Hands hygiene after coughing, sneezing, using tissues, or after contact with respiratory secretions or objects contaminated by these secretions (WHO, 2017).

- Encourage frequent hand hygiene: Hand hygiene and alcohol-based hand sanitizer should be performed following a recommendation from WHO (MDHMH, 2014).

- Always use standard precautions when caring for all residents/patients (MDHMH, 2014).

- Screen visitors for signs of illness before they enter the facility. Discourage people with signs of illness from visiting (MDHMH, 2014).

- Maintain an environmental cleaning regimen that includes regular cleaning and disinfection of frequently touched surfaces (MDHMH, 2014).

- Employees should be trained in general infection control and in best practices for the prevention and control of respiratory illness outbreaks (MDHMH, 2014).

- Promptly identify employees who may have influenza and ensure that they have access to medical consultation and, if necessary, early treatment with antivirals (MDHMH, 2014).

- Non-punitive, flexible sick leave policies should be in place to prevent ill employees from spreading respiratory illness and other infectious diseases in the facility (MDHMH, 2014).

2. Prevention of respiratory infections

Respiratory infections cause 4 million deaths per year globally. In the United States, influenza, pneumonia, and respiratory syncytial virus (RSV) are projected to infect more than 13 million people annually, with 69,000 to nearly 100,000 deaths in the 2017-2018 season alone by influenza. In patients with advanced age and weak immunity, respiratory infections often cause more severe illness and higher risk of death than in young adults (Childs, 2019). Respiratory infections can refer to a range of infections that affect the upper or lower respiratory system.

2.1. Prevention of upper respiratory infections

Upper respiratory infections (URIs) are located in the upper respiratory tract, including

mouth, nose, throat, larynx, and trachea. URIs can be one of the following conditions: Naso-pharyngitis (common cold), Sinusitis, Pharyngitis, Laryngitis, Laryngotracheitis/ Laryngotracheobronchitis (Grief, 2013).

- Nasopharyngitis (common cold): This is a common infection disease of the upper respiratory tract and caused by virus.

- Acute Sinusitis: Acute sinusitis (AS) is defined as inflammation of the nasal mucosa and sinuses. It is very common and caused by bacteria such as Streptococcus pneumoniae, Haemophilus influenzae, and Moraxella catarrhalis.

- Pharyngitis: It is caused by viruses or bacteria, such as group A hemolytic streptococcus.

- Laryngotracheitis/Laryngotracheobronchitis: It is an infectious-induced inflammatory condition affecting the larynx, trachea, and bronchi and caused mostly by viruses, such as influenza type A or B, respiratory syncytial virus (RSV), and adenovirus.

- <u>Prevention of upper respiratory infections</u>:

+ Hand washing is the most important activity that can reduce the risk of URIs.

+ Identify the cause of disease and transmission route of pathogens, avoid risk factors, methods for respiratory hygiene and advice patients to contact you if they develop dyspnea, productive cough, or temperature >102°F (39°C).

+ Eliminate environmental factors that could trigger allergic reactions such as cigarette smoke, pollution/fumes.

+ Obtain adequate rest and sleep with head of bed elevated.

+ Avoid extremely cold or dry air (Grief, 2013).

2.2. Prevention lower respiratory infection.

<u>Prevention of respiratory infections in children</u>:

Globally, lower respiratory tract infections are the most common cause of both illness and mortality in children. In developing countries, there are approximately 0.22 episodes of pneumonia per child a year, with 11.5% progressing to severe disease. Pneumonia accounted

for 15% of the 6.3 million deaths among children younger than five years in 2013, a total of approximately 935,000 deaths worldwide (Oliwa & Marais, 2017).

Five simple interventions have been recommended to reduce severe pneumonia in childhood:

1. Exclusive breastfeeding for six months and continued breastfeeding complemented by nutritious solid foods up to two years of age;

2. Routine vaccination against pertussis, measles, *Haemophilus influenzae* type B (HiB) and pneumococcus;

3. Drinking safe water, sanitation, and hand washing facilities;

4. Improved cooking stoves to reduce indoor air pollution; and

5. Effective treatment including amoxicillin dispersible tablets and oxygen (Oliwa & Marais, 2017).

Prevention of respiratory infections among adult patients:

- Pneumonia

Promote vaccination; Ensure adequate nutrition and hydration; Daily oral care; Elevate the head of the bed 30 to 45 degrees during tube feeding and maintain at least 1 hour after to reduce potential aspiration; Use gloves for suctioning and cleaning respiratory equipment and perform hand hygiene after contact with respiratory secretions (California Department of Public Health [CDPH], 2021).

- Ventilator- associated pneumonia

*(*https://www.youtube.com/watch?v=P8C9RI1zi6Q*)*

Ventilator-associated pneumonia (VAP) is a lung infection that progresses within 48 hours in a patient who is on a ventilator. An infection may happen if germs enter through the tube and get into the patient's lungs. It is one of the most common infections that occur in the Intensive Care Unit (ICU). Compliance with the best nursing practices may help to prevent VAP, so nurses need to know and implement prevention measures while caring for patients (Shudaifat et al, 2021). Prevention strategies include:

1. Prevent Aspiration of Secretions: Maintain elevation of head of bed (HOB) 30-45 degrees; Avoid unplanned extubation and re-intubation; Avoid the patient pulling the

endotracheal tube; Prevent the tube from slipping while caring for the patient; Use cuffed tracheostomy tube with in-line suctioning; Encourage early mobilization of patients and manage oral secretions (CDPH, 2021).

2. Minimize ventilator exposure: This is the most important measure to reduce the risk of ventilator-associated pneumonia. Use noninvasive ventilation approaches, such as bi-level positive airway pressure or continuous positive airway pressure; Minimize ventilator duration by early weaning off mechanical ventilation for patients starting with daily intermittent mechanical ventilation in combination with spontaneous breathing can help patients eliminate mechanical ventilation quickly (Boltey et al., 2017).

3. Provide excellent oral hygiene care: Oral health quickly deteriorates in mechanically ventilated patients because some patients sustain injuries to the oral mucosa during the intubation procedure and some are more prone to dry mouth after intubation. Weakened immune system causes an increase in bacteria entering the respiratory tract through the endotracheal tube. Nurses need to regularly evaluate and perform oral care for patients daily in the ICU to reduce the risk of infection (Boltey et al., 2017).

4. Coordinate care for subglottic suctioning: Aspiration of secretions that accumulate around the endotracheal tube of mechanically ventilated patients can lead to VAP. A meta-analysis reported that aspiration of lower respiratory tract fluid reduces the risk of ventilator-associated pneumonia by 45%, so medical staff need to regularly aspirate lower respiratory fluids to help prevent pneumonia (Boltey et al., 2017).

5. Maintain optimal positioning and encourage mobility: Keeping the head of the bed elevated between 30–45 degrees (semi-recumbent position) is recommended to reduce reflux and subsequent risk for VAP. Encourage the patient to be mobilized early, starting from sitting with legs hanging at the edge of the bed to standing at the edge of the bed, to marching in place. (Boltey et al., 2017).

6. Ensure adequate staffing: Adequate nurse staffing in the ICU can help minimize VAP risk. Nurses have enough time to monitor and care for patients, making it easier to detect early signs of ventilator-associated pneumonia and treat them promptly (Boltey et al., 2017).

7. Prevent exposure to contaminated equipment: Use sterile water to rinse reusable respiratory equipment; Remove condensate from ventilatory circuits, change ventilatory circuit only when malfunctioning or visibly soiled; Store and disinfect respiratory equipment effectively, avoid storing in places where the equipment can be contaminated (CDPH, 2021).

- Influenza

Vaccinate patients and HCWs; Implement work restrictions for ill employees and ensure adherence to hand hygiene; Post “Cover Your Cough” signage and visitation restrictions; Screen visitors during flu season and encourage patients and visitors to practice respiratory hygiene and cough etiquette; and Apply transmission precautions for suspected cases immediately (CDPH, 2021).

3. Nursing care of lower respiratory tract infection after surgery

Lower respiratory tract infection after surgery is one of the most common diseases in clinical practice and can result in severe complications with an incidence rate of 13-17.5%. Prevention and care of respiratory tract infections are critical for a successful patient outcome (Cao & Zhang, 2015).

3.1. Cause of infection

Invasive procedures: The bacteria may be brought from oro-pharynx to the respiratory tract by invasive procedures. The disappearance of cough reflex after general anesthesia may lead to the accumulation and leakage of the secreta around the tracheal tampon, which facilitates bacteria to enter the bronchus and lungs (Cao & Zhang, 2015).

Accumulation of Respiratory Secretions: It is a condition where sputum is stagnant at the bottom of the lungs due to a decrease in the patient's ability to expel sputum from the respiratory tract after surgery (Cao & Zhang, 2015).

Medical Devices Contamination: Atomizing inhalation devices, oxygen tubes, humidifiers, and ventilator pipes, which are not completely disinfected or stored improperly, may lead to contamination. Thus, the absence of strict aseptic procedures and devices may result in widespread contamination of bacteria, causing or aggravating the lower respiratory tract infection (Cao & Zhang, 2015).

Improper Use of Antibiotics: Some doctors use antibiotics based on their experience. Long-term use of broad-spectrum antibiotics inhibits the growth of normal flora in the oro-pharynx and stomach, leading to mass propagation of opportunistic and drug-resistant bacteria (Cao & Zhang, 2015).

3.2. Nursing strategies to prevent respiratory infection after surgery

Respiratory tract infection is the most frequent complication which occurs within 3 days after surgery, and thus prevention measures should be applied in this period.

- Elimination of predisposing factors: Lower respiratory tract infection after surgery most commonly occurs amongst individuals with reduced immunity. Therefore, it is necessary to encourage the patient to eat properly to improve their tolerance levels, ask the patient to quit smoking and educate the patient on measures to prevent respiratory infections (Cao & Zhang, 2015).

- Assisting Patients to Discharge Sputum

1. Keeping the airway open: Keep the patient lying on the side of the head; suck sputum through the endotracheal tube quickly and gently; increase the oxygen flow for the patient before aspirating sputum; each suction should not exceed 15 seconds; provide 5l/min oxygen after the completion of suction and regulate oxygen flow after balance (Cao & Zhang, 2015).

2. Effective coughing and Expectoration: Support patients to stand and pat them on their backs. Encourage patients to perform effective coughing to remove sputum from pharynx and cough out sputum rapidly (Cao & Zhang, 2015).

3. Humidifying the respiratory tract: Give the patients ultrasonic atomizing inhalation, 2-3 times a day, to sufficiently humidify the respiratory tract. Disinfect ventilator pipes periodically and keep fluid in humidifiers and atomizers aseptic. Perform disinfection of the breathing machines, atomizers, oxygen humidifiers, and tubes, and keep them in a dry place in case they are not in use. Perform oral care once a shift on the patients who have trans-nasal intubation and the indwelling of stomach tubes to reduce the formation of the oropharynx

bacteria and the spreading of gastrointestinal bacteria into respiratory tract to cause infection (Cao & Zhang, 2015).

- ***Strict Aseptic Techniques***

1. Device disinfection: Apply disposable endotracheal intubation, sputum intubation, and mask devices to one patient only. Perform disinfection of the breathing machines, atomizers, oxygen humidifiers, and tubes, and keep them in a dry place in case they are not in use (Cao & Zhang, 2015).

2. Hand hygiene: Medical staff must practice preventive measures by means of washing their hands carefully. Intensive washing of the hands is the most crucial preventative factor to avoid exogenous nosocomial infection caused by procedures conducted by medical staff (Cao & Zhang, 2015).

