Kingdom of Saudi Arabia
Ministry of Health
General Directorate of Infection Prevention and Control

Healthcare-Associated Outbreak Management Manual

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Message of the General Director

This manual (January 2023 edition) of the “Healthcare-Associated Outbreak Management Manual”, was prepared by the General Directorate of Infection Prevention and Control

(GDIPC) Outbreak Management Department. The current edition aimed at guiding healthcare workers, especially infection preventionists who manage healthcare-associated infections (HAIs) across different levels of Healthcare Facilities in Saudi Arabia. The 7th version included several modifications based on the feedback of fellow professionals.

This manual helps in early detection and notification, proper investigation, management, and control of outbreaks. It is considered an essential strategy for managing healthcare-associated outbreaks in the Ministry of Health and non-Ministry of Health Hospitals.

I encourage healthcare workers to follow and implement this manual with great care, as it is expected to have a beneficial effect in reducing the number of outbreaks and their associated morbidity and mortality.

My sincere thanks to members of the Outbreak Management Department for their contributions and hard efforts in formulating, editing, reviewing, submitting, and publishing this manual.

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General director of infection Prevention and Control, GDIPC, MOH

Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
ARDS	Acute respiratory distress syndrome
ASC	Active surveillance cultures
ATP	Adenosine Triphosphate
BAL	Bronchoalveolar Lavage
C. Diff	Clostridium Difficile
CAP	Community Acquired Pneumonia
CAUTI	Catheter-Associated Urinary Tract Infection
CDC	Centers For Disease Control and Prevention
CDI	Clostridium difficile infections
CHG	Chlorhexidine gluconate
CLABSI	Central Line Associated Bloodstream Infection
CO	Community-onset
COVID-19	Coronavirus Disease 2019
CRE	Carbapenem-Resistant Enterobacteriaceae
CRKP	Carbapenem-resistant Klebsiella pneumonia
CSF	Cerebrospinal Fluid
DNA	Deoxyribonucleic Acid
ELISA	Enzyme-Linked Immunoassay
ESBL	Extended-Spectrum Beta-Lactamases
FFP2	Filtering Face Pieces Offer Protection
GDIPC	General Directorate for Infection Prevention & Control
GIT	Gastrointestinal tract
HAI	Healthcare-Associated Infections
HAIO	Hospital-Associated Infection Outbreaks
HAP	Hospital Acquired Pneumonia
HBsAg	Hepatitis B Surface Antigen
HCW	Health care workers
HEPA	High-Efficiency Particulate Air
HAV	Hepatitis A Virus
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
HO	Healthcare facility-onset
HSCT	Hematopoietic stem cell transplantation
HVAC	Heating, Ventilation, and Air Conditioning.
IC	Infection Control
ICP	Infection Control Practitioner

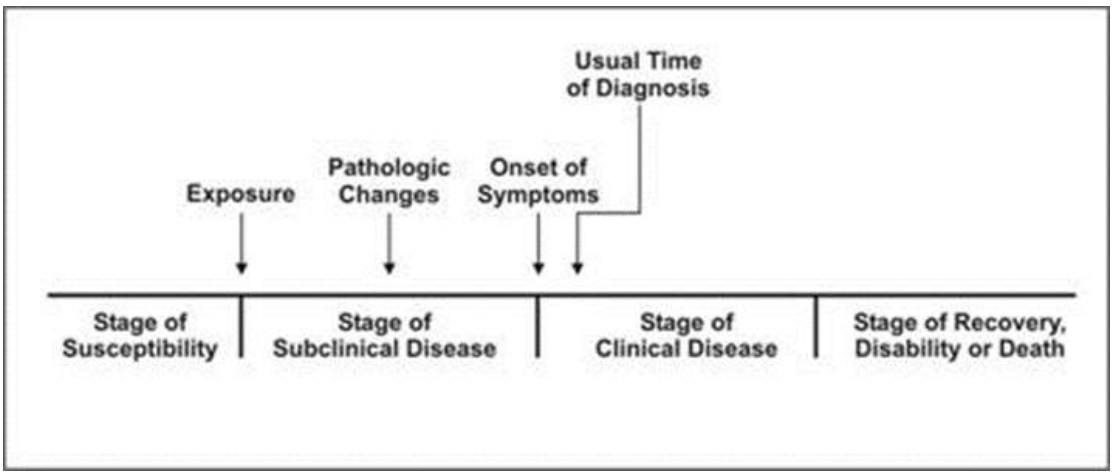
ICU	Intensive Care Unit
ILI	Influenza Like Illness
IP	Infection Preventionist
IPC	Infection Prevention and Control
IT	Information Technology
IV	Intravenous
LCM	Lymphocytic choriomeningitis
MDR	Multidrug-Resistant
MDRO	Multidrug-Resistant Organisms
MDR-TB	Multidrug-Resistant Tuberculosis
MERS-CoV	Middle East Respiratory Syndrome Coronavirus
MMR	Measles, Mumps, and Rubella
MOH	Ministry of Health
MRSA	Methicillin-Resistant Staphylococcus Aureus
MSSA	Methicillin-Sensitive Staphylococcus Aureus
NIAID	National Institute of Allergy and Infectious Diseases
N95	Non-Oil 95 Percent Efficiency Mask
OMAP	Outbreak Management Action Plan
OMT	Outbreak Management Team
OR	Operating Room
PCR	Polymerase Chain Reaction
PDR	Pan-Drug Resistance
PFGE	Pulsed-field gel electrophoresis
PPE	Personal Protective Equipment
RHD	Regional Health Directorate
RNA	Ribonucleic Acid
RSV	Respiratory Syncytial Virus
SARI	Acute Respiratory Infection
SARS	Severe Acute Respiratory Syndrome
SOT	Solid organ transplantation
SSI	Surgical Site Infection
TB	Tuberculosis
UTI	Urinary Tract Infection
VAP	Ventilator-Associated Pneumonia
VRE	Vancomycin-Resistant Enterococci
VZV	Varicella Zoster Virus
WGS	Whole genome sequencing
XDR	Extensive Drug Resistance
WHO	World Health Organization

Table of Contents

Introduction to epidemiology of infectious diseases

Natural course of disease:

It refers to the progression of a disease process in an individual over time in the absence of treatment



Impacts of pathogens:

Infection	Colonization
• Infection is the entry and multiplication of organisms in the tissue of a host. • Infection may be clinical or subclinical and may not produce identifiable disease. • However, it is usually accompanied by measurable host response(s), either through the appearance of specific antibodies or through cell-mediated reaction(s)	• The multiplication of a microorganism at a body site or sites without any overt clinical expression or detected immune reaction in the host at the time that the organism is isolated. • Colonization may or may not be a precursor of infection. • Colonization may be a form of carriage and a potential transmission source. • Commensal or normal flora are microorganisms present in or on a body site without causing clinical infection.

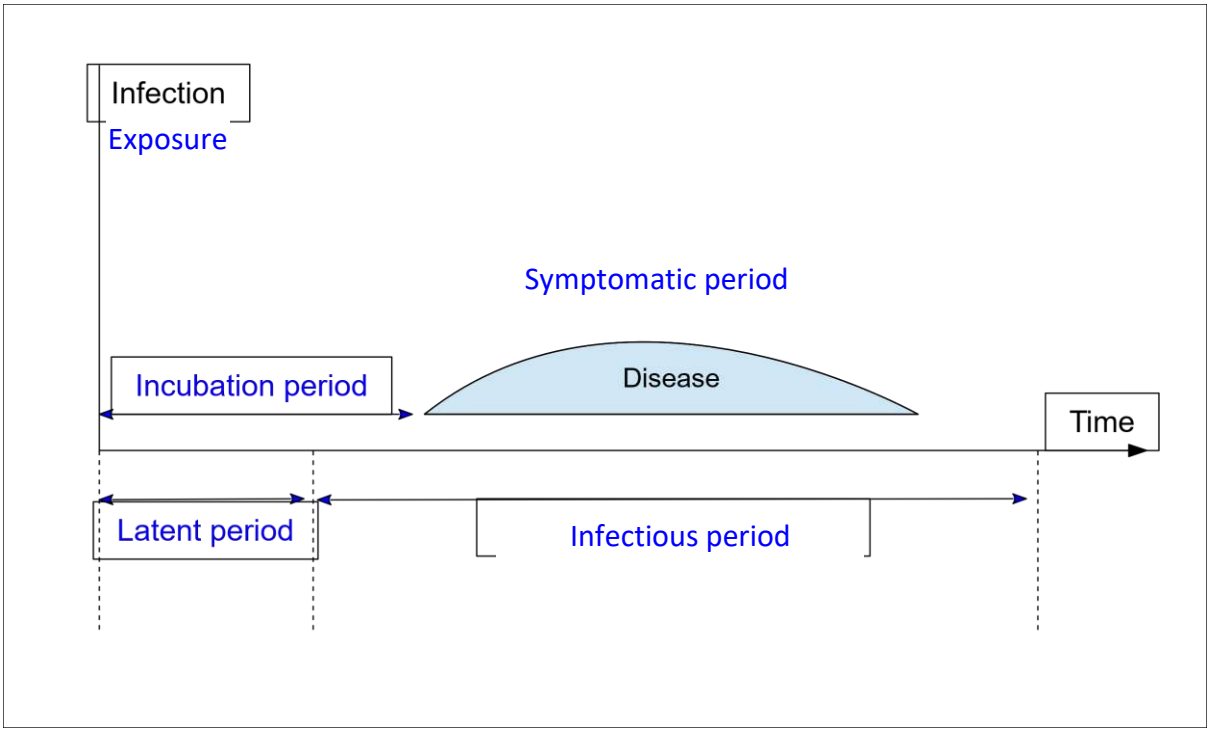
Types of patients:

Case	Carrier
• A case is a person who has the pathogen multiplying (infected) and meets the case definition of a specific disease • A clinical case is a term that refers to overt disease when the signs and symptoms are apparent • The subclinical case is a term that refers to an apparent (subclinical) infection, and an immune response can occur without overt clinical disease.	• A carrier is a person in whom organisms are present and may be multiplying but who shows no clinical response to their presence. • The carrier state may be permanent, with the organism always present; intermittent, with the organism present for various periods; or temporary, with carriage for only a brief period. • Carriers may shed microorganisms during the incubation period and recovery.

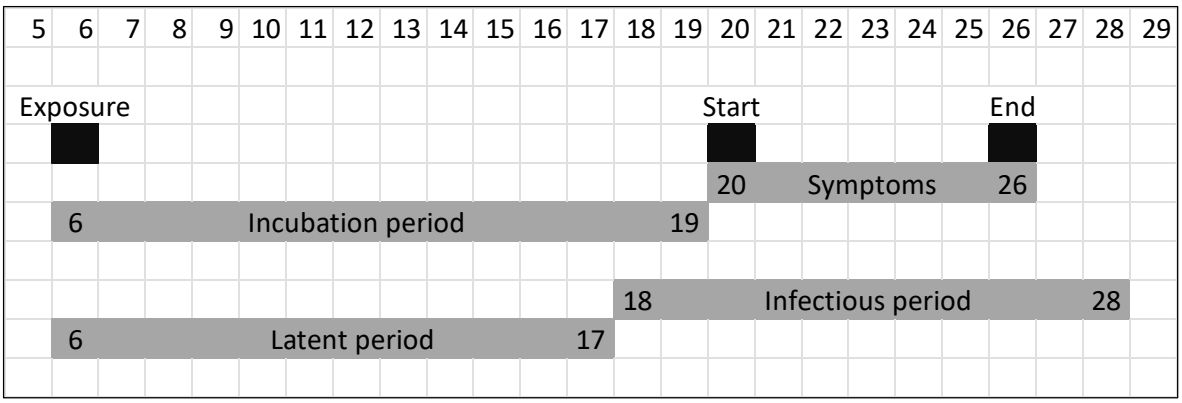
Timelines for infection and disease

Infection-wise	Disease-wise
• **Latent period** (also known as the latency period or the pre-infectious period): It is the time interval from exposure to infection (infected by a pathogen) to infectiousness (capable of transmitting pathogens to other susceptible individuals). • It is usually shorter or sometimes similar to the incubation period	• **Incubation period:** It is the time from exposure to infection (infected by a pathogen) to the development of symptomatic disease (appearance of the first symptom) • It is usually longer or sometimes similar to the latent period. • It determines the duration of quarantine for exposed persons until they can resume regular activities.
• **Infectious period** (also known as the period of communicability or infectivity): It is the time during which the host is infectious (capable of transmitting pathogens to other susceptible individuals) • A related term is a shedding period, which is defined as the period during which a host or patient excretes pathogens through sputum, saliva, urine, feces, or other bodily fluids.	• **Symptomatic period:** It is the period in which characteristic symptoms of the disease are present • Although variable form disease to disease, the patient can be infectious before and after the symptomatic period

For incubation periods of common infectious diseases, see Appendix-1: Incubation periods



Exercise: A child was exposed to a case of chickenpox on Jan 6 and got a fever and rash two weeks later. The blisters have crusted over within a week from the appearance of rash. When is this child considered infectious?



Answer:

- The ***incubation period*** is 14 days (Jan 6 to Jan 19)
- The ***symptomatic period*** is 7 days (Jan 20 to Jan 26)
- The ***infectious period*** is probably 11 days (Jan 18 to Jan 28, as the patient with chickenpox is infectious from 1-2 days before the rash first appears to 1-2 days after the final crop of blisters have crusted over).
- The ***latent period*** is 12 days (Jan 6 to Jan 17)

Case definition:

It is a set of uniform criteria used to define a disease for surveillance purpose. Case definition in an outbreak situation can be divided into three categories:

- **Suspected/possible case:** clinical signs and symptoms without epidemiologic link or laboratory confirmation
- **Probable case:** clinical signs and symptoms with epidemiologic link (been exposed to a confirmed case, eaten the same food, stayed in the same ward, etc.) To a confirmed case
- **Confirmed case:** the diagnosis is confirmed by appropriate laboratory analysis of appropriate specimen(s) with or without clinical signs and symptoms and epidemiologic link

Index case:

The first case among a number of similar cases that are epidemiologically related

Case finding:

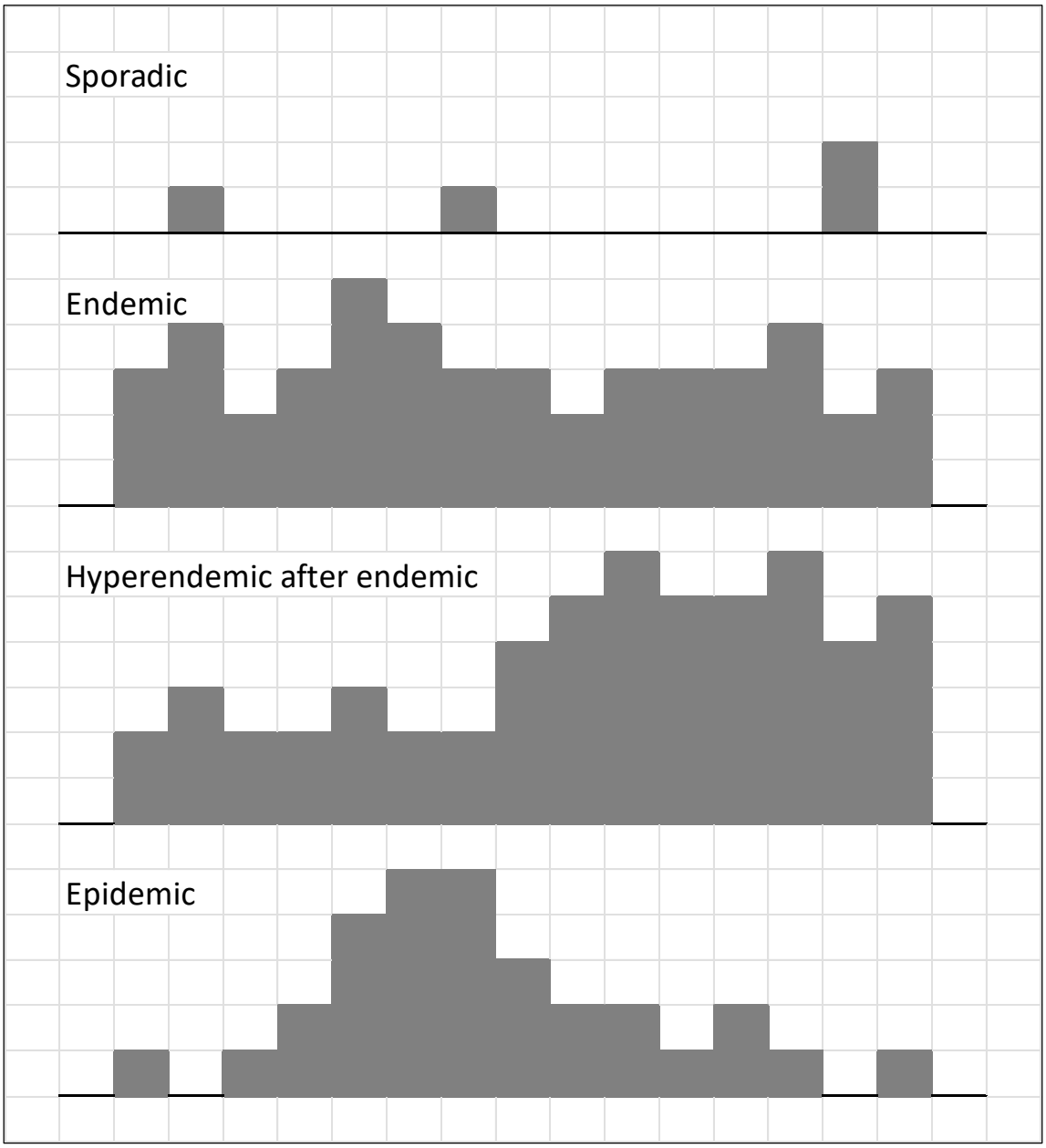
It is a method of identifying patients with healthcare-associated events (infection/colonization) through a combination of reviewing medical records, asking questions directed to patients or HCWs, and checking laboratory, imaging, or other relevant data, if available.

Environmental sampling:

It is the collection of samples from the health care environment or equipment (rather than from humans) that are cultured for microorganisms.

Levels of disease occurrence:

- Sporadic level: occasional cases occurring at irregular intervals
- Endemic level: persistent occurrence with a low to moderate level
- Hyperendemic level: persistently high level of occurrence
- Epidemic or outbreak: occurrence clearly in excess of the expected level for a given time period and location
- Pandemic: epidemic spread over several countries or continents, affecting a large number of people.



Levels of disease occurrence:

Level	Example
Sporadic disease	• A Single case of rabies was diagnosed in a community. • Records showed another 6 cases over the last 2 years. • The duration between cases ranged between 2 and 8 months. • Therefore, rabies spread sporadically in this community. • Similar examples in Saudi Arabia, rubella, tetanus, and MERS-CoV
Endemic disease	• Every year between 2010 and 2020, about 7 to 11 thousand tuberculosis cases were reported in the US (the rate ranged between 2.2 to 3.6 per 100,000). • Therefore, tuberculosis is an endemic disease in the US. • Similar examples in Saudi Arabia, hepatitis-B, salmonellosis, brucellosis, and tuberculosis
Hyperendemic disease	• The Average annual incidence was 364 cases of pulmonary tuberculosis per 100,000 populations in one Indian city, compared with national average of 188 cases per 100,000 populations. • Therefore, pulmonary tuberculosis is hyperendemic in that city. • Similar example in Saudi Arabia, hepatitis B in Jeddah is approximately 31.5 per 100,000 while the national average in 19.8 per 100,000. • Therefore, hepatitis B is hyperendemic in Jeddah.
Epidemic disease	• Health authorities detected 22 cases of legionellosis occurred within 3 weeks among residents of a particular neighborhood (that usually report 0 or 1 case per year). • Therefore, an epidemic of legionellosis can be declared. • Similar examples in Saudi Arabia, COVID-19, influenza, chickenpox, and MERS-CoV
Pandemic disease	• More than 20 million people worldwide died from influenza in 1918–1919. • Pandemics of influenza were re-recorded again in 1957, and 1968, and 2009. • Currently, COVID-19 is considered the biggest pandemic in the current century.

Health care-associated infection (HAI):

- It is an infection that occurs in a patient as a result of care at a healthcare facility that was not present at the time of admission to the facility.
- To be considered an HAI, the infection must be diagnosed after the patient spends more than two calendar days in the healthcare facility. Therefore, HAI can be diagnosed on or after the third day of admission, considering admission on the first day). For example, if admitted Sunday, HAI cannot be diagnosed on Sunday or Monday, and the first acceptable diagnosis of HAI will be Tuesday or after. Note that we are using calendar days (Sunday, Monday, ...etc.). In HAI determination (>2 calendar days).
- The term "healthcare-associated infection" replaces the formerly used "nosocomial" or "hospital" infection because evidence has shown that these infections can affect patients in any setting where they receive health care.

  - It should be noted that HAI and outbreaks are two different terms.
  - Therefore, HAI is not necessarily to be an outbreak (when detected sporadically).
  - Additionally, an outbreak can be due to HAI or non-HAI events (when community infections become the source of in-hospital outbreak).
  - Prevention measures should be implemented for any detected HAIs, whether outbreak or not

Outbreak:

- It is the disease occurrence in a population above the normally expected rates at any given time or location.
- The expected number of cases can be determined through ongoing disease surveillance.
- This involves the systematic collection of numerator and denominator data using standardized case definitions and surveillance methods.

Healthcare-Associated Outbreak:

- It is an increase in the number of healthcare-associated events (infection/colonization) among patients or staff over and above the expected number of cases.

  - Healthcare-associated outbreak is met when there are two or more cases of infection/colonization caused by the same organism, epidemiological linked to the location, exposure, and duration. See below.
  - When outbreak definition is met, record all involved patients, irrespective they have infection or colonization, caused by sensitive or resistant organisms, or meet the definition of HAI or community-related infection. See Presentation by onset time and by symptoms.
  - Once the healthcare-associated outbreak is met, notification process should be started according to the steps described in the Operation of Outbreak

Epidemiological linked cases

- **Epidemiologically linked locations:** Cases involved in the outbreak shared the same unit or stop in one unit (example radiology section) during the course of hospital stay
- **Epidemiologically linked exposure:**
  - ***Human to human transmission:*** Any person who has had contact with a laboratory-confirmed human case in such a way as to have had the opportunity to acquire the infection
  - ***Environmental exposure:*** Any person who has contact with a contaminated environmental source that has been laboratory confirmed
  - ***Exposure to a common source:*** Any person who has been exposed to the same common source or vehicle of infection as a confirmed human case
- **Epidemiologically linked duration:** The duration varies from one infection to another based on the incubation period of different organisms or diseases.

- Outbreaks in healthcare facilities are often multifactorial, including branches in infection control or clinical practices, contaminated devices, and infected or colonized patients and/or HCWs.
- For more details, see Outbreak Classification Matrix- Class A
  Outbreak Classification Matrix- Class B
  Outbreak Classification Matrix- Class C

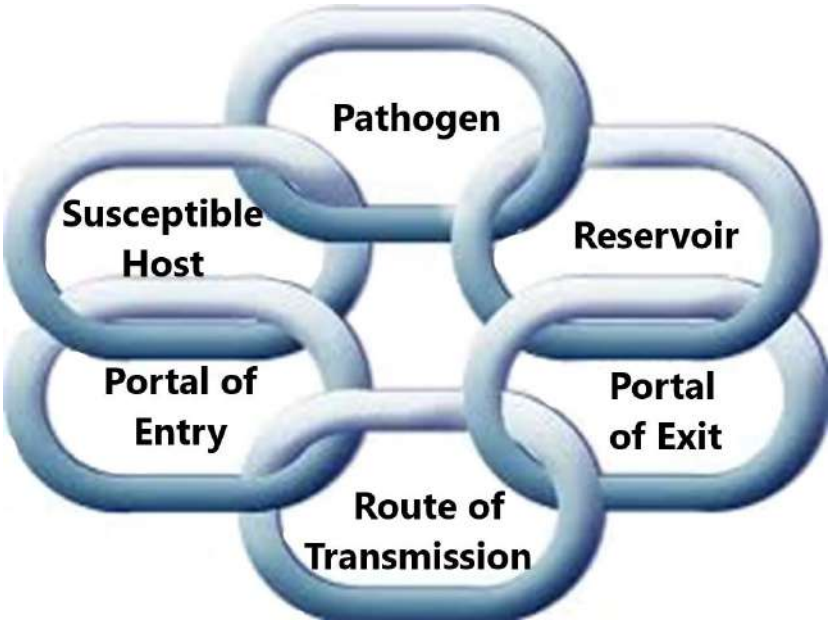
Emerging infections:

- In some rare, emerging and re-emerging diseases, and high-risk pathogens, one pathogen is enough to declare an outbreak in healthcare facilities that unlikely to be affected by that type of pathogens e.g., MERS-CoV, Monkeypox, and Ebola…. etc.
- Emerging infectious diseases are defined as infectious diseases that are newly recognized in a population or have existed but are rapidly increasing in incidence or geographic range.
- Zoonotic pathogens cause most emerging infectious diseases.
- Factors contributing to EID include population growth, spread in health care facilities, aging population, global travel, and changing vector habitats related to climate change.
- It should be noted that a disease that can be considered emerging/reemerging in one country is not necessarily considered emerging/reemerging. For example, dengue fever is considered emerging/reemerging disease in the US, while it is endemic in certain cities of Saudi Arabia, such as Jeddah and Makkah
- A list of emerging infections is shown in Appendix-2: Emerging Infectious Diseases.

Chain of infection:

The chain of infection is a model to display interconnected steps that describe how a pathogen is causing an infection. The chain of infection includes:

- **Infectious Agent** is a pathogen (germ) that causes diseases.
- **The reservoir** includes places in the environment where the pathogen lives (this includes people, animals and insects, medical equipment, and soil and water)
- **Portal of exit** is the way the infectious agent leaves the reservoir (through open wounds, aerosols, and splatter of body fluids, including coughing, sneezing, and saliva)
- **Mode of transmission** is the way the infectious agent can be passed on (through direct or indirect contact, ingestion, or inhalation)
- **Portal of entry** is the way the infectious agent can enter a new host (through broken skin, the respiratory tract, mucous membranes, and catheters and tubes)
- **A susceptible host** can be any person (the most vulnerable of whom are receiving healthcare, are immunocompromised, or have invasive medical devices including lines, devices, and airways)



Infectious Agent (pathogen):

- Infectious agents are microorganisms with the ability to cause disease:
- Bacteria: tuberculosis, plague, or anthrax
- Viruses: influenza, yellow fever, or AIDS
- Fungi: candidiasis or histoplasmosis.
- Parasites: malaria and toxoplasmosis

Mode of infections:

- Endogenous infections: caused by body flora in immuno-compromised patients
- Exogenous infections: caused by organisms from the outside environment

Ability to survive:

- The ability of the agent will remain viable in the environment until contact with the host, which is affected by:
- Ability to resist the effects of heat, drying, UV light, and chemical agents, including antimicrobials (See Appendix-3: Survival of Microorganisms)
- Ability to compete with other microorganisms
- Ability to independently multiply in the environment or to develop and multiply within another (vector) host

Infectivity:

- The capacity of an agent to enter and multiply in a susceptible host producing infection or disease, is affected by:
- The virulence: ability to grow and multiply
- The invasiveness: ability to enter the tissue
- Pathogenicity: the ability to cause clinical disease in the infected host
- Toxigenicity: ability to produce toxins
- Dose: number at the entry site of the host

Resistance:

- The ability of an agent to survive adverse environmental conditions (hepatitis agents are generally very resistant, whereas influenza viruses are typically fragile). Note: “resistance” is also applied to the host.

Antigenicity:

- An agent can induce antibody production in the host. (e.g., re-infection with the measles virus is very rare).
- The related term “immunogenicity” refers to an infection’s ability to produce specific immunity.

A reservoir of infection:

- Any animate or inanimate niche in the environment in which an infectious agent may survive and multiply to become a source of transmission to a susceptible host
- The reservoir typically harbors the infectious agent without injury to itself and serves as a source from which other individuals can be infected.
- The infectious agent primarily depends on the reservoir for its survival.
- It is from the reservoir that the infectious substance is transmitted to a human or another susceptible host.
- **Examples from a healthcare setting**
  - ***Human reservoir***
    - ✓ Healthcare worker carriage of staphylococci in the anterior nares: methicillin-resistant Staphylococcus aureus (MRSA) in the nares, groin, or axilla of patients
  - ***Inanimate reservoir***
    - ✓ Pseudomonas species or Legionella in air-conditioning humidification systems
    - ✓ Clostridium difficile spores on inpatient work surfaces
    - ✓ Serratia marcescens growing in contaminated soap or hand lotion preparations

Mode of transmission

- Mode of transmission is the method of transfer by which the organism moves from host to susceptible individual
- Transmission could be direct or indirect

Direct	Indirect
• ***Droplet contact:*** coughing or sneezing (1 meter) • ***Direct physical contact:*** to infected person secretions, blood, stool/urine (This method includes sexual contact) • ***Trans-placental infection****:* from mother to the fetus	• ***Airborne transmission:*** if the microorganism can remain in the air for long periods (TB, varicella, measles) • ***Indirect contact:*** usually by touching contaminated surface • ***Fecal-oral transmission:*** usually from contaminated food or water sources • ***Vector borne transmission:*** carried by insects or other animals • ***Iatrogenic Transmission***: Transmission due to contaminated medical procedures

Mode of Transmission with examples

Type of transmission	Disease/pathogen
Airborne transmission ○ Transmission via aerosols (airborne particles <5μm) that contain organisms in droplet nuclei or in dusts ○ Can spread via ventilation systems ○ Precautions: Single negative pressure room and respirator (e.g. N 95) mask	○ Tuberculosis ○ Chickenpox ○ Measles ○ Herpes zoster ○ SARS ○ Smallpox ○ Pulmonary plague ○ Legionella ○ Fungal spores
Droplet transmission ○ Transmission via sneezes or coughs ○ Also can happen during suctioning ○ Droplets are relatively large (>5 μm) and can be projected up to about one meter ○ Precautions: Masks, cover mouth, stand clear, and other droplet precautions	○ Bacterial Meningitis ○ Respiratory viruses ○ Influenza ○ Mumps ○ Whooping cough ○ Diphtheria ○ Group A streptococcus ○ MERS-CoV
Fecal-oral transmission ○ Transmission via ingestion of contaminated food and water drinks ○ This included some victor-borne, swimming pools and even oral sex ○ Precautions: hand hygiene, food sanitations, adequate sewage treatment, water chlorination, cleaning, and proper hygiene.	○ Rotavirus ○ Enteroviruses ○ Clostridium difficile ○ Hepatitis A ○ Poliomyelitis ○ Cholera ○ Salmonella ○ Shigella ○ Parasites

Type of transmission	Disease/pathogen
Waterborne transmission o Ingestion of contaminated water o Contact with or the inhalation of aerosols o Precautions: o Water disinfection and shock treatment o Periodic cleaning and maintenance of showers, baths and sinks o Installing disinfection systems and filters o Avoiding the installation of other potential sources of infection such as decorative pools and fountains.	o Pseudomonas aeruginosa, o Legionella pneumophila o Burkholderia cepacia o Stenotrophomonas maltophilia o Acinetobacter o Non-tubercular mycobacteria
Direct contact transmission o Direct physical contact between infected or colonized individual and susceptible host o Examples of transmission: touching, kissing, sexual contact, contact with oral secretions, or contact with body lesions o Precautions: Hand hygiene, masks, & condoms	**Sexually transmitted diseases** o HIV/AIDS o Chlamydia o Genital warts o Gonorrhea o Hepatitis B o Syphilis o Common cold o Ebola
Indirect contact transmission o Contact with reservoir as contaminated surfaces or objects, or to vectors such as mosquitoes, flies, mites, fleas, rodents or dogs o No direct human-to-human contact o Precautions: Sterilizing instruments, disinfect surfaces, and other contact precautions	o MDRO o MRSA o VRE o Gram negatives o RSV o Norwalk virus o Rhinovirus

Type of transmission	Disease/pathogen
Vector borne transmission ○ Transmission may be mechanical or biologic transmission ○ Mechanical vector such as housefly can cause food-born diseases ○ Biological vectors such as mosquitoes and fleas are often responsible for blood-borne diseases ○ Precautions: barriers (window screens, bed nets), insect sprays, killing animals	○ Mosquitoes ○ Dengue fever ○ Rift Valley fever ○ Yellow fever ○ Malaria ○ West Nile fever ○ Sandflies ○ Leishmaniosis ○ Fleas ○ Plague ○ Rickettsiosis ○ Aquatic snails ○ Schistosomiasis

Susceptible host:

- Susceptible Host: A person who cannot resist a microorganism invading the body, multiplying, and resulting in infection.
- A combination of host defense reductions and an agent's ability to cause infection are typical of the acquisition of opportunistic infections in immunocompromised patients.
- Intrinsic or extrinsic factors influence the susceptibility and response of a host to an agent

Body's Defense Mechanism

- Barriers: intact skin, tears of eyes, cough, sneeze, respiratory cilia, stomach acids, and vaginal secretions
- Immune response:
  - ✓ Non-specific: neutrophils and monocytes
  - ✓ Specific: cellular (T cells) and humoral (B cells)

Intrinsic factors	Extrinsic factors
○ Age at infection ○ Sex ○ Race ○ Nutritional status ○ Birth weight ○ Comorbid conditions ○ Immune status ○ Immunosuppression associated with other infections, diseases, or therapy ○ Vaccination or immunization status ○ Previous experience with this or similar agents ○ The psychologic state of the host	○ Invasive medical or surgical procedures ○ Medical devices, such as intravenous catheters, urinary catheter, or mechanical ventilators ○ Duration of antimicrobial therapy ○ Duration of hospitalization ○ Exposure to hospital personnel. ○ Sexual practices and contraception ○ Behavior as smoking or alcohol intake

Breaking the Chain of Infection:

1. **Control or elimination of infectious agents:**
   - ✓ Rapid identification and isolation of source
   - ✓ Applying barrier precautions
   - ✓ Disinfection and sterilization of items and equipment
   - ✓ Environmental cleanliness
2. **Control of reservoir:**
   - ✓ Using disposable equipment
   - ✓ Disinfection and sterilization of non-disposable equipment
   - ✓ Identifying and controlling infections in carriers
3. **Control of Portal of Exit:**
   - ✓ Proper control of secretions and excretion
   - ✓ Environmental sanitations (waste disposal)
4. **Control of transmission:**
   - ✓ Hand hygiene
   - ✓ Source isolation
   - ✓ Aseptic techniques and proper device care
   - ✓ Control of air flow

- ✓ Proper food handling
- ✓ Environmental sanitations

5. **Control of Portal of Entry:**
   - ✓ Aseptic techniques and proper device care
6. **Control of susceptible host:**
   - ✓ Identifying high risk patients
   - ✓ Treating underlying disease

Herd immunity:

- Herd immunity is indirect protection from an infectious disease that happens when a population is immune through vaccination or immunity developed through the previous infection.
- Once a high proportion of all people in the community are immune, the likelihood is small that an infected person will encounter a susceptible person.
- Achieving herd immunity for a specific disease limits the probability of an outbreak of that disease and, if it happens, makes its control much more manageable.
- For herd immunity to work,
- Disease agents must be restricted to a single host species, and
- Transmission must be relatively direct from one member of the host species to another (e.g., no reservoir outside the human host in which the organism can exist, such as birds or mosquitoes)
- Herd immunity operates when there is random mixing of the population.
- The percentage of people who need to be immune in order to achieve herd immunity varies with each disease. For example, herd immunity against measles requires about 95% of the population to be vaccinated. The remaining 5% will be protected by the fact that measles will not spread among those who are vaccinated. For poliomyelitis, the threshold is about 80%. The remaining 20% will be protected by the fact that polio-myelitis will not spread among those who are vaccinated.
- Herd immunity does not apply to all diseases. For example, herd immunity against COVID-19 probably cannot be achieved because the virus continually changes its phenotype (therefore, new variants can escape immunity derived from infections and vaccines). Moreover, neither infection nor vaccination appears to induce prolonged protection against COVID-19 in many or most people.

Levels of prevention:

Primary prevention:

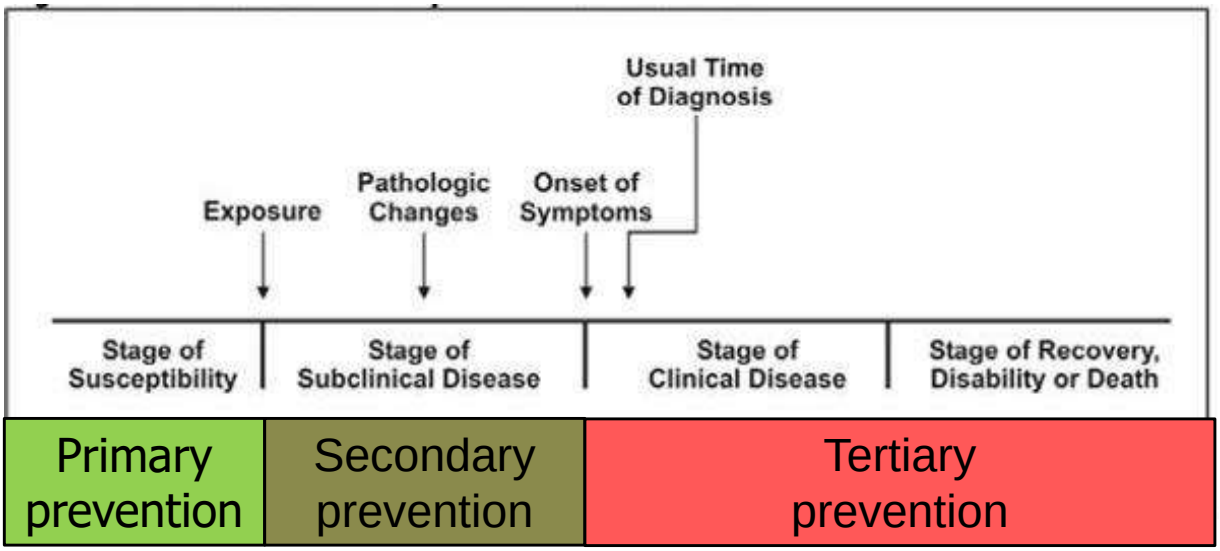
- Measures are taken to prevent the development of a disease in a person who is well and does not have the disease in question (by eliminating or reducing the disease risk factors)
- Example: immunizing a healthy baby against infectious diseases

Secondary prevention:

- Through screening and early intervention, measures are taken to identify people who have already developed the disease at an early stage in the disease's natural history.
- Example: Surveillance culture to detect MRSA carriers to reduce HAI in ICU patients

Tertiary prevention:

- Measures taken to care of persons with already established disease, with attempts made to restore to highest function, minimize the negative effects of a disease, and prevent disease-related complications.
- Example: Treating pulmonary tuberculosis to prevent complications and restore workability



Steps of investigation of an outbreak

Steps of initial investigation of an outbreak

1. Recognize potential outbreak
2. Confirm presence of outbreak
3. Alert key individuals
4. Perform literature review
5. Establish a preliminary case definition
6. Develop method for case findings
7. Perform descriptive epidemiology
8. Implement initial control measures
9. Identify potentially implicated health practices
10. Consider environmental sampling
11. Communicating Information about Outbreaks

Steps of follow up investigation of an outbreak

1. Refine the case definition
2. Continue case finding
3. Review regularly control measures
4. Consider if analytic study should be performed

Steps of the initial investigation of an outbreak

1- Recognize potential outbreak:

➢ A potential outbreak may be identified by:

1. **Laboratory reports**
   - Frequently involves the identification of a particular organism in a number of clinical isolates that exceeds the expected baseline from a specific setting or within a specific period of time
2. **Surveillance system.**
   - Such as infection control surveillance and communicable disease surveillance
   - However, since targeted surveillance has rarely done continuously in the same place, the possibility of regular surveillance to detect surveillance is low
3. **Front-line HCWs** (nurses and physicians working in the affected unit)
   - Many outbreaks are first recognized by front-line HCWs who recognize
   - Increase in infections or deaths or identification of an unusual pathogen
   - Un-common anatomic site of infection
   - Unusual organisms, or infections occurring within a special subpopulation or specific location in a facility

➢ Using advanced laboratory technologies in outbreak identification:

- Whole genome sequencing (WGS): It provides highly supported phylogenic trees and has become the new reference standard for bacterial typing. WGS provides detailed and precise data for identifying outbreaks cause. Additionally, WGS is used to characterize bacteria as well as track outbreaks
- Pulsed-field gel electrophoresis (PFGE): It is a laboratory technique used by scientists to produce a DNA fingerprint for a bacterial isolate. A bacterial isolate is a group of the same type of bacteria. It has been used to determine epidemiological links between bacterial isolates

Note: Advanced laboratory technologies can help in outbreak identification. However, they are not necessarily available to diagnose an outbreak. Most of outbreaks are detected in hospitals that do not have these advanced laboratory technologies

2- Confirm the presence of the healthcare-associated outbreak

➢ How to confirm the presence of outbreak:

- Compare the observed (the current) number of cases with the expected (previous) number of cases (same location and period)
- To detect the occurrence of more cases of disease than expected

➢ Sources expected rates:

- Laboratory reports: for some pathogens, like Klebsiella pneumonia and Pseudomonas aeruginosa.
- Local hospital discharge records or local mortality statistics for hospitalized infections
- Ministry of Health (MOH) surveillance reports for notifiable disease
- If local data are unavailable, you may conduct a telephone survey of physicians to determine whether they have seen more cases of the disease than usual.

➢ Pseudo-outbreak:

- It is generally applied to situations with a rise in positive laboratory findings (e.g., positive microbiology cultures) without a similar increase in the number of related clinical cases.
- It may also be caused by a change in the surveillance system/ laboratory methods resulting in the misclassification of non-infected cases as infection or identification of cases that were always present but previously missed by surveillance.

➢ Causes of rising positive laboratory findings:

1- Laboratory factors

- Introduction of a new test, which was previously unavailable locally.
- Improving laboratory techniques for identification.
- Introduction of new laboratory tests with poor specificity and/or sensitivity.
- Contamination during laboratory processing, e.g., contamination of media or cross-contamination of a specimen during processing.

2- Non-laboratory factors.

- Incorrect diagnosis of the clinical entity
- Contamination during collection if the correct procedure for the collection of specimens is not followed
- Use of water of poor microbiological quality in the washer-disinfectors. Example. Misdiagnosis of tuberculosis has been reported due to contamination of the endoscope with environmental mycobacteria (e.g., Mycobacterium chelonae) from the rinse water

➢ **Example of rising positive laboratory findings:**

- Several pseudo-outbreaks of bloodstream infection have been reported (increase in laboratory positive blood culture not parallel to clinically diagnosed bloodstream infection) due to contaminated culture media, contaminated antiseptics, contaminated blood culture vials, or inadequate disinfection of the analyzer.

➢ **Causes of overcalling cases:**

- Changes in local reporting procedures
- Changes in the case definition
- Increased interest because of local or national awareness
- Improvements in diagnostic procedures

If, after investigation, an outbreak is not confirmed, then the IPC team must inform the clinical team who have reported the outbreak and provide reassurance.

3- Alert key individuals

- It is important to make supervisors and hospital leadership aware of the presence of an outbreak situation so that resources can be made available and communication with staff and the community can be managed.
- In addition, the microbiology laboratory and staff working in the area where the outbreak is occurring should be alerted to look out for new cases and to collect and save the appropriate samples for investigation.
- Alerting key individuals in the hospital are essential to halting hospital outbreaks, especially those of large-scale, serious outbreaks and those that need unusually high resources

➢ **Example of alerting key individuals:**

- After confirming the presence of the Burkholderia Cepacia outbreak in one of the big tertiary care hospitals, the IPC staff communicated the early finding to the healthcare workers and hospital administration to stop using chlorhexidine which was confirmed to be the contaminated solution. Additionally, a notice was sent to the Saudi Food and Drug Administration (FDA) to withdraw the product from all other hospitals
- After confirming the presence of a carbapenem-resistant *Enterobacterales* outbreak in one of the hospital wards, the IPC staff communicated the early finding with healthcare workers in other units to take extra measures to prevent the spread of the outbreak into their units.
- Early during the COVID-19 pandemic, the outbreak management team alerted the hospital administration in one of the big tertiary care hospitals about the shortage of staff and supplies to levels that can impede the control measures in the near future. The administration reacted by stipulating several managerial orders to facilitate logistics and supply management. Adopting a central tracking and distribution system for personal protective equipment, creating surge capacity in unfavorable pressure rooms, establishing quarantine hotels, and training and up-skilling nursing staff in non-urgent units.

4- Perform a literature review

- Literature reviews help answer several questions about the current outbreak, especially in the case of rare pathogens such *as Burkholderia Cepacia*. For example, in previous similar outbreaks, what have been the sources, modes of transmission, and risk factors for the disease? Previously used sample questionnaires can be reused to detect new cases.
- A literature review can also guide the investigators in looking for the cause and providing strategies to stop the outbreak.

➢ The following resources may be of help to those in limited-resource settings:

- ✓ GDIPC website (https://gdipc.sa/)
- ✓ Ministry of Health of Saudi Arabia (https://www.moh.gov.sa/)
- ✓ Public Health Authority-Weqaya (https://covid19.cdc.gov.sa/)
- ✓ Public Health Authority (https://od.data.gov.sa/Data/en/organization/about/weqaya)
- ✓ National Library of Medicine (http://www.nlm.nih.gov/)
- ✓ US Centers for Disease Control and Prevention (CDC) (www.cdc.gov/) provides abundant information ranging from current outbreaks and immunizations to disease-specific subject matter.
- ✓ Worldwide Database for Nosocomial Outbreaks (www.outbreak-database.com)
- ✓ The World Health Organization (WHO) Global Outbreak Alert and Response Network (http://www.who.int/ihr/alert_and_response/outbreak-network/en/).

5- Establish a preliminary case definition

➢ Develop a case definition which may include:

- Persons: description of affected individuals
- Time: range for when the illnesses occurred
- Place: geographic range, such as residency in a state or region
- Agent: pathogen or toxin, if known
- Symptoms: certain symptoms typical for that pathogen or toxin

Element	Descriptive Feature	Example
Laboratory	Pathogen, serotype	E. Coli O157:H7
Symptoms	Acute gastrointestinal tract (GIT) illness	3 or more loose stools in a 24 hour period
Person	Age group	Children under 5 years old
	Sex	Males
	Occupation	HCWs at hospital A
	Exclusion criteria	Persons with chronic diarrhea
Place	Geographic location	Resident or visitor to ward B
	Water source	Residents connected to water line C
Time	Illness onset	Onset of illness on or after January 1, 2020

➢ Example of preliminary case definition

- Three cases of new HIV infection among hemodialysis patients at a hemodialysis unit in Saudi Arabia were investigated to determine if there was an HAI outbreak.
- The investigators developed the following case definition:
- A case was defined as a patient among those undergoing treatment at hemodialysis unit 1, during November and December 2011. They seroconverted to HIV-positive status, and their self-reported behaviors did not include HIV risk factors, and their spouse was seronegative for HIV.

➢ Categories of case definition:

Case category	General features
Confirmed	Laboratory confirmation of agent
Probable	Typical clinical features of illness **AND** Partial laboratory results (confirmation pending) **OR** Epidemiologic link to a laboratory-confirmed case
Suspected	Typical clinical features of illness **AND** Missing laboratory and epidemiologic information

➢ Primary versus secondary cases

- It is important to distinguish between primary and secondary cases.
- Primary cases are directly exposed to the outbreak source. In contrast, secondary cases are defined as individuals who contracted the illness through exposure to a primary case rather than the outbreak source (e.g., household contacts who become infected).
- Secondary cases should be included in defining the scope of the outbreak but are not included in an analytic study to identify the source of the outbreak; only.
- Primary cases would be included in a study.
- For example, studies were done to see how many exposed households get COVID-19 infection. It was found that 15% of households became secondary cases in the 14 days since the last unprotected exposure to the primary case.
- Another example was the MERS-CoV outbreak in one of the large tertiary care hospitals; it was found that primary cases (admitted with the infection from the community) were 20% while secondary cases (got the infection in the hospital from primary cases) were 80%. Secondary cases were less likely to infect patients than primary ones, which helped completely control the outbreak after enforcing infection control practices. Few primary cases spread the infection to a large number of secondary patients (called super-spreader)

➢ Sensitivity versus specificity in a case definition

- Ideally, a case definition will include all cases (high sensitivity) but exclude any person who does not have the illness (high specificity).
- A sensitive case definition will detect many cases (true positives) but may also count as cases of individuals who do not have the disease (false positives).
- A more specific case definition is more likely to include only persons who truly have the disease under investigation (reduce false positives) but also more likely to miss some cases (false negatives).
- There are no rules about how sensitive or specific a case definition should be.
- At the start of an outbreak, use a broad case definition (more sensitive) and then narrow the case definition down (more specific) at a later date when more information is available from the clinical and laboratory investigation.

	Sensitive case definition	**Specific case definition**
Advantages	Increase chances of finding cases ("**true positives**"); able to find as much information on true cases early on, rather than having to go back and find cases later.	Improve case classification (i.e., minimize "**false positives**"); strengthen subsequent analytical tests or studies; may be more resource efficient.
Disadvantages	May capture individuals who are not actually part of the outbreak ("**false positives**"); may be resource intensive.	May miss cases ("**false negative**").
Example	In the peak of an outbreak of chickenpox, case definition can be "any generalized rash illness of acute onset." This sensitive definition can detect all chickenpox cases (true positive) but also cases with similar disease as measles, rubella, and drug allergies (false positive).	When the number of cases is reduced and the resources became available, more specific case definition can be used "positive PCR test to detect Varicella-zoster virus in skin lesions". It will not report similar disease (false positive) but may miss some chickenpox cases who are tested towards the end of the disease (false negative)

6- Develop a method for case finding

➢ Methods of case finding:

- The investigator conducts a planned search for cases using case definitions to identify new or additional cases of an infection or disease.
- Looking both backward and forward in time may be necessary to identify new cases as well as additional cases from the past using the time frame in the case definition.
- Signs and symptoms of the infection or positive laboratory results from the case definition may be used to trigger a further investigation to see if a patient matches the case definition.
- A simple data collection form (line list) is usually developed to collect information on possible cases.
- The line list may include a few variables or be comprehensive. The benefits should be weight against the efforts required to collect the data.
- The line list data will be used in plotting the epidemic curve later.

➢ Sources for cases findings:

- Assemble the information from medical charts, microbiology reports, pharmacy reports, and logbooks from affected areas.
- Surveillance culture for high-risk groups. However, benefits should be weight against the cost. This may be done for a short period to determine the burden of colonized patients, which will help you decide whether to extend the surveillance culture or not.
- Reviewing regular surveillance reports
- Asking local clinical and laboratory professionals to report cases of the particular illness more quickly, as soon as they suspect the diagnosis
- Reviewing emergency room records for similar illnesses
- Sometimes, alert the public to seek medical advice if they have symptoms compatible with the case definition.

➢ Data variables to be collected:

- These data may vary from outbreak to outbreak but may include the following:
  - ✓ Identifying information: ID, name, and telephone number
  - ✓ Items from the case definition
  - ✓ Demographic information (age, sex, date, the reason for admission, diagnosis, date of surgery or procedures, antibiotics, etc.)
  - ✓ Location information (admission, discharge, and transfer)
  - ✓ Clinical data (onset of signs and symptoms, frequency and duration, treatments, medical devices)
  - ✓ Outcome information (hospitalization, ICU care, ventilator, and death).
  - ✓ Risk factor information: differ from disease to disease

7- Perform descriptive epidemiology

➢ Descriptive epidemiology:

- Characterizing an outbreak by time, place, and person using an epidemic curve
- Calculating the attack rate

➢ Epidemic curve:

- It plots the cases in an outbreak based on the time of onset of illness.
- Done by drawing a histogram of the number of cases (on the y-axis) by their date of onset (on the x-axis)

➢ Advantages of the epidemic curve:

- Can identify the exact period of the outbreak
- Can identify the probable period of exposure
- Can determine the epidemic pattern; common source, propagated, or both
- When combined with other information gathered during the investigation, it can help identify the possible exposure.

➢ Calculating the attack rate

- An attack rate is a form of incidence that measures the proportion of persons in a defined population who had an acute health event during a limited time period (e.g., during an outbreak).
- It is typically used in the investigation of acute outbreaks of disease, where they can help identify exposures that contributed to the illness (e.g., using Burkholderia-contaminated saline solution).

$$\text{Attack Rate} = \frac{\text{Number of new cases who got infected during the outbreak specified location and time interval}}{\text{Population at the same location at the start of outbreak}} \times 100$$

- The attack rate can also be calculated stratified by relevant characteristics such as sex, age, location, or specific exposure (ventilation, catheterization, operating rooms, and occupational exposure).
- At the end of the descriptive analysis, it should be possible to:
  - ✓ Formulate a hypothesis on the type of infection (exogenous, endogenous)
  - ✓ Tentatively identify the source and route of infection
  - ✓ Suggest and implement initial control measures.

8- Implement initial control measures

➢ Implement initial control measures

- Take action and implement infection control measures without delay.
- Full implementation of infection control measures as recommended by the IPC
- Special cleaning and disinfection procedures.
- Depending on the type of pathogen, incubation period, and susceptibility, consider the isolation of patients, staff, and visitors and initiate contact tracing as appropriate.
- Determine patients/staff at risk of becoming ill and offer the appropriate treatment, e.g., antimicrobial agents, active and/or passive immunization
- It is always appropriate to educate or reinforce HCWs about IPC precautions and to develop a plan to ensure ongoing compliance with them.
- Closure of catering facilities, if considered appropriate.
- Closure of health care facilities, if necessary.
- For the details of the control measures required according to the transmission type, see Appendix-4: Control measures.

9- Identify potentially implicated health practices (creating hypothesis)

➢ How to identify potentially implicated health practices

- An outbreak can be stopped by identifying and interrupting the chain of transmission.
- Information from the literature review on the type of pathogen and infection, and a review of the cases in the line list, may help identify which healthcare practices to focus on.
- Discussing the outbreak and possible causes with staff is also essential.
- Investigations are more productive if investigators are seen as partnering with the staff rather than attempting to find someone to blame
- Observations should at first be done without a detailed data collection form and should focus on workflow and practices that are different from best practices, recommended IPC guidelines, and hospital policies.
- General IPC practices such as hand hygiene and Standard Precautions should be observed.
- It can be helpful to ask about shortcuts and methods that have been created by staff to work around perceived barriers to make workflow easier.

➢ Examples of useful questions to ask during observations:

1. **Exposure to a reusable instrument**
   - ✓ Review of the facility's reprocessing procedures for that instrument
2. **Infections associated with indwelling devices**
   - ✓ Review of procedures for the access and maintenance of these devices

3. **MDRO**
   - ✓ Assessment of staff adherence to hand hygiene and contact precautions, as well as cleaning and disinfection of high-touch surfaces and shared medical equipment
4. **Environmental organisms (e.g., Aspergillus)**
   - ✓ Review and observations of construction activities in or near patient areas
5. **Waterborne pathogens (e.g., Legionella or Pseudomonas aeruginosa)**
   - ✓ Assessment for potential routes of exposure to tap water
   - ✓ Review of local wound care practices, preparation, and handling of injectable or aerosolized medications (near vicinity of sinks)
6. **Similar types of injectable medications among case-patients**
   - ✓ Review of medication preparation and handling in the affected unit, central pharmacy, particularly if the medication was prepared or compounded onsite
7. **Assessing environmental cleaning and disinfection**
   - ✓ Fluorescent markers
   - ✓ Adenosine triphosphate (ATP) bioluminescence assay can also be used to detect residual organic material after cleaning

10- Consider environmental sampling

➢ When to consider environmental sampling

- If environmental sampling is an option, cautious consideration should be given before deciding upon this course of action due to cost, lack of standards for interpretation, and the high possibility of inconclusive results (see Appendix-5: Environmental Sampling)
- Isolation of an organism from the environment rarely explains an outbreak.
- Environmental sampling should be pursued only if strong epidemiological evidence indicates a possible source or reservoir of organisms exists.
- Environmental sampling may not be possible due to a lack of lab capacity or supplies
- On the other hand, if environmental sampling is indicated and possible, a positive result matching the pathogen causing the outbreak can be very satisfying.