3. Environmental monitoring: Lower respiratory tract infections can be caused by environmental pollution, so keep the environment clean and limit visitors (Cao & Zhang, 2015).

4. Drug Use: Follow physicians' advice on the use of antibiotics, perform bacteria cultivation and drug-sensitive tests, and select the third-generation antibiotics when you suspect an infection. Nurses should master the pharmacology of various antibiotics, following physicians' advice (Cao & Zhang, 2015).

4. **Evidence-Informed Recommendations**

- Use clinical triage for early identification of patients with acute respiratory infections (ARIs) to prevent the transmission of ARI pathogens to healthcare workers (HCWs) and other patients.

- Respiratory hygiene should be used in persons with ARIs to reduce the dispersal of respiratory secretions containing potentially infectious particles.

- Maintain spatial separation of at least 1m between each ARI patient and others, including HCWs (without the use of PPE), to reduce the transmission of ARI.

- Consider the placement of patients infected or colonized with the same laboratory-identified pathogens in the same designated unit, zone, or ward. If not, the placement of patients with the same suspected diagnosis – similar epidemiological and clinical information

– in the same designated unit, zone or ward to reduce transmission of ARI pathogens to HCWs and other patients.

- Use appropriate PPE as determined by risk assessment. Appropriate PPE when providing care to patients presenting with ARI syndromes may include a combination of the following: gloves, long-sleeved gowns, eye protection (goggles or face shields) and facial mask (surgical or procedure mask, or particulate respirators) during aerosol-generating procedures that have been consistently associated with an increased risk of transmission of ARI pathogens.

- Use adequately ventilated single rooms when performing aerosol-generating procedures that have been consistently associated with increased risk of ARI transmission.

- Vaccinated HCWs should care for patients at high risk of severe or complicated influenza disease, to reduce illness and mortality among these patients.

- Considerations for Ultraviolet Germicidal Irradiation – no recommendations possible.

- Implement additional IPC precautions at the time of admission and continue for the duration of symptomatic illness and modify according to the pathogen and patient information. Always use Standard Precautions (Seto et al., 2013).

IV. Post-test

1. What is the most important measure to minimize VAP for patients in ICU?

A. Utilizing non-invasive ventilation approaches whenever possible or minimizing the duration of ventilation if patients require it.

B. Performing continuous suctioning of the upper respiratory tract secretions.

C. Implementing oral care routines once a day.

D. Maintaining the patient's bed head elevated at 10-30 degrees.

2. Choose the most appropriate method to prevent VAP in patients:

A. Maintaining the bed head elevated at a low angle.

B. Ensuring patients' oral hygiene care.

C. Employing prophylactic antibiotics to prevent infection.

D. Performing suctioning of lower respiratory tract secretions every four hours.

3. What is the cause of respiratory infection that occurs after abdominal surgery?

A. Effective coughing and expectoration

B. Improper use of antibiotics

C. Sufficient device disinfection

D. Adequate elimination of predisposing factors

4. What is the cause of postoperative respiratory tract infections?

A. Long-term use of broad-spectrum antibiotics impedes the growth of normal floral in the oro-pharynx and stomach, causing mass multiplication of opportunistic and drug-resistant bacteria.

B. Adherence to strict aseptic procedures during endotracheal intubation.

C. Consuming a diet high in sugar and processed foods before surgery.

D. Lack of regular physical exercise in the preoperative period.

5. Upper respiratory tract infections include the following diseases:

A. Nasopharyngitis (common cold), sinusitis, pharyngitis, laryngitis, pneumonia

B. Nasopharyngitis (common cold), sinusitis, pharyngitis, laryngitis, bronchitis

C. Nasopharyngitis (common cold), sinusitis, pharyngitis, laryngitis, laryngotracheitis

D. Laryngitis, pharyngitis, bronchitis and pneumonia

6. What is the most common cause of nasopharyngitis?

a. Virus

B. Fungi

C. Bacteria

D. Parasites

7. What are the measures taken to eliminate predisposing factors for postoperative infections?

A. Conduct oral hygiene care for patients once a day.

B. Nurses wash their hands only when they are visibly soiled.

C. Restrict suctioning of phlegm for patients.

D. Encourage patients to maintain a balanced diet to ensure adequate energy and vitamin intake, improve their tolerance levels, quit smoking, and educate them on preventing respiratory tract infections.

8. What are the measures to help the patient discharge sputum?

A. Serving the patient cold food and beverages to constrict the throat.

B. Using antibiotics to prevent increased respiratory secretions.

C. Encouraging the patient to perform effective coughing and expectoration.

D. Keeping the patient's environment clean.

9. Which of the following strategies are crucial for maintaining asepsis when caring for postoperative patients?

A. Practicing proper hand hygiene, ensuring equipment sterilization, and performing meticulous wound care.

B. Providing adequate nutrition for the patient.

C. Encouraging patients to perform effective coughing and expectoration.

D. Ensuring humidification of the respiratory tract.

10. Which of the following factors contribute to respiratory infections in postoperative patients?

A. Patient cannot eat early before they have bowel movement.

B. Patient smokes, has immune diseases, and has difficulty deep breathing and effective coughing due to pain.

C. Patient takes medication according to doctors' prescriptions.

D. Patient must change position soon after surgery.

Further reading

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Module 8. Safe practices in the preparation and administration of intravenous drugs

I. Overview

Following safe intravenous (IV) therapy practices is the key to preventing the spread of infection during healthcare delivery. In this module, students will learn about factors that increase risks of IV therapy-related infections and guidelines for:

- The safe preparation of IV therapy: hand hygiene, preparation of parenteral solutions and medications and preparation of materials.

- The safe administration of IV therapy: hand hygiene; site selection; selection of IV needles or catheters; aseptic technique and skin preparation; catheter site assessment, care and dressing; replacement of IV catheters; sorting and packaging of clinical waste and decontamination of reusable material; patient education; documentation.

- Education, training and staffing.

II. Learning objectives

After the completion of this module, students should be able to

1. Identify safe practices in the preparation and administration of IV therapy.

2. Understand and identify factors that increase the risk of IV therapy-related infections.

III. Major concepts

1. Introduction

Venous access is any method used to access the bloodstream through the veins to administer intravenous therapy, obtain blood for analysis and provide an access point for blood-based treatment such as hemodialysis (Fernández-Ruiz et al., 2014; Olimpia et al., 2021).

Peripheral intravenous catheters (PIVCs) are inserted into and reside in the veins of the periphery that includes all extremities, the external jugular vein, and scalp veins in neonates. PIVCs are inserted into superficial veins located just under the skin in the superficial tissue, as well as deep veins located under the muscle tissue. There are three types of PIVCs:

short peripheral intravenous catheters (short PIVC), long peripheral intravenous catheters (long PIVC), and midline catheters (Gorski et al., 2021).

Safe injection or intravenous device insertion is one that does not harm the patients, does not expose the provider to any avoidable risk, and does not result in any waste that is dangerous for other people.

Aseptic technique is "a set of infection prevention actions aimed at protecting patients from infection during invasive clinical procedures and management of indwelling medical devices". This term is used interchangeably with other terms such as clean, sterile, and non-touch technique (Gorski et al., 2021). *Aseptic non-touch technique (ANTT)* is "a specific and comprehensively defined type of aseptic technique. The ANTT integrates standard precautions such as hand hygiene and personal protective equipment with appropriate aseptic field management of invasive medical devices" (Gorski et al., 2021).

2. Safe practice in the preparation and administration of IV therapy

It is important to adapt effective infection control and prevention strategies and adhere to the safe practices in the preparation and administration of IV medication. This chapter was developed based on the following national and international recommendations : Infusion therapy standards of practice from the Infusion Nurses Society (Gorski et al., 2021), Guidelines for the prevention of intravascular catheter-related infections (O'Grady et al., 2017), Guidelines on bloodstream infection prevention on patients with intravascular catheters (Vietnam Ministry of Health [VMOH], 2012), and ISMP safe practice guidelines for adult IV push medications (Institute for Safe Medication Practices [ISMP], 2015).

This section presents the safe practice guidelines for the preparation and administration of IV therapy, taking into account the following aspects for:

The safe administration of IV therapy:

- Hand hygiene
- Preparation of parenteral solutions and medications
- Preparation of material
- The safe administration of IV therapy:

- Hand hygiene
- Site selection
- Selection of IV needles or catheters
- Aseptic technique and skin preparation
- Catheter site assessment, care and dressing
- Replacement of IV catheters
- Sorting and packaging of clinical waste and decontamination of reusable material
- Patient education
- Documentation
- Education, training and staffing

2.1. The administration of IV therapy

2.1.1. Hand hygiene

Hand hygiene must be performed before and after the procedure (and all times needed during the procedure) (ISMP, 2015). Please see Module 3 “Hand hygiene” for further information.

2.1.2. Preparation of parenteral solutions and medications

Before preparing medications and infusion solutions, nurses should check medication to ensure safety. According to Gorski et al., (2021), nurses should:

- Compare medications and infusions against the medication order. Review label for the name, dosage and concentration, total volume, beyond-use/expiration date, route of administration, frequency, rate of administration, and any other special instructions.

- Use at least 2 patient identifiers, including patient's full name (or distinct methods of identification for infants), to ensure accurate patient identification when administering medications.

- Check patient's history of drug allergies.

Healthcare professionals must follow safe injection practices when preparing therapeutic and parental medications and solutions; improper infusion and injection practices

have resulted in transmission of bloodborne viruses and other microbial pathogens (Gorski et al., 2021).

- Adhere to ANTT. Refer to Standard 18 in Infusion Therapy Standards of Practice (Gorski et al., 2021).

- Use medications packaged as single-dose or single-use for only 1 patient (Gorski et al., 2021).

- Discard a single-dose vial after a single entry (Gorski et al., 2021).

- Dedicate a multidose vial for a single patient (Gorski et al., 2021).

- Use a multidose vial (e.g., Insulin) for up to a maximum of 28 days of opening or puncture unless there is a specified expiration date labeled by the manufacturer: label a multidose vial with the beyond-use date (BUD) and store the vial according to the manufacturer's recommendations. Discard if the vial lacks a BUD, the sterility is compromised or questionable, and out of date (Gorski et al., 2021).

- The "pop-off" vial caps from manufacturers are only considered as "dust covers" and are not intended to maintain sterility of the vial diaphragm or access point. Thus, the diaphragm must always be disinfected after removing the cap of a new vial (ISMP, 2015). According to the Infusion Nurses Society, practitioners should disinfect of the vial septum before each entry and the neck of a glass ampoule with 70% alcohol prior to vial access or breaking of the ampule; allow the disinfectant to dry prior to entry (Gorski et al., 2021). Prepare medications and assemble needed supplies in a clean area using a General Aseptic Field/Micro Critical Aseptic Fields in accordance with ANTT (Gorski et al., 2021).

Figure 8: Disinfection of the vial cover and ampoule with alcohol.

2.1.3. Preparation of materials

Healthcare professionals should:

- Prepare injection trolley with appropriate clean and sterile equipment for administration of different injection and infusion therapies. The materials should be well prepared, although that depends on each country and the facilities of each hospital.

- The materials should include sterile tray, clean gloves, catheters or IV needles, skin disinfection swab, reusable or single-use tourniquet, syringe, container for sharps, anaphylaxis shock kit, quick hand sanitizer, medications, medical record, among others.

2.2. Administration of IV therapy

2.2.1. Hand hygiene

Hand hygiene must be performed before and after the procedure (and all times needed during the procedure) (ISMP, 2015). Please see Module 3 “Hand hygiene” for further information.