➢ Interpreting negative environmental sampling

- It is important to note that if negative results occur, it will not be known if the environment can be ruled out or if the sampling failed for some reason.
- There are many reasons why sampling the environment might not reveal a source pathogen, even if it is present.
   - ✓ Inadequate collection or cultural technique
   - ✓ The pathogen was already removed by cleaning or only present transiently.
   - ✓ The sample was taken from the wrong place.

➢ Recommendations that can improve environmental sampling:

- Perform these cultures after making the line list and doing observations so that they can focus on items that seem the most likely to be implicated. Environmental cultures should never be the first step in an outbreak investigation.
- Before obtaining any environmental cultures, talk with microbiology laboratory personnel to determine whether they are able to process the cultures that will be obtained and discuss the optimal methods of obtaining them.
- Culture-only items are possible vectors of transmission.
- Culture the items that make the most sense as the likely reservoir for the organism. For example, outbreaks of Pseudomonas should focus on liquid items, whereas outbreaks of Acinetobacter should focus on surfaces.

11- Communicating information about outbreaks

➢ Communicate early:

- If an outbreak is identified, it is important to communicate early and clearly.
- Notification process should be started according to the steps described in the Operation of Outbreak
  - ✓ Meeting the MOH outbreak criteria of notification
  - ✓ New or emergent pathogen that is first identified in the healthcare facility
  - ✓ Outbreak with the source is suspected or traced to an iatrogenic
  - ✓ Outbreaks that are deemed not manageable by the facility
- Keep the staff, patients, relatives, and visitors informed and assured.
- Flag the electronic medical system in certain conditions (such as MDRO) to allow other staff to deal with the patient using appropriate infection control measures
- Communication between health care facilities in case of transfer to enable the receiving institution to put in place appropriate precautions.
- Communication between laboratory and clinicians to provide instant information about the organism and resistance
- Communication between pharmacy and clinicians to provide instant information about appropriate medication and to modify formulary if required
- It is also essential that the spokesperson, not the staff members, would communicate directly with the media.

➢ Write preliminary and final confidential outbreak reports

- The report must summarize complete investigations, lessons learned, and recommendations to prevent a recurrence in the future.
- The report must be sent to the senior management and other appropriate personnel/authorities for action.

➢ When to declare that the outbreak is over

- The point at which an outbreak can be declared over depends on the nature of the outbreak (type of microorganism).

Outbreak	Explanation
Healthcare-associated outbreaks	○ There are no new cases epidemiologically linked to the relative outbreak are identified within 14 days from the last outbreak case (the last case included in the outbreak should be either negative, discharged, or deceased) ○ The declaration of outbreak end must be arranged with GDIPC
Ebola outbreak	○ No confirmed or probable Ebola cases are detected for a period of 42 days (i.e. twice the maximum incubation period for Ebola infections) since the death/recovery of the last confirmed case
MERS-CoV outbreak	○ No confirmed MERS-CoV cases are detected for a period of 28 days (i.e. twice the maximum incubation period for MERS-CoV infections) since the death/recovery of the last confirmed case
Cholera	○ No new cases reported for 7 weeks
Meningitis	○ Weekly number of reported cases below the "epidemic and alert threshold" for 8 weeks

Source: https://doi.org/10.1093/aje/kwaa212

Steps of follow-up investigation of an outbreak

1. Refine the case definition:

- As the outbreak continues, the outbreak case definition may need to be refined
- We can refine the case definition with the new information available with time or with additional diagnostic information.
- In the early stage of an outbreak investigation, the aim is to detect as many cases as possible; this requires a more sensitive case definition (e.g., a person with three or more loose stools in 24 hours).
- As the outbreak evolves and more information becomes available, case definitions can be refined to be more specific using additional laboratory or epidemiologic restrictions.
- These restrictions help to avoid misclassification (false positive) and are useful for hypothesis testing.
- The use of subtyping methods to differentiate strains or subtypes of pathogens enables more precise and efficient outbreak detection and source tracking. For example, WGS and PFGE techniques can be used to determine epidemiological links between bacterial isolates collected from a group of outbreak patients to determine the main outbreak strains and the possible sources/clusters. This is usually done for research purposes and is not done on a regular basis. Additionally, not all hospitals are equipped to perform typing techniques.
- Changing the case definition can have a considerable impact on the data collected and the interpretation.
  - ✓ For example, the early case definition of MDR Acinetobacter was "Acinetobacter non-susceptible resistant or intermediate to **all tested agents** in at least 3 out of 6 antimicrobial classes, (penicillins, aminoglycosides, cephalosporins, fluoroquinolones, carbapenems, and sulbactam). Later it was changed to Acinetobacter non-susceptible resistant or intermediate to **at least one agent** in at least 3 out of 6 antimicrobial classes. This increased the number of MDR Acinetobacter reported.
  - ✓ In early case definitions of COVID-19, travel history was added to detect all possible exposed cases. Later, travel history lost importance and was then ignored

2. Continue Case Finding and Surveillance

- Case finding and surveillance should be continued throughout the outbreak investigation.
- Methods of case finding and surveillance will vary for each outbreak but may consist of one or all of the following point-prevalence screening, admission screening, discharge screening, retrospective laboratory surveillance, prospective laboratory surveillance, self-report, etc.

3. Review Control Measures Regularly

- All interventions implemented during the investigation should be reviewed for necessity and monitored for compliance.
- Additionally, any interventions that are difficult to maintain or are labor and resource intensive should be reviewed frequently to determine when those interventions can be discontinued.

- ✓ Examples of this intervention include cohort patients on a particular unit or dedicating staff to case patient care only.
- ✓ Another example; using specialized or advanced PPE as in case of the beginning of the MERS-CoV outbreak.
- ✓ These interventions cannot be sustained over long periods of time due to disruption of facility workflow and throughput and due to cost in terms of time and resources.

4. Consider if an analytic study should be performed

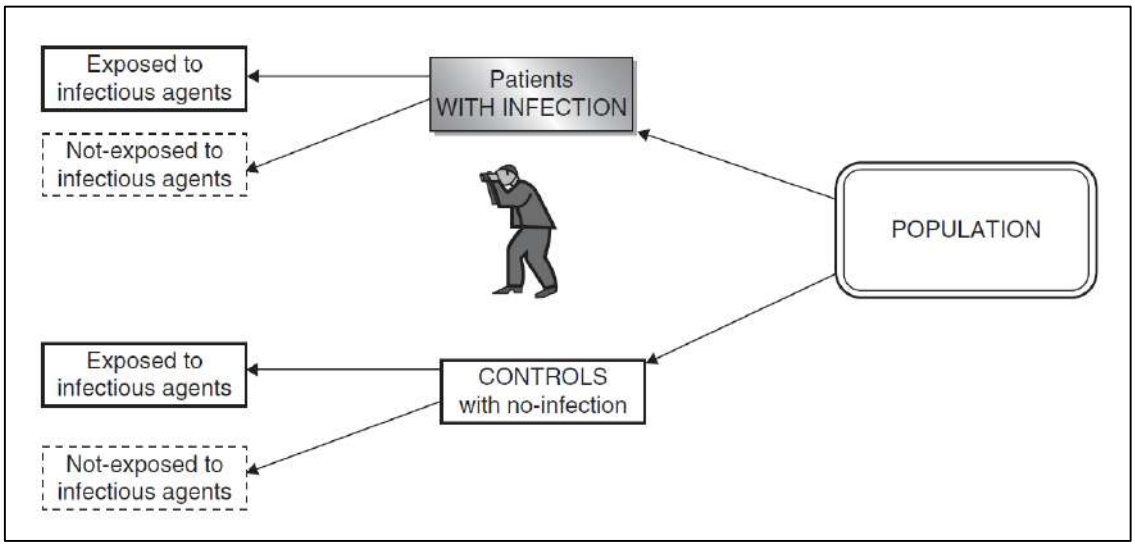
- Analytic studies typically should be used to test hypotheses, not generate them.
- However, in certain situations, collecting data quickly about patients and a comparison group can be a way to explore multiple hypotheses.
- In almost all situations, generating hypotheses before designing a study will help you clarify your study objectives and ask better questions.
- Studies can be time- and resource-intensive, and a hastily constructed study might not answer the correct questions.
- There are two types of analytic studies that can be done: case-control and cohort studies
- In more significant outbreaks, a case-control method may be the most efficient way of testing a hypothesis
- If a single hospital ward is affected, a retrospective cohort study should be done
- Case-control or cohort studies can be used in outbreak investigations to compare rates of infection in various populations to determine which exposures or risk factors are most likely responsible for the infection.

Post-outbreak analytic studies

- There are two types of analytic studies that can be done: case-control and cohort studies

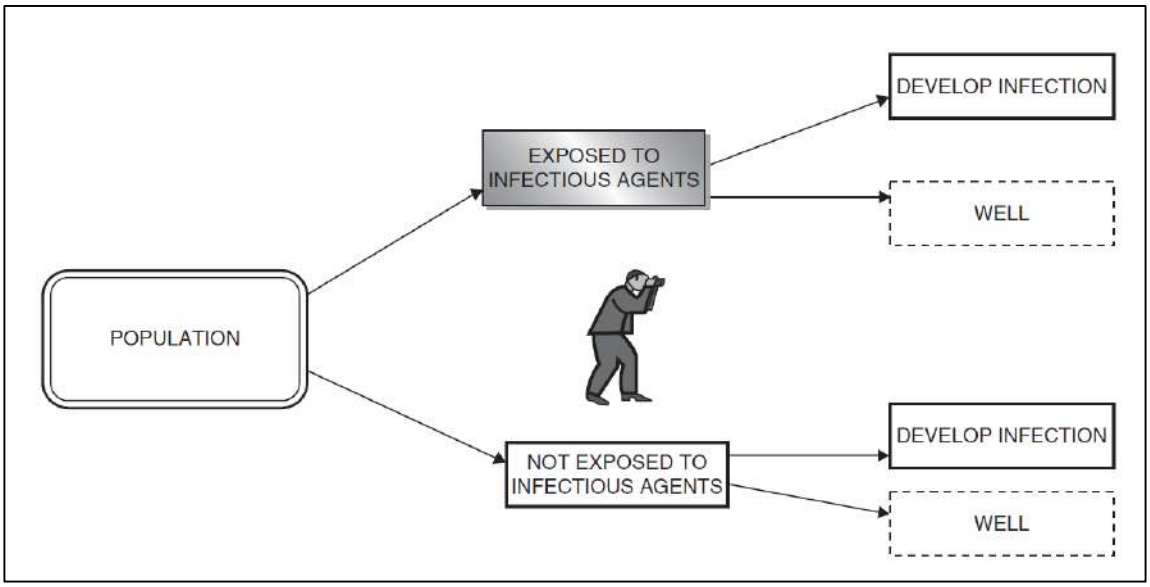
Case-control study

- It is an analytical epidemiological study whose aim is to investigate the association between disease and suspected causes and is usually cross-sectional or retrospective in nature
- In a case-control study, people with an outcome (an infection or a disease) are identified, and their medical and social history is examined retrospectively in an attempt to determine exposure to potentially infectious agents or risk factors.
- Case-control study is the method most commonly used to investigate outbreaks because it is relatively inexpensive to conduct, is usually of short duration, and requires relatively few study subjects
- A matched control group free from the disease or infection is also identified, and data is identically collected from them.



Cohort study

- Cohort study is an observational study usually carried out over a long period of time, and designed to investigate the etiology of diseases or outcomes.
- such studies aim to investigate the link between a hypothetical cause and a defined outcome.
- Before undertaking a cohort study, investigators should seek statistical advice regarding the number of subjects needed in each group.
- Cohort study starts with a hypothesis that the outcome (an infection or a disease) is caused by exposure to an infectious agent or event (risk factor).
- Subjects exposed to the suspected risk factor (cases) and similar groups that have not been exposed (control) are identified.
- Often, a complete population sample (cohort) is followed prospectively over a period of time (usually several years) to identify the incidence of the outcome in both groups.
- Cohort studies can be prospective or retrospective.
- The disease occurrence among persons with different exposures is compared to assess whether the exposures are associated with increased risk for disease.



Use of Epidemic Curve in outbreak

Epidemic curve:

- It plots the cases in an outbreak based on the time of onset of illness.
- Done by drawing a histogram of the number of cases (on the y-axis) by their date of onset (on the x-axis)

Steps for making an epidemic curve

- Create a horizontal axis (X-axis) with increments of continuous time. Start with each increment being 1 day (depending on the period over which the outbreak occurred, these might need to be changed to intervals of days/weeks/months). No time should be left out of the graph as the pattern of cases over time will be important
- Create a vertical access (Y axis) with continuous whole numbers starting from 0. This will be the number of cases.
- On the line list, find the case that occurred first and if no other cases occurred on that day, insert a bar that reaches to the number 1 on the Y-axis (or if more than one case, make the bar higher to show the number of cases occurring on that day).
- For each day, add up the number of cases on the line list and insert a bar on the graph reaching that number. Note: The bars for consecutive days should be touching each other. Since the time is continuous, there should not be any gap between the bars.
- Show confirmed and suspected cases in different colors or shading. If there are confirmed and suspected cases on the same day, distinguish between them by showing them on the same bar but in different colors or shading, with the confirmed cases at the bottom and suspected cases stacked on top.

Advantages of epidemic curve:

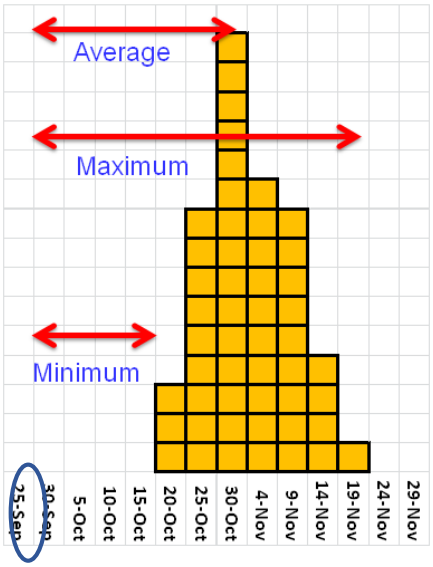
- Can determine the exact period of the outbreak
- Can determine the probable period of exposure
- Can determine the probable incubation period
- Can determine the epidemic pattern; common source, propagated, or both
- When combined with other information gathered in the course of the investigation, can help identify the possible exposure

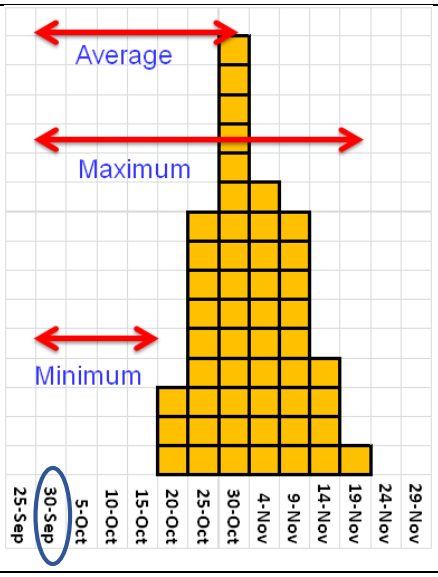
How the epidemic curve determines the exact period of the outbreak?

- Simple plotting will determine the start, peak, and end of outbreak
- The magnitude of an outbreak can be assessed easily with a glance of the epi curve.
- The time trend, or the distribution of cases over time, will give an indication of where the outbreak is in its course. Are cases still rising or has the outbreak already peaked? Does it appear that the outbreak is over? How long has it been since the last case occurred?
- Outliers are cases that stand apart from the other cases. Outliers include the index case, which might be the source of the outbreak, and cases that occur well after other cases, which might indicate secondary spread of the illness.

How the epidemic curve determines the probable period of exposure/incubation period?

- Can be done in common source outbreaks when the causative agent is known
- Identify the mean or median incubation period or minimum and maximum incubation periods of the known agent from the literature
- Use the peak of epidemic curve as the start point for the median incubation period
- Use the first case in the epidemic curve as the start point for the minimum incubation period
- Use the last case in the epidemic curve as the start point for the maximum incubation period

• For example, this epidemic curve was done for a common source outbreak of hepatitis A. It can be used to determine the **probable period of exposure** if the agent is known • If the agent is hepatitis A • The incubation period for hepatitis A ranges from 15 to 50 days, with an average incubation period of 28-30 days • So the probable time of exposure is around the end of September	

• It can be used to determine the **incubation period** of the agent if exposure is known • If the time of exposure is at the end of September • Bases on the start, peak, and end of the epidemic curve, the incubation period is as follow: • Minimum: 15 days • Maximum: 50 days • Average: 30 days	

How the epidemic curve determines the epidemic patterns of outbreaks?

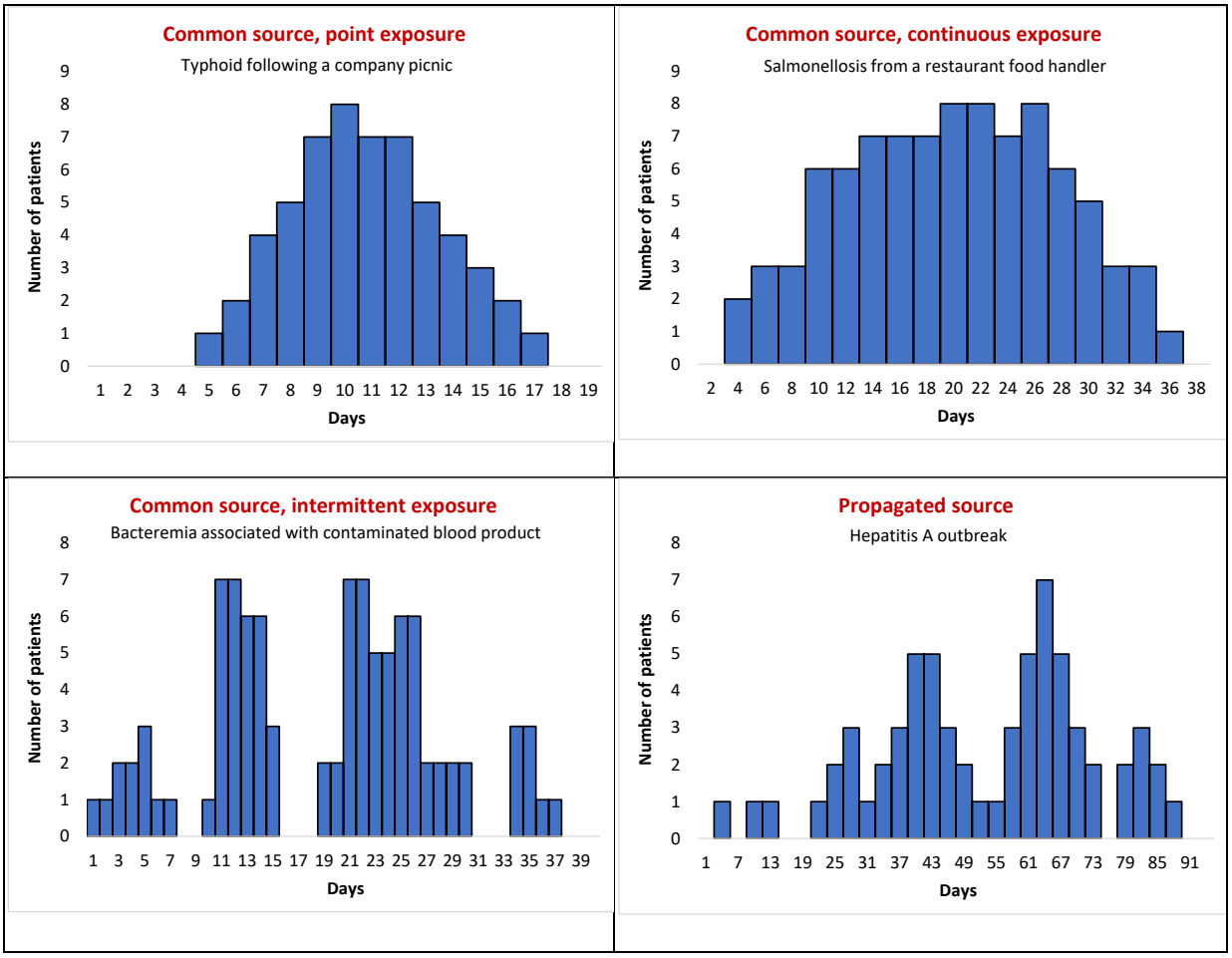
- Outbreaks can be classified according to their manner of spread within a population:

1. Common-source (exposed to the same infectious agent or toxin)
   - ✓ Point
   - ✓ Continuous
   - ✓ Intermittent
1. Propagated
2. Mixed
3. Other

	Common source outbreak	Propagated (ongoing) outbreak
Definition	○ All cases have the same origin (exposure can be: point, continuous or intermittent)	○ Cases cannot be attributed to a single origin.
Person to person transmission	○ No	○ Yes
Number of cases	○ Small	○ Large (can be epidemic)
Period of outbreak	○ Short	○ Longer
Example	○ Waterborne Legionella associated VAP outbreak in ICU (source is contaminated air conditioning cooling towers)	○ COVID-19 associated VAP outbreak in ICU (Source is other patients with COVID-19)

How the epidemic curve determines epidemic pattern of the outbreak?

- **Common source, point exposure:** The epidemic curve has a steep up slope and a more gradual down slope (a lognormal curve). The majority of cases occur within one incubation period of the disease
- **Common source, continuous exposure:** The epidemic curve has a plateau instead of a peak and the cases extend over one incubation period
- **Common source, intermittent exposure:** Epidemic curve is irregularly jagged
- **Propagated source:** Epidemic curve has a series of progressively taller peaks one-incubation period apart


Common source, point exposure
Typhoid following a company picnic
Number of patients
Days
Common source, continuous exposure
Salmonellosis from a restaurant food handler
Number of patients
Days
Common source, intermittent exposure
Bacteremia associated with contaminated blood product
Number of patients
Days
Propagated source
Hepatitis A outbreak
Number of patients
Days

Epidemiology and Prevention of MDRO outbreaks

Definition of Multiple drug resistant organisms (MDRO):

Pathogens that develop resistance to one or more commonly used antibiotics

Types of MDROs

Gram positive MDROs:

- **Methicillin-resistant Staphylococcus aureus (MRSA):** Includes S. Aureus cultured from any specimen that tests oxacillin-resistant, cefoxitin-resistant, or methicillin-resistant by standard susceptibility testing methods
- **Vancomycin-resistant Enterococci (VRE):** Enterococcus faecalis, Enterococcus faecium, or Enterococcus species unspecified that is resistant to vancomycin, by standard susceptibility testing methods

Gram negative MDROs:

- **Carbapenem-resistant Enterobacteriaceae (CRE):** Any Escherichia coli, Klebsiella oxytoca, Klebsiella pneumoniae, or Enterobacter spp. Testing resistant to imipenem, meropenem, doripenem, or ertapenem by standard susceptibility testing methods OR by production of a carbapenemase demonstrated using a recognized test (e.g., PCR or Modified-Hodge test)
- **Cephalosporin-resistant Klebsiella:** Klebsiella oxytoca or Klebsiella pneumoniae testing non-susceptible (i.e., resistant or intermediate) to ceftazidime, cefotaxime, ceftriaxone, or cefepime
- **MDR Acinetobacter:** non-susceptible (resistant or intermediate) to at least one agent in at least 3 out of 6 antimicrobial classes (penicillins, aminoglycosides, cephalosporins, fluoroquinolones, carbapenems, and sulbactam)

✓ Classes: Penicillins (Piperacillin, Piperacillin/Tazobactam), Aminoglycosides (Amikacin, Gentamicin, Tobramycin), Cephalosporins (Cefepime, Ceftazidime), Fluoroquinolones (Ciprofloxacin, Levofloxacin), Carbapenems (Imipenem, Meropenem, Doripenem), And

- **MDR Klebsiella or Pseudomonas:** non-susceptible (resistant or intermediate) to at least one agent in at least 3 out of 5 antimicrobial classes (penicillins, aminoglycosides, cephalosporins, fluoroquinolones, and carbapenems)
- **Extended-spectrum beta-lactamases (ESBL):**

✓ ESBL are enzymes that confer resistance to most beta-lactam antibiotics, including penicillins, cephalosporins, and the monobactam aztreonam

✓ They are present in Enterobacteriaceae (such as Escherichia coli and Klebsiella) and other gram negatives (such as Pseudomonas aeruginosa)

Clostridium difficile

- A positive laboratory test result for C. Difficile toxin A and/or B, (includes molecular assays [PCR] and/or toxin assays) tested on an unformed stool specimen (must conform to the container) OR A toxin-producing C. Difficile organism detected by culture or other laboratory means performed on an unformed stool sample (must conform to the container).

Presentation by onset time

- Community-Onset (CO): MDRO specimens collected in an outpatient location or an inpatient location ≤3 days after admission to the facility (i.e., days 1, 2, or 3 of admission).
- Healthcare Facility-Onset (HO): MDRO specimens collected >3 days after admission to the facility (i.e., on or after day 4).

- MDRO is not necessarily HAI; it could be infection or colonization
- Healthcare facility-onset MDRO means that clinical specimens collected after 3 days from admission (admission is considered day 1) are positive.
- HAI means the definition of infection is met for the first time after 2 days from admission (admission is considered day 1).

<table>
<tr><th>Admission days</th><th>HAI</th><th>Present on admission (Community associated infection)</th><th>MDRO-Community-onset</th><th>MDRO-Healthcare-onset</th></tr>
<tr><td>1</td><td rowspan="2">Free during the first 2 days</td><td rowspan="2">Signs of infection in the first 2 days</td><td rowspan="3">Clinical specimen collected in the first 3 days is positive</td><td rowspan="3">Clinical specimen collected in the first 3 days is negative</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td rowspan="3">Signs of infection on or after 3rd day</td><td rowspan="3">Signs of infection may or may not continue on or after 3rd day</td></tr>
<tr><td>4</td><td rowspan="2">Clinical specimen collected after 3rd day is positive or negative</td><td rowspan="2">Clinical specimen collected after 3rd day is positive</td></tr>
<tr><td>5</td></tr>
</table>

Description of the patient	HAI designation	MDRO designation
Asymptomatic patient in the medical unit had a urine sample obtained in the **second day** and was found later positive for carbapenem-resistant Escherichia coli but the patient was still not meeting definition of UTI.	Colonization	CRE community-onset
A patient in the medical unit with fever and dysuria had a urine sample obtained in the **fourth day** and was found later positive for carbapenem-resistant Escherichia coli.	Infection (UTI)	CRE healthcare-onset
A patient with symptomatic decubitus ulcer was transferred from the medical unit to the neurological unit and wound swab taken in the **third day** of admission was positive for MRSA.	Infection (infected decubitus ulcer)	MRSA community-onset
A patient with asymptomatic decubitus ulcer was transferred from the medical unit to the neurological unit and wound swab taken in the **fifth day** of admission was positive for MRSA.	Colonization	MRSA healthcare-onset

Presentation by symptoms

- **Colonization**
  - ✓ The multiplication of a microorganism at a body site or sites without any overt clinical expression or detected immune reaction in the host at the time that the microorganism is isolated.
  - ✓ Colonization may or may not be a precursor of infection.
  - ✓ Colonization may be a form of carriage and is a potential source of transmission
  - ✓ Does not require treatment
- **Infection**
  - ✓ The successful transmission of a microorganism to the host with subsequent multiplication, colonization, and invasion.
  - ✓ Infection may be clinical or subclinical and may not produce identifiable disease.
  - ✓ However, it is usually accompanied by measurable host immune response(s), such as specific antibodies or cell-mediated reactions
  - ✓ Requires treatment

Factors contributing to MDRO in healthcare setting

- Selective pressure exerted by exposure to antimicrobial in the community
- Inappropriate and uncontrolled use of antimicrobial agents in healthcare setting
  - ✓ Increased use of antimicrobial prophylaxis
  - ✓ Increased use of poly microbial antimicrobial therapy
  - ✓ Administration of suboptimal doses and/or for insufficient duration
  - ✓ Inappropriate choice of drug due to misdiagnosis, lack of microbiologic lab, and empirical treatment
  - ✓ Poor patient compliance
  - ✓ Lack of alternative appropriate antimicrobials
- Inadequate adherence to infection control measures
- Contact with colonized or infected patients (lack of isolation)
- Availability of vulnerable host
  - ✓ Severe underlying disease
  - ✓ Compromised host defenses such as dialysis, transplant, and oncology patients
  - ✓ Recent surgery
  - ✓ Indwelling medical devices
  - ✓ Transfer of the patient between institutions, specially suspected ones
  - ✓ Prolonged hospital stay

Prevention of MDROs arranged according to CDC Guideline

1. Structures and system administrative support

- Make MDRO prevention and control an organizational patient safety priority.
- Provide administrative support, and both fiscal and human resources, to prevent and control MDRO transmission within the healthcare organization.
- Keep good communication and feedback to update on the progress and effectiveness of interventions
- Implement systems to communicate information about reportable MDROs
- Implement multidisciplinary measures to monitor and promote healthcare staff compliance
- Implement systems to designate and communicate information about patients known to be colonized or infected with a targeted MDRO
- Support participation of the facility or healthcare system in local, regional, and national coalitions to combat emerging or growing MDRO problems.
- Human resources: trained infection control practitioners and adequate staffing level
- IT measures to automate antimicrobial requests and control restriction
- Provide hand hygiene and environmental cleaning products
- Provide clinicians with antimicrobial susceptibility reports and analysis of current trends, updated at least annually, to guide antimicrobial prescribing practices.
- Written plan for implementation

2. Education and training of healthcare workers

- Provide training and education on risks and prevention of MDRO spreading during orientation and periodic educational updates for healthcare personnel.
- Do the assessment and evaluation of the staff's knowledge and skills by field observation and the online Infection Control module when available
- Provide clinicians with updated antimicrobial susceptibility reports and analysis of current trends, to guide antimicrobial prescription practices
- Increase the frequency of MDRO educational programs for those who work in areas with high MDRO rates.
- Additional review of wise utilization of antimicrobial agents

3. Judicious use of antimicrobials

- Appropriate use of antimicrobials
  - ✓ Limit antimicrobial prescription
  - ✓ Use local antibiogram to effectively treat infections
  - ✓ Treat infection, not contamination
  - ✓ Treat infection, not colonization
  - ✓ Stop treatment when infection is cured or unlikely
  - ✓ Avoid excessive duration of treatment
  - ✓ Use narrow spectrum agents and restrict broad spectrum and potent antibiotics

- Implement systems (e.g., computerized physician order entry, comment in microbiology susceptibility report, notification from a clinical pharmacist or unit director) to prompt clinicians to use the appropriate antimicrobial agent and regimen for the given clinical situation.
- Provide clinicians with antimicrobial susceptibility reports and analysis of current trends, updated at least annually, to guide antimicrobial prescribing practices.
- Monitor trends in the incidence of target MDROs in the facility over time using appropriate statistical methods to determine whether MDRO rates are decreasing and whether additional interventions are needed
- Establish a baseline (e.g., incidence) for targeted MDRO isolates by reviewing results of clinical cultures

4. MDRO Surveillance

- A critical component of any MDRO control program
  - ✓ Important patient safety component
  - ✓ Allows detection of newly emerging resistance pattern
  - ✓ Monitors epidemiologic trends in incidence of MDROs over time
  - ✓ Measures the effectiveness of interventions
- Establish systems to ensure that clinical microbiology laboratories (in-house and out-sourced) promptly notify infection control staff or a medical director/ designee when a novel resistance pattern for that facility is detected
- Use standardized laboratory methods and follow published guidance for determining antimicrobial susceptibility of targeted (e.g., MRSA, VRE, MDR-ESBL) and emerging (e.g., VRSA, MDR-Acinetobacter baumannii) MDROs

➢ Healthcare pathogen screening

- Screening is the collection of specimens from specific body sites known to be associated with colonization by a specific microorganism

Microorganism	Required specimens for screening
MRSA	○ Nares, axilla, and groins
VRE	○ Rectal swab or ○ Perianal swab
CRE	○ Stool sample or ○ Rectal swab AND, if indicated ○ Urine (in the presence of a urinary catheter) ○ Stoma swab (patient with colostomy or ileostomy) ○ Wounds ○ Catheter exit sites
ESBL	○ Stool sample or ○ Rectal swab AND, if indicated ○ Urine (in the presence of a urinary catheter)
Acinetobacter	○ Nostrils, pharynx, and skin surface
Candida Auris	○ Screen for C. auris colonization using a composite swab of the patient's bilateral axilla and groin. Available data suggest that these sites are the most common and consistent sites of colonization. ○ Although patients have been colonized with C. auris in the nose, mouth, external ear canals, urine, wounds, and rectum, these sites are usually less sensitive for colonization screening.

➢ Indication of screening:

- In the following conditions:
  - ✓ During an outbreak as a part of outbreak investigation and case finding
  - ✓ As part of infection control measures to manage the outbreak
  - ✓ As part of routine infection control measures, to find new cases before admission to critical care units and special papulation
- Screening specimens should be taken once the antibiotic has been discontinued for at least 48 hours to avoid false negative results
- Screening may not be appropriate in the following conditions:
  - ✓ Routine screening of well people admitted from the community is not recommended
  - ✓ Routine screening of staff is not recommended. If staff are epidemiologically linked to the transmission of a MDRO, review infection control practices and predisposing

factors

- ✓ If it is found incidentally that staff are colonized with MDROs, no work restrictions for these staff are required. Instead, staff should receive education on standard precautions, particularly hand hygiene

➢ **Targeted patients for screening:**

Microorganism	Targeted patients for screening
MRSA	Screen all patients who are: o Transferred from another hospital o Have a history of hospitalization one month before admission o Previously infected or colonized with MRSA o Admitted to ICU and oncology unit o Scheduled for Cardiac Surgery, Orthopedic surgery, Neurosurgery and surgery with an implant. o Continuous ambulatory peritoneal dialysis o Roommates of positive patients not on precautions for more than 72 hours
VRE	o Patients who were previously VRE positive within the past 6-12 months. o Roommates exposed to VRE-positive patients.
CRE	o Roommates exposed to CRE-positive patients o Active surveillance culture before admission in specific units
ESBL	o Roommates exposed to ESBL-positive patients o Active surveillance culture for specific at-risk units such as intensive care, burn, oncology-hematology, hemodialysis and organ transplant units
Acinetobacter	o Active surveillance culture before admission in specific units
Candida Auris	Screen all patients who are: o Admitted to the critical care units and with specific risk factors to rule out Candida auris colonization. o Patients with an indwelling medical device, such as a central venous catheter, breathing aid tubes, urinary catheter, biliary catheter, or wound drain. o Any patient transferred from another healthcare facility OR long-term facility. o Roommates were exposed to C. auris-positive patients for more than 48 hours. o Individuals with current multidrug-resistant gram-negative bacteria who received healthcare outside of the Kingdom of Saudi Arabia (KSA) within the last 12 months. o Patients transferred from a unit with current transmission within the

	healthcare facility of C. auris or recent transmission within the last 30 days. o Carbapenem-Resistant entero bacterales (CRE) positive patient (infected & colonized). o Immunocompromised patient. Others: o Screening is recommended in departments that are experiencing outbreaks or having an increase in the number of ongoing cases and/or colonization. NB: In all cases, in the four weeks prior to diagnosis in the index patient, the healthcare facility should look back to see if there has been an increase in detection of Candida in the same intensive care setting or ward as this may represent unrecognized transmission.

5. Infection control measures

➢ Prevent healthcare associated infection

- Implementing standard precautions, particularly hand hygiene
- Implement contact precautions routinely for all patients infected with target MDROs and for patients that have been previously identified as being colonized with target MDROs (e.g., patients transferred from other units or facilities who are known to be colonized).
- Use masks according to Standard Precautions when performing splash-generating procedures (e.g., wound irrigation, oral suctioning, intubation)
- Implementing evidence-based best practices to prevent device-associated and procedure-associated HAIs
- Accurate and rapid diagnosis of infections and treatment of infectious etiology
- Reduce device utilization and improve insertion and post insertion care

➢ Prevention of MDRO transmission

- Strict hand hygiene and monitor HCWs compliance rate
- PPE: Wear gloves and gown when entering the room, removing before exiting
- Active surveillance cultures: to detect asymptomatic patients
- Use of isolation precautions: standard & contact for patients colonized or infected with MDRO
- **Patient placement in hospital** :
  - ✓ All Patients with MDROs should be placed in a single room.
  - ✓ When single patient rooms are not available, cohort patients with the same MDRO in the same room.
  - ✓ When cohort cases with the same MDRO are not possible, place MDRO patients in rooms with patients who are at low risk for acquiring an MDRO and who are likely to have shorts length of stay after discussion with ICP.

- Assign dedicated nurses and ancillary service staff to the care of MDRO patients only.
- Stop new admissions to the unit if transmission continues despite the implementation of the increased control measures.
- **Enhanced environmental measures:**
  - ✓ Clean and disinfect surfaces and equipment that may be contaminated with pathogens, including those that are in proximity to the case and frequently touched surfaces in the patient care setting on an extra frequent schedule compared to that for minimal touch surfaces.
  - ✓ Dedicate noncritical items to use on individual patients known to be infected or colonized with MDRO.
  - ✓ Designate cleaning equipment for contact isolation rooms.
  - ✓ Focus on cleaning and disinfection of frequently touched surfaces and equipment in the immediate vicinity of the patient.
  - ✓ Disinfect reusable medical equipment between patients

➢ Precautions during the transportation of patients

- Keep patient movement to a minimum if possible to prevent the transmission of MDROs.
- Perform tests at the bedside if possible.
- Inform the receiving department about the infectious status of the patient.
- Follow the procedures if the transportation is unavoidable.
  - ✓ Give bath to the patient.
  - ✓ Seal all open wounds with impermeable dressings.
  - ✓ The patient must wear a new gown before transport.
  - ✓ Both patient and HCWs should perform hand hygiene before leaving from the patient's room.
  - ✓ Remove and discard of contaminated PPE and perform hand hygiene before transporting patients on contact precautions
- The patient NEVER wears yellow gown or gloves.

✓ Transport staff should NOT wear yellow gown or gloves to transport patients, except when close contact is required during transport. At least one transporter should be not wear PPE in order to help with doors, elevators, etc.

✓ If the patient bed and /or other equipment such as an IV pole accompany the patient the patient on the transport, the bedrails and equipment should be wiped down with hospital approved disinfectant prior to the transport.

- HCWs should wear PPE to handle the patient at the transport destination.
- Clean the testing and procedure area with hospital approved disinfectant after MDROs-patient leaves the area.
- Do all procedures in the patient's room if applicable.
- Do not allow sitter except if medically indicated.
- Educate the sitter to follow infection control precautions.
- Make sure all visitors of patients who are on contact isolation for MDROs should follow

the isolation requirements. This means that visitors should use a gloves and gown when in the patient's room. A mask should also be worn if the organism is in the patient's sputum. When the visitor exits, the gown, gloves, and mask should be removed inside the room and hand washing with water and soap or alcohol-based hand cleanser should be performed. If visitors follow these requirements, there is no restriction on their movement in the hospital.

- Make sure isolation requirements are followed whenever possible in the case of visitors who sleep in the patient's room (i.e. Parents staying with a child on isolation for MDROs).
- Put on a clean change of clothes and perform thorough hand hygiene must be followed by the visitors prior to exiting the patient's room if gowns and gloves are not worn (i.e. When sleeping or during prolonged hospitalizations). If these isolation requirements cannot be met for any reason, then when leaving the patient's room the visitor should proceed directly out of the hospital without visiting other patients or any common-use areas.
- Reprocess ventilators used by patients with MDROs according to manufacturer recommendations.
- Designate respiratory therapist to provide care to patients with MDROs.
- Make sure patients with MDROs are seen last or at the end of the day if possible, including patient travelling to wound care room or physiotherapy rooms. Physical therapy/ Occupational therapy/ Speech therapy.

➢ **Manage MDROs positive patient as follows**

- Start contact precautions in addition to standard precautions and place contact precautions sign on the door.
- Practice strict hand washing.
- Cohort non-critical items to the patient (in the patient room).
- Minimize the amount of supplies in the patient room.
- Use isolation cart outside the patient room.
- Limit patient's activity outside the room for treatment or tests.
- Make sure that same time and terminal cleaning of isolation room and equipment is per housekeeping procedures.
- Handle/discard contaminated objects as per Standard Precautions.
- Request Infectious Diseases consultation as needed.
- Discharge patient if medical condition allows.
- Discontinue isolation after prior consultation with the ICP
- Review implementation of HAIs bundles (Surveillance MOH GDIPC Guideline).

6. Enhanced environmental measures:

- Start patient-dedicated or single use disposable non-critical equipment (e.g. Blood pressure cuff, stethoscope), instruments, and devices.
- Monitor compliance to environmental cleaning policies.
- Monitor cleaning performance to make sure of consistent cleaning and disinfection of

surfaces in close proximity to the patient.

- Obtain environmental cultures when there is epidemiological evidence than an environmental source is associated with on-going transmission of the targeted MDROs.
- Empty units for environmental intensive cleaning when previous efforts have failed.

➢ **Clean patient's room:**

- Clean rooms everyday by the designated personnel with disposable or dedicated equipment.
- Change the mop water after each isolation patient's room is completed.
- Wipe mop handles with disinfectant and the mop head will be bagged and sent to the laundry.
- Clean all equipment with hospital approved disinfectant after each use.
- Do terminal cleaning of the room: This includes changing the curtains and wet disinfectant/mopping of floors, walls, bed, bedside table, telephone, and IV poles, etc. Curtains, sheets, and other durable items will be bagged and sent to the laundry.
- Use single-use or disposable equipment for the care of patients with MDROs- whenever possible.
- Clean when durable equipment is used, including but not limited to portable x-ray machines, ABG machines, dialysis machines, etc., the equipment with hospital approved disinfectant and/or according to manufacturer's recommendations before the equipment is used to care for another patient.
- Keep all medical items such as dressings, syringes, IV fluids, etc. To minimal in the patient room; if these items found in the patient room after diagnosis with MDROs - all should be discarded.
- Keep linen in water-soluble bag and send to laundry as per hospital policy.

✓ For intensified interventions to prevent MDROs transmission, see Appendix-6: Intensified interventions to prevent MDROs
✓ For risk assessment of MDROs, see Appendix-7: Risk Assessment Tool for MDRO

Epidemiology of specific MDRO outbreaks in hospitals

- MRSA
- VRE
- CRE
- ESBL
- MDR Pseudomonas aeruginosa
- MDR Acinetobacter
- Clostridium difficile

MRSA	
Pathogen	• Methicillin-resistant Staphylococcus aureus (MRSA): Includes S. Aureus cultured from any specimen that tests oxacillin-resistant, cefoxitin-resistant, or methicillin-resistant by standard susceptibility testing methods. • Methicillin-sensitive Staphylococcus aureus (MSSA): S. Aureus cultured from any specimen testing intermediate or susceptible to oxacillin, cefoxitin, or methicillin by standard susceptibility testing methods.
Burden	• Approximately 5% of patients in U.S. hospitals carry MRSA in their nose or on their skin. • Approximately 4% to 9% of all HAI are caused by MRSA • Approximately 25-50% of staphylococcus aureus causing HAI are MRSA
Risk factors	**Risk factors in hospital setting:** • Frequent/prolonged hospitalization • People with indwelling central line, urinary catheters, implants, prostheses, and drains • Immunocompromised patients (HIV/AIDS, lupus, or cancer sufferers; transplant recipients; severe asthmatics; etc.) • Surgical and non-surgical wound • Diabetics • Users of quinolone antibiotics • Elderly people • Nursing home and long-term care **Risk factors in community setting:** • People who are frequently in crowded places, especially with shared equipment and skin-to-skin contact • Participating in contact sports. MRSA can spread easily through cuts, scrapes, and skin-to-skin contact. • Intravenous drug users and homosexual • Prison inmates and military personnel
Hospital outbreak	• Common cause of hospital outbreaks
Symptoms & clinical picture	• The symptoms of a MRSA infection depend on the part of the body that is infected. For example, bloodstream infection is manifested as fever, shivering, and low blood pressure. • Staph skin infections cause swelling, warmth, redness, and pain, which may become abscess • It can cause severe infections including: ✓ Bloodstream infections ✓ Pneumonia ✓ Surgical site infections

	✓ Sepsis ✓ Death
Diagnosis	• Positive culture for MRSA. Normally, a bacterium must be cultured from blood, urine, sputum, or other body-fluid samples • PCR • Rapid latex agglutination test
Mode of Transmission	• Direct contact with contaminated hands (usually HCWs) or infected patients • Direct contact with colonized patients • Indirect contact with contaminated surfaces and objects
Screening	• In health-care settings, isolating those with MRSA from those without the infection is one method to prevent transmission. • Rapid culture and sensitivity testing and molecular testing identifies carriers and reduces infection rates • Swabbing sites: nares, axilla, and groins • Screen the following patients: ✓ Patients transferred from another hospital ✓ Patients with history of hospitalization one month before admission ✓ Patients who are previously infected or colonized with MRSA ✓ Before admission to ICU and oncology unit ✓ Scheduled for Cardiac Surgery, Orthopedic surgery, Neurosurgery and surgery with an implant. ✓ Patients on continuous ambulatory peritoneal dialysis ✓ Roommates of positive patients not on precautions for more than 72 hours • Screening of HCWs is not recommended, unless they are epidemiologically linked to new acquisitions of MRSA
Prevention and control	**Implement core prevention strategies** • Promote hand hygiene • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's environment. • Use dedicated patient-care equipment (e.g. Blood pressure cuffs, stethoscopes), and single use disposable items (e.g. Single patient digital thermometer) whenever possible • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging. • Provide education on management of MRSA patients to HCWs. **Implement interventions to reduce device-associated and procedure-associated HAIs:** • Implement strategies for preventing CLABSI • Implement strategies for preventing SSI

	• Implement strategies for preventing bacteremia in dialysis patients **Implement supplemental prevention strategies:** • Performance of active surveillance testing before admission to ICU and oncology unit • Decolonization and chlorhexidine bath
Decolonization	• Decolonization for MRSA carriers who were implicated in an outbreak (intranasal mupirocin twice a day to each nare for 5 days). For more details, see Appendix-8: MRSA Decolonization
Discontinue Contact isolation	• Discontinue contact isolation after three consecutive negative cultures (taken 3 days apart) from a previously positive patient (in the absence of antibiotic therapy for at least three days) • Consult IC / RHD outbreak coordinators and treating physician

VRE	
Pathogen	• Vancomycin-resistant Enterococci (VRE): Enterococcus faecalis, Enterococcus faecium, or Enterococcus species unspecified that is resistant to vancomycin, by standard susceptibility testing methods • Enterococci are bacteria normally present in the human intestines and in the female genital tract, and are often found in the environment, like in soil and water.
Burden	• Approximately 3% of all HAI are caused by VRE • Approximately 10-20% of enterococci causing HAI are VRE
Risk factors	Risk factors in hospital setting • Frequent/prolonged hospitalization • People with indwelling central line, urinary catheters, implants, prostheses, and drains • Immunocompromised patients (cancer, transplant recipients, neutropenia, or renal dysfunction) • Diabetes mellitus • Patients undergoing surgical procedures • Patients who have been previously treated with antibiotics, including vancomycin, for long periods of time
Hospital outbreak	• Common cause of hospital outbreaks
Symptoms & clinical picture	• The symptoms of a VRE infection depend on the part of the body that is infected. For example, bloodstream infection is manifested as fever, shivering, and low blood pressure. • It can cause severe infections including: ✓ Bloodstream infections ✓ Urinary tract infection ✓ Surgical site infections ✓ Dialysis bacteremia
Diagnosis	• Positive culture for VRE. Normally, a bacterium must be cultured from infected wound, blood, urine, or stool
Mode of Transmission	• Indirect contact with contaminated surfaces and objects. Items such as bedrails, stethoscopes, blood pressure cuffs are reservoirs for VRE • Direct contact with contaminated hands (usually HCWs) or infected patients • Direct contact with colonized patients • It is not spread through the air by coughing or sneezing
Screening	**Screening for VRE:** • Patients who were previously VRE positive within the past 6-12 months. • Roommates exposed to VRE-positive patients. • Screening of HCWs is not recommended, unless they are epidemiologically linked to new acquisitions of VRE

	Sites to screen: • Rectal swab or • Perianal swab
Prevention and control	**Implement core prevention strategies:** • Promote hand hygiene. Patients and their caregivers should wash their hands with soap and water or use alcohol-based hand sanitizer, particularly: ✓ After using the bathroom ✓ Before and after handling medical devices or caring for wounds ✓ Before preparing food • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's environment. • Use dedicated patient-care equipment (e.g. Blood pressure cuffs, stethoscopes), and single use disposable items (e.g. Single patient digital thermometer) whenever possible • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging. • Provide education on management of VRE patients to HCWs. **Implement interventions to reduce device-associated and procedure-associated HAIs:** • Implement strategies for preventing CLABSI • Implement strategies for preventing CAUTI • Implement strategies for preventing SSI • Implement strategies for preventing bacteremia in dialysis patients
Decolonization	• None
Discontinue Contact isolation	• Discontinue contact isolation after three consecutive negative cultures (taken 3 days apart) from a previously positive patient (in the absence of antibiotic therapy for at least three days) • Consult IC / RHD outbreak coordinators and treating physician

CRE	
Pathogen	• Carbapenem-resistant Enterobacteriaceae (CRE): Any Escherichia coli, Klebsiella oxytoca, Klebsiella pneumoniae, or Enterobacter spp. Testing resistant to imipenem, meropenem, doripenem, or ertapenem by standard susceptibility testing methods OR by production of a carbapenemase demonstrated using a recognized test (e.g., PCR or Modified-Hodge test) • Enterobacteriaceae are a large family of Gram-negative bacteria that includes a number of pathogens such as Klebsiella, Escherichia coli, Enterobacter, Citrobacter, Salmonella, Shigella, Proteus, Serratia and other species. • These pathogens are present in the human intestinal tract and are a normal part of the gut flora.
Burden	• CRE is endemic in many parts of the world • Approximately 5% of Enterobacteriaceae causing HAI are CRE • Approximately 30% of CRE produce carbapenemases, enzymes that break down carbapenems • Why are CRE considered epidemiologically important? ✓ CRE organisms are often resistant to multiple classes of antibiotics, substantially limiting treatment options. ✓ Infections caused by these organisms are associated with high mortality rates among hospitalized patients, up to 50% in some studies. ✓ Many CRE produce carbapenemases, which can be transmitted from Enterobacterales to other germs, facilitating spread of resistance. ✓ Although CRE is currently primarily associated with inpatient healthcare settings, it has the potential to spread to community settings.
Risk factors	**Risk factors in hospital setting:** • Frequent/prolonged hospitalization • People with indwelling central line, urinary catheters, and ventilator • Patients who have been previously treated with antibiotics, including carbapenems, cephalosporins, fluoroquinolones, and vancomycin, for long periods of time • Immunocompromised patients (cancer, transplant recipients, neutropenia, or renal dysfunction) • Advanced age
Hospital outbreak	• Common cause of hospital outbreaks
Symptoms & clinical picture	• The symptoms of a CRE infection depend on the part of the body that is infected. • CRE can cause infections in almost any body part, including: ✓ Urinary tract infection ✓ Bloodstream infections ✓ Ventilator-associated pneumonia

	✓ Intra-abdominal abscesses ✓ Surgical site infections ✓ Dialysis bacteremia
Diagnosis	• Positive culture for CRE. • Phenotypic diagnosis requires bacterial culture and identification. • Disk diffusion or automated susceptibility testing is done to identify the carbapenem resistance phenotype. • Molecular identification is much faster (hours instead of days) and can quickly determine the type of resistance mechanism involved. The five carbapenemases most frequently identified in CRE: KPC, NDM, VIM, OXA-48-type, and IMP. However, this method simply indicates the presence of a resistance gene and may not determine the efficacy of specific antibiotics.
Mode of Transmission	• Indirect contact with contaminated surfaces and objects. Sink drains and toilets are increasingly recognized as an environmental reservoir and CRE transmission source. • Direct contact with contaminated hands (usually HCWs) or infected patients
Screening	• Screening certain high-risk patients for CRE colonization is a recommended intervention. However, screening are generally reserved for carbapenemase producing-CRE, which have greater potential for spread. • Roommates exposed to CRE-positive patients • Active surveillance culture before admission in specific units • Screening of HCWs is not recommended, unless they are epidemiologically linked to new acquisitions of CRE • Specimens: ✓ Stool sample or ✓ Rectal swab AND, if indicated ✓ Urine (in the presence of a urinary catheter) ✓ Stoma swab (patient with colostomy or ileostomy) ✓ Wounds ✓ Catheter exit sites
Prevention and control	**Implement core prevention strategies:** • Promote hand hygiene. Patients and their caregivers should wash their hands with soap and water or use alcohol-based hand sanitizer, particularly: ✓ After using the bathroom ✓ Before and after handling medical devices or caring for wounds • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's environment. • Whenever possible, place patients currently or previously colonized or

	infected with CRE in a private room with a bathroom and dedicate noncritical equipment (e.g., stethoscope, blood pressure cuff) to CRE patients. • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging • Provide education on management of CRE patients to HCWs. • Prescribe and use antibiotics appropriately. • Discontinue devices like urinary catheters as soon as no longer necessary. **Implement interventions to reduce device-associated and procedure-associated HAIs:** • Implement strategies for preventing CAUTI • Implement strategies for preventing CLABSI • Implement strategies for preventing VAP • Implement strategies for preventing bacteremia in dialysis patients • Implement strategies for preventing SSI
Decolonization	• None
Discontinue contact isolation	• Contact isolation should continue for duration of acute care hospitalization. • Only discontinue after consultation with IPC • Consult IC / RHD outbreak coordinators and treating physician

ESBL	
Pathogen	• ESBL are enzymes that confer resistance to most beta-lactam antibiotics, including penicillins, cephalosporins, and the monobactam aztreonam • They are present in Enterobacteriaceae (such as Escherichia coli and Klebsiella) and other gram negatives (such as Pseudomonas aeruginosa)
Burden	• Approximately 15-30% of Enterobacteriaceae causing HAI are ESBL
Risk factors	• Anyone can get an ESBL producing bacteria. **Risk factors in hospital setting:** • Patients who have been previously treated with broad spectrum antibiotics, particularly third-generation cephalosporins, fluoroquinolones, vancomycin, and quinolones • Frequent/prolonged hospitalization • ICU admission • People with indwelling central line, urinary catheters, and ventilator • Open wound or drain • Multiple comorbidity • Advanced age **Risk factors in community setting:** • History of repeated UTIs • Prior antibiotic exposure
Hospital outbreak	• Can cause hospital outbreaks
Symptoms & clinical picture	• The symptoms of an ESBL infection depend on the part of the body that is infected. • ESBL can cause infections, including: ✓ Urinary tract infection (most common) ✓ Abdominal infection and diarrhea ✓ Wound infection ✓ Bloodstream infections ✓ Ventilator-associated pneumonia
Diagnosis	• Positive culture • Phenotypic diagnosis requires bacterial culture and identification. • Disk diffusion or automated susceptibility testing is done to identify resistance or decreased sensitivity to ceftazidime, cefotaxime, ceftriaxone and aztreonam • A second confirmatory test, based on the synergy between a cephalosporin (cefotaxime or ceftazidime) and a ß-lactamase inhibitor (clavulanic acid), should then be carried out. This test could be a double disk test, combination disk method or ESBL E-test
Mode of Transmission	• Indirect contact with contaminated surfaces and objects. • Direct contact with contaminated hands (of HCWs) or infected patients