In addition, hand hygiene should be performed before and after palpating insertion sites as well as before and after inserting, replacing, accessing, repairing, or dressing an intravascular catheter. Palpation of the insertion site should not be performed after the application of antiseptic, unless aseptic technique is maintained (O’Grady et al., 2017; VMOH, 2012).

2.2.2. Site selection

Gorski et al., (2021) recommended site selection for different types of vascular access devices (VAD). There are some recommendations for short PIVC access site selection such as:

- Insert short PIVC via a forearm vessel to prolong the dwell time, increase the likelihood of the PIVC lasting the full length of the prescribed therapy, decrease pain during dwell time, promote self-care, and prevent accidental removal and occlusions. Choose veins found on the dorsal and ventral surfaces of the upper extremities, including metacarpal, cephalic, basilic, and median veins.

- Consider hand veins for short-term therapy (less than 24 hours). Short PIVC insertion in areas of flexion such as the hand is associated with higher rates of failure over time.

- Consider use of the external jugular vein in patients in acute care settings and in emergency situations when other veins cannot be accessed.

2.2.3. Selection of IV needles and catheters

- Use a new needle and syringe for every injection (Gorski et al., 2021).

- Never use the same syringe to administer medication to more than 1 patient (Gorski et al., 2021).

- Use single-use, commercially prepared, prefilled syringe of appropriate solution to flush and lock vascular access devices to reduce the risk of catheter-associated bloodstream infection (CABSI) and save time for syringe preparation (Gorski et al., 2021).

- Nurses should discuss with doctors to determine the appropriate type of catheters and consider the following practical guidelines:

- Select catheters based on the prescribed therapy or treatment regimen, including anticipated duration of therapy, vascular characteristics, patient's age, comorbidities, history of infusion therapy, preference for vascular access devices type and location, and ability and resources available to care for the device (Gorski et al., 2021).

- Select a peripheral intravenous catheter when the duration of therapy is below 4 days (Gorski et al., 2021). Insert a midline catheter or peripherally inserted central catheter (PICC), instead of a short PICV, when the duration of IV therapy will likely exceed 6 days (O'Grady et al., 2017).

- Avoid the use of steel needles for the administration of fluids and medication that might cause tissue necrosis if extravasation occurs (O'Grady et al., 2017).

- Select different types of catheters including short peripheral intravenous catheters, long peripheral intravenous catheters, midline catheters, and central venous access devices. Choose a short PIVC as follows:

- Evaluate the infusate characteristics in conjunction with limited duration of infusion therapy and availability of peripheral vascular access sites.

- Use vascular visualization technology to increase success for patients with difficult intravenous access.

- Avoid use for continuous infusion of medication with irritant or vesicant properties.

- Do not use a short PIVC when the vein lies deep in subcutaneous tissue or for veins classified as deep veins, thus restricting the proportion of catheter that will be located within the vein. At least two-thirds of the PIVC should reside within the vessel to reduce the risk of PIVC failure.

- Select the smallest-gauge PIVC that will accommodate the prescribed therapy and patient need.

2.2.4. Aseptic technique and skin preparation

Aseptic technique:

- Maintain aseptic technique for insertion of IV needles and care of intravascular catheters (O'Grady et al., 2017).

- Wear clean gloves, rather than sterile gloves, for the insertion of IV needles or peripheral venous catheters, if the access site is not touched after the application of skin antiseptics (O'Grady et al., 2017).

Skin preparation:

- Remove excess hair at the insertion site if needed to facilitate application of VAD dressing; use single-patient-use scissors or disposable-hair surgical clippers; do not shave as this may increase the risk for infection (Gorski et al., 2021).

- Check patient history of any allergy or sensitivity to skin antiseptics (Gorski et al., 2021).

- Perform skin antisepsis using alcohol-based chlorhexidine solution (Gorski et al., 2021).

- Use povidone-iodine or 70% alcohol instead of chlorhexidine if there is a contraindication (Gorski et al., 2021).

- Use iodophor (povidone-iodine), alcohol-based or aqueous chlorhexidine solution for preterm neonates, low-birth-weight infants, and within the first 14 days of life. Use both

aqueous and alcohol-based chlorhexidine with caution due to risks of chemical burns to the skin (Gorski et al., 2021).

2.2.5. Catheter site assessment, care and dressing

After catheter insertion, nurses work with doctors to assess, care for, and change catheter dressing.

- Palpate and inspect the catheter site and surrounding area for signs of complications (dislodgement, redness, tenderness, swelling, infiltration, induration, body temperature elevation, and drainage) (Gorski et al., 2021).

+ Remove nontransparent dressing to visually inspect site if patient has local tenderness or other signs of possible local infection; otherwise use palpation for assessment (Gorski et al., 2021).

+ Measure the external central VAD length at each dressing change or when catheter dislodgement is suspected and compare it to the external central VAD length documented at insertion (Gorski et al., 2021).

+ Measure circumference of the extremity and compare to baseline measurement when clinically indicated to assess the presence of edema and possible catheter-associated deep vein thrombosis (CA-DVT) for midline and peripheral inserted central catheters (Gorski et al., 2021).

- The assessment frequency is based on patient factors such as age, condition, and cognition; type/frequency of infusate; and healthcare setting (Gorski et al., 2021).

- Change transparent semipermeable membrane (TSM) dressing at least 7 days or immediately if dressing integrity is disrupted or compromised skin integrity is present under the dressing (Gorski et al., 2021).

- Change sterile gauze at least every 2 days when inspection of the insertion site is necessary or if dressing integrity disrupted; note that a gauze dressing underneath a TSM dressing is considered a gauze dressing, unless the site is not obscured (Gorski et al., 2021).

- Follow the Standard-ANTT or Surgical-ANTT when performing catheter dressing change (Gorski et al., 2021).

- Use a dressing change kit to standardize the procedure and improve time efficiency (Gorski et al., 2021).

- Prepare skin for optimal skin health and dressing adherence (Gorski et al., 2021).

- Select the type of sterile dressing (TSM or gauze) considering factors such as the type of catheter, risk of bleeding or infection, skin condition, known allergies or sensitivities, patient size, patient preference, cost, sterility, wear time, and ease of use of dressing, with the goal of selecting and applying a dressing that will have minimal dressing disruptions (Gorski et al., 2021).

- Use a securement method to stabilize and secure catheter (Gorski et al., 2021).

- Label the dressing with the date performed or date to be changed, avoiding placement of the label over the insertion/exit site (Gorski et al., 2021).

- Use chlorhexidine bathing to minimize the risk of catheter-associated bloodstream infections (Gorski et al., 2021).

- Protect catheter when patient is showering or bathing by covering the catheter site with a clear plastic wrap or device designed for this purpose. Cover the connections and protect hub connections from water contamination (Gorski et al., 2021).

- Avoid taking blood pressure measurements or placement of a tourniquet over the site/upper extremity with a PICC or on an extremity with a peripheral catheter during periods of infusion (Gorski et al., 2021).

2.2.6. Replacement of IV catheters

With peripheral catheters, there is no need to replace them more frequently than every 72–96 hours to reduce the risk of infection and phlebitis in adults (O'Grady et al., 2017). Replace peripheral catheters in children only when clinically indicated (O'Grady et al., 2017).

2.2.7. Sorting and packaging of clinical waste and decontamination of reusable material

All materials used in the preparation and administration of the intravenous therapy and clinical waste must be adequately sorted and packaging (please see Module 10 "Proper clinical waste management"). The reusable material must be properly decontaminated

according to current international recommendations (please see Module 9 “Decontamination of clinical devices and equipment).

2.2.8. Patient education

Healthcare professionals must provide proper education to patients about the administration procedure, changes in catheter site, or any new discomfort that they should report (Gorski., 2021). This information must be clear and understandable.

2.2.9. Documentation

After the administration procedure, healthcare professionals should document the following information (Gorski et al., 2021):

- Type of therapy;
- Identification of the medication;
- Dosage;
- Rate of administration;
- Time of administration;
- Route of administration;
- Method of administration;
- Identification of the device used for administration;
- Type of device and patency (before and after the administration);
- Discontinuation of IV therapy (and reasons);
- Abnormal symptoms, especially in the insertion sites;
- Patient’s involvement in the procedure.

3. Factors that increase risks of IV therapy-related infection

3.1. Patient-related factors

Immunocompromised patients, surgery, prolonged corticosteroid use, organ transplantation, diabetes mellitus, HIV, the elderly, premature infants, children suffering from infectious diseases or open skin injuries, malnutrition, etc. (VMH, 2012).

3.2. Intervention-related factors

The risk of infection due to intravascular catheterization depends on the type of hospital, the department used, the type of catheter, the insertion technique, the aseptic technique, and the indwelling time (VMH, 2012).

- Infections from short-term or long-term catheters

- Placement: peripheral vascular catheter, central (tunneled and non-tunneled type):

+ Peripheral catheters have a lower risk of infection than central catheters because central catheters are placed in blood vessels closer to the heart and are more likely to cause trauma. Peripherally-inserted central catheters reduce this risk.

+ For tunneled catheters: usually related to bacteria that accumulate and multiply in the lumen and at the injection port of the catheter, with CRBSI being the most common infection.

- The longer the catheter is in place, the greater the risk of infection.

3.3. Environment related factors

Placing catheters in a high-risk environment for infection and in emergency situations carries a higher risk of infection than in a prepared and controlled environment (VMH, 2012). Non-compliance with strict aseptic placement techniques can also contribute to an increased risk of infection. Placing central catheters in poor environmental conditions and overcrowding patients (patients sharing a bed, understaffed staff, overworked staff) will increase the risk of infection.

4. Conclusion

In summary, this module covered knowledge of safe IV therapy, including safe preparation for administration of IV therapy; the safe administration of IV therapy; education, training, and staffing. Safe IV therapy practices can reduce the risk of harm to the patient or other HWs and prevent the spread of bloodborne pathogens like HBV, HVC, HIV, and bacterial pathogens. Meanwhile, students should be able to apply their knowledge in practice.

IV. Post-test

Please select the correct answers to the following questions or statements.

1. What are the recommended practices in the preparation of therapeutic and parental medications?

A. Practitioners do not need to disinfect the vial septum before each entry.

B. A multidose vial can be used for more than 28 days of opening or puncture.

C. Practitioners can use the same needle and syringe for every injection.

D. Practitioners should follow the aseptic technique when preparing the iv medication.

2. When preparing parental medications and solutions, health professionals must:

A. Use multi-dose or multi-use medications.

B. Use a multidose vial for up to a maximum of 10 days.

C. Adhere to aseptic non-touch technique.

D. Reuse needle and syringe for every injection.

3. A peripheral intravenous catheter should be used when treatment is expected to last less than:

A. 4 days.

B. 5 days.

C. 6 days.

D. 7 days.

4. When inserting peripheral intravascular catheters, health professionals should:

A. Wear clean gloves.

B. Wear sterile gloves.

C. Disinfect hands with alcohol-based solutions.

D. Wear clean or sterile gloves.

5. Which disinfecting solution is best recommended for skin antisepsis?

A. Iodophor (povidone-iodine).

B. 70% alcohol.

C. Chlorhexidine solution.

D. 70% alcohol and iodophor.

6. When a patient has local tenderness or other signs of possible local infection at the insertion site, nurses should:

A. Remove nontransparent dressing to visually inspect site.

B. Measure the external central vad length.

C. Measure circumference of the extremity.

D. Palpate and inspect surrounding area.

7. If dressing integrity is disrupted or compromised skin integrity is present under the dressing, change transparent semipermeable membrane (TSM) dressings at least every:

A. 5 days.

B. 6 days.

C. 7 days.

D. 8 days.

8. Peripheral intravenous catheters should be replaced:

A. More frequently.

B. Every 12-24 hours.

C. Every 24-48 hours.

D. Catheters should only be replaced when signs or symptoms of complications are present.

9. Healthcare professionals must educate patients, except for:

A. Administration procedure.

B. Self-dressing catheter insertion site.

C. Any changes in their catheter site.

D. Report any new discomfort.

10. After the administration procedure, healthcare professionals must document the procedure, except fort:

A. Type of therapy.

B. Identification of the medication.

C. Patient's information.

D. Method of administration.

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Module 9. Decontamination of medical devices and equipment

I. Overview

The decontamination of medical devices and equipment used in patient care and treatment is a routine practice at healthcare facilities. If this process of reusing medical equipment is not strictly followed from the cleaning to the disinfection and sterilization stages, it can have serious consequences on the quality of patient care. This module will cover six topics:

- Factors affecting the cleaning, disinfection, and sterilization process
- Sorting tools according to Spaulding's classification
- Disinfection methods
- Sterilization methods
- Disinfection-sterilization process
- Reusing single-use medical devices.