Screening	• Screening certain high-risk patients for ESBL • Roommates exposed to ESBL-positive patients • Active surveillance culture for specific at-risk units such as intensive care, burn, oncology-hematology, hemodialysis and organ transplant units • Screening of HCWs is not recommended, unless they are epidemiologically linked to new acquisitions of ESBL • Specimens: ✓ Stool sample or ✓ Rectal swab AND, if indicated ✓ Urine (in the presence of a urinary catheter)
Prevention and control	**Implement core prevention strategies:** • Promote hand hygiene. Patients and their caregivers should wash their hands with soap and water or use alcohol-based hand sanitizer, particularly: ✓ After using the bathroom ✓ Before and after handling medical devices or caring for wounds • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's environment. • Whenever possible, place patients currently or previously colonized or infected with ESBL in a private room with a bathroom and dedicate noncritical equipment (e.g., stethoscope, blood pressure cuff) to ESBL patients. • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging • Provide education on management of ESBL patients to HCWs. • Prescribe and use antibiotics appropriately. • Discontinue devices like urinary catheters as soon as no longer necessary. **Implement interventions to reduce device-associated and procedure-associated HAIs:** • Implement strategies for preventing CAUTI • Implement strategies for preventing SSI • Implement strategies for preventing CLABSI • Implement strategies for preventing VAP
Decolonization	• None
Discontinue contact isolation	• Contact isolation should continue for duration of acute care hospitalization. • Only discontinue after consultation with IPC • Consult IC / RHD outbreak coordinators and treating physician

MDR Pseudomonas aeruginosa	
Pathogen	• Pseudomonas aeruginosa is a leading nosocomial pathogen • Pseudomonas aeruginosa lives in the environment and can be spread to people in healthcare settings when they are exposed to contaminated water or soil • MDR pseudomonas: non-susceptible (resistant or intermediate) to at least one agent in at least 3 out of 5 antimicrobial classes (penicillins, aminoglycosides, cephalosporins, fluoroquinolones, and carbapenems)
Burden	• Approximately 5-20% of Pseudomonas aeruginosa causing HAI are meeting the definition of MDRO
Risk factors	**Risk factors in hospital setting:** • Frequent/prolonged hospitalization • ICU admission • People with indwelling device such as ventilator, central line, and urinary catheters • Open wound or drain • Immunocompromised patients • Multiple comorbidity • Previous use of broad-spectrum antimicrobials (both antipseudomonal and non-antipseudomonal)
Hospital outbreak	• Can cause hospital outbreaks
Symptoms & clinical picture	• The symptoms of a MDR pseudomonas infection depend on the part of the body that is infected. • MDR pseudomonas can cause infections, including: ✓ Ventilator-associated pneumonia ✓ Bloodstream infections ✓ Surgical site infection ✓ Urinary tract infection ✓ Abdominal infection
Diagnosis	• Positive culture. • Phenotypic diagnosis requires bacterial culture and identification. • Disk diffusion or automated susceptibility testing is done to identify resistance phenotype of MDR pseudomonas.
Mode of Transmission	• Indirect contact with contaminated surfaces and objects. • Direct contact with contaminated hands (usually HCWs) or infected patients • Can cause waterborne outbreaks due to exposure to contaminated water
Prevention and control	**Implement core prevention strategies:** • Promote hand hygiene, particularly before and after caring for wounds or touching a medical device • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's

	environment. • Whenever possible, place patients currently or previously colonized or infected with MDR pseudomonas in a private room with a bathroom and dedicate noncritical equipment (e.g., stethoscope, blood pressure cuff) to MDR pseudomonas patients. • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging • Provide education on management to HCWs. • Precautions to prevent waterborne transmission • Water disinfection • Periodic cleaning and maintenance of showers, baths and sinks • Installing disinfection systems and filters • Avoiding the installation of other potential sources of infection such as decorative pools and fountains. **Implement interventions to reduce device-associated and procedure-associated HAIs:** • Implement strategies for preventing VAP • Implement strategies for preventing CLABSI • Implement strategies for preventing CAUTI • Implement strategies for preventing SSI
Discontinue Contact isolation	• The patient has two consecutive negative rectal swab at least 7 days apart • Consult IC / RHD outbreak coordinators and treating physician

MDR Acinetobacter	
Pathogen	• Acinetobacter baumannii is a leading nosocomial pathogen • Acinetobacter lives in the environment and can be spread to people in healthcare settings when they are exposed to contaminated water or soil • MDR Acinetobacter: non-susceptible (resistant or intermediate) to at least one agent in at least 3 out of 6 antimicrobial classes (penicillins, aminoglycosides, cephalosporins, fluoroquinolones, carbapenems, and sulbactam)
Burden	• Approximately 40-65% of Acinetobacter causing HAI are meeting the definition of MDRO
Risk factors	**Risk factors in hospital setting:** • Frequent/prolonged hospitalization • ICU admission • People with indwelling device such as ventilator, central line, and urinary catheters • Open wound or drain • Immunocompromised patients • Multiple comorbidity • Previous use of broad-spectrum antimicrobials such as carbapenems and piperacillin/tazobactam
Hospital outbreak	• Can cause hospital outbreaks
Symptoms & clinical picture	• The symptoms of a MDR Acinetobacter infection depend on the part of the body that is infected. • MDR Acinetobacter can cause infections, including: ✓ Ventilator-associated pneumonia ✓ Bloodstream infections ✓ Surgical site infection ✓ Urinary tract infection
Diagnosis	• Positive culture. • Phenotypic diagnosis requires bacterial culture and identification. • Disk diffusion or automated susceptibility testing is done to identify resistance phenotype of MDR Acinetobacter.
Mode of Transmission	• Indirect contact with contaminated surfaces and objects. • Direct contact with contaminated hands (usually HCWs) or infected patients
Prevention and control	**Implement core prevention strategies:** • Promote hand hygiene, particularly before and after caring for wounds or touching a medical device • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's environment.

	• Whenever possible, place patients currently or previously colonized or infected with MDR Acinetobacter in a private room with a bathroom and dedicate noncritical equipment (e.g., stethoscope, blood pressure cuff) to MDR Acinetobacter patients. • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging • Provide education on management to HCWs. **Implement interventions to reduce device-associated and procedure-associated HAIs:** • Implement strategies for preventing VAP • Implement strategies for preventing CLABSI • Implement strategies for preventing CAUTI • Implement strategies for preventing SSI
Discontinue Contact isolation	• The patient has two consecutive negative rectal swab at least 7 days apart • Consult IC / RHD outbreak coordinators and treating physician

Clostridium difficile	
Pathogen	• Anaerobic, spore-forming Gram-positive bacilli • Present in soil and environment • Hospitals are major reservoirs ✓ Hospital toilets ✓ Metal bedpans ✓ Commodes ✓ Thermometers ✓ Floors • Spores can persist in rooms up to 40 days after infected patient is discharged • Resistant to many commonly used cleaning agents. • Detergent-based agents do not eliminate C. Difficile spores
Burden	• Normal flora in ~2-3% of healthy adults • The overall rate is 2-3 per 1000 admissions/year • Recurrence occurs in 15-20% of patients after discontinuation of treatment.
Risk factors	**Risk factors in hospital setting:** • Older age • Prolonged or multiple antimicrobial therapy • Use of acid-reducing drugs (proton-pump inhibitors or H2 blockers) • Infected roommate • Recent or prolonged hospitalization • ICU stay • Multiple, severe underlying conditions • Immunocompromised patients • Surgery of the GIT • Colon disease e.g. Inflammatory bowel disease or colorectal cancer • Tubal feeding • Previous C. Diff infection **High risk antimicrobials:** • 2nd generation cephalosporins • 3rd generation cephalosporins • Clindamycin • Fluoroquinolones **Low risk antimicrobials:** • Aminoglycosides • Beta-lactam/beta-lactamase inhibitors
Hospital outbreak	• Can cause hospital outbreak
Symptoms & clinical picture	A spectrum of C. Difficile infections (CDI), including: • Asymptomatic colonization • Diarrhea (mild to severe) and abdominal pain

	• Fever, loss of appetite, and nausea • Colitis +/- pseudomembranes • Toxic megacolon • Colonic perforation/peritonitis • Sepsis & acute abdomen without diarrhea
Diagnosis	• A positive laboratory test result for C. Difficile toxin A and/or B, (includes molecular assays [PCR] and/or toxin assays) tested on an unformed stool specimen (must conform to the container) OR • A toxin-producing C. Difficile organism detected by culture or other methods performed on an unformed stool sample (must conform to the container)
Categorization	**CDI event categorization by prior positivity:** • Incident CDI: Positive specimen obtained >8 weeks from most recent (previous) positive stool sample or first time • Recurrent CDI: Positive specimen obtained > 2 weeks but ≤8 weeks from most recent (previous) positive stool sample • Duplicate CDI: Positive specimen obtained ≤2 weeks from most recent (previous) positive stool sample (do not report) **CDI event categorization by source:** • Community-onset: Specimen collection (event) date is in the first 3 days of admission • Healthcare-onset: Specimen collection (event) date is after the first 3 days of admission • Community-onset healthcare -associated: Specimen collection (event) date is in the first 3 days of admission BUT within 4 weeks from last discharge
Mode of Transmission	• Indirect contact with contaminated surfaces and objects. C. Diff is shed in feces. Any surface, device, or material (such as commodes, bathtubs, and electronic rectal thermometers) that becomes contaminated with feces could serve as a reservoir for the C. Diff spores. • C. Diff spores can also be transferred to patients via the hands of HCWs who have touched a contaminated surface or item.
Prevention and control	• Promote hand hygiene, particularly After using the bathroom, before preparing food or eating, and after diapering a child or caring for an ill person. • Implement contact precautions. Wear a gown and gloves for all interactions that may involve contact with the patient or the patient's environment • Ensure adequate cleaning and disinfection of surfaces such as countertops, sinks, faucets, bathroom doorknobs, and toilets regularly using warm/hot water (see below) • Whenever possible, place patients currently or previously colonized

	or infected with C. Diff in a private room with a bathroom and dedicate noncritical equipment (e.g., stethoscope, blood pressure cuff) to C. Diff patients. • If common use of equipment for multiple patients is unavoidable, clean and disinfect such equipment before use on another patient • Recognize previously colonized patients through screening and flagging • Provide education on management to HCWs.
	• C diff spores are resistant to extreme environmental conditions • Elimination needs physical cleaning and disinfection • Disinfectant of choice for environmental cleaning is household bleach (5% sodium hypochlorite solution) in 1:5 dilutions (250/L) or 10,000 ppm (1%) • Some disinfectants (e.g., glutaraldehyde) normally used to reprocess gastrointestinal endoscopes need prolonged contact times to kill clostridium difficile spores
Discontinue contact isolation	• When the patient returns to his/her normal stooling pattern for minimum of 48 hours • Because C diff patients continue to shed the organism for a number of days following cessation of diarrhea, some institutions routinely continue isolation until discharge • Consult IC / RHD outbreak coordinators and treating physician

Epidemiology of specific bacterial outbreaks in hospitals

- Mycobacterium Tuberculosis
- Legionella Pneumophila
- Burkholderia Cepacia
- Salmonella Species
- Shigella Species
- S. Pyogenes (Group A Streptococcus)

Tuberculosis (TB)	
Pathogen	• Mycobacterium Tuberculosis
Epidemiology	• Globally, tuberculosis is a leading cause of death from a single infectious agent, with 1.4 million deaths every year • Tuberculosis affects approximately 10 million new patients every year • Globally, tuberculosis incidence is falling at about 2% per year • High-risk population groups, including household contacts of tuberculosis affected individuals, persons living with human immunodeficiency virus (HIV), persons with medical conditions that weaken the immune system, and HCWs • HCWs are at increased risk of hospital-acquired tuberculosis infection due to persistent exposure to Mycobacterium tuberculosis in healthcare settings. • Multidrug-resistant tuberculosis (MDR-TB) remains a public health crisis and a health security threat
Hospital outbreak	• Tuberculosis is a common cause of hospital outbreaks among HCWs and patients across the world
Symptoms & clinical picture	• Pulmonary tuberculosis: Continuous cough (lasting for 3 weeks or more), hemoptysis, chest pain during breathing or coughing, anorexia, fatigue, fever, night sweats and chills. • Extra pulmonary tuberculosis: site swelling, abscess, hematuria.
Diagnosis	• Positive culture for M. Tuberculosis complex • Positive microscopic examination for acid-fast bacilli when a culture has not been or cannot be obtained • Demonstration of M. Tuberculosis complex nucleic acid directly from specimens • Histology strongly suggestive of tuberculosis when there is a strong clinical probability.
Mode of Transmission	• Transmission is by inhalation of airborne droplets produced by people with pulmonary or laryngeal tuberculosis, especially during coughing or sneezing. • People with extrapulmonary tuberculosis alone cannot transmit the infection to others. • People with latent tuberculosis infection are not infectious. • Bovine tuberculosis may also be transmitted from infected cattle to humans by ingestion of contaminated unpasteurized milk or milk products or by airborne droplet spread to people who work closely with cattle.
Incubation Period	• The period from infection to demonstrable primary lesion or significant tuberculin (Mantoux) reaction is between 2 and 10 weeks
Period of Infectivity	• Untreated adults and adolescents with pulmonary TB may be intermittently infectious for years. • Children under the age of 12 years are rarely infectious.

	• Once a person with pulmonary TB has been commenced on effective treatment, the risk of transmission declines over 2–4 weeks to negligible levels in most cases
Prevention and control	• The WHO multimodal IPC strategy consists of a combination of interventions designed to minimize and prevent the risk of tuberculosis transmission in healthcare settings. **1. Administrative controls** • Triage and isolation of people (with presumed or confirmed tuberculosis infection). Isolation and airborne precautions are indicated for cases with active pulmonary or laryngeal tuberculosis • Prompt initiation of effective treatment • Respiratory hygiene (practice of covering of the mouth and nose during coughing and sneezing) • Management of HCWs (including education and training) **2. Environmental controls** • Ventilation systems; natural, mechanical, mixed-mode, and recirculated air through HEPA filters • Germicidal ultraviolet systems **3. Personal respiratory protection** • Particulate respirators (N95 or FFP2) • Respirator fit testing
Vaccines	• The BCG is a live attenuated Mycobacterium Bovis vaccine that protects against tuberculosis • The overall protective efficacy of 50% with 56% protection against TB meningitis. • It is given as part of childhood immunization and high risk HCWs • However, BCG is not generally recommended for use in many low risk countries such as USA and UK

Legionella	
Pathogen	• Legionella Pneumophila is a Gram-negative bacterium • Legionella lives and grows in water systems at temperatures of 20 to 50 degrees Celsius (optimal 35 degrees Celsius). • Legionella can survive and grow as parasites within free-living protozoa and within biofilms which develop in water systems.
Epidemiology	• Legionnaires' disease is a severe type of pneumonia. • It is typically acquired by inhalation of contaminated water containing the Legionella pneumophila • Hospital-acquired Legionnaires' disease usually originates in hospital water systems • The overall death rate is usually within the range of 5–10%. • The death rate may be as high as 40–80% in untreated immuno-suppressed patients
Hospital outbreak	• Legionella one of the most common cause of waterborne outbreaks in hospitals
Symptoms & clinical picture	• The severe pneumonia occurs most frequently in susceptible patients • People 50 years or older • Current or former smokers • People with a chronic lung disease • People with weak immune systems, cancer, and organ failure **Pneumonic form,** • Incubation period of 2 to 16 days • Initially, symptoms are fever, loss of appetite, headache, malaise and lethargy. • Later symptoms are cough and may be hemoptysis • The severity of disease ranges from a mild cough to a rapidly fatal pneumonia. • Death occurs through progressive pneumonia with respiratory failure and/or shock and multi-organ failure. **Non-pneumonic form (Pontiac disease)** • It is an acute, self-limiting influenza-like illness usually lasting 2–5 days. • The incubation period is from a few and up to 48 hours. • The main symptoms are fever, chills, headache, malaise and muscle pain (myalgia). • No deaths are associated with this type of infection.
Diagnosis	• PCR testing • Positive Legionella culture • Legionella urinary antigen test
Mode of Transmission	• Inhalation of contaminated water aerosols from shower heads, some medical equipment (i.e., respiratory devices), air conditioning cooling towers, hot tubs, hot water tanks and heaters, complex plumbing

	systems, hydrotherapy equipment's and/or decorative water fountains • Less commonly, people can get sick by aspiration of drinking water containing Legionella. • Rarely person to person transmission
Incubation Period	• The average is 5 to 6 days from the time of exposure to symptom onset, (range 2 to 16 days)
Period of Infectivity	• As long as the contamination source is available
Prevention and control	• Minimizing Legionella growth in complex hospital water systems and devices is key to preventing infection. • Water disinfection is generally insufficient to control the risk of infection, as the biofilm contamination can be extensive and very difficult to remove. • Education of all direct care providers and family members to minimize patient exposure to tap water • Provision of sterile water to immunocompromised patients • Organizing a program of periodic cleaning and maintenance of showers, baths and sinks • Installing disinfection systems and/or point-of-use filters on taps and shower heads in those settings • Shock treatment: heating, flushing, and shock chlorination • Avoiding the installation of other potential sources of infection such as decorative pools and fountains.
Vaccines	• None

Burkholderia	
Pathogen	• Burkholderia cepacia is Gram-negative bacteria found in soil and water
Epidemiology	• Burkholderia has been linked to multiple healthcare-associated outbreaks. • Medical products, antiseptics, and disinfectants are the most frequent source. • In outbreak investigations, HCWs should look for contaminated object to withdraw. This would be the critical point to immediately stop new cases due to contamination.
Hospital outbreak	• Multiple outbreaks have been reported in relation to use of contaminated medical products, antiseptics, and disinfectants, mainly in immunocompromised patients
Symptoms & clinical picture	• The signs and symptoms will depend on the cause • It can produce severe lung infections in young people with cystic fibrosis, often late in the course of the disease. • If contaminated saline is administered to flush into a vein through an IV, bloodstream infections can happen: ✓ Fever ✓ Chills or shivering ✓ Clammy or sweaty skin ✓ Confusion or disorientation ✓ Shortness of breath ✓ Increased heart rate • If contaminated chlorhexidine is administered for oral care of ventilated patients, ventilator associated pneumonia can happens: ✓ Fever ✓ Purulent tracheobronchial secretions ✓ New or progressive infiltrate on chest radiograph, ✓ Leukocytosis
Diagnosis	• Culture of clinical and environmental specimens • PCR testing
Mode of Transmission	• Use of contaminated medical products, antiseptics, and disinfectants. • Person-to-person through droplet and direct/indirect contact
Incubation Period	• The average is 9 days (range between 1 and 21 days)
Period of Infectivity	• Unclear, probably during the period of the disease
Prevention and control	• Stop using any remaining contaminated products. • Immediately destroy any unused product from pharmacies, medication carts, medication preparation areas, and patient care areas. • Notify health authorities of any cases and implicated products to stop the spread in other hospitals • Other measures based on disease; droplet precautions for ventilator

	associated pneumonia and contact precautions and hand hygiene for bloodstream infection
Vaccines	• None

Epidemiology of specific viral outbreaks in hospitals

Respiratory viruses

- SARS
- SARS-cov- 2 or (COVID-19)
- MERS-CoV
- Influenza Viruses A and B
- Varicella Zoster
- Measles
- Respiratory Syncytial Virus

Blood-borne

- Hepatitis B Virus
- Hepatitis C Virus
- Human Immunodeficiency Virus

Contact viruses

- Varicella Zoster virus
- Herpes Simplex virus
- Cytomegalovirus
- Epstein Barr virus

GIT viruses

- Rotavirus
- Hepatitis A Virus

SARS	
Pathogen	• Coronavirus causing severe acute respiratory syndrome (SARS)
Epidemiology	• SARS was first reported in Asia in February 2003. The illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak of 2003 was contained. • According to the WHO, a total of 8098 people worldwide became sick with SARS during the 2003 outbreak. Of these, 774 died. • Currently, there is no known SARS transmission anywhere in the world
Hospital outbreak	• Multiple hospital outbreaks have been reported in China and other countries among HCWs, their family and friends, hospital visitors, and in inpatients
Symptoms & clinical picture	• Relatively insidious onset with fever, myalgia, malaise and headache, followed a few days to 1 week later by dry cough and dyspnea. • About 10-20% of cases have diarrhea. • Symptoms of upper respiratory tract infection (rhinorrhea and sore throat) are uncommon. • About 10-20% of cases develop severe pulmonary disease that may lead to death from respiratory failure.
Diagnosis	• Symptoms & clinical picture, especially with epidemiologic link • Chest X-rays typically show scattered peripheral and lower zone opacification. • Laboratory confirmation requires at least one of the following • Detection of diagnostic levels of serum antibody to SARS-CoV • Isolation (for example, in cell culture) of SARS-CoV • Detection of SARS-CoV nucleic acid
Mode of Transmission	• Person to person, by droplet transmission, direct contact with respiratory tract secretions and possibly fomites. • Airborne transmission of SARS can occur during aerosol generating procedures, such as intubation or nebulization
Incubation Period	• The average is 2-7 days but may be as long as 10 days
Period of Infectivity	• From onset of symptoms until 10 days after resolution of fever
Prevention and control	• In hospital, place cases under airborne and contact precautions throughout the period of communicability. • Staff should also wear eye protection and footwear that can be decontaminated or disposed of and use disposable equipment for the case wherever possible. • Clean and disinfect surfaces and articles soiled with respiratory secretions or feces, using a product with antiviral activity. • Prompt detection of cases through good surveillance and contact tracing

	• Quarantine of suspected contacts for 10 days • Outside hospital, cases should be isolated at home or in some other suitable facility throughout the period of communicability.
Vaccines	• None

SARS-cov-2 (COVID-19)	
Pathogen	• The virus is severe acute respiratory syndrome coronavirus 2 (SARS-cov-2) • The disease is called coronavirus disease of 2019 (COVID-19)
Epidemiology	• At the end of 2019, a novel coronavirus was identified as the cause of a cluster of pneumonia cases in Wuhan • It rapidly spread, resulting in an epidemic throughout China, followed by a global pandemic. • It caused the largest pandemic in human history
Hospital outbreak	• Multiple hospital outbreaks across the globe have been reported among patients and HCWs • According to MOH Regulation
Symptoms & clinical picture	• Most common symptoms: fever, cough, tiredness, and loss of taste or smell • Less common symptoms: sore throat, headache, aches and pains, diarrhea, a rash on skin, discoloration of fingers or toes, red or irritated eyes • Serious symptoms: difficulty breathing or shortness of breath, loss of speech or mobility, confusion, and chest pain
Diagnosis	**Suspected case:** One of the following • Sudden onset of at least one of the following: fever, cough, or shortness of breath • Patient with sudden onset of at least one of the following: headache, sore throat, rhinorrhea, nausea, diarrhea or loss of smell or taste. In addition (in the 14 days prior to symptom onset), had contact with a confirmed COVID-19 case OR working in or attended a healthcare facility • Any admitted adult patient with unexplained sever acute respiratory infection (SARI), either Community Acquired Pneumonia (CAP) or Hospital Acquired Pneumonia (HAP). **Confirmed Cases** • A person who meets the suspected case definition with laboratory confirmation of COVID-19 infection (PCR)
Mode of Transmission	• Person to person, by droplet transmission, direct contact with infected people through infected secretions such as saliva and respiratory secretions or their respiratory droplets, which are expelled when an infected person coughs, sneezes, talks or sings • Airborne transmission of SARS-cov-2 can occur during aerosol generating procedures
Incubation Period	• The average is 5-6 days (range 2 to 14 days)
Period of Infectivity	• Up to 10 days after symptom onset or 24 hours after resolution of fever • Up to10 days after the first positive test in asymptomatic patients

	• Up to 20 days after symptom onset in severely ill patients (i.e., those requiring hospitalization, intensive care, or ventilation support) or severely immunocompromised patients
Prevention and control	See the latest version of the Public Health Authority COVID-19 guidelines. **Early recognition and source control** • Encourage HCWs to have a high level of clinical suspicion. • Activation of respiratory triage • Post signage reminding symptomatic patients to alert HCWs. • Promotion of respiratory hygiene is an important preventative measure. • Suspected COVID-19 patients should be placed in an area separate from other patients, and additional Infection Prevention and Control IPC (droplet and contact) precautions promptly implemented **Application of Standard Precautions for all patients** • Universal masking of all HCWs, patients and visitors • Correct and consistent use of available PPE and appropriate hand hygiene. • Perform hand hygiene after contact with respiratory secretions. • Ensure that environmental cleaning and disinfection procedures are followed consistently and correctly. **Contact and droplet precautions for suspected COVID-19** • Place patients in adequately ventilated single rooms • In cases of severe shortage of single rooms, it is possible to cohort suspected COVID-19 patients **Airborne precautions** • For aerosol-generating procedures for suspected COVID-19 **Management of exposure** • Patients sharing the same room (any setting e.g. Ward with shared beds, open ICU, open emergency unit etc.) With a confirmed case of COVID-19 for at least 15 minutes should be monitored and tested **Precautions during transportation of patients** • There should be arrangement between the transporting facility and the receiving facility for transportation timing, personal and clinical information. • The patient should be masked with surgical mask during transportation. • The patient must be health educated about respiratory etiquette. • The driver should wear surgical mask during transportation. • Never transport suspected with confirmed COVID-19 in one vehicle. • The used vehicle should be disinfected using MOH approved disinfectant (quaternary ammonium chloride wipes or spray / freshly prepared sodium hypochlorite solution 1000 ppm). **Administrative controls** • Establishment of sustainable IPC infrastructures and activities. • Adequate staff training and specifically appropriate human behavior, and patients' care givers education.

	• Policies on early recognition of acute respiratory infection potentially due to COVID-19. • Access to prompt laboratory testing for identification of the etiologic agent. • Prevention of overcrowding especially in the emergency department. • Provision of dedicated waiting areas with clear signage of "Respiratory Waiting Area" for symptomatic patients and appropriate placement of hospitalized patients promoting an adequate patient-to-staff ratio. • Provision and use of regular supplies. • IPC policies and procedures for all facets of healthcare provisions with emphasis on surveillance of acute respiratory infection potentially due to COVID-19 among HCWs and the importance of seeking medical care. • Monitoring of HCW compliance with standard precautions, along with mechanisms for improvement as needed. **Environmental and engineering controls** • Basic health-care facility infrastructures. • Ensuring adequate environmental ventilation. • Adequate environmental cleaning in all areas within the health-care facility. • Terminal room cleaning at the time of discharge or transfer of patients. • Physical separation of at least 1.5-2-meter distance should be maintained between each suspect patient and others. **Precautions during collection and handling of laboratory specimen** • All samples collected for laboratory investigations should be regarded as potentially infectious. • HCWs who collect or transport clinical specimens should adhere rigorously to Standard Precautions to minimize the possibility of exposure to pathogens. • Ensure that HCWs who collect specimens use appropriate PPE (eye protection, surgical mask, long-sleeved gown, gloves). • The respiratory specimen should be collected under aerosol generating procedure, personnel should wear a particulate certified N95 respirator. • Ensure that all personnel who transport specimens are trained in safe handling practices and spill decontamination procedures. • Place specimens for transport in leak-proof specimen bags (secondary container) that have a separate sealable pocket for the specimen (i.e. A plastic biohazard specimen bag), with the patient's name label on the specimen container (primary container), and a clearly written laboratory request form. • Ensure that health-care facility laboratories adhere to appropriate biosafety practices and transport requirements according to the type of organism being handled. • Deliver all specimens by hand whenever possible.