II. Learning objectives

After the completion of this module, students should be able to

1. Identify the differences between cleaning, disinfection, and sterilization.
2. Describe how tools are classified according to Spaulding's classification,
3. Explain the principles of disinfection and sterilization.
4. Describe the disinfection-sterilization methods.
5. Describe the sterilization quality control and equipment storage processes.
6. Recognize the safety issues and the risks of reusing single-use medical devices.

III. Major concepts

1. Introduction

Based on international standards (WHO, 2016), the major concepts in this field are described below:

- ***Cleaning*** is the first step required to remove contamination resulting from the presence of foreign material (e.g., soil, dust, blood, secretions) in an instrument, usually with

detergents or enzymatic solutions. Cleaning should be performed prior to disinfection and sterilization.

- ***Disinfection*** is a process that reduces the number of viable microorganisms to a less harmful level, although it may not inactivate some viruses, prions, and bacterial spores. There are 3 levels of disinfection:

+ Low-level disinfection: Low-level disinfectants are used for 10 minutes or less to kill most vegetative microorganisms, some fungi, and some viruses.

+ Intermediate-level disinfection: kills tubercle bacilli, vegetative bacteria, most viruses and fungi, but does not kill bacterial spores.

+ High-level disinfection: It kills all microorganisms, except for some bacterial spores.

+ Sterilization: A process that destroys or eliminates all forms of living microorganisms.

The decontamination of medical devices and equipment is critical to the prevention and control of healthcare-associated infections (HAIs) and, therefore, to the protection of patients and healthcare professionals.

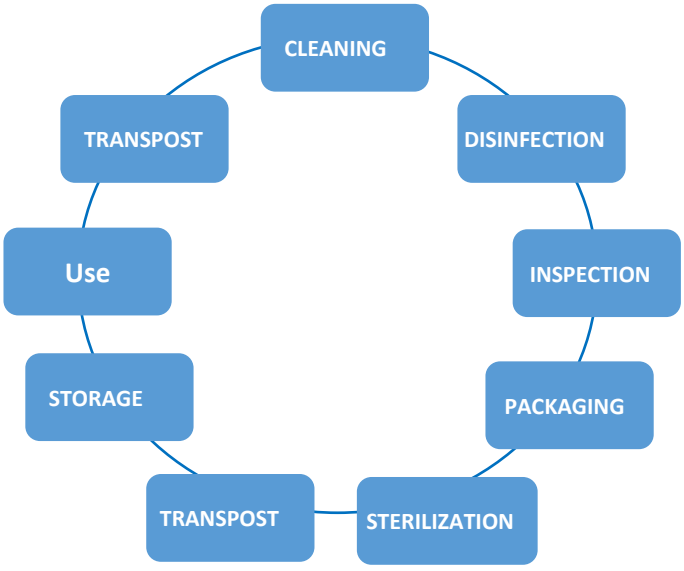

Figure 9: The decontamination life cycle

Source: Adapted from Health Building Note 13, Department of Health, United Kingdom, 2004

For these reasons, it is important to understand the importance of the decontamination process and review the recommendations for the best practices regarding cleaning, disinfection, and sterilization of medical devices.

2. Factors affecting the cleaning, disinfection, and sterilization process

2.1. Number and location of pathogens

The amount of time it takes to kill bacteria depends on the number of microorganisms present in the instrument. Under standard conditions, tests on bactericidal ability (autoclaves) revealed that it took 30 minutes to kill 10 spores of Bacillus atrophaeus (formerly Bacillus subtilis) but 3 hours to kill 100,000 Bacillus atrophaeus spores. Therefore, it is very important to clean the installations after use before disinfecting and sterilizing them to reduce the number of pathogens, shorten the sterilization and sterilization process, and ensure quality. Careful cleaning is required for all types of reusable medical equipment/devices. (VMH, 2012; 2017).

2.2. Ability to inactivate bacteria

Many that are resistant to the bactericidal and sterilizing chemicals used to destroy them. The mechanism of their resistance to antibacterial agents is different. Therefore, the selection of chemicals for sterilization should consider if the chemicals are not inactivated by bacteria or least resistant. It should take into account the whole sterilization cycle and the contact time of the chemical to destroy most pathogens (VMH, 2012 & 2017).

2.3. Concentration and effectiveness of disinfectant chemicals

The time of contact with chemicals should also be considered in the disinfection process. Results show that 70% isopropyl alcohol killed 10 *M. tuberculosis* in 5 minutes, whereas phenolic took up to 2-3 hours of exposure (VMH, 2012 & 2017).

2.4. The physical and chemical factors of disinfectant chemicals

Many physical and chemical properties of chemicals affect the sterilization process, such as temperature, pH, humidity, and water hardness. Most of the effects of chemicals increase with increasing temperature and can damage the tools and change the ability to kill bacteria.

An increase in pH may improve the bactericidal ability of some chemicals (e.g., glutaraldehyde, quaternary ammonium), but decrease the bactericidal ability of others (e.g., phenols, hypochlorites, iodine). Humidity is an important factor affecting gaseous disinfectants and sterilization chemicals such as Ethylene oxide (ETO), chlorine dioxide, and formaldehyde. High water hardness (determined by the high concentration of certain metal cations such as calcium, magnesium) reduces the ability to kill bacteria and can damage the tools (VMH, 2012 & 2017).

2.5. Organic and inorganic matter

Organic matter in the form of blood, serum, pus, feces, or lubricants can affect the bactericidal ability of disinfectant chemicals in two ways: reducing the ability to kill bacteria by reducing the concentration of chemicals and protecting bacteria against the process of sterilizing. Therefore, the cleaning process to remove organic and inorganic matter clinging to surfaces, joints, joints and inside the tools is a very important task, which greatly determines the quality of bactericidal and sterilizing materials (VMH, 2012 & 2017).

2.6. Chemical exposure time

Instruments, when disinfected and sterilized, must absolutely comply with the minimum contact time with chemicals. This exposure time is usually very well specified by the manufacturer and specified in the instructions for use (VMH, 2012 & 2017).

2.7. Biological substances produced by bacteria (Biofilm)

Microorganisms can be protected from the effects of bactericidal and sterilizing agents due to their ability to produce biological substances, which surround the bacteria and adhere to the installation surface and make cleaning difficult. The most common tools are the tubular tools. These bioactive microorganisms are all highly resistant and 1,000 times more resistant than non-resistant microorganisms. Therefore, when choosing disinfectant chemicals, this ability must be considered for some bacteria such as Staphylococcus, gram-negative bacilli when handling endoscopes, pacemakers, glasses, hemodialysis systems, vascular and urinary catheters. Certain enzymes and detergents can dissolve and reduce the formation of these biologics (VMH, 2012 & 2017).

3. Sorting tools according to Spaulding's classification

According to Spaulding's classification, medical items can be classified as critical, semi-critical or non-critical. There is a recommended decontamination process for each type of item, ranging from cleaning (non-critical items) to sterilization (critical items) (WHO, 2016).

Table 2: Spaulding's classification of equipment decontamination (WHO, 2016)

Category	Recommended decontamination process	Examples
High (critical) Items that are involved with a break in the skin or mucous membrane or entering a sterile body cavity	Sterilization	Syringes, needles, surgical instruments, implants/ prostheses, rigid endoscopes
Intermediate (semi critical) Items in contact with mucous membranes or body fluids	Disinfection (high-level)	Respiratory equipment, non-invasive flexible endoscopes, bedpans, urine bottles
Low (non-critical) Items in contact with intact skin	Cleaning	Blood pressure cuffs, stethoscopes

4. Principles of disinfection and sterilization of instruments

4.1. Principles of disinfection and sterilization of instruments

Instruments used for each patient must be handled appropriately:

- Instruments after handling must be stored safely until use.

- Medical staff must be fully trained and equipped with protective equipment.

- Medical instruments in medical examination and treatment facilities must be managed and handled centrally (VMH, 2012 & 2017).

4.2. Principles of choosing chemicals for disinfection and sterilization

- The selection of chemicals for disinfection and sterilization should be based on the following principles (VMH, 2012 & 2017):

+ Cost-effectiveness and compatibility with the equipment/devices/surfaces to be disinfected.

+ Efficacy for the intended use.

+ Safety for use, with minimal toxic and irritating effects to staff.

+ Environmental safety and biodegradability.

- *Criteria for selection of disinfectant chemicals* (VMH, 2012 & 2017)*:*

+ Broad antibacterial spectrum.

+ Fact acting.

+ Not affected by environmental factors.

+ Non-toxic.

+ Does not harm metal tools as well as rubber and plastic.

+ Lasting effect on surfaces.

+ Easy to use.

+ Odorless or pleasant odor.

+ Economy.

+ Potential for dilution.

+ Stable concentration even when diluted for use.

+ Good cleaning ability.

5. Sterilization methods [1]

Various sterilization methods are used, such as high-temperature sterilization with steam, low-temperature sterilization with ethylene oxide, and sterilization with hydrogen peroxide plasma technology (WHO, 2016).

5.1. Steam sterilization

Steam sterilization is the most widely accepted method for sterilizing invasive instruments that are resistant to heat and humidity. This method is reliable, nontoxic,

inexpensive, and rapidly kills pathogens, including spores. Steam can penetrate upholstery, wrapping paper, metal containers, and packaging tools. However, this method can damage some instruments, resulting in corrosion and reduced accuracy of microsurgical instruments (WHO, 2016).

The method is carried out by autoclaves and uses saturated steam under pressure. Each instrument has different requirements for steaming time, and in each different steaming cycle the parameters are also different. The parameters commonly used to monitor the sterilization process are steam, time, pressure, and temperature. (WHO, 2016).

All steam cycles must be monitored by mechanical, chemical, and biological parameters.

5.2. Dry heat

Dry heat is used for sterilizing only non-hazardous materials, reusable glass syringes, ointments or oils, and sharp instruments. Use a hot air oven with a fan or ducting to ensure even distribution of the heat. The time is 160ºC (320ºF) for 2 hours or 170ºC (340ºF) for 1 hour and 150ºC (300ºF) for 150 minutes (2 hours 30 minutes). This method is cheap, non-toxic to the environment, easy to install, but damages tools, especially metal and rubber tools, and takes a long time. It is currently not recommended for use in hospitals (WHO, 2016).

5.3. Low-temperature sterilization using hydrogen peroxide gas plasma

Sterilize medical devices by diffusing hydrogen peroxide into the chamber and then “activating” the hydrogen peroxide molecules into plasma. Using a combination of steam and plasma hydrogen peroxide safely and quickly sterilizes medical instruments and materials without leaving toxic residues. The end product is oxygen and water, so it is very safe for users and the environment. All stages of the sterilization cycle, including the plasma phase, operate in a dry environment at low temperatures, and therefore the cycle does not damage heat and moisture sensitive instruments. This method provides a sterilization assurance level (SAL) of 10-6, as defined by the international standard. Sterilization time from 28 to 75 minutes depends on the type of tool and machine generation. It is suitable for sterilizing endoscopic

and microsurgery instruments in different specialties: general surgery, cardiac surgery, neurosurgery, eye, maxillofacial, orthopedic trauma, and obstetrics (WHO, 2016).

5.4. Sterilization by Ethylene Oxide

This method is compatible with a wide range of instruments. It has high permeability, requires a low temperature at 37°C for 5 hours or 55°C for 3 hours, does not damage the instrument, and is suitable for sensitive instruments. Vapors of ethylene oxide are toxic, potentially carcinogenic, and can cause fires and explosions. They are time-consuming because of their long intake and exhaust cycles, up to 12 hours. Its main disadvantages include the lengthy cycle time, the emission of CO2, and it requires a waste gas treatment unit to make it non- toxic to the environment and users. The user must also undergo periodic health checks. With the improvement of the new autoclave, these disadvantages have partly been overcome (WHO, 2016).

6. Disinfection-sterilization process

6.1. Clean patient care equipment

- Instruments must be cleaned immediately after use.

- Instruments must be cleaned with water and detergent, preferably an enzyme-based cleaner, before sterilization or sterilization at a sterilization center.

- Cleaning can be done manually or with a mechanical washer.

- Select a detergent or enzyme that is compatible with the instrument and recommended by the manufacturer.

- The instruments should be checked after cleaning and any broken, damaged, or rusty tools should be removed or repaired before being disinfected and sterilized (VMH, 2012 & 2017).

6.2. Disinfection

Low-level disinfection**,** High-level disinfection, Intermediate-level disinfection (VMH, 2012 & 2017).

6.3. Sterilization methods

6.4. Place the tools in the oven/steam chamber

- Instruments placed in the autoclave chamber must ensure the circulation of sterilizing agents around the instrument packages. The surface of the instrument is in direct contact with the sterilizing agent. Do not let the instrument touch the wall of the autoclave chamber.

- Arrange the instruments vertically. Plastic-wrapped instruments should be sealed at the two edges (VMH, 2012 & 2017).

6.5. Store and preserve

- Sterilized instruments must be stored in a separate area to ensure maximum safety.

- They should be stored in closed cabinets and shelves to ensure that they are not damaged.

- Cabinets and racks must be 12-25cm from the floor, 12.5cm from the ceiling if not near the fire sprinkler system, 45cm if near the fire sprinkler system. The distance from the wall is 5cm, ensuring circulation and ventilation, easy to clean, preventing insects from entering.

- Instrument storage at the central sterilization unit should have good ventilation and be monitored for temperature, humidity, and dust: Temperature: 18-22°C, Humidity: 35-60%.

- Regular inspection of tools to avoid expiration date problems.

+ The shelf life of sterilized tools depends on the sterilization method, the quality of the wrapping paper, and the storage condition.

+ Specialized paper packaging tools have a shelf life of no more than 3 months.

+ Sterilized instruments packaged with a single-sided plastic wrap made of polyethylene can be kept for 6 months and according to the manufacturer's recommendations.

+ If the label is blurred, unclear, or has no expiration date, it is necessary to re-sterilize those instruments (VMH, 2012 & 2017).

6.6. Quality control

- Medical staff working in disinfection and sterilization areas should receive regular training in disinfection and sterilization of medical instruments from certified training providers.

- All records of monitoring results of each sterilization cycle and kits must be stored at the central sterilization unit.

- Persons responsible for controlling the quality of the disinfection and sterilization of medical examination and treatment facilities must be professionally trained.

- Routinely invite the competent authorities to inspect and control the quality of autoclaves and disinfection and sterilization machines (VMH, 2012 & 2017).

7. Reusing single-use medical devices

7.1. What is a reusable device and a single-use device?

According to the World Health Organization and the Pan American Health Organization (2016), "a reusable device, such as a surgical instrument, is designed to be used many times on different patients, and the manufacturer provides detailed instructions on how it can be safely reprocessed between each patient". A single-use device is designed by a manufacturer to be used once only for a single patient and then discarded. A single-use device may be used multiple times on the same patient, depending on its design and the manufacturer's instructions (WHO, 2016; Branaghan, 2021).

7.2. Reusing single-use medical devices

- Single-use devices may not be designed to allow thorough decontamination processes.

- Single-use devices have not undergone extensive testing, validation, and documentation for reuse.

- Single-use devices may present a potential for cross-infection due to design.

- Some materials can absorb certain chemicals, which can gradually leach from the material over time.

- Chemicals may cause corrosion or changes to device materials.

- Some devices may experience stress during reuse and may fail, stretch, or break.

- Inadequately cleaned equipment can carry bacterial endotoxins, which remain after bacteria are killed (WHO, 2016; Branaghan, 2021).

7.3. Risks of reusing single-use devices

The health risks of reusing a single-use device depend to a great extent on the type of device and the way it interacts with the patient's body. Most non-critical devices, such as compression sleeves, can be cleaned and reused with minimal risk. Opened, but unused, sterile instruments can sometimes be re-sterilized, provided that the materials can withstand the sterilization procedure. However, some invasive single-use devices, especially those with long lumens, hinged parts or crevices between components, are difficult or impossible to clean once body fluids or tissues have entered them.

Reusing single-use devices carries the obvious risk of cross-patient infection, but also the increased probability that the device could malfunction due to the adverse effects of reprocessing on materials or delicate components (WHO, 2016; Branaghan, 2021).

IV. Post-test

Please choose the best answer to the following questions:

1. In the decontamination process of medical devices

A. Sterilization eliminates bacterial spores.

B. Disinfection eliminates microorganisms, including bacterial spores.

C. Only the combination of disinfection and sterilization processes eliminates bacterial spores.

D. Disinfection eliminates bacterial spores.

2. After the measurement of rectal temperature, a thermometer should be

A. Disinfected and sterilized since it is in contact with mucous membranes.

B. Disinfected since it is a high-risk item.

C. Sterilized since it is a critical item.

D. Cleaned since it is a semi-critical item.

3. The correct sequence of events for cleaning from point-of-use to inspection is:

A. Sort, rinse off at point-of-use, manual cleaning, inspection.

B. Rinse off at point-of-use, sort, manual cleaning, inspection.

C. Rinse off at point-of-use, manual cleaning, sort, inspection

D. All the sequences are wrong.

4. Which of the following factors affect the effectiveness of the disinfection process?

A. Concentration of the agents, physical and chemical factors, and stability

B. Number of microorganisms, organic matter, and resistance of microorganisms to the chemical agent

C. Number of microorganisms, inorganic matter, and resistance of microorganisms to the chemical agent

D. Concentration of the agents, inorganic matter, and resistance of microorganisms to the chemical agent

5. The characteristics of an ideal disinfectant are...

A. Being rapid to kill microorganisms, chemically stable, and compatible with surfaces.

B. Having low germicidal activity and ability to penetrate into crevices.

C. Having high germicidal activity and ability to penetrate into crevices.

D. Being rapid to kill microorganisms and ability to penetrate into crevices.

6. Regulations on handling instruments for gastrointestinal endoscopy:

A. Cleaning.

B. Low-level disinfection.

C. Moderate disinfection.

D. High-level disinfection.

7. Regulations on handling instruments for vascular forceps:

A. Low-level disinfection.

B. Moderate disinfection.

C. High-level disinfection.

D. Sterilization.

8. Transparent pouches (Polymers/Polyethylene/PVC/Polypropylene& polycarbonates /Nylon) available in sterile services tolerate:

A. Steam.

B. All answers are correct.

C. Dry heat.

D. Steam and ethylene oxide (ETO).

9. Most medical and surgical devices used in nursing practice are made of heat-resistant materials. In such cases, which is the primary method for device sterilization?

A. Hydrogen peroxide plasma.

B. Steam/moist heat.

C. Dry heat.

D. Ethylene oxide (ETO).

10. Which of the following tools should not be reused?

A. Syringe pump.

B. Oxygen wire.

C. Gloves.

D. Sputum suction tube.

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Module 10. Clinical waste management

I. Overview

The healthcare sector is growing at a very rapid pace, which in turn has generated an ever-increasing amount of medical waste in developing countries, especially by hospitals, clinics, and other healthcare facilities. Improper management of healthcare waste from hospitals, clinics, and other facilities in developing nations poses occupational and public health risks to patients, health workers, waste handlers and the general public. Medical waste management has a negative impact on the local environment (air pollution, soil, water), habitats and life forms (including humans). Therefore, all healthcare workers should know more about medical waste management and how to recycle and transport waste safely.

II. Learning objectives

After the completion of this module, students should be able to:

1. Identify the main categories of healthcare waste.
2. Identify the risks associated with healthcare waste.
3. Understand the principles of sustainable healthcare waste management.

III. Major concepts

This module provides knowledge related to concepts, categories of healthcare waste, risks associated with health-care waste and healthcare waste management.

1. Healthcare waste: definition, categories, and sources

1.1. Definition

Health-care waste includes all the waste generated within health-care facilities, research centers and laboratories related to medical procedures. In, addition, it includes the same types of waste originating from minor and scattered sources, including waste produced in the course of health care undertaken in the home (e.g. home dialysis, self-administration of insulin, recuperative care) (WHO, 2014).

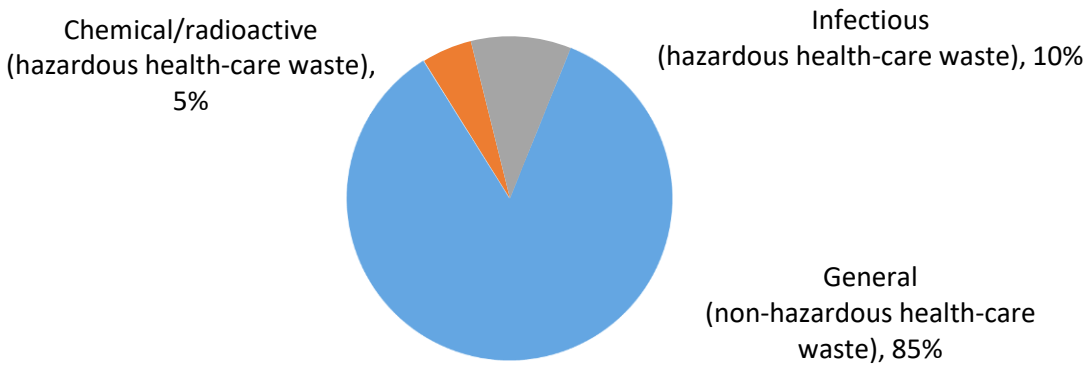

Figure 10: Waste compositions in healthcare facilities (WHO, 2017)

1.2. Categories

Healthcare waste can be divided into **hazardous** healthcare waste and **non-hazardous** or **general healthcare waste** (Table 3).

Table 3: Categories of healthcare waste

Waste category	**Descriptions and examples**
Non-hazardous or general healthcare waste	
Waste that does not pose any particular biological, chemical, radioactive or physical hazard.	
Hazardous healthcare waste	
Sharps waste	Used or unused sharps, e.g., needles, hypodermic needles, blades, knives, infusion sets, scalpels, broken glass, and pipettes.
Infectious waste	Waste known or suspected to contain pathogens and that poses a risk of disease transmission, e.g., waste contaminated with blood and other body fluids such as laboratory cultures and microbiological stocks.
Pathological waste	Human tissues, organs; body parts; fetuses; unused blood products.