	• DO NOT use pneumatic-tube systems to transport specimens. • HESN Printed lab requisitions must be sent with samples and national lab reception report and result values must be updated on HESN on their corresponding **Environmental cleaning and disinfection after a COVID-19** • In-patient rooms (housing COVID-19 patients) should be cleaned and disinfected at least daily and at the time of patient transfer or discharge • More frequent cleaning and disinfection may be indicated for high-touch surfaces and following aerosol producing procedures (e.g. Tables, hard-backed chairs, doorknobs, light switches, remotes, handles, desks, toilets, sinks) • Cleaning staff should wear disposable gloves, surgical mask and isolation gowns for all tasks in the cleaning process, including handling of waste. • Cleaning and disinfection of the environmental surfaces should be with approved MOH disinfectant e.g. Hydrogen peroxide, quaternary ammonium chloride 4th generation, freshly prepared sodium hypochlorite solution 1000 ppm with consideration to the contact time in accordance with manufacturer's instructions for environmental surface disinfection. • After patient transfer, terminal cleaning should be done using manual method and /or ultraviolet germicidal irradiation or hydrogen peroxide dry mist or vapor
Discontinuing Isolation	• According to the last update Public Health Authority "Management of Healthcare Workers Exposed to COVID-19" guide
Vaccines	• Messenger RNA (mRNA) vaccine such as Pfizer-bion Tech and the Moderna vaccines • Vector vaccine such as astrazeneca and Johnson & Johnson COVID-19 vaccines • Protein subunit vaccine such as Novavax

MERS-CoV	
Pathogen	• Middle Eastern Respiratory Corona Virus (MERS-CoV)
Epidemiology	• It was first isolated in Saudi Arabia in 2012 • Currently present more than 27 countries including the KSA, UAE, Qatar, Austria, Bangladesh, Thailand, Indonesia, UK and USA. • Around 2500 cases of MERS-CoV have been reported till now with approximately 80% of reported cases have been linked to exposure in Saudi Arabia • The disease had approximately 35% fatality rate
Hospital Outbreak	• According to last update of National guideline of MERS-CoV (MERS-CoV Outbreak evidence of secondary transmission within a healthcare facilities of one or more secondary cases)
Symptoms & clinical picture	• Most people with this illness present with: Fever greater than 38 C, cough, shortness of breath and breathing difficulties, body aches, runny nose, sore throat. • More severe disease in people with weakened immune systems, older people, and those with such chronic diseases as diabetes, cancer and chronic lung disease • Suspect MERS-CoV in any of the followings: ✓ Severe pneumonia (severity score ≥3 points) or ARDS (based on clinical or radiological evidence) ✓ Unexplained deterioration of a chronic condition of patients with congestive heart failure or chronic kidney disease on hemodialysis ✓ Acute febrile illness (T ≥380 C) with/without respiratory symptoms ✓ Gastrointestinal symptoms (diarrhea or vomiting), AND leukopenia (WBC≤3.5x109 /L) or thrombocytopenia (platelets < 150x109/L)
Diagnosis	**Suspected case:** • A person with any of the above mentioned signs and symptoms and has been in contact with a confirmed MERS-CoV confirmed case or is a resident of or has visited any of the MERS-CoV endemic countries. **Confirmed Cases** • A clinically compatible illness that is laboratory confirmed (positive PCR)
Mode of Transmission	• Human to human: The virus does not pass easily from person to person unless there is close contact with an ill patient suffering from an acute respiratory illness in the community or healthcare setting in the 14 days before the onset of illness • Non-Human to human: History of contact with camels or camel's products in the 14 days before the onset of illness
Incubation Period	• (Range 2 to 14 days)
Period of Infectivity	• Unknown but is likely to extend from the onset of fever until 10 days after fever resolves

Prevention and control	• Suspected and confirmed cases who are not critically ill should be placed in single rooms under standard, contact and droplet precautions. • Those who are critically ill should be placed in Airborne Infection isolation rooms (negative pressure rooms) or, if unavailable, adequately ventilated single rooms with HEPA filter placed to the side of the bed. • Staff should also wear PPE that includes gowns, surgical mask, eye protection and gloves. Those who are entering an airborne isolation room should wear fit-tested seal-checked N95 mask. • Symptomatic contacts should be managed as suspected cases
Vaccines	• None

Influenza Viruses A and B	
Pathogen	• Influenza A and subtyping (such as H1N1, H3N2, H7N9) • Influenza B and subtyping (such as B/Washington, B/Phuket, and B-Yamagata)
Epidemiology	• Seasonal influenza affects 5–10% of the world's population • It can cause hospital outbreaks and sometimes large pandemics
Hospital outbreak	• Influenza outbreaks are frequent, with attack rates from 12% to 60% • The transmission of influenza from HCWs to patients is well described • The diagnosis is commonly missed because of substantial proportions of asymptomatic cases
Symptoms & clinical picture	• Symptoms can be mild to severe. • The most common symptoms include: a high fever, runny nose, sore throat, muscle pains, headache, coughing, and feeling tired. • These symptoms typically begin two days after exposure to the virus and most last less than a week. • Gastrointestinal symptoms, more common in in children than adults. • Complications: viral pneumonia, secondary bacterial pneumonia, sinus infections, and worsening of previous health problems such as asthma or heart failure
Diagnosis	• Symptoms & signs • Confirmation using PCR or other diagnostic tests using nasopharyngeal specimens
Mode of Transmission	• Human to human: from person to person by inhalation or ingestion of droplets containing virus from people sneezing or coughing • Non-human to human: from infected animals such as Pork or birds (usually in the community)
Incubation Period	• The average is 2 days (range 1 to 7 days)
Period of Infectivity	• The infected patient is contagious one day before onset of symptoms to about a week after symptoms • In severely ill patients and in some children, some contagious viruses may be shed for a few weeks.
Prevention and control	• Vaccination, especially among HCWs • Respiratory hygiene/cough etiquette • Clinical triage • Cohorting patients with the same diagnosis • Management of patient flow, beds and care organization • Droplet precautions and extra caution when performing aerosol-generating procedures • Proper environmental hygiene • Restrict visitor access and movement within the facility • Training and education (hand hygiene, droplet precautions, etc.) • Surveillance of nosocomial influenza and early warning

Vaccines	• It contains 4 strains; two influenza A (H1N1and H3N2) and two influenza B viruses. • It should be given annually to: ✓ HCWs ✓ Age <5 years and >65 years ✓ Pregnancy ✓ Chronic lung disease as asthma and COPD ✓ Other chronic disease as CVD, cancer, neuro,..etc ✓ Residents of nursing homes and other long-term care facilities • Reduce symptoms by 40% and 60% • Reduce ICU admission and death by 30% to 60%

Varicella	
Pathogen	• Varicella Zoster Virus, a member of the herpesvirus group
Epidemiology	• Chickenpox (varicella) is a highly contagious rash illness with secondary attack rates is approximately 80% • It is transmitted from patients with either varicella or herpes zoster by direct contact or airborne spread • Once chickenpox has resolved, the virus may remain inactive in nerve cells. In about 10–20% of cases, the virus reactivates later in life, producing a disease known as shingles or herpes zoster
Hospital outbreak	• Hospital outbreaks are common among HCWs and sometimes in patients • Adult and immunocompromised patients suffering from varicella (chicken pox) are potential source of infection to HCWs.
Symptoms & clinical picture	**Chickenpox (varicella):** • The classic symptom of chickenpox is a pruritic rash, which progresses rapidly from macules to papules to vesicular lesions before crusting • Other typical symptoms that may begin to appear 1-2 days before rash include fever, malaise, loss of appetite and headache. • Some people who have been vaccinated against chickenpox can still get the disease. However, the symptoms are usually milder. **Shingles:** • Painful skin rash with blisters in a localized area that follows a dermatome • Can disseminate in immunocompromised patients
Diagnosis	• Symptoms & signs • Confirmation using PCR to detect VZV in skin lesions or positive IgG ELISA result indicates that a person has antibodies to VZV either from past varicella disease history or vaccination.
Mode of Transmission	• Varicella is highly contagious. • The virus can be spread from person to person by direct contact, inhalation of aerosols from vesicular fluid of skin lesions of acute varicella or zoster and possibly through infected respiratory secretions that also may be aerosolized
Incubation Period	• The average is 14–16 days (range, 10–21 days).
Period of Infectivity	• Patient is infectious from 1 to 2 days before the rash appears and until all lesions are crusted over (average range, 4–7 days after rash onset)
Prevention and control	• Vaccination of children and high-risk groups • Pre-employment screening of HCWs and vaccination if needed • Patients with uncomplicated chickenpox or shingles should, if possible, be nursed at home. • Chickenpox cases should be placed in isolation: Follow standard precautions plus airborne precautions, and contact precautions until

	lesions are dry and crusted • Contact precautions with shingles and isolation is preferable but most of the time not necessary • Post-exposure screening and vaccination • Sick leave for affected HCWs
Vaccines	• Live-attenuated vaccine given in 2 doses children 12 to 18 months of age • Varicella vaccine is 70% to 90% effective for preventing varicella and more than 95% effective for preventing severe varicella • Anyone who is not fully vaccinated, and never had chickenpox, should receive one or two doses of chickenpox vaccine • Not given during pregnancy or immunosuppression • Herpes zoster vaccine contains the same strain used in the varicella vaccine, but 14x more potent • Herpes zoster vaccine gives 50-60% protection for at least 3-4 years • VZIG (varicella immunoglobulin): for immunocompromised or pregnant within 96 hours of exposure

Measles	
Pathogen	• Measles morbillivirus
Epidemiology	• Measles is a highly contagious serious disease. • Before widespread vaccination, major epidemics occurred approximately every 2–3 years, with 2.6 million deaths each year. • Even though a safe and cost-effective vaccine is available, in 2018, there were more than 140 000 measles deaths globally, mostly among children under the age of five. • Measles vaccination resulted in a 73% drop in measles deaths between 2000 and 2018 worldwide
Hospital outbreak	• Hospital outbreaks are common among HCWs and sometimes in patients
Symptoms & clinical picture	• Generalized maculopapular rash, starting on the head and neck. • Fever (at least 38ºc if measured) present at the time of rash onset. • Cough, coryza, conjunctivitis or Koplik's spots present at the time of rash onset. • Serious complications are more common in children under the age of 5, and adults over the age of 30. • The most serious complications include blindness, encephalitis (an infection that causes brain swelling), severe diarrhea and related dehydration, ear infections, or severe respiratory infections such as pneumonia.
Diagnosis	• Detection of IgM antibody specific to the virus. • IgG seroconversion or a significant rise (four-fold or greater) in antibody level for the virus between paired sera tested in parallel where the convalescent serum was collected 10 to 14 days after the acute serum. • Isolation of measles virus by culture. • Detection of measles virus nucleic acid.
Mode of Transmission	• Measles is one of the world's most contagious diseases. • Transmitted by airborne spread and by direct contact • It is spread by coughing and sneezing, close personal contact or direct contact with infected nasal or throat secretions. • The virus remains active and contagious in the air or on infected surfaces for up to 2 hours
Incubation Period	• The average is 10 days (range, 7-18 days).
Period of Infectivity	• For public health purposes, this can usually be considered from 5 days before to 5 days after rash onset, counting the day of rash onset as day 1.
Prevention and control	• MMR vaccination of children and high-risk groups • Pre-employment screening of HCWs and vaccination if needed • Patients with uncomplicated measles, if possible, be nursed at home.

	• Measles cases should be placed in isolation: Follow standard precautions plus airborne and contact precautions • Post-exposure screening and vaccination • Exclude HCWs without evidence of immunity from duty from day 5 after first exposure to day 21 after last exposure, regardless of the post-exposure prophylaxis given.
Vaccines	• MMR is live-attenuated vaccine against measles, mumps, and rubella (German measles). • The first dose is generally given to children around 9 months to 15 months of age, with a second dose at 15 months to 6 years of age, with at least 4 weeks between the doses. • After two doses, 97% of people are protected against measles, • The vaccine is also recommended for those who do not have evidence of immunity, those with well-controlled HIV/AIDS, and within 72 hours of exposure to measles • Measles immunoglobulin within 6 days of exposure in health care facility with work restriction

Respiratory Syncytial Virus	
Pathogen	• Respiratory Syncytial Virus (RSV)
Epidemiology	• RSV infections can be dangerous for certain pediatric patients: ✓ Premature infants ✓ Very young infants, especially those 6 months and younger ✓ Children younger than 2 years old with chronic lung disease or congenital heart disease ✓ Children with suppressed immune systems • RSV infections can be dangerous for certain adult patients: ✓ Older adults, especially those 65 years and older ✓ Adults with chronic heart or lung disease ✓ Adults with weakened immune systems
Hospital outbreak	• Hospital outbreaks have been reported specially in pediatric and neonatal ICUs. Also in adult hematology and bone marrow transplant
Symptoms & clinical picture	• Mild symptoms: cold-like symptoms including runny nose, sore throat, cough, and headache • Severe symptoms viral pneumonia, secondary bacterial pneumonia, sinus infections, and worsening of previous health problems such as asthma or heart failure
Diagnosis	• Symptoms & signs • Confirmation using PCR or antigen testing
Mode of Transmission	• Respiratory (droplet) route: Contact with large droplets that form when a child talks, coughs, or sneezes. • Contact with the respiratory secretions from or contaminated objects. The virus can live on surfaces for many hours and 30 minutes or more on hands.
Incubation Period	• The average is 4 to 6 days (range 2 to 8 days)
Period of Infectivity	• The patient is infectious for 3 to 8 days after symptoms • In severely ill patients and in some children, some contagious viruses may be shed for a few weeks.
Prevention and control	• Respiratory hygiene/cough etiquette • Hand hygiene • Droplet precautions • Proper environmental cleaning • Restrict visitor access and movement within the facility
Vaccines	• Not yet

Hepatitis B virus	
Pathogen	• Hepatitis B virus
Epidemiology	• Hepatitis B is a viral infection that attacks the liver and can cause both acute and chronic disease. • WHO estimates that 296 million people were living with chronic hepatitis B infection in 2019, with 1.5 million new infections each year? • In 2019, hepatitis B resulted in an estimated 820 000 deaths, mostly from cirrhosis and hepatocellular carcinoma (primary liver cancer).
Hospital outbreak	• Hospital outbreaks are still detected in patients in long-term care facilities, dialysis units, dental clinics, and pain management clinic
Symptoms & clinical picture	• The onset is usually insidious with anorexia, abdominal discomfort, nausea, vomiting, lethargy and occasional rash and arthralgia. • It often progresses to dark urine and jaundice. • At least 50% of infections asymptomatic • Some cases present with fulminating extensive acute hepatic necrosis • Hepatitis B infection acquired in adulthood leads to chronic hepatitis in less than 5% of cases, whereas infection in infancy and early childhood leads to chronic hepatitis in about 95% of cases.
Diagnosis	• At least one of the following: ✓ HbsAg positive. ✓ Change from HBsAg negative to HBsAg positive within a 12-month period ✓ Anti-HB core IgM reactive (unless HBsAg positive more than 6 months ago and the history is readily available in laboratory information systems) ✓ Detection of hepatitis B virus (HBV) DNA.
Mode of Transmission	• Many body substances and tissues (such as blood, semen and vaginal fluids) are capable of transmitting hepatitis B, via percutaneous (intravenous, intramuscular, subcutaneous or across broken skin) or per-mucosal exposure. This includes transmission through sexual contact, body piercing and tattooing. • Perinatal mother-to-infant transmission and transmission through occupational exposure to infected blood is possible.
Incubation Period	• The average is 60–90 days (range 30 to 180 days)
Period of Infectivity	• The case is potentially infective 2–3 weeks before the onset of symptoms, during the clinical disease and usually for 2–3 months after acute infection or as long as HBsAg continues to be present in blood.
Prevention and control	• Vaccination of children and high risk groups • Screening of HCWs and vaccination if needed • Ensure that all blood and blood products are screened and not derived from donors at risk of infection

	• Adopt universal procedures for the prevention of blood-borne virus transmission in hospitals, laboratory, barber shops, acupuncture clinics, tattoo shops. • Clean equipment and surfaces potentially contaminated with blood or body fluids. • Double-gloving during exposure-prone procedure • Disposable syringes and other instruments • Consider referral to needle-stick management. • Promote condom use and safe sex practices
Vaccines	• Composition: Recombinant HBsAg • Efficacy: 95% (Range, 80%-100%) • Duration of Immunity: 20 years or more • Schedule: 3 Doses • Booster doses not routinely recommended • Given to infants and high risk groups

Hepatitis C virus	
Pathogen	• Hepatitis C virus
Epidemiology	• The virus can cause both acute and chronic hepatitis, ranging in severity from a mild illness to a serious, lifelong illness including liver cirrhosis and cancer. • Globally, an estimated 58 million people have chronic hepatitis C virus infection, with about 1.5 million new infections occurring per year. • WHO estimated that in 2019, approximately 290 000 people died from hepatitis C, mostly from cirrhosis and hepatocellular carcinoma (primary liver cancer). • Antiviral medicines can cure more than 95% of persons with hepatitis C infection, but access to diagnosis and treatment is low.
Hospital outbreak	• Hospital outbreaks are still detected in patients in long-term care facilities, dialysis units, dental clinics, and pain management clinic
Symptoms & clinical picture	• Acute HCV infections are usually asymptomatic and most do not lead to a life-threatening disease. • Around 30% (15–45%) of infected persons spontaneously clear the virus within 6 months of infection without any treatment. • The remaining 70% (55–85%) of persons will develop chronic HCV infection. • Of those with chronic HCV infection, the risk of cirrhosis ranges from 15% to 30% within 20 years.
Diagnosis	HCV infection is diagnosed in 2 steps: • Testing for anti-HCV antibodies with a serological test identifies people who have been infected with the virus. • If the test is positive for anti-HCV antibodies, a nucleic acid test for HCV ribonucleic acid (RNA) is needed to confirm chronic infection
Mode of Transmission	• Reuse or inadequate sterilization of medical equipment, especially syringes and needles in healthcare settings • Transfusion of unscreened blood and blood products • Injecting drug use through the sharing of injection equipment.
Incubation Period	• The average is 40-60 days (range 15 to 180 days)
Period of Infectivity	• From 1 week before onset of first symptoms. • Infection usually persists indefinitely without treatment. Infectivity correlates with serum HCV RNA levels
Prevention and control	• In almost all cases, there are no restrictions on work, attendance at early childhood services or school or other community activities. • Ensure that all blood and blood products are screened and not derived from donors at risk of infection • Adopt universal procedures for the prevention of blood-borne virus transmission in hospitals, laboratory, barber shops, acupuncture clinics, tattoo shops.

	• Clean equipment and surfaces potentially contaminated with blood or body fluids. • Double-gloving during exposure-prone procedure • Disposable syringes and other instruments • Consider referral to needle-stick management.
Vaccines	• None

Hepatitis A Virus	
Pathogen	• Hepatitis A virus
Epidemiology	• Hepatitis A is an inflammation of the liver that can cause mild to severe illness. • Almost everyone recovers fully from hepatitis A with a lifelong immunity. However, a very small proportion of people infected with hepatitis A could die from fulminant hepatitis. • The risk of hepatitis A infection is associated with a lack of safe water and poor sanitation and hygiene (such as contaminated and dirty hands).
Hospital outbreak	• A hepatitis A outbreak infrequently happened among hospital patients and HCWs, resulting from exposure to a single patient with undiagnosed HAV infection.
Symptoms & clinical picture	• Following a prodrome of fever, malaise, anorexia, nausea or abdominal discomfort, there is jaundice, elevated serum aminotransferase levels and sometimes an enlarged tender liver. • Cases are often asymptomatic • Unlike hepatitis B and C, hepatitis A does not cause chronic liver disease but it can cause debilitating symptoms and rarely fulminant hepatitis (in 0.5% of cases), which is often fatal.
Diagnosis	• Positive hepatitis A-specific IgM in serum (in the absence of recent vaccination).
Mode of Transmission	• Ingestion of contaminated food and water or through direct contact with an infectious person. • Foodborne outbreaks have been linked to an infected food handler, raw or undercooked shellfish harvested from contaminated water, and contaminated produce such as lettuce or berries.
Incubation Period	• The average is 28 days (range 15–50 days)
Period of Infectivity	• Maximum infectivity is during the 1–2 weeks before and the first few days after the onset of jaundice. • Prolonged viral excretion (up to 6 months) has been documented in infants and children.
Prevention and control	• Vaccination of children and high-risk groups • Patients should stay away from work or school for at least 1 week from onset of jaundice or symptoms • The likelihood of nosocomial transmission can be reduced with proper hand hygiene, standard precautions, and routine disinfection. • In case of food hander, educate about hand hygiene and advise not to prepare or handle food for others until no longer considered infectious • The spread of hepatitis A in the community can be reduced by: ✓ Adequate supplies of safe drinking water ✓ Proper disposal of sewage within communities

	✓ Personal hygiene practices such as regular handwashing before meals and after going to the bathroom
Vaccines	• It is given as two shots, 6 months apart, and both shots are needed for long-term protection against hepatitis A. • The following people should be vaccinated against hepatitis A: ✓ All children aged 12–23 months ✓ All children and adolescents 2–18 years of age who have not previously received hepatitis A vaccine (catch up vaccination) ✓ People at increased risk for hepatitis A o International travelers o Those who use illegal drugs o People with occupational risk for exposure o People experiencing homelessness

Rotavirus	
Pathogen	• Rota virus
Epidemiology	• Rotavirus constitutes the principal causal agent of intra-hospital diarrhea in children • Incidence of intra-hospital gastroenteritis is 2 to 7% of hospitalized children primarily between 6 and 23 months old • Responsible for an estimated 20-50% of all hospitalizations for diarrhea among infants and children under 5 years
Hospital outbreak	• Hospital outbreak have been reported mainly in pediatric wards • Outbreaks were also seen in adult wards treating immunosuppressed patients (hematology/oncology)
Symptoms & clinical picture	• Fever, abdominal pain, and vomiting, followed by watery diarrhea that lasts for 4 to 7 days • Gastroenteritis in immunocompromised and elderly patients and may be outbreaks
Diagnosis	• Rapid detection of rotavirus antigen in stool specimens
Mode of Transmission	• The transmission is from person to person and indirectly • Rotavirus can be spread by contaminated hands, objects (toys, surfaces), food, or water • The virus survives on the hands of health workers for four hours and in inanimate objects it could survive for several days.
Incubation Period	• It is usually short (1 to 2 days)
Period of Infectivity	• Infected persons shed large quantities of virus in their stool beginning 2 days before the onset of diarrhea and for up to 10 days after onset of symptoms.
Prevention and control	• Vaccination • Hand hygiene and environmental cleaning • Contact precautions • Single room or cohort isolation • In early childhood services or other institutional situations, ensure satisfactory facilities and practices regarding hand cleaning; nappy changing; toilet use and toilet training; preparation and handling of food; and cleaning of sleeping areas, toys and other surfaces. • Community: sanitation-based strategies and breastfeeding
Vaccines	• Live-attenuated vaccine • Given to children in 2-3 doses • Provide 74% to 87% protection against rotavirus illness of any severity • Provide 85% to 98% protection against severe rotavirus illness • Provide 40-90% reduction of rotavirus hospitalizations and 60-70% reduction of Rota-caused deaths

Epidemiology of specific fungal outbreaks in hospitals

- Candida (Nosocomial/invasive candidiasis)
- Candida Auris
- Aspergillus Species

Nosocomial/invasive candidiasis	
Pathogen	• Candida albicans (the most prevalent pathogenic species) ✓ Candida tropicalis ✓ Candida glabrata ✓ Candida krusei ✓ Candida parapsilosis ✓ Candida lusitaniae
Epidemiology	• Candida normally lives on skin and inside the body, such as the mouth, throat, gut, and vagina, without causing problems. • Candida can cause infections if it grows out of control, penetrate into the mucosa, or enter the blood • In the recent years, the frequency of nosocomial candidiasis is increased because of newer diagnostic and therapeutic techniques. • It can cause severe illness (invasive candidiasis) among high risk patients • Invasive candidiasis is associated with increased hospital costs and in-hospital all-cause mortality of approximately 30%. • These risk factors include: ✓ Critical illness with a prolonged intensive care unit stay ✓ Presence of central venous catheters and other devices ✓ Use of broad-spectrum antibiotics or total parenteral nutrition ✓ Having hematologic or solid organ malignancy, stem cell transplantation, neutropenia, or recent abdominal surgery (especially in the presence of an anastomotic leak) ✓ Pre-term infant with a very low birth weight ✓ Renal failure or hemodialysis ✓ Injection drug use
Hospital outbreak	• Hospital outbreak have been reported in admitted patients in different units, specially in: ✓ Oncology/hematology unit ✓ Hematopoietic stem cell transplantation (HSCT) ✓ Solid organ transplantation (SOT) ✓ Neonatal ICU ✓ Burns ICU
Symptoms & clinical picture	• Candida infections in the mouth and throat (thrush) or vaginal are non-invasive infections localized to one part of the body • Invasive candidiasis is a serious infection that can affect the blood, heart, brain, eyes, bones, and other parts of the body. • Candidemia (bloodstream infections) is the most common form of invasive candidiasis • Signs and symptoms of invasive candidiasis are often non-specific and include fever and chills that do not respond to antibacterial treatment.

	• Other symptoms can develop if the infection spreads to other parts of the body, including endocarditis, peritonitis, meningitis, osteomyelitis, arthritis, and endophthalmitis.
Diagnosis	• For invasive candidiasis, the specimens should be collected from sterile sites; blood (candidemia), CSF (meningitis), or other sterile site (e.g. Pleural fluid, peritoneal fluid, joint fluid, etc). • Confirmatory laboratory evidence: ✓ Culture of blood or other body fluids ✓ PCR • Presumptive laboratory evidence ✓ Serological tests to detect antigen or antibody in serum or other body fluids (Mannan, antimannan antibody, and Candida albicans germ tube antibody, β-d-glucan)
Mode of Transmission	• Most infections arise from the endogenous flora of patients with risk factors following disruption of skin and mucosal barriers. • Less commonly, candida can be transmitted via healthcare workers' hands or contaminated medical devices.
Incubation Period	• It probably varies from patient to patient.
Period of Infectivity	• Invasive candidiasis doesn't spread directly from person to person. • However, some candida species live on skin, so it's possible that Candida can be passed from patients or healthcare workers to at risk patients
Prevention and control	• In healthcare settings, these measures are important to prevent invasive candidiasis: ✓ Adhering to hand hygiene recommendations ✓ Contact isolation ✓ Following recommendations for placement and maintenance of central venous catheters ✓ Practicing antibiotic stewardship • Some groups of patients may benefit from antifungal prophylaxis: ✓ Some solid organ transplant recipients ✓ High-risk ICU patients ✓ Patients with chemotherapy-induced neutropenia ✓ Stem cell transplant recipients with neutropenia • Setting a surveillance system for invasive candidiasis: ✓ Track incidence of candidemia and monitor laboratory and epidemiologic trends ✓ Identify new risk factors for candidemia ✓ Detect changes in resistance to antifungal agents
Discontinue Contact isolation	• Discontinue Contact isolation after obtaining two negative cultures from the previous positive site one week apart.
Vaccines	• None

Candida Auris	
Pathogen	• Candida Auris
Epidemiology	• Candida auris is an emerging fungus that presents a serious global health threat due to several reasons: ✓ It is becoming more common ✓ It is often multidrug-resistant ✓ It is difficult to identify with standard laboratory methods ✓ It has caused outbreaks in healthcare settings • Only three classes of antifungal drugs are available to treat severe Candida infections: azoles, echinocandins, and amphotericin B. • It can cause severe illness among patients with immunocompromising conditions or those receiving high acuity care • These risk factors include: ✓ A prolonged hospital or ICU stays. ✓ Carbapenem-Resistant Enterobacterales (CRE) positive patient (infected & colonized). ✓ Current or active outbreak in the healthcare facility. ✓ An indwelling medical device, such as a central venous catheter, urinary catheter, biliary catheter, or wound drain. ✓ An impaired immune system. ✓ Prolonged use or misuse of broad-spectrum antibiotics or antifungals drugs. ✓ Patients in critical care areas (ICU, NICU, PICU, Dialysis).
Hospital outbreak	• Hospital outbreak have been reported in admitted patients in different units
Symptoms & clinical picture	• Colonization is asymptomatic. It is generally on the skin, nares, and other external body sites. • Infection: Candida auris has caused bloodstream infections, wound infections, and ear infections. • It also has been isolated from respiratory and urine specimens, but it is unclear if it causes infections in the lung or bladder. • **Suspected case:** A person with a non-Candida albicans species isolated from diagnostic or screening specimens. • **Confirmed case:** A person with confirmatory laboratory evidence from invasive clinical specimen (blood, cerebrospinal fluid), non-invasive sites (wounds, urine, and the respiratory tract) or screening specimens (axilla, groin, nares, rectum, or other external body sites)
Diagnosis	• Culture of blood or other body fluids • Candida auris is more difficult to accurately identify in the laboratory than other more common types of Candida using conventional commercial systems and can be confused with other more commonly encountered candida species.