Waste category	Descriptions and examples
Non-hazardous or general healthcare waste	
Waste that does not pose any particular biological, chemical, radioactive or physical hazard.	
Hazardous healthcare waste	
Pharmaceutical waste, cytotoxic waste	Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals. Cytotoxic waste containing substances with genotoxic properties.
Chemical waste	Waste containing chemical substances consisting of discarded solid, liquid, and gaseous chemicals, for example from diagnostic and experimental work and from cleaning and disinfecting procedures.
Radioactive waste	Waste containing radioactive substances, e.g., radiotherapy waste contaminated with blood and other body fluids.

(WHO, 2017)

2. Risks associated with healthcare waste

2.1. Persons at risk

Individuals who are in proximity with hazardous healthcare waste are potentially at risk, including those working within healthcare facilities who generate hazardous waste, and those who handle or contact with such waste in a careless manner (WHO, 2014).

According to WHO (2014), the main groups of people at risk are:

- Medical doctors, nurses, health-care auxiliaries, and hospital maintenance personnel
- Patients in healthcare facilities or receiving home care.
- Visitors to healthcare facilities
- Workers in support services, such as cleaners, people who work in laundries, porters.
- Workers transporting waste to a treatment or disposal facility.

- Workers in waste-management facilities (such as landfills or treatment plants) and informal recyclers. The general public could also be at risk whenever hazardous healthcare waste is abandoned or disposed of improperly.

2.2. Risks associated with hazards from infectious waste and sharps

According to WHO (2014), whenever the waste is not professionally managed, pathogens in infectious waste may enter the human body through several routes: through a puncture, abrasion or cut in the skin, through mucous membranes, by inhalation, or by ingestion. The transmission of infection and its control follows the chain of infection, and health workers must understand the significance of each link and how the chain can be interrupted. Some potential infections caused by exposure to healthcare waste include:

- Gastroenteric infections: causative organisms are Enterobacteria (e.g., Salmonella, Shigella spp., Vibrio cholerae, Clostridioides difficile). They are transmitted through faces and/or vomit.

- Respiratory infections: causative organisms are *Mycobacterium tuberculosis,* Measles virus*, Streptococcus pneumoniae,* severe acute respiratory syndrome (SARS). They are transmitted through inhaled secretions and/or saliva.

2.3. Risks associated with hazards from chemical and pharmaceutical waste

Many of the chemicals and pharmaceuticals used in healthcare are hazardous. They may cause intoxication, either by acute or chronic exposure, or physical injuries – the most common being chemical burns. Intoxication can result from absorption of a chemical or pharmaceutical through the skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes or the mucous membranes of the airways can occur by contact with flammable, corrosive or reactive chemicals (WHO, 2014).

2.4. Other risks

Hazards from genotoxic waste, hazards from radioactive waste, and hazards from health-care waste-treatment methods.

3. Healthcare waste management

3.1. Segregation of healthcare waste

According to WHO (2014), there are general principles of waste segregation, storage and transportation r that must be followed, from generation to disposal (Table 4).

Table 4: General principles of waste segregation

General principles of waste segregation
Healthcare waste is generated in a medical area and should be segregated into different fractions, based on their potential hazard and disposal route, by the person who produces each waste item.
Separate containers should be available in each medical area for each segregated waste fraction.
Waste containers, when filled, should be labelled to help managers control waste production.
Closed local storage inside or near to a medical area may be needed if waste is not collected frequently.
Hazardous and non-hazardous wastes should not be mixed during collection, transport or storage.
Collected waste is often taken to central storage sites before onsite or offsite treatment and disposal.
Staff should understand the risks and safety procedures for the waste they are handling.

(WHO, 2014).

The segregation of non-hazardous waste, potentially infectious waste, and used sharps into separate containers is often referred to as the “three-bin system” (Figure 11). Further types of containers can be used for other categories of wastes, such as chemical and pharmaceutical wastes, or to separate out pathological waste, where it is to be handled and disposed of in diverse ways from the other portions of the waste flow (WHO, 2014 & 2017).

Figure 11: *Three-bin segregation system*

Source: World Health Organization (2017). Safe Management of Wastes from Health-Care Activities: A Summary. Geneva: World Health Organization. (WHO/FWC/WSH/17.05). License: CC BY-NC-SA 3.0 IGO.

3.2. Waste containers, color codes and labels

Many countries have national legislation that prescribes the waste segregation categories to be used and a system of color coding for waste. Where there is no legislation, the World Health Organization provides a scheme (Table 5).

Table 5: WHO-recommended segregation and collection scheme

Waste categories	Color of container and markings	Type of container
Infectious waste	Yellow, marked “HIGHLY INFECTIOUS”, with biohazard symbol.	Leak-proof durable plastic bag placed in a container (bags for highly infectious waste should be autoclaved)
Pathological and anatomical waste	Yellow with biohazard symbol.	Leak-proof durable plastic bag placed in a container
Sharp waste	Yellow, marked “SHARPS”, with biohazard symbol.	Puncture-proof container

Chemical and pharmaceutical waste	Brown, labelled with appropriate hazard symbol.	Plastic bag or rigid container
Radioactive waste	Labelled with radiation symbol.	Lead box
General healthcare waste	Black	Plastic bag inside a container or container which is disinfected after use

Adapted from WHO (2017) and ICRC (2020)

Internationally, some countries have adopted WHO's recommendations and other standards and developed their own normative policies. For example, Vietnam developed a circular on healthcare waste management within healthcare facilities adapted from WHO's recommendations (MOH, 2021).

3.3. Key aspects related to healthcare waste management, namely its segregation

Within each major category (e.g., non-hazardous, potentially infectious, used sharps), further segregation may be advantageous. For example, general non-hazardous waste can be broken down into recyclables, biodegradable waste, and non-recyclable portions. If these are mixed at the point of generation, it may prevent recyclables from being recovered.

According to WHO (2014), highly infectious waste, such as diagnostic laboratory samples and waste from infectious patients in isolation, should be collected separately and autoclaved at the point of generation. Once disinfected, the waste would leave a medical area in the infectious health-care waste container.

Anatomical waste, particularly recognizable body parts or fetal material, should be handled according to prevailing religious and cultural preferences (most commonly, authorized burial or cremation).

Sharps waste (needle and syringe combination) should be placed directly into a sharp's container. In some places, it is permitted for syringes to have their needles removed or destroyed before placing the syringe in an infectious waste bin. Any removed needles are placed in a puncture-proof container and dealt with accordingly. This approach is not universally accepted as best practice.

Different chemical and pharmaceutical wastes should be segregated and collected separately: subcategories include mercury, batteries, cadmium-containing wastes, photo chemicals, stains and laboratory reagents, cytotoxic drugs, and other pharmaceuticals. All should be clearly labelled with the type of waste and the name of the major chemical, with any necessary hazard labels (corrosive, flammable, explosive or toxic chemicals) attached. Liquid chemical waste should be stored in strong leak-proof containers (never be mixed or disposed of down the drain).

Medical staff should be encouraged to think of waste disposal as part of a patient's treatment, so all aspects of the care process are completed at the bedside or treatment room. It is important that appropriate waste receptacles (bags, bins, sharps boxes) should be available to staff in each medical and other waste-producing area in a health-care facility. This allows staff to segregate and dispose of waste at the point of generation and reduces the need for staff to carry waste through a medical area. Posters showing the type of waste that should be disposed of in each container should be posted on the walls to guide staff and reinforce good habits.

A mobile trolley with infectious waste and sharp containers may therefore be more versatile and should be given sincere consideration. The alternative is establishing a limited number of locations in a medical area where general waste (black bags) and infectious health-care waste (yellow bags and sharps containers) are placed. The locations should be away from patients; typical sites are the sluice (utility) room, treatment room and nurses' station.

Where containers for segregating hazardous and non-hazardous health-care wastes are in use, they should be located close together, wherever possible. Containers for infectious

waste should not be placed in public areas because patients and visitors may use the containers and encounter potentially infectious waste items.

Organic waste often contains too many liquids to be suitable for incineration with volume reducers or batch auto-combustion incinerators. The temperature reduction due to the evaporation of the liquids will result in formation of more toxic gases, survival of potential thermoresistant pathogens or even bringing the combustion to a halt.

4. Conclusion

In summary, this module has covered knowledge related to medical waste management, including the definition of medical waste, categories of medical waste, source of medical waste, the risks associated with medical waste for healthcare providers, and the importance of proper medical waste management. Implementing safe medical waste management practices not only contributes to a cleaner hospital environment but also reduces the risks posed to patients, healthcare providers, and the community. Furthermore, safe medical waste management helps to prevent the spread of bloodborne viruses like Hepatitis B, Hepatitis C, HIV, and other microbiological pathogens.

IV. Post-test

Please select the correct answers to the following questions or statements.

1. Which of the following statements are true?

A. Healthcare waste must be analyzed according to its origin, whether it is hazardous or non-hazardous.

B. Healthcare waste is a particular problem because it always poses a threat to the environment.

C. Healthcare waste produced in the course of home care is not dangerous as it originates from minor and scattered sources.

2. Hazardous healthcare waste includes:

A. Used or unused sharps, infectious and pathological waste, cytotoxic and chemical waste

B. Used or unused sharps, infectious and pathological waste, pharmaceutical and cytotoxic waste, chemical and radioactive waste

C. Used sharps, infectious and pathological waste, pharmaceutical and cytotoxic waste, radioactive waste

3. Sharps are objects that can cause cuts or puncture wounds, including:

A. Needles, hypodermic needles, scalpels and other blades, knives, infusion sets, saws.

B. Needles, hypodermic needles, knives, infusion sets, saws, broken glass, and pipettes.

C. Needles, hypodermic needles, scalpels and other blades, knives, infusion sets, saws, broken glass, and pipettes.

4. Infectious waste is:

A. Waste suspected of containing pathogens that may cause disease in susceptible hosts.

B. Waste suspected of containing pathogens (bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts.

C. Waste suspected of containing pathogens (bacteria, viruses, parasites, or fungi) in concentrations that may cause disease in susceptible hosts.

5. Chemical waste consists of:

A. Discarded solid, liquid, and gaseous chemicals that are considered hazardous waste regardless of its specific properties.

B. Discarded solid, liquid, and gaseous chemicals that can be hazardous or non-hazardous depending on their specific properties.

C. Discarded liquid and gaseous chemicals that can be hazardous or non-hazardous depending on their specific properties.

6. Select from A to C the one that best completes the sentence. “The fundamental reason for implementing a system of healthcare waste management is…”

A. The protection of the health of staff, patients, and the public that could be at risk if healthcare waste is abandoned or disposed of improperly.

B. The protection of the health of healthcare staff and patients that could be at risk if healthcare waste is abandoned or disposed of improperly.

C. The protection of the health of staff and the public that could be at risk if healthcare waste is abandoned or disposed of improperly.

7. Select the best option to complete the sentence. “There are several routes for pathogens...”

A. To enter the human body, namely throughout a puncture or cut in the skin, by inhalation, ingestion or through mucous membranes.

B. To transmit infection. In what concerns waste infection, there is no relation with chain of infection.

C. To enter the human body, meaning that the only secure way to prevent infection is with adequate medication.

8. Select the best option to complete the sentence. “Healthcare staff, both medical and nurse staff should be...”

A. Encouraged to think of waste disposal as part of a patient's treatment, so all aspects of the care process are completed at the bedside.

B. Responsible for the patient's treatment and leave waste management for the experts on the subject.

C. A part of the process of waste management, but as supervisors.

9. Select the best option to complete the sentence. "It is important that appropriate waste containers are available to staff..."

A. In all medical and public areas to facilitate waste segregation and promote good habits.

B. In all medical and other waste-generating areas of a healthcare facility to separate and dispose of waste at the point of generation.

C. So that waste can be segregated and disposed of near the patients and contamination is reduced.

10. Select the best option to complete the sentence. "All sharp materials must be placed in..."

A. A durable plastic, yellow bag.

B. A puncture-proof container that must be securely closed when it is no more than ¾ full. All colors can be used.

C. A puncture-proof container that must be securely closed when it is no more than ¾ full. The color of the container depends on the origin of the material.

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Module 11. Environmental control and decontamination of surfaces in healthcare facilities

I. Overview

This module addresses the most critical aspect in cleaning and disinfecting healthcare facilities to avoid infectious outbreaks. This module has three parts: Infection in the healthcare environment, Cleaning and disinfection in healthcare environment, and cleaning procedur

II. Learning objectives

After the completion of this module, students should be able to:

1. Apply knowledge to prevent and control the infections caused by airborne pathogens, water, vector, and food.

2. Reduce microbiological contamination to transform the healthcare environment into a safe environment for patients and healthcare workers.

3. Prevent and control HAIs through proper cleaning and disinfection in healthcare environment.

III. Major concepts

1. Introduction

Healthcare environments (i.e., all surfaces and objects within it) play a key role in the spread of pathogenic microorganisms, causing HAI in patients, staff, and visitors. Many of these microorganisms are multi-resistant, even more in humid and dirty environments, as they favor its growth. Therefore, maintaining a clean environment and high hygiene levels are crucial to reducing their transmission.

Cleaning and disinfecting healthcare environments constitute a first-order preventive action strategy. Contaminated environmental surfaces play a significant role in the transmission of pathogens. Most of these pathogens persist in the environment for days or months, frequently contaminating the environmental surfaces of patient rooms (Piedrahita, et al., 2017), colonizing the hands of healthcare personnel (Siani & Maillard, 2015; Stiefel et al. 2011) and causing infectious outbreaks. Evidence shows that environmental cleaning and disinfection constitutes, together with medical devices and equipment, a basic strategy in the

prevention of infections to avoid the transmission of pathogens. This strategy will be successful if based on continuous healthcare personnel training, direct feedback, and strong commitment of institutional managers in its implementation (Han et al. 2015).

Cleaning is a complex process that includes the physical action of cleaning a surface to eliminate organic and inorganic material, followed by disinfection to eliminate pathogenic microorganisms, and a final control to guarantee its effectiveness. Factors influencing the effectiveness of correct cleaning and disinfection of surfaces are: Inorganic charge present on the surface, type and level of microbial contamination, concentration and time of exposure, the physical nature of the object, presence of biofilm, temperature and PH of the disinfection process and the relative humidity of the sterilization process (Donskey, 2013).

2. Infection in the healthcare environment

HAIs are caused by the patients' contact with three main sources: patients' own flora, pathogens present in other patients or in health personnel, and pathogens present in the hospital environment. Microorganisms of environmental origin can be transmitted by direct or indirect contact, namely with surfaces, inhalation, through water, food, and intravenous solution (Rutala & Weber, 2019).

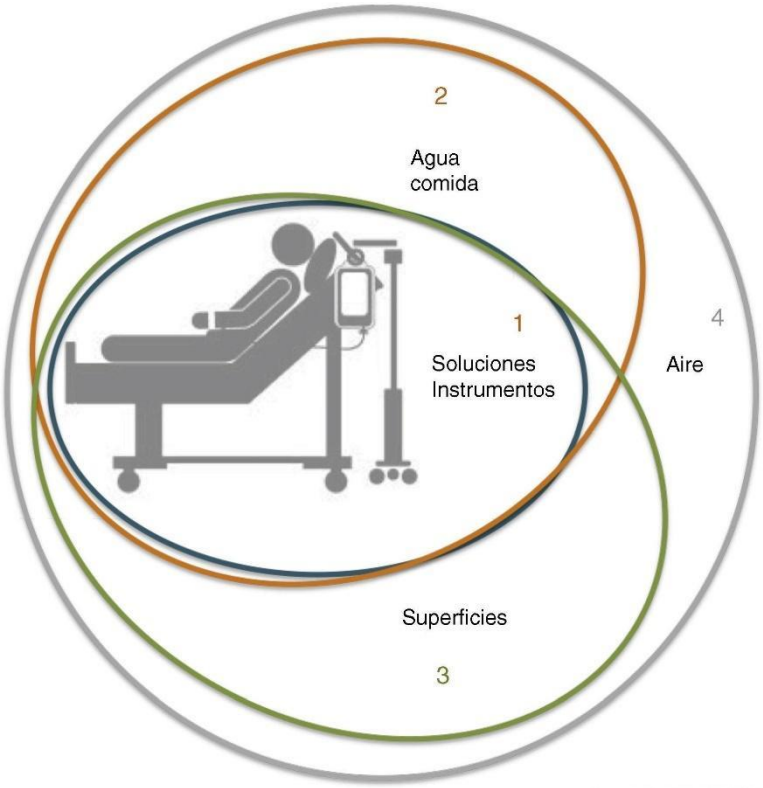

Figure 12: Classification of environmental areas based on proximity to the patients.

Source: López-Cerezo, 2014

2.1. Air as a source of infection

Three types of airborne pathogens can be classified: Pathogens transmitted through the air from an infected patient to a non-infected patient, usually via respiratory route; Pathogens transmitted through the air from contaminated surfaces or infected patients, but are acquired via non-respiratory means; and Pathogens traditionally considered airborne, such as Aspergillus spp. Hospitals implement several strategies to prevent the aerial spread of these pathogens such as anti-aerosol cleaning procedures, air ventilation, filters, rooms with negative pressure, automatic disinfection systems, etc.

2.2. Water as a reservoir and source of infection

Moist environments and aqueous solutions in healthcare settings can serve as reservoirs for waterborne microorganisms. Modes of transmission for waterborne infections include direct contact, ingestion of water, indirect-contact transmission, inhalation of aerosols

dispersed from water sources and aspiration of contaminated water. Additionally, this transmission can occur through transfer from contaminated surfaces via the hands of personnel or when bacterial endotoxins are transferred through the dialysis membrane in hemodialysis machines.

2.3. Food as a source of infection

For this category, two groups of pathogens are considered: those related to gastroenteritis (*Salmonella enterica, Baccillus cereus and Listeria monocytogenes*) and those acquired by eating food, but which produce non-intestinal infections.

2.4. Surfaces

Contamination of surfaces in patient settings is one of the most controversial aspects of HAI control and prevention. Some aspects to consider include survivability on inanimate surfaces, difficulty of eliminating the pathogens in surfaces, and lack of surface cleaning control standards for nosocomial pathogens.

Traditionally, the CDC does not recommend the study of the surfaces, except for outbreak situations (WHO, 2007), meaning the information available comes from the analysis of surfaces in outbreaks and a few experimental studies of transmission control interventions. Most nosocomial pathogens can survive on dry inanimate surfaces for hours to months.

Table 6: Persistence of nosocomial agents on inanimate surfaces

Type of microorganism	**Duration of persistence (range)**	**Type of microorganism**	**Duration of persistence (range)**
Gram-negative bacteria		**Gram-positive bacteria**	
Acinetobacter	3 days - 5 months	C. difficile (spores)	5 months
P. aeruginosa	6h - 16 months	Enterococcus	5 days - 4 months
Klebsiella	2h - 30 months	S. aureus	7 days - 7 months

Yeast		**Virus**	
C. albicans	1 day -120 days	Rotavirus	2 months
C. parapsilosis	14 days	Norovirus	42 days

Modified by Kramer et al. (2006) (pp-27)

3. Cleaning and disinfection in healthcare environment

A clean healthcare unit should be a protective factor against transmittable diseases. Therefore, any environmental cleaning and disinfection program must seek to reduce the risk of pathogen transmission. Although microbiologically contaminated surfaces can be a source of contagion, they are not the most common. Instead, the main route of transmission is hand-to-surface contact, so hand hygiene and cleaning and disinfection of environmental surfaces are key to reducing transmission (Kanamori et al., 2017).

Every environmental cleaning program begins by forming a multidisciplinary team, where each discipline must be represented so that cleaning policies and procedures are well defined. This team should include members of the administration, nursing, environmental services, hospital epidemiologist (infection prevention, preventive medicine, and public health), administration personnel, biomedical engineering, pharmacy, and laboratory personnel (Otter et al., 2013).

In this program, the direct cleaning personnel play a special role, cleaning all surfaces on a daily basis and maintaining hygienic conditions in health facilities (WHO, 2005).

Their daily responsibilities are:

- Classify the different divisions of the hospital according to their different cleaning needs.

- Establish rules on appropriate cleaning techniques (procedure, frequency, the agents used in each type of room).

- Establish rules for the collection, transport, and disposal of different types of waste.

- Make sure that soap and paper towel dispensers are regularly filled.

- Inform the maintenance service personnel about any building problem that needs repair: cracks, defects in sanitary or electrical equipment, etc.

- Maintain flowers and plants in public areas.

- Control pests (insects, rodents).

- Offer appropriate training to new employees, and special training when a new technique is introduced.

- Establish cleaning and disinfection methods for bedding.

- Determine the frequency of curtain washing (of windows and patient partitions).

- Review renovation plans or modern furniture to determine the feasibility of cleaning.

To properly comply with the cleaning program, the staff involved should undergo continuous training that prioritizes personal hygiene, hand washing, and cleaning methods. Likewise, fluid communication between cleaning and healthcare personnel is necessary to solve problems related to cleaning protocols, products and materials. The staff should also be alert to infections and report them immediately (WHO, 2005).

4. Cleaning procedures

4.1. Cleaning procedures

Cleaning is intended to break pathogen transmission mechanisms to reduce the risk of HAIs and cross-contamination (Rutala & Weber, 2013a).

According to Rutala and Weber (2013a), there are four factors involved in effective cleaning: water temperature, disinfectants, mechanical action, and cleaning time. This cycle is followed by a disinfection procedure to eliminate microorganisms that can survive in the environment for extended periods of time.

Effective routine cleaning is key in this regard, especially when many pathogens can persist for extended periods of time on inanimate surfaces. Transmission through the environment may also occur as there is scientific evidence of infections in patients by organisms acquired from inanimate environments (Dancer, 2014; Doll et al., 2018). It should be noted that 30%-40% of HAIs are caused by the contamination of the hands of staff

personnel by direct contact with infected or colonized patients or with the environment (Dancer, 2014).

The recommendations for surface cleaning may vary due to certain products, such as soap and water, or disinfectants. The effectiveness of disinfectants varies according to the concentration of the product, the time of contact with surfaces, the type of bacteria or viruses, and the maintenance of cleaning utensils.

There is epidemiological evidence associated with the use of surface disinfectants or detergents in non-critical environmental surfaces. All critical surfaces due to their high potential for cross-transmission of pathogens should be cleaned with disinfectants.

4.2. Use, concentration and type of detergent and disinfectants

Cleaning products and disinfectants are essential for effective hospital cleaning. Their correct use provides a barrier against existing germs on surfaces, hence their importance in the prevention of hospital infection. They should always be used at the recommended doses, as a lower dose does not prevent the emergence of germs, while a higher dose is not only not any more effective, but also toxic to cleaning personnel.

Disinfecting solutions must be stable and freshly prepared. In addition, they must be changed frequently to avoid contamination and always consider the conditions of stability of the product.

All cleaning and disinfection products should comply with current regulations in this regard, be authorized by the Ministry of Health, and follow the manufacturers' instructions.

Rotation of disinfecting agent is convenient to avoid the formation of resistant strains.