	• All invasive isolates should undergo antifungal susceptibility testing. • The following aspects in regard of specimen processing must be considered: ✓ Candida auris grows on blood agar as all other Candida species but for sub-culturing, use Sabouraud's agar. ✓ Growth at 40-42 C is useful to differentiate it from many other Candida species. CHROM agar is widely used as a differentiation medium, Candida auris appear pale purple or pink colonies. ✓ Microscopically is indistinguishable from other Candida species, but it is germ tube negative budding yeast. ✓ It is commonly misidentified with other yeast (especially Candida haemulonii) in: VITEK-2 YST, API 20C, Microscan and BD phoenix yeast identification system.
Mode of Transmission	• Typically, Candida auris spreads in hospitals and other care facilities through contact with contaminated surfaces or equipment. • However, it can also spread from person to person. People with Candida may shed the fungus through their skin cells. • Candida auris is transmissible whether a patient has Candida auris infection or colonization. Thus, infection prevention & control precautions are the same for patients with Candida auris infection or colonization.
Incubation Period	• Scientists do not know how long it takes for symptoms to appear. • It probably varies from patient to patient.
Period of Infectivity	• Patients and residents in healthcare facilities often remain colonized with Candida auris for many months, perhaps indefinitely, even after acute infection (if present) has been treated and resolves
Screening	A. Screen all patients who are: • Admitted to the critical care units and with specific risk factors to rule out Candida auris colonization. • Patients with an indwelling medical device, such as a central venous catheter, breathing aid tubes, urinary catheter, biliary catheter, or wound drain. • Any patient transferred from another healthcare facility OR long-term facility. • Roommates were exposed to C. auris-positive patients for more than 48 hours. • Individuals with current multidrug-resistant gram-negative bacteria who received healthcare outside of the Kingdom of Saudi Arabia (KSA) within the last 12 months. • Patients transferred from a unit with current transmission within the healthcare facility of C. auris or recent transmission within the last 30 days. • Carbapenem-Resistant entero bacterales (CRE) positive patient

	(infected & colonized). • Immunocompromised patient. Others: • Screening is recommended in departments that are experiencing outbreaks or having an increase in the number of ongoing cases and/or colonization. NB: In all cases, in the four weeks prior to diagnosis in the index patient, the healthcare facility should look back to see if there has been an increase in detection of Candida in the same intensive care setting or ward as this may represent unrecognized transmission. B. Screening of healthcare workers (HCWs) and the environment: • Routine screening of healthcare workers and the environment are not recommended unless epidemiological evidence links to transmission or indicated by the infection prevention & control (IPC) team.
Prevention and control	• Screening contacts of newly identified case patients to identify Candida auris colonization. • Strict adherence to proper hand hygiene practices. • Application of contact-based precautions: ✓ Keep patients in single rooms ✓ Review the visitor's situation according to the IPC recommendation ✓ In case of limited single rooms may be cohorting with other patients with Candida auris ✓ HCWs wear gowns and gloves during patient care. ✓ Practicing regular hand hygiene • Improved adherence to bundles of care for venous and urinary catheters, as well as tracheostomy care is essential. • Enhanced environmental cleaning and disinfecting (daily and terminal cleaning) using recommended disinfectants. • Single -patient use items such as blood pressure cuffs and stethoscope should be considered, especially in outbreak situations. • If single use items not available, reusable equipment should be properly cleaned and disinfected with the recommended disinfectants post providing patient care, and shared mobile equipment (e.g., glucometers, blood pressure cuffs) should be focused on. • Limit patient transfer and if mandatory, infection prevention & control measures should be strictly applied. • Laboratory surveillance of clinical specimens should be applied to detect additional cases. • Specific considerations should be applied to specific healthcare department and program (dialysis and home healthcare).
Decolonization	• At this time, no specific intervention is known to reduce or eliminate Candida auris colonization.

	• C. auris decolonization not recommended in evidence. However, regular routine body washing, skin preparation for invasive procedures, and care bundles by using approved skin disinfectants should be implemented for all critical care patients.
Discontinue Contact isolation	• Patients in healthcare facilities often remain colonized with Candida auris for long period of time lasts for several months even after an acute infection (if present) has been treated and resolves. • It is recommended to continue contact isolation precautions for the whole duration of all inpatient healthcare stays, including those in long-term healthcare settings.
Environmental Cleaning	• Candida auris can persist on surfaces in healthcare environments. • Quaternary ammonia products that are routinely used for disinfection are not effective against Candida auris • Educate environmental cleaning staff and implement supervised cleaning. • Routine (at least daily or when required), and terminal cleaning and disinfection of patients' rooms and other areas where patients receive care (e.g., radiology, physical therapy) should be implemented applying an appropriate disinfectant that effective against Candida auris. • MOH approved disinfectants (Sodium hypochlorite 1000 ppm, Hydrogen peroxide, etc.) as high-level disinfectant s should be used with consideration of the manufacturer instructions such as for contact time. • It is preferable to use the new and evolving disinfection technologies, like ultraviolet light and hydrogen peroxide vapor/mist decontamination machines for terminal cleaning, and they should be used only post standard cleaning. • Housekeepers performing environmental cleaning should wear the recommended PPEs described above. • Use designated cleaning equipment (e.g., mop, buckets, etc.) and disposable cleaning materials in the isolation room/unit. • Environmental sampling could be done only to support outbreak investigations.
Vaccines	• None

Aspergillosis	
Pathogen	• Aspergillus Species • Most commonly, Aspergillus fumigatus and A. Flavus. Less common species include A. Terreus, A. Nidulans, A. Niger, and A. Versicolor.
Epidemiology	• Nosocomial aspergillosis represents a serious threat for severely immunocompromised patients • High-risk groups include individuals undergoing hematopoietic stem cell transplantation, solid organ transplantation, major surgery (especially gastrointestinal surgery), or severe burns; those with neutropenia, AIDS, neoplastic disease, immunosuppressive therapy, or advanced age; and premature babies
Hospital outbreak	• Multiple hospital outbreaks have been reported in admitted immunocompromised patients in different units such as ✓ Oncology/hematology unit ✓ Hematopoietic stem cell transplantation ✓ Solid organ transplantation ✓ Neonatal ICU ✓ Burns ICU • Sources of Aspergillus Species in hospital are; construction work, renovation activities, and contaminated or defective air supply system
Symptoms & clinical picture	• Allergic bronchopulmonary aspergillosis in people who have cystic fibrosis or asthma; coughing, shortness of breath, and wheezing • Allergic Aspergillus sinusitis; stuffiness, runny nose, headache, and reduced ability to smell • Chronic pulmonary aspergillosis in patients with other chronic lung disease; weight loss, cough, coughing up blood, fatigue, and shortness of breath • Invasive aspergillosis in immunocompromised patients: most commonly affects the lungs, but it can also spread to other parts of the body; fever, chest pain, cough, hemoptysis, and shortness of breath • Cutaneous aspergillosis can also occur if invasive aspergillosis spreads to the skin from somewhere else in the body
Diagnosis	• Microscopy: Evaluation of respiratory specimens after the application of special stains can allow for visualization of Aspergillus elements. • Galactomannan antigen detected in plasma, serum, bronchoalveolar Lavage (BAL), or cerebrospinal fluid (CSF) • Aspergillus PCR • Aspergillus species recovered by culture from sputum, BAL, bronchial brush, or aspirate
Mode of Transmission	• Inhalation of Aspergillus spores • Aspergillosis can’t spread from person to person
Incubation Period	• Unclear • Incubation Period of invasive aspergillosis is estimated at 15 days

Period of Infectivity	• As long as the source of Aspergillus spores is available • Aspergillosis can't spread from person to person
Prevention and control	• Protect patients especially high-risk ones from the sources of Aspergillus spores ✓ Seal off patient care areas with adequate and impermeable barriers, and keep doors and windows closed ✓ Avoid non-emergent admissions during heavy construction periods ✓ If possible, locate high-risk patients as far as possible from areas of demolition or construction ✓ Verify that HEPA air filtration is sufficient and proper air exchange rates are maintained. ✓ Provide treatment in the patient's room if possible. ✓ Transport patients via an alternate route to avoid dust, schedule transportation during periods with minimal construction activity, and use appropriate face masks for susceptible patients ✓ Wet-clean wards thoroughly without raising dust • Surveillance of increased risk patients to early detect cases
Vaccines	• None

Operation of Outbreak

Notification Process

- The outbreak level is determined using an Outbreak Classification Matrix

1- Once an outbreak is confirmed or suspected, the healthcare facility outbreak coordinator is required to fill all required an online outbreak process starting with

✓ Notification form in the platform within the first (48) hours of an outbreak onset.

✓ The filled outbreak notification form for outbreak will be received by cluster, regional directorate coordinator and the GDIPC simultaneously.

2- Healthcare facility infection department should start the control measures immediately according to the outbreak management action plan (OMAP).

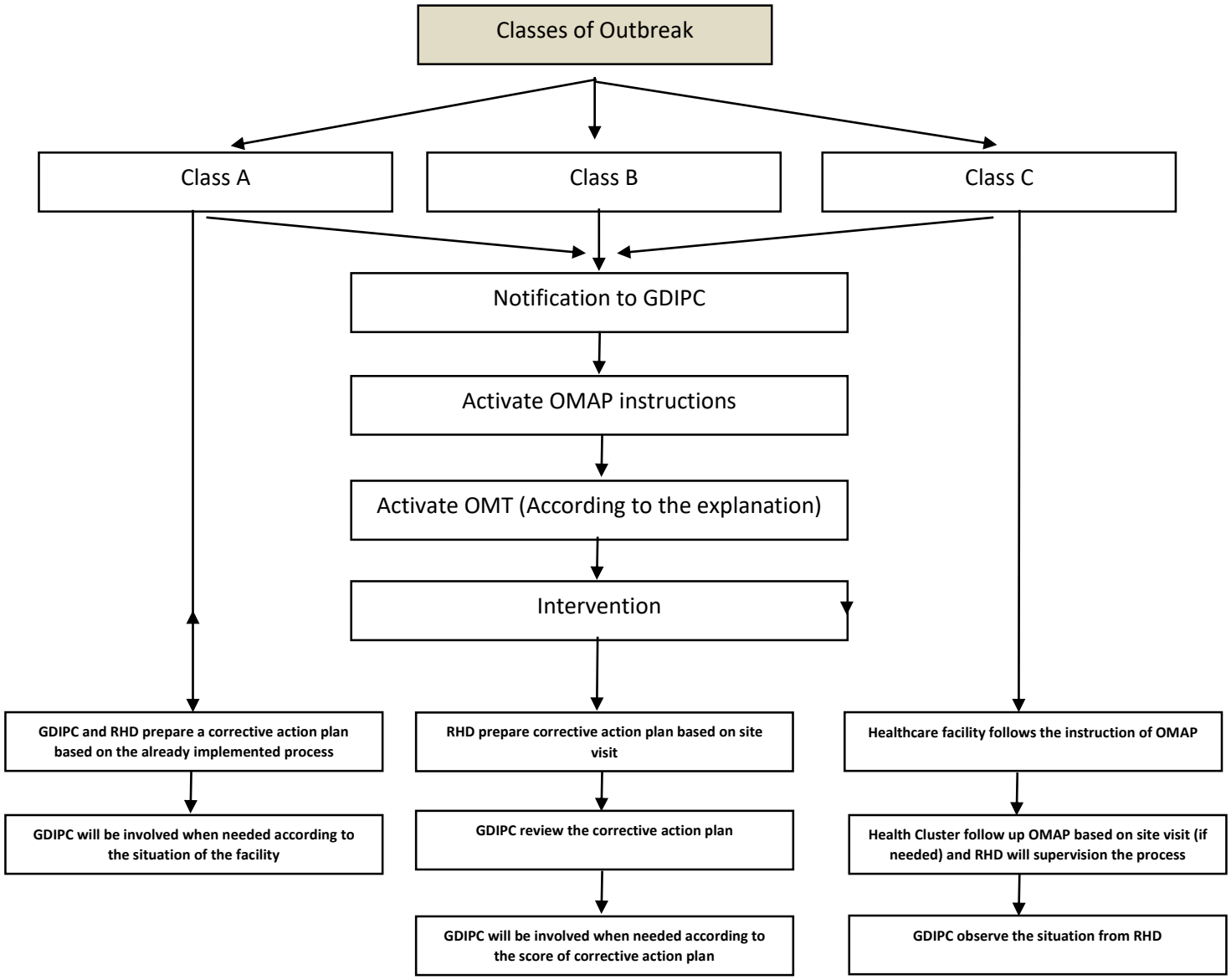
3- The regional outbreak coordinator is responsible to follow up with the health cluster to ensure control measures are applied by the healthcare facility outbreak team performing the outbreak investigation and follow up, according to the flowchart shown below

4- The healthcare facility must fill-up the forms within the first (72) hours and update the investigation form immediately when new cases or deaths occurs, otherwise, data will be updated once weekly

5- Meanwhile the regional directorate and GDIPC will keep following the updates, status of the outbreak and classify the level of the outbreak (A, B or C) according to the provided data.

6- In case the outbreak is type A or B, the regional directorate coordinator will work on the corrective action plan and outbreak facility assessment. Additionally, the GDIPC will make a field visit, if necessary.

Control of outbreak (Flowchart approved by GDIPC)



- In case outbreak class C, the OMT implemented according to the decision of IPC department inside the Healthcare facility (if needed or not) but is recommended if the outbreak class C contain 3 cases and more or if the same outbreak is repeated within short duration, to be consider the OMT should be activated in case outbreak class B or A.

GDIPC: General Directorate of Infection Prevention and Control
OMAP: Outbreak Management Action Plan
OMT: Outbreak Management Team
RHD: Regional Health Directorate
HC: Health Cluster

Outbreak Classification Matrix- Class A

Intervention:

- ✓ Prepare the corrective action plan with Regional Health directorate (RHD).
- ✓ Assess the outbreak facility assessment done by RHD.
- ✓ Maintain close communication with RHD.
- ✓ GDIPC will be involved when the above three points have not achieved their outcome.

Responsibility

- ✓ Regional health directorate.
- ✓ GDIPC's responsibility, if needed.

		Pathogen	Number of cases
A	1	Acinetobacter baumanni complex	8 Cases & Above
	2	Acinetobacter baumannii	
	3	Acinetobacter baumannii MDR	
	4	Acinetobacter baumannii PDR	
	5	Acinetobacter baumannii XDR	
	6	Burkholderia cepacian	
	7	Klebsiella oxytoca	
	8	Klebsiella Pneumonia (CRKP)	
	9	Klebsiella Pneumonia (ESBL)	
	10	Klebsiella spp.	
	11	Morganella morganii	
	12	MRSA	
	13	Mycobacterium Bovis	
	14	Mycobacterium tuberculosis	
	15	Proteus mirabilis	
	16	Providencia stuartii	
	17	Pseudomonas aeruginosa	
	18	Pseudomonas spp.	
	19	Salmonella spp.	
	20	Serratia marcescens	
	21	Shigella spp.	
	22	Staphylococcus aureus	
	23	Staphylococcus epidermis	
	24	Stenotrophomonas maltophilia	
	25	Streptococcus agalactiae	
	26	Streptococcus lugdensis	
	27	Streptococcus pneumonia, meningeal	
	28	Streptococcus pneumonia, non-meningeal	
	29	Streptococcus viridans	
	30	Enterobacter cloacae	
	31	Enterococcus faecalis	
	32	Enterococcus faecium	
	33	Other MDROs	
	34	Clostridium Difficile	
	35	E.coli- CRE	
	36	E.coli- ESBL	
	37	Clostridium Botulinum	
	38	VRE	

		Pathogen	Number of cases
A	39	Legionella pneumophila	8 Cases & Above
	40	Candida Auris	8 Cases & Above
	41	Candida Albicans	
	42	Candida Species	
	43	Candida Glabrata	
	44	Candida Parapsilosis	
	45	Candida Tropicalis	
	46	Candida Haemulonii	
	47	Aspergillus Species	5 Cases& Above
	48	Hepatitis A virus (HAV)	8 Cases & Above
	49	Hepatitis B virus (HBV)	
	50	Hepatitis C virus (HCV)	5 Cases & Above
	51	Measles	8 Cases & Above
	52	Chickenpox	
	53	Influenza or Influenza-Like Illness (ILI)	8 Cases & Above
	54	Not Known or New - Emerging Organism	Only One Case
	55	COVID- 19	≥ 11 Cases
	56	MERS-CoV	≥ 6 Cases

For more information about commensal's organism list, see Appendix-9 Classification of organisms

Outbreak Classification Matrix- Class B

Intervention:

- ✓ Prepare the corrective action plan by RHD.
- ✓ Assess the outbreak facility assessment by RHD.
- ✓ Maintain close communication with RHD.
- ✓ GDIPC will involve when the above three points have not achieved their outcome.

Responsibility

- ✓ Regional health directorate.
- ✓ Health cluster.

		Pathogen	Number of cases
B	1	Acinetobacter baumanni complex	5 - 7 Cases
	2	Acinetobacter baumannii	
	3	Acinetobacter baumannii MDR	
	4	Acinetobacter baumannii PDR	
	5	Acinetobacter baumannii XDR	
	6	Burkholderia cepacia	
	7	Klebsiella oxytoca	
	8	Klebsiella Pneumonia (CRKP)	
	9	Klebsiella Pneumonia (ESBL)	
	10	Klebsiella spp.	
	11	Morganella morganii	
	12	MRSA	
	13	Mycobacterium Bovis	
	14	Mycobacterium tuberculosis	
	15	Proteus mirabilis	
	16	Providencia stuartii	
	17	Pseudomonas aeruginosa	
	18	Pseudomonas spp.	
	19	Salmonella spp.	
	20	Serratia marcescens	
	21	Shigella spp.	
	22	Staphylococcus aureus	
	23	Staphylococcus epidermis	
	24	Stenotrophomonas maltophilia	
	25	Streptococcus agalactiae	
	26	Streptococcus lugdensis	
	27	Streptococcus pneumonia, meningeal	
	28	Streptococcus pneumonia, non-meningeal	
	29	Streptococcus viridans	
	30	Enterobacter cloacae	
	31	Enterococcus faecalis	
	32	Enterococcus faecium	
	33	Other MDROs	
	34	Clostridium Difficile	
	35	E.coli- CRE	
	36	E.coli- ESBL	

		Pathogen	Number of cases
B	37	Clostridium Botulinum	5 - 7 Cases
	38	VRE	
	39	Legionella pneumophila	3 - 7 Cases
	40	Candida Auris	5 – 7 Cases
	41	Candida Albicans	
	42	Candida Species	
	43	Candida Glabrata	
	44	Candida Parapsilosis	
	45	Candida Tropicalis	
	46	Candida Haemulonii	
	47	Aspergillus Species	3 - 4 Cases
	48	Hepatitis A virus (HAV)	5 - 7 Cases
	49	Hepatitis B virus (HBV)	
	50	Hepatitis C virus (HCV)	3 - 4 Cases
	51	Measles	4 - 7 Cases
	52	Chickenpox	
	53	Influenza or Influenza-Like Illness (ILI)	5 - 7 Cases
	54	COVID- 19	6-10 Cases
	55	MERS-CoV	3-5 Cases

For more information about commensal's organism list, see Appendix-9 Classification of organisms

Outbreak Classification Matrix- Class C

Intervention:

- ✓ Fill up the forms through the GDIPC platform, including notification form within 48 hours, Complete OMAP form, the outbreak investigation form (outbreak line list and contact tracing for patients and HCWs) within 72 hours.
- ✓ Follow up the OMAP with cluster
- ✓ RHD coordinator will visit the facility as needed or as recommended by GDIPC
- ✓ Note: GDIPC will be involved when it is necessary.

Responsibility

- ✓ Healthcare facility.
- ✓ Cluster is pertaining healthcare facility are under the responsibility of the cluster, itself.

		Pathogen	Number of cases
C	1	Acinetobacter baumanni complex	2 - 4 Cases
	2	Acinetobacter baumannii	
	3	Acinetobacter baumannii MDR	
	4	Acinetobacter baumannii PDR	
	5	Acinetobacter baumannii XDR	
	6	Burkholderia cepacia	
	7	Klebsiella oxytoca	
	8	Klebsiella Pneumonia (CRKP)	
	9	Klebsiella Pneumonia (ESBL)	
	10	Klebsiella spp.	
	11	Morganella morganii	
	12	MRSA	
	13	Mycobacterium Bovis	
	14	Mycobacterium tuberculosis	
	15	Proteus mirabilis	
	16	Providencia stuartii	
	17	Pseudomonas aeruginosa	
	18	Pseudomonas spp.	
	19	Salmonella spp.	
	20	Serratia marcescens	
	21	Shigella spp.	
	22	Staphylococcus aureus	
	23	Staphylococcus epidermis	
	24	Stenotrophomonas maltophilia	
	25	Streptococcus agalactiae	
	26	Streptococcus lugdensis	
	27	Streptococcus pneumonia, meningeal	
	28	Streptococcus pneumonia, non-meningeal	
	29	Streptococcus viridans	
	30	Enterobacter cloacae	
	31	Enterococcus faecalis	
	32	Enterococcus faecium	
	33	Other MDROs	
	34	E.coli- CRE	
	35	E.coli- ESBL	

		Pathogen	Number of cases
C	36	Clostridium Botulinum	2 - 4 Cases
	37	VRE	
	38	Legionella pneumophila	1 - 2 Cases
	39	Candida Auris	1- 4 Cases
	40	Clostridium Difficile	
	41	Candida Albicans	2- 4 Cases
	42	Candida Species	
	43	Candida Glabrata	
	44	Candida Parapsilosis	
	45	Candida Tropicalis	
	46	Candida Haemulonii	
	47	Aspergillus Species	1 - 2 Case
	48	Hepatitis A virus (HAV)	2 - 4 Cases
	49	Hepatitis B virus (HBV)	
	50	Hepatitis C virus (HCV)	1 - 2 Cases
	51	Measles	1 - 3 Cases
	52	Chickenpox	
	53	Influenza or Influenza-Like Illness (ILI)	2 - 4 Cases
	54	COVID- 19	2 - 5 Cases
	55	MERS-CoV	1 - 2 Cases

For more information about commensal's organism list, see Appendix-9 Classification of organisms

Note: Class C represents the minimum level to meet the outbreak definition

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Appendices

Appendix-1: Incubation periods

Appendix-2: Emerging Infectious Diseases

Appendix-3: Survival of Microorganisms

Appendix-4: Control measures

Appendix-5: Environmental Sampling

Appendix-6: Intensified interventions to prevent MDROs

Appendix-7: MRSA Decolonization

Appendix-8: Risk Assessment Tool for MDRO

Appendix-9 Classification of organisms

Appendix-1: Incubation periods

Disease	Incubation period	Unit
Aspergillosis	3-17	Days
Burkholderia	1-21	Days
Chicken pox	10 to 21	Days
Cholera	2-5	Days
Common cold	1-3	Days
COVID-19	2-14	Days
Dengue fever	5-8	Days
Ebola	1-21	Days
Hand, foot, and mouth disease	3-6	Days
Hepatitis A	15-50	Days
Hepatitis B	30–180	Days
Hepatitis C	15–180	Days
HIV	0.75-20	Years
Infectious mononucleosis	28-49	Days
Influenza	1-3	Days
Legionella	2-16	Days
Measles	7-18	Days
Meningitis	2-10	Days
MERS-CoV	2-14	Days
Mumps	14-18	Days
Norovirus	1-2	Days
Pertussis (whooping cough)	7-14	Days
Poliomyelitis	5-20	Days
Rabies	30-100	Days
Respiratory syncytial virus	2-8	Days
Rotavirus	1-2	Days
Rubella (German measles)	14-21	Days
Salmonella	0.5-3	Days
SARS	2-10	Days
Scarlet fever	2-6	Days
Shingles	14-16	Days
Smallpox	12-14	Days
Syphilis	10-90	Days
Tetanus	7-21	Days
Tuberculosis	14-70	Days
Typhoid	7-28	Days
Whooping cough	7-10	Days

Source: https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section9.html
Source: https://doi.org/10.1016/S1473-3099(09)70069-6
Source: https://hhma.org/healthadvisor/pa-incubate-hhg/

Appendix-2: Emerging Infectious Diseases

The U.S. National Institute of Allergy and Infectious Diseases (NIAID) maintains a list of Biodefense and Emerging Infectious Diseases (2019):

Definition	Pathogens
Category A: **Organisms/biological agents that pose the highest risk to national security and public health** ○ Can be easily disseminated or transmitted from person to person ○ Result in high mortalities; potential for major public health impact ○ Might cause public panic and social disruption ○ Require special action for public health preparedness	**Category A Priority Pathogens** ○ *Bacillus anthracis* (anthrax) ○ *Clostridium botulinum* toxin (botulism) ○ *Yersinia pestis* (plague) ○ *Variola major* (smallpox) and other related pox viruses ○ *Francisella tularensis* (tularemia) ○ Viral hemorrhagic fevers: ○ Arenaviruses: Lymphocytic choriomeningitis (LCM), Junin virus, Machupo virus, Guanarito virus, Lassa fever ○ Bunyaviruses: Hantaviruses, Rift Valley Fever, Crimean-Congo hemorrhagic fever virus ○ Flaviviruses: Dengue ○ Filoviruses: Ebola, Marburg
Category B: **Second highest priority organisms/biological agents** ○ Moderately easy to disseminate ○ Result in moderate morbidities and low mortalities ○ Require specific enhancements for diagnostic capacity and enhanced disease surveillance	○ Category B Select Priority Pathogens ○ Burkholderia pseudomallei (melioidosis) ○ Coxiella burnetii (Q fever) ○ Brucella species (brucellosis) ○ Ricin toxin (Clostridium perfringens) ○ Staphylococcus enterotoxin B ○ Typhus fever (Rickettsia prowazekii) ○ Foodborne and water-borne pathogens: bacteria (eg, E coli, shigella; salmonella, campylobacter); viruses (eg, hepatitis A); protozoa (eg, Cryptosporidium parvum, Giardia lamblia), fungi ○ Mosquito-borne viruses (eg, West Nile, yellow fever, chikungunya, Zika)
Category C: **Third highest priority** ○ Includes emerging pathogens that could be engineered for mass dissemination in the future because of availability	**Category C Select Priority Pathogens** ○ Nipah and Hendra viruses ○ Additional hantaviruses ○ Tick-borne hemorrhagic fever viruses (Bunyaviruses, Flaviviruses)

○ Ease of production and dissemination ○ Potential for high morbidities and mortalities and major health impact	○ Tick-borne encephalitis complex flaviviruses ○ Tuberculosis, including drug-resistant tuberculosis ○ Influenza virus ○ Other rickettsias ○ Rabies virus ○ Severe acute respiratory syndrome associated coronavirus

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7096727/pdf/main.pdf

Appendix-3: Survival of Microorganisms

Bacteria	Range of survival (environment)
Acinetobacter spp.	3 days to 1 year (in-vitro) 36 days within biofilm 15 days for non-biofilm-forming strains
Bordetella pertussis	3 to >10 days >4 days in pernasal swabs
Campylobacter jejuni	>6 days >60 days in water
Clostridium difficile spores	5 months
C. Difficile, vegetative form	15 min (dry surface) 6 h (moist surface)
Chlamydia pneumoniae	≤96 h
C. Trachomatis	<1 week
Chlamydia psittaci	15 days to months (environment)
Corynebacterium diphtheriae	7 days to 6 months
Corynebacterium pseudotuberculosis	1–8 days, up to several weeks (environment)
Enterococcus spp. Including VRE	5 days up to 30 months
Escherichia coli	1.5 h to 16 months
E. Coli O157:H7	27 days on spinach leaves, 179 days in soil, 98 days in water
Haemophilus influenzae	12 days
Helicobacter pylori	≤90 min; 2–30 days in water
Klebsiella spp.	2 h to >30 months, ≤144 h in detergent solution
Listeria spp.	1 day–months, 141 days in water
Mycobacterium bovis	>2 months
Mycobacterium tuberculosis	1 day up to 4 months
Neisseria gonorrhoeae	1–3 days
Neisseria meningitidis	72 h
Parachlamydia acanthamoebae	<4 weeks, <7 weeks in presence of blood
Proteus vulgaris	1–2 days
Pseudomonas aeruginosa	6 h up to 16 months 5 weeks on dry floor Few hours in aerosol
Salmonella typhi	6 h up to 4 weeks
Salmonella typhimurium	10 days up to 4.2 years
Salmonella spp.	1 day