4.3. Cleaning and disinfection techniques

Cleaning is the removal of substances from a surface or object without causing damage. There are several types of cleaning techniques:

- *Routine cleaning:* Done by basic cleaning techniques.

- *General cleaning:* Carried out with caution; in addition to cleaning daily use surfaces, walls and ceilings are also cleaned and, if necessary, furniture structures are moved and / or disassembled. It must be done periodically (weekly, monthly, etc. as established).

- *Terminal cleaning:* Performed when a process ends to make the area operational again.

- *Special cleaning* carried out in exceptional situations. An example of special cleaning is that which can be performed in an operating room after the vents are removed to clean its interior surface. All non-fixed furniture is taken out of the operating room and disassembled so that it is thoroughly cleaned. Outside areas are also cleaned thoroughly

- Disinfection: A process that removes most or all the pathogenic microorganisms from the instrument but does not kill bacterial spores. There are 3 levels of disinfection: low, medium, and high.

4.4. General cleaning rules

Cleaning staff should wear waterproof aprons and rubber gloves (not latex). A disinfectant-impregnated microfiber cloth is used to guarantee that germs are not transmitted, exempting cleaning personnel from washing their hands before and after cleaning each room or area. However, hand washing is necessary in several situations:

- At the beginning and end of the daily workday.

- When entering an isolation room.

- After cleaning an isolation room or area where a patient with isolation measures resides.

- After using the toilet and when necessary.

- Personnel must be vaccinated against hepatitis B, wear mask and protective goggles when handling irritating products that may pose a risk of splashing.

- Ventilate the room in which any type of cleaning is to be carried out.

Cleaning will be done...

- With maximum silence and respecting the assigned schedule. If work is interrupted, no element or item will be left that could potentially interrupt the flow of personnel.

- Starting in the cleanest areas and finishing in the dirtiest areas, from the inside out and from the top down, adapting to the work routine of the unit itself and respecting the established frequency.

- Wet sweep is recommended.

- The cleaning of surfaces and elements will be carried out with a water and detergent/ disinfectant solution in adequate concentrations.

- As a cleaning product, detergent is acceptable for surfaces in most areas. A disinfectant is recommended for cleaning pediatric areas, intensive care, emergencies, and operating rooms.

- Cleaning and disinfection products must be used following the manufacturer's instructions.

- Cloths will be of an assorted color, depending on the area and surface to be cleaned, using a double bucket (product/ rinse).

- Regardless of the frequency established in the work protocol, cleaning must be carried out in case of any anomaly or deficiency.

- Cleaning in areas with daily presence of patients, family members, or healthcare personnel must be carried out with the same procedure and intensity on working days and on holidays or weekends.

- Immunosuppressed patient rooms should be cleaned first.

- Infectious isolation rooms should be cleaned last.

- Cleaning and waste collection should not be done at the same time as the distribution of food or clean clothes.

- Waste should be collected following hospital regulations, but at least every time an area is cleaned.

4.5. Materials and products

The staff should have all the necessary materials in the cleaning cart equipped for this purpose.

Materials: The cleaning trolley should have two well-defined areas: clean and dirty.

- The cleaning trolley should have: A double-bucket system (blue and red) and a mop; A microfiber mop system with a lower tray with a draining bucket and support to hold dirty mops.

- The cleaning trolley should also have: Two small buckets, cloths of different colors, long poles for accessing difficult surfaces, a broom and dustpan set, bin liners, two pairs of different colored rubber gloves, a ballpoint pen, a notebook to record incidents, waste collection bags, a caution sign for wet floor. All products must be approved by each hospital and the Ministry of Health.

In critical or high-risk areas, specific material should be used for each area or room and staff should wear protective glasses.

4.6. Material maintenance

All materials must be thoroughly rinsed when finishing each zone and before moving to the next to avoid transforming cleaning into a contamination source. At the end of each shift and working day, all materials should be washed and disinfected with a detergent-disinfectant solution for 15 minutes. Materials should be dried for next shift use. Mop heads should be dried upright, , cloths should be air dried , and buckets should be dried, cleaned, and turned upside down. Cloths, mops, buckets, carts, and sticks or handles should be cleaned. Cleaning materials should be stored clean in a designated area.

IV. Post-test

Choose the right answer to the following questions:

1. Which hospital area or zone has a high risk of infection?
   A. Medical exploration areas.
   B. Older and chronic patient areas.
   C. Icu (intensive care unit)
   D. Er (emergency room)
2. Why is cleaning and disinfection important in healthcare environments?
   A. Because it promotes the well-being of patients.
   B. Because it improves hygiene and prevention.
   C. Because it is part of patient safety.
   D. Because the regulations require it.
3. The hospitals where patients have a higher risk of developing HAIs are
   A. The possibilities of infection are the same in all hospitals.
   B. Small acute hospitals.
   C. Chronic hospitals.
   D. Teaching hospitals.
4. The hospital disinfection protocol for environmental surfaces should be designed by
   A. Nursing staff
   B. Clinical assistants
   C. Preventive medicine staff
   D. A multidisciplinary team
5. A relevant factor in the effectiveness of hospital cleaning is
   A. Appropriate cleaning time
   B. Preventive medicine staff
   C. Adequate disinfectant
   D. All of the above.

6. Surface cleaning is a complex process that includes:

A. Controlling the efficiency of the entire process

B. Disinfection to remove pathogenic microorganisms.

C. The removal of organic and inorganic material.

D. All options are correct.

7. Which factors influence the effectiveness of surface cleaning and disinfection?

A. Concentration and time of exposure to the germicide

B. Physical force during cleaning

C. Sterilization of equipment

D. Test cultures

8. What is cleaned in the room after the patient is discharged?

A. Wardrobe, tables, and armchairs

B. Everything because of general cleaning

C. Room's bathroom surfaces

D. Headboard, bed, and mattress

9. Which hospital service is responsible for cleaning and disinfection to prevent infections?

A. Infectious Disease Service

B. Preventive Medicine Service

C. Internal Medicine Service

D. Occupational Health Service

10. Areas with patients, family members, or healthcare staff should be cleaned

A. Monthly

B. Weekly

C. Upon patient discharge

D. Every day

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CONCLUSIONS

The PrevInf project has generated an innovative set of educational resources for nursing students, teachers, and tutors. These resources, including the PrevInf model, HAIs-PC e-books, and scenario-based simulation learning structure, have redefined our approach to IPC education. By promoting the essential capability of infection prevention and control, we are taking significant measures to ensure patient safety and minimize human and financial damage in healthcare settings throughout Asia.

The introduction of these educational materials into nursing education ensures an equal standard of expertise in HAIs-PC, ultimately raising the status of Asian nurses and nursing education. In addition, these innovative resources can have broader applications, such as contributing to the development of healthcare professionals, especially those trained abroad or returning to work after a break.

The project will help improve the quality of Asian nursing education, leading to safer patient care. This initiative will potentially serve as a model for successful collaboration between European and Asian nursing education and set a precedent for the joint advancement of healthcare education.

Incorporating this model into educational programs across Asia is a pivotal step in shaping the future of IPC. Universities must tailor incorporation to their specific needs and recognize opportunities to replace traditional teaching methods with e-learning tools such as e-books and simulation. E-learning can empower health students to take charge of their own learning, fostering their independence and competence in HAI-PC. Furthermore, faculty can focus on other essential aspects of student development and assessment.

Each module of the e-book provides concise content descriptions, up-to-date references and self-assessment quizzes, making it a comprehensive resource for students. Additionally, the e-book is an invaluable guide for teachers and platforms that facilitates scenario-based simulation training and debriefing. The user-friendly approach ensures that both students and educators can easily implement simulation-based learning.

Our educational outputs are based on research evidence and validated teaching methods and provide a strong foundation for nursing education. When applied on a larger scale, these outputs will produce valuable data for nursing education in Asia, particularly in the area of IPC, over the next decade. In addition, this content has been designed to allow for future updates, ensuring their continued relevance and effectiveness in an ever-evolving healthcare landscape.

Throughout the development phase of the project, we gathered extensive feedback from stakeholders and refined our outputs based on qualitative and quantitative evidence. The PrevInf model, e-book, and simulation scenarios, complete with instructions, are now ready for implementation. However, we recognize that nursing education is a dynamic field that requires constant adjustments. The COVID-19 pandemic has highlighted the need to continuously update and evaluate curricula to reflect the latest evidence-based practices.

We are pleased to announce that these outputs will be integrated into the curricula of partner universities and disseminated throughout Vietnam and Cambodia. The PrevInf or InovSafeCare community will play a crucial role in disseminating the project's knowledge and experience and promoting international collaboration. Furthermore, we plan to expand our simulation-based educational approach to other nursing topics to increase its impact in health education.

Nursing education is closely linked to healthcare practice, making our project a catalyst for greater collaboration between academia and the healthcare sector. Representatives from industry have shown great interest in our project, and their feedback on student competence will provide valuable insight into the effectiveness of our educational methods. We are proud to promote sectoral collaboration in IPC, contributing to an open and collaborative culture among nursing schools in Asia.

In conclusion, the PrevInf project is an example of the potential of international collaboration to address urgent global issues. By improving the competence of health professionals, encouraging universities to collaborate, and promoting a safe work environment, we can prevent future pandemics and ensure the well-being of patients and health professionals worldwide. Together, we can create a safer and healthier wor

Answers key

Module 1: 1 - D; 2 - A; 3 - D; 4 - B; 5 - C; 6 - B; 7 - C; 8 - D; 9 - A; 10 - C.

Module 2: 1 - E; 2 - D; 3 - D; 4 - E; 5 - B; 6 - A; 7 - B; 8 - D; 9 - E; 10 - B.

Module 3: 1 - D; 2 - D; 3 - D; 4 - B; 5 - B; 6 - D; 7 - B; 8 - T; 9 - F; 10 - T.

Module 4: 1 - C; 2 - D; 3 - D; 4 - A; 5 - D; 6 - A; 7 - D; 8 - D; 9 - B; 10 - D.

Module 5: 1 - C; 2 - A; 3 - D; 4 - C; 5 - B; 6 - B; 7 - C; 8 - B; 9 - T; 10 - F.

Module 6: 1 - D; 2 - C; 3 - B; 4 - A; 5 - B; 6 - A; 7 - A, C & D;

8 - *i* - T, *ii* - T, *iii* - F, *iv* - F;

9 - i -T; ii -T, iii -T, iv - F;

10 - i - F, ii - F, iii - T, iv - T

Module 7: 1 - A; 2 - B; 3 -B; 4 - A; 5 - C; 6- A; 7 - D 8 - C; 9 - A; 10 - B.

Module 8: 1 - D; 2 - C; 3 - A; 4 - A; 5 - C; 6- A; 7 - C; 8 - D; 9 - B; 10 - C.

Module 9: 1 - A; 2 - A; 3 - A; 4 - A; 5 - A; 6- D; 7 - D; 8 - D; 9 - B; 10 - A.

Module 10: 1 - B; 2 - B; 3 - C; 4 - B; 5 - B; 6- A; 7 - A; 8 - A; 9 - B; 10 - C.

Module 11: 1 - D; 2 - C; 3 - A; 4 - D; 5 - D; 6- D; 7 - A; 8 - B; 9 - A; 10 - D.

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InovSafeCare Project Extension

Capacitating Asia's Nursing Students on Innovative and Sustainable Prevention and Control of Healthcare-associated Infections

SAVONIA
University of Applied Sciences

Escola Superior de Enfermagem de Coimbra

Co-funded by the Erasmus+ Programme of the European Union

This study was carried out within the scope of the PrevInf Project (618396-EPP-1-2020-PT-EPPKA2-CBHE-JP), co-funded by the Erasmus+ Program of the European Union.