Non typhoid Salmonella spp.	336 days
Salmonella enteritidis (broiler farms)	1 year
Salmonella enteritica sv. Tennessie	30 days (dried in desiccated milk powder)
Serratia marcescens	3 days up to 2 months; on dry floor: 5 weeks
Shigella spp.	2 days up to 5 months 3–11 days in water
MRSA and MSSA	7 days up to 1 year (in-vitro) 9–12 days (plastic surfaces) 72 h (stainless steel) 6 h (copper) ≤28 days (dry mops) ≤14 days (in water)
Streptococcus pneumoniae	1 day up to 30 month
Streptococcus pyogenes	3 days up to 6.5 months
Vibrio cholerae	1–7 days
Yersinia enterocolitica	Up to 64 weeks (in water)
Yersinia pestis	Up to 5 days

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7123372/pdf/978-3-319-08057-4_Chapter_2.pdf

Viruses	Range of survival (environment)
Adenovirus	<6 h up to 3 months (type dependent), ≤ 301 days (in water)
Astrovirus	7–90 days
Avian metapneumonovirus	~48 h up to 6 days
SARS Coronavirus	<5 min up to 24 h (on paper) 5–28 days (at room temp.) 28 days (at 4 °C)
Coxsackievirus	7–10 days, up to >2 weeks
Cytomegalovirus	1–8 h
Echovirus	Up to 7 days
Hepatitis A virus	2 h up to 60 days
Hepatitis B virus	≥1 week
Human immunodeficiency virus	Up to 7 days, 7 days (in peritoneal dialysis effluent), 48 h (on peritoneal dialysis exchange and tubing), 4–8 weeks (on glass cover slides)
Herpes simplex virus, Type 1 & 2	<2 h up to 8 weeks
Influenza virus	1–28 days (strain dependent)
	1–3 days (on banknotes), Up to 8 days (admixed in mucous)
Marburg virus (strain Popp)	4–5 days
Para-influenza virus	10 h
Norovirus	8 h up to 7 days, > 40 days (in diapers and gauze)
Papillomavirus 16	≤7 days
Papovavirus	8 days
Parvovirus	>1 year
Poliovirus type 1	4 h to <8 days
Poliovirus type 2	1 day up to 8 weeks
Pseudorabies virus	≥7 days, <1 h (in aerosol infectivity decreases by 50%/hour)
Respiratory syncytial virus	Up to 6 h
Rhinovirus	2 h up to 7 days
Rotavirus	30 min, 6–60 days
Vacciniavirus	3 weeks up to >20 weeks

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7123372/pdf/978-3-319-08057-4_Chapter_2.pdf

Fungi	Range of survival (environment)
Aspergillus spp.	>30 days
Candida albicans	1 up to 120 days, 24 weeks (in soil-water mixture)
Candida parapsilosis	>30 days
Candida krusei	11 days
Cryptococcus spp.	24 weeks (in soil-water mixture)
Fusarium spp.	>30 days
Mucor spp.	>30 days
Paecilomyces spp.	11 days
Torulopsis glabrata	102–150 days

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7123372/pdf/978-3-319-08057-4_Chapter_2.pdf

Appendix-4: Control measures

Measures required according to the type of transmission

Precautions	Disease	Measures
Airborne precautions	Open/active pulmonary tuberculosis (TB), measles, and chicken pox	Place patient in a single negative pressure room The air should be discharged to the outdoors (better) or specially filtered (HEPA Filter) before it is circulated to other areas of the health care facility. Keep doors closed all the time
Droplet precautions	Pneumonias, pertussis, diphtheria, influenza type B, mumps, and meningitis	Implement standard precautions. Place patient in a single room (or in a room with another patient infected by the same pathogen). Wear a surgical mask when working within 1-2 meters of the patient.
Contact precautions	Colonization or infection with multiple-resistant organisms, enteric infections and skin infections	Implement standard precautions Place patient in a single room (or in a room with another patient infected by the same pathogen). Wear clean, non-sterile gloves when entering the room.
Standard precautions	A group of infection prevention practices that apply to all patients, regardless of infection status.	Hand hygiene compliance Use of personal protective equipment (e.g., gloves, gowns, masks) Safe use and disposal of sharps Environmental cleaning Safe patient equipment and instruments/devices Respiratory hygiene and cough etiquette

Source: https://www.cdc.gov/infectioncontrol/basics/transmission-based-precautions.html

Appendix-5: Environmental Sampling

- Microbiologic sampling of air, water, and inanimate surfaces (i.e., environmental sampling) is an expensive and time-consuming process that is complicated by many variables in protocol, analysis, and interpretation.

1. Air Sampling

- Microbiologic air sampling is used as needed to determine the numbers and types of microorganisms, or particulates, in indoor air. Air sampling for quality control is, however, problematic because of lack of uniform air-quality standards.
- Preliminary concerns for conducting air sampling
  - ✓ Consider the possible characteristics and conditions of the aerosol, including size range of particles, relative amount of inert material, concentration of microorganisms, and environmental factors.
  - ✓ Determine the type of sampling instruments, sampling time, and duration of the sampling program.
  - ✓ Determine the number of samples to be taken.
  - ✓ Ensure that adequate equipment and supplies are available.
  - ✓ Determine the method of assay that will ensure optimal recovery of microorganisms.
  - ✓ Select a laboratory that will provide proper microbiologic support.
  - ✓ Ensure that samples can be refrigerated if they cannot be assayed in the laboratory promptly.
- Bacteria, fungi, and particulates in air can be identified and quantified with the same methods and equipment. The basic methods include
  - ✓ Impingement in liquids,
  - ✓ Impaction on solid surfaces,
  - ✓ Sedimentation,
  - ✓ Filtration,
  - ✓ Centrifugation,
  - ✓ Electrostatic precipitation, and
  - ✓ Thermal precipitation.
- Selection of an instrument for air sampling requires a clear understanding of the type of information desired and the particular determinations that must be made. Information may be needed regarding
  - ✓ One particular organism or all organisms that may be present in the air,
  - ✓ The concentration of viable particles or of viable organisms,
  - ✓ The change in concentration with time, and
  - ✓ The size distribution of the collected particles.
- The following factors must be considered when choosing an air sampling instrument:
  - ✓ Viability and type of the organism to be sampled
  - ✓ Compatibility with the selected method of analysis
  - ✓ Sensitivity of particles to sampling
  - ✓ Assumed concentrations and particle size
  - ✓ Whether airborne clumps must be broken (i.e., total viable organism count vs. Particle count)

- ✓ Volume of air to be sampled and length of time sampler is to be continuously operated
- ✓ Background contamination
- ✓ Ambient conditions
- ✓ Sampler collection efficiency
- ✓ Effort and skill required to operate sampler
- ✓ Availability and cost of sampler, plus back-up samplers in case of equipment malfunction
- ✓ Availability of auxiliary equipment and utilities (e.g., vacuum pumps, electricity, and water)

2. Water Sampling

- Water sampling in health-care settings is used detect waterborne pathogens of clinical significance or to determine the quality of finished water in a facility's distribution system.
- Routine testing of the water in a health-care facility is usually not indicated, but sampling in support of outbreak investigations can help determine appropriate infection-control measures.
- Health-care facilities that conduct water sampling should have their samples assayed in a laboratory that uses established methods and quality-assurance protocols.
- Water specimens are not "static specimens" at ambient temperature; potential changes in both numbers and types of microbial populations can occur during transport. Consequently, water samples should be sent to the testing laboratory cold (i.e., at approximately 39.2°F [4°C]) and testing should be done as soon as practical after collection (preferably within 24 hours).
- Because most water sampling in health-care facilities involves the testing of finished water from the facility's distribution system, a reducing agent (i.e., sodium thiosulfate [Na2S2O3]) needs to be added to neutralize residual chlorine or other halogen in the collected sample. If the water contains elevated levels of heavy metals, then a chelating agent should be added to the specimen.
- The minimum volume of water to be collected should be sufficient to complete any and all assays indicated; 100 ml is considered a suitable minimum volume. Sterile collection equipment should always be used.
- Sampling from a tap requires flushing of the water line before sample collection. If the tap is a mixing faucet, attachments (e.g., screens and aerators) must be removed, and hot and then cold water must be run through the tap before collecting the sample. If the cleanliness of the tap is questionable, disinfection with 500–600 ppm sodium hypochlorite (1:100 v/v dilution of chlorine bleach) and flushing the tap should precede sample collection.
- Use of aerobic, heterotrophic plate counts allows both a qualitative and quantitative measurement for water quality. If bacterial counts in water are expected to be high in number (e.g., during waterborne outbreak investigations), assaying small quantities using pour plates or spread plates is appropriate.

3. Environmental Surface Sampling

- Routine environmental-surface sampling (e.g., surveillance cultures) in health-care settings is neither cost-effective nor warranted.

- When indicated, surface sampling should be conducted with multidisciplinary approval
- The following factors should be considered before engaging in environmental-surface sampling:
  - ✓ Background information from the literature and present activities (i.e., preliminary results from an epidemiologic investigation)
  - ✓ Location of surfaces to be sampled
  - ✓ Method of sample collection and the appropriate equipment for this task
  - ✓ Number of replicate samples needed and which control or comparison samples are required
  - ✓ Parameters of the sample assay method and whether the sampling will be qualitative, quantitative, or both
  - ✓ An estimate of the maximum allowable microbial numbers or types on the surface(s) sampled (refer to the Spaulding classification for devices and surfaces)
  - ✓ Some anticipation of a corrective action plan
- Effective sampling of surfaces requires moisture, either already present on the surface to be sampled or via moistened swabs, sponges, wipes, agar surfaces, or membrane filters. Dilution fluids and rinse fluids include various buffers or general purpose broth media
- If disinfectant residuals are expected on surfaces being sampled, specific neutralizer chemicals should be used in both the growth media and the dilution or rinse fluids.
- The inclusion of appropriate control specimens should be included to rule out both residual antimicrobial activity from surface disinfectants and potential toxicity caused by the presence of neutralizer chemicals carried over into the assay system

Methods of environmental-surface sampling

Method	Suitable for appropriate surface(s)	Assay technique	Procedural notes	Points of interpretation	Available standards
Sample/rinse (Moistened swab/rinse)	Non-absorbent surfaces, corners, crevices, devices, and instruments	Dilutions; qualitative or quantitative assays	Assay multiple measures areas or devices with separate swabs	Report results per measured areas or if assaying an object, per the entire sample site	YES: food industry; NO: health care
Sample/rinse (Moistened sponge/rinse)	Large areas and housekeeping surfaces (e.g., floors or walls)	Dilutions; qualitative or quantitative assays	Vigorously rub a sterile sponge over the surface	Report results per measured area	YES: food industry; NO: health care
Sample/rinse (Moistened wipe/rinse)	Large areas and housekeeping surfaces (e.g., countertops)	Dilutions; qualitative or quantitative assays	Use a sterile wipe	Report results per measured area	YES: food industry; NO: health care
Direct immersion	Small items capable of being immersed	Dilutions; qualitative or quantitative assays	Use membrane filtration if rinse volume is large and anticipated microbiological concentration is low	Report results per item	NO
Containment	Interior surfaces of containers, tubes, or bottles	Dilutions; qualitative or quantitative assays	Use membrane filtration if rinse volume is large	Evaluate both the types and numbers of microorganisms	YES: food and industrial applications for containers prior to fill
RODAC (Replicate Organism Direct Agar Contact)	Previously cleaned and sanitized flat, non-absorbent surfaces; not	Direct assay	Overgrowth occurs if used on heavily contaminated surfaces; use neutralizers in	Provides direct, quantitative results; use a minimum of 15 plates per an	NO

	suitable for irregular surfaces		the agar if surface disinfectant residuals are present	average hospital room	

Source:
https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/sampling.html

Appendix-6: Intensified interventions to prevent MDROs

Intensified interventions to prevent MDROs transmission according to CDC guideline

Intervention	Description
1- Indication and Approach	• When incidence of MDROs is not decreasing despite implementation of and correct compliance to the routine control measures described above. • When an outbreak of an epidemiological important MDRO is identified for the first time in the healthcare facility.
2- Administrative measures.	• Assess healthcare system constituents for their role in creating and continuing transmission of MDROs. • Develop, implement and monitor action plans to correct system failures. • Keep good communication and feedback to update on the progress and effectiveness of interventions.
3- Educational interventions:	• Increase the frequency of MDRO educational programs for those who work in areas with high MDRO rates. Additional review of wise utilization of antimicrobial agents: • Review the role of antimicrobial use in continuing the MDRO problem. • Antimicrobial agents that may be targeted cover vancomycin anti-anaerobic agents for VRE, 3rd generation cephalosporin for ESBL, quinolones and carbapenems. • Give education on prevention and control of MDROs to all HCWs. • Do the assessment and evaluation of the staff's knowledge and skills by field observation and the online Infection Control module when available
4-. Judicious use of Antimicrobial Agents	• Use antimicrobial prophylaxis in surgical patients and monitor it in terms of type of antibiotic, timeline between antibiotic administration and incision, antibiotic re-dosing during long duration surgeries and discontinuation of antibiotics. • Discontinue antimicrobial surgical prophylaxis within 24 hours from anesthesia end time for all surgeries including cardiovascular surgeries
5- Surveillance:	A- Collect, calculate and analyze prevalence and incidence rates of targeted MDRO infections and colonization in at-risk populations.

	• When calculating rates, include only one-isolated bacteria per patient, not multiple isolates from the same patient. • Increase the frequency of collecting and monitoring antimicrobial susceptibility summary reports for a targeted MDRO, as indicated by increase in incidence of infection or colonization with that MDRO. • Develop and implement protocols to obtain active surveillance cultures (ASC) for targeted MDROs from patients in populations at risk. B- Obtain ASC from areas of skin breakdowns and draining wounds. In addition, it includes the following sites: • For MRSA: a swab from the anterior nares is usually sufficient in adults. For pediatric age groups and neonates, swab axillae and groins. • For VRE: rectal swab. • For MDR-GNB: rectal swab. C-Take surveillance cultures for the target MDRO from patients at the time of admission to high-risk areas and at periodic intervals as needed to assess MDRO transmission. D-Carry out culture surveys to evaluate the effectiveness of the enhanced MDRO control interventions. E- Conduct serial (e.g. Weekly, until the transmission has ceased and then decreasing frequency) unit-specific point-prevalence culture surveys of the target MDRO to decide if the transmission has reduced or stopped. F- If indicated, collect cultures to assess the colonization status of roommates and other patients with substantial exposure to patients with known MDRO infection. G-Obtain cultures of HCW for target MDRO when there is epidemiological evidence that HCW is a source of ongoing transmission.
6- Enhanced Infection Control Precautions	**Transmission-Based Precautions** • Start contact precautions in addition to standard precautions and place contact precautions sign on the door. • Practice strict hand washing. • Cohort non-critical items to the patient (in the patient room). • Minimize the amount of supplies in the patient room.

	• Use an isolation cart outside the patient's room. • Limit patient activity outside the room for treatment or tests. • Ensure the same time and terminal cleaning of the isolation room and equipment are per housekeeping procedures. • Handle/discard contaminated objects as per Standard Precautions. • Request Infectious Diseases consultation as needed. • Discharge patient if medical condition allows. • Discontinue isolation after prior consultation with the ICP. **Notification OF MDROs:** • Report all MDROs by phone to the ICP & to the ward of the MDRO patient. • Assign ICP to key areas to observe the staff compliance to infection control guidelines regarding isolation and contact precautions for patients with MDROs. • Identify patients with MDROs by daily review of microbiology results. • Provide feedback on MDRO by patient-care units quarterly to hospital administration and infection control committee. **Screening** • Manage the Outbreak in coordination with ICP and the cooperation of medical, nursing, laboratory and other departments. • Screen Healthcare workers (HCWs) and the environment only when indicated e.g . When there is an epidemiological link to an ongoing outbreak. • Do not routinely culture HCW or environment since it is not indicated and causes unnecessary costs. • Consult ICP before screening **DO MDROs screening for**: • Patients transferred from other hospitals • Patient with history of Hospitalization in the last 90 days. • All patients in ICU/NICU …on admission. • Patient who undergo the following surgeries: neurosurgery, cardiac surgery, and orthopedic surgery **N.B**; according to type of microorganisms / indication of screening / site of sampling

7- Patient admission and Placement	• Perform contact precautions routinely for all patients colonized or infected with the target MDROs. • Put on gowns and gloves before or upon entry to the patient's room. Start maximum contact precautions until the surveillance culture is reported negative. • Start policies for patient admission and placement as needed to prevent transmission of MDROs. • Place MDROs patients in single patient rooms. • Or cohort patients with the same MDRO. • Assign dedicated nurses and ancillary service staff to the care of MDROs patients only. • Stop new admissions to the unit if transmission continues despite the implementation of increased control measures.
8-Enhanced Environmental Measures:	• To start patient-dedicated or single-use disposable non-critical equipment (e.g. Blood pressure cuff, stethoscope), instruments, and devices. • Monitor compliance to environmental cleaning policies. • Monitor cleaning performance to ensure consistent cleaning and disinfecting of surfaces close to the patient. • Obtain environmental cultures when there is epidemiological evidence that an environmental source is associated with ongoing transmission of the targeted MDROs. • Evacuate the units for intensive environmental cleaning when previous efforts have failed. • Clean the patient's room. • Clean rooms everyday by the designated personnel with disposable or dedicated equipment. • Change mop water after each isolation patient’s room is completed. • Wipe mop handles with disinfectant and the mop head will be bagged and sent to the laundry. • Clean all equipment with hospital approved disinfectant after each use. • Do terminal cleaning of the room: This includes changing the curtains and wet disinfectant/mopping of floors, walls, bed, bedside table, telephone, and IV poles, etc. Curtains, sheets, and other durable items will be bagged and sent to the laundry. • Use single-use or disposable equipment for the care of patients with MDROs- whenever possible. • Clean when durable equipment is used, including but not limited to portable x-ray machines, ABG machines, dialysis machines, etc., the equipment with hospital approved disinfectant and/or

	according to manufacturer's recommendations before the equipment is used to care for another patient. • Keep all medical items such as dressings, syringes, IV fluids, etc. To minimal in the patient room; if these items found in the patient room after diagnosis with MDROs - all should be discarded. • Keep linen in water-soluble bag and send to laundry as per hospital policy. • If the patient bed and /or other equipment such as an IV pole accompany the patient the patient on the transport, the bedrails and equipment should be wiped down with hospital approved disinfectant prior to the transport. • HCWs should wear PPE to handle the patient at the transport destination. • Clean the testing and procedure area with hospital approved disinfectant after MDROs- patient leaves the area. • Do all procedures in the patient's room if applicable. • Do not allow sitter except if medically indicated. • Educate the sitter to follow infection control precautions. • Make sure all visitors of patients who are on contact isolation for MDROs should follow the isolation requirements. This means that visitors should wear gloves and gowns in the patient's room. A mask should also be worn if the organism is in the patient's sputum. When the visitor exits, the gown, gloves, and mask should be removed inside the room, and hand washing with water and soap or alcohol-based hand cleanser should be performed. If visitors follow these requirements, there is no restriction on their movement in the hospital. • Make sure isolation requirements are followed whenever possible in the case of visitors who sleep in the patient's room (i.e. Parents staying with a child on isolation for MDROs). • Put on a clean change of clothes and perform thorough hand hygiene must be followed by the visitors prior to exiting the patient's room if gowns and gloves are not worn (i.e. When sleeping or during prolonged hospitalizations). Suppose these isolation requirements cannot be met for any reason. In that case, when leaving the patient's room, the visitor should proceed directly out of the hospital without visiting other patients or any common-use areas. • Reprocess ventilators used by patients with MDROs according to manufacturer recommendations. • Designate respiratory therapists to provide care to patients with MDROs.

	• Make sure patients with MDROs are seen last or at the end of the day if possible, including patients travelling to the wound care room or physiotherapy
9-Decolonization .	• Consult with Infection Control Practitioner (ICP) on a case-by-case basis regarding the appropriate use of decolonization therapy. • When decolonization for MRSA is practiced, perform sensitivity testing for the decolonizing agent. • Monitor susceptibility to detect emergence resistance to decolonizing agents. • Test for mupirocin resistance. • Limit decolonization of HCW discovered to be colonized with MRSA to people who have been epidemiologically linked as a likely original source of ongoing transmission. • Consider reassignment of HCW if decolonization is not successful and ongoing transmission to patients persists. • There is no recommendation for decolonizing cases with MDR-GNB or VRE. Regimens and efficacy of decolonization protocols for these VRE and MDR-GNB have not been established– CRE Protocol) • Discuss, analyze and approve all issues to the Infection Control committee in control, prevention and surveillance of MDRO infection

Source: https://www.cdc.gov/infectioncontrol/guidelines/MDRO/recommendations.html

Appendix-7: Risk Assessment Tool for MDRO

Risk Assessment for Multiple Drug Resistant Organisms												
Risk Event	**Probability the Risk Will Occur**				**Potential Severity if the Risk Occurs**				**How well is the organization prepared to risk event address this risk?**			**Risk Priority**
	High	Med	Low	None	Life Threatening	Permanent Harm	Temporary Harm	None	Poorly	Fairly Well	Well	
Score	**4**	**3**	**2**	**1**	**4**	**3**	**2**	**1**	**3**	**2**	**1**	
Increasing incidence of infections with MDROs												
Methicillin-resistant *Staphylococcus aureus* (MRSA)												
Vancomycin-resistant Enterococci (VRE)												
Clostridium difficile												
Multidrug-resistant *Pseudomonas*												
Multidrug-resistant *Enterobacter* ssp												
Multidrug-resistant *Klebsiella*												
Multidrug-resistant *Acinetobacter*												
Other												

Risk Assessment for Multiple Drug Resistant Organisms												
Risk Event	**Probability the Risk Will Occur**				**Potential Severity if the Risk Occurs**				**How well is the organization prepared to risk event address this risk?**			**Risk Priority**
	High	Med	Low	None	Life Threatening	Permanent Harm	Temporary Harm	None	Poorly	Fairly Well	Well	
Score	**4**	**3**	**2**	**1**	**4**	**3**	**2**	**1**	**3**	**2**	**1**	
Increasing MDRO infections of specific types/site												
Catheter-associated bloodstream infections (CABSI)												
Ventilator-associated pneumonia (VAP)												
Catheter-associated urinary tract infections (CAUTI)												

Appendix-8: MRSA Decolonization

Assessment of MRSA decolonization

- Assessment for decolonization will be performed by the Infection Control Practitioner (ICP).
- Consult with ICP on a case-by-case basis regarding the appropriate use of decolonization therapy.
- When decolonization for MRSA is practiced, perform sensitivity testing for the decolonizing agent.
- Monitor susceptibility to detect emergence resistance to the decolonizing agent.
- Test for mupirocin resistance.
- Limit decolonization of HCW discovered to be colonized with MRSA to people who have been epidemiologically linked as a likely original source of ongoing transmission.
- Consider reassignment of HCW if decolonization is not successful and ongoing transmission to patients persists.
- No recommendation for decolonizing cases with MDR gram-negative pathogens such as VRE, CRE

Requirements:

- Maintain Contact Isolation during decolonization treatment.
- Supplies:
  - ✓ Chlorhexidine 4%.
  - ✓ Mupirocin/Bactroban, per MD order.
  - ✓ Clean linens for the bed and patient.
  - ✓ Personal protective equipment (PPE).

Process

- Spread full-strength Chlorhexidine 4% solution from neck to toes, ensuring coverage of underarms, groin, and between fingers and toes.
- Cover the patient with a sheet and wait for 10 minutes.
- Rinse with warm water.
- Change the bed linens and the patient's clothing completely after each bath/shower.
- Repeat this process twice a day.
- Shampoo hair with the Chlorhexidine solution for 3 days.
- Apply Mupirocin/Bactroban ointment to anterior nares (inside nose) after Chlorhexidine treatment when the patient is dry and dressed as ordered by the MD.
- Mupirocin should not be applied to open wounds.
- These treatments must be given for 7 consecutive days.
- Take a complete set of cultures from nares and previously positive sites 72 hours after decolonization.
- If the first set of samples is negative, repeat cultures 48 hours later.
- Three negative cultures are required before the patient is cleared of MRSA and can be taken out of isolation.

- The ICP will assess these results.
- NOTES:
- The patient must not be on antibiotics at the time of screening.
- If any swab is positive, stop the screening process until further assessment.
- Please complete all documentation on this form. The ICP will collect the form when completed.

MRSA Decolonization Record

START DATE: _____

Treatment time	Chlorhexidine 4% wash & shampoo	Mupirocin/Bactroban ointment	Initials
DAY 1			
DAY 2			
DAY 3			
DAY 4			
DAY 5			
DAY 6			
DAY 7			

Appendix-9 Classification of organisms

Gram-Positive		Gram-Negative		Other Organisms			
Gram-Positive Cocci	**Gram-Positive Bacilli**	**Gram-Negative Cocci**	**Gram-Negative**	**Fungi**	**Anaerobic**	**Chlamydia**	**RNA Viruses**
Enterococcus species	Actinomyces Species	Moraxella catarrhalis	Acinetobacter Species	Aspergillus Species	Bacteroides and Prevotella Species	Chlamydia pneumoniae	Arboviruses..
Rhodococcus Species	Bacillus anthracis	Neisseria gonorrhoeae	Aeromonas Species	Blastomyces dermatitidis	Clostridium botulinum	Chlamydia Psittaci	Coxsackieviruses.
Methicillin-resistant Staphylococcus aureus (MRSA)	Bacillus cereus	Neisseria meningitides	Alcaligenes Species	Candida Species	Clostridium difficile	Chlamydia trachmoatis	Dengue Virus.
Methicillin-susceptible Staphylococcus aureus (MSSA)	Corynebacterium diphtheriae		Bartonella Species	Coccidioides immitis	Clostridium perfringens		Echovirus.
Staphylococcus epidermidis, Methicilin-Resistant	Corynebacterium jeikeium		Bordetella bronchiseptica	Cryptococcus neoformans	Clostridium tetani		Enterovirus
Staphylococcus epidermidis, Methicillin-Susceptible	Corynebacterium Species, Other Than C. jeikeium		Bordetella pertussis	Dematiaceous Fungi	Mobiluncus Species		Hantavirus
Staphylococcus saprophyticus	Erysipelothrix rhusiopathiae		Brucella Species	Dermatophytes			Hepatitis A Virus
CI Streptococcus agalactiae	Listeria monocytogenes		Burkholderia cepacia	Fusarium Species			Hepatitis C Virus
Streptococcus Bovis	Nocardia Species		Calymmatobacterium granulomatis	Histoplasma capsulatum			Hepatitis D Virus.
Diplococcus pneumoniae, Drug-Resistant			Campylobacter jejuni	Malassezia furfur			Hepatitis E Virus

streptococcus pneumoniae, Drug-Susceptible			Capnocytophaga Species	Mucor Species			Human Immunodeficiency Virus.
Streptococcus pyogenes			Citrobacter Species	Penicillium marneffei			Human T-Cell Lymphotropic Viruses.
Streptococcus-Related Gram-Positive Cocci			Enterobacter Species	Prototheca Species			Influenza Virus
Streptococcus-Species			Escherichia coli, Enterohemorrhagic	Sporothrix schenckii			Measles Virus
SreptocOccus, viridans Group			Escherichia coll, Enterotoxigenic				Mumps Virus
			Escherichia coli, Nonenterohemorrhagic				Parainfluenza Virus
			Francisella tularensis				Poliovirus.
			Gardnerella vaginalis				Rabies Virus
			Haemophilus ducreyi				Respiratory Syncytial Virus
			Haemophilus influenzae				RotaviruS
			Helicobacter pylori				
			Klebsiella Species				
			Legionella pneumophila				
			Pasteurella muiltocIda				
			Proteus Species				
			Providencia Species				
			Pseudomonas aeruginosa				
			Salmonella Species				

For more commensal's organism list: https://www.cdc.gov/nhsn/xls/master-organism-com-com