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ALDO MORO

HYGIENE COURSE

Scuola
di
Medicina

Hospital Hygiene

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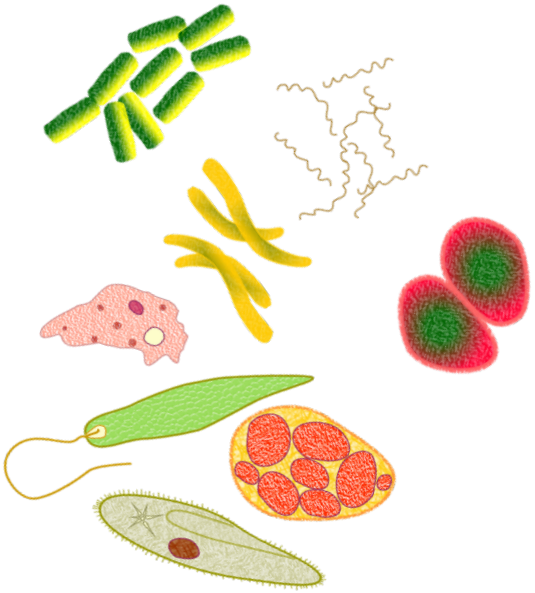
The main characters



The main characters

- Examples of surfaces where pathogens have been found
  - Door handles
  - Soap dispensers
  - Sink taps
  - Sites where dust has accumulated
  - Stethoscopes
  - Lifting equipment
  - Ultrasound probes

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Before starting let's point out some

Definitions

The Terminology of Microbial Control

- **Sepsis** refers to microbial contamination
- **Asepsis** is the absence of significant contamination
- Aseptic surgery techniques prevent microbial contamination of wounds

Cleaning/Degerming

- The most basic measures for **maintaining hygiene in a healthcare facility**
- **Cleaning** is the physical removal of **visible contaminants** such as dirt from objects and surfaces, without necessarily destroying microorganisms.
- **Degerming** removes microbes from live tissue.
- Normally accomplished manually or mechanically using water with detergents or enzymatic products.
- **Through cleaning with soaps and detergents can remove more than 90% of microorganisms**

Disinfection

- The destruction of many or **all pathogenic** and other kinds of microorganisms by physical and chemical means **on inanimate objects**.
- Disinfection is less aggressive process than sterilization because it destroys most recognized pathogenic microorganisms, but not necessarily all microbial forms such as bacterial spores.

Disinfection

High-level disinfection

destruction of all microorganisms except for large numbers of bacterial spores

Intermediate disinfection

inactivation of Mycobacterium tuberculosis, vegetative bacteria, most viruses and fungi, but not bacterial spores

Low-level disinfection

destruction of most bacteria, some viruses and fungi, but no resistant microorganisms such as tubercle bacilli or bacterial spores

Antisepsis

- A process involving the destruction or inhibition of microrganisms in **living tissue** thereby limiting or preventing the harmful effects of infection**.**
- Mainly carried out by **chemical means**, but less harmful and irritating than disinfectants.

Antiseptic vs Disinfectant

- Typically an **antiseptic** is a **chemical agent** that is applied to living tissue to kill microbes.
- Not all disinfectants are antiseptics because an antiseptic additionally must not be so harsh that it damages living tissue.
- **Antiseptics are less toxic than disinfectants used on inanimate objects**. Due to the lower toxicity, antiseptics can be **less active** in the destruction of normal and any pathogenic flora present.

Sterilization

- The complete elimination or destruction of **all forms of microbial life**
- It is carried out in health-care facilities by **physical** or **chemical methods.**
- rendering an object free from microorganisms; shown by a 99.9999% reduction of microorganisms

Disinfestation

- Physical or chemical process to destroy or remove small undesirable **animal forms**, particularly **arthropods** or **rodents**, present on the body, clothing, or environment of a person or domestic animals.

Sanitization

- The process of reducing microbial contamination in the inanimate environment to a level considered safe as determined by Public Health Ordinance, or that reduces the bacterial population by significant numbers where public health requirements have not been established

Decontamination

- The killing and removal of pathogenic microorganisms or removal of contamination after use, with no quantitative implication, generally referring to procedures for making items safe to handle, use, or discard.

Basic Principles of Microbial Control

Terminology of Microbial Control

Term	Definition	Examples	Comments
Antisepsis	Reduction in the number of microorganisms and viruses, particularly potential pathogens, on living tissue	Iodine; alcohol	Antiseptics are frequently disinfectants whose strength has been reduced to make them safe for living tissues.
Aseptic	Refers to an environment or procedure free of pathogenic contaminants	Preparation of surgical field; handwashing; flame sterilization of laboratory equipment	Scientists, laboratory technicians, and health care workers routinely follow standardized aseptic techniques.
-cide -cidal	Suffixes indicating destruction of a type of microbe	Bactericide; fungicide; germicide; virucide	Germicides include ethylene oxide, propylene oxide, and aldehydes.
Degerming	Removal of microbes by mechanical means	Handwashing; alcohol swabbing at site of injection	Chemicals play a secondary role to the mechanical removal of microbes.
Disinfection	Destruction of most microorganisms and viruses on nonliving tissue	Phenolics; alcohols; aldehydes; soaps	The term is used primarily in relation to pathogens.
Pasteurization	Use of heat to destroy pathogens and reduce the number of spoilage microorganisms in foods and beverages	Pasteurized milk and fruit juices	Heat treatment is brief to reduce alteration of taste and nutrients; microbes still remain and eventually cause spoilage.
Sanitization	Removal of pathogens from objects to meet public health standards	Washing tableware in scalding water in restaurants	Standards of sanitization vary among governmental jurisdictions.
-stasis -static	Suffixes indicating inhibition, but not complete destructhon, of a type of microbe	Bacteriostatic; fungistatic; virustatic	Germistatic agents include some chemicals, refrigeration, and freezing.
Sterilization	Destruction of all microorganisms and viruses in or on an object	Preparation of microbiological culture media and canned food	Typically achieved by steam under pressure, incineration, or ethylene oxide gas.

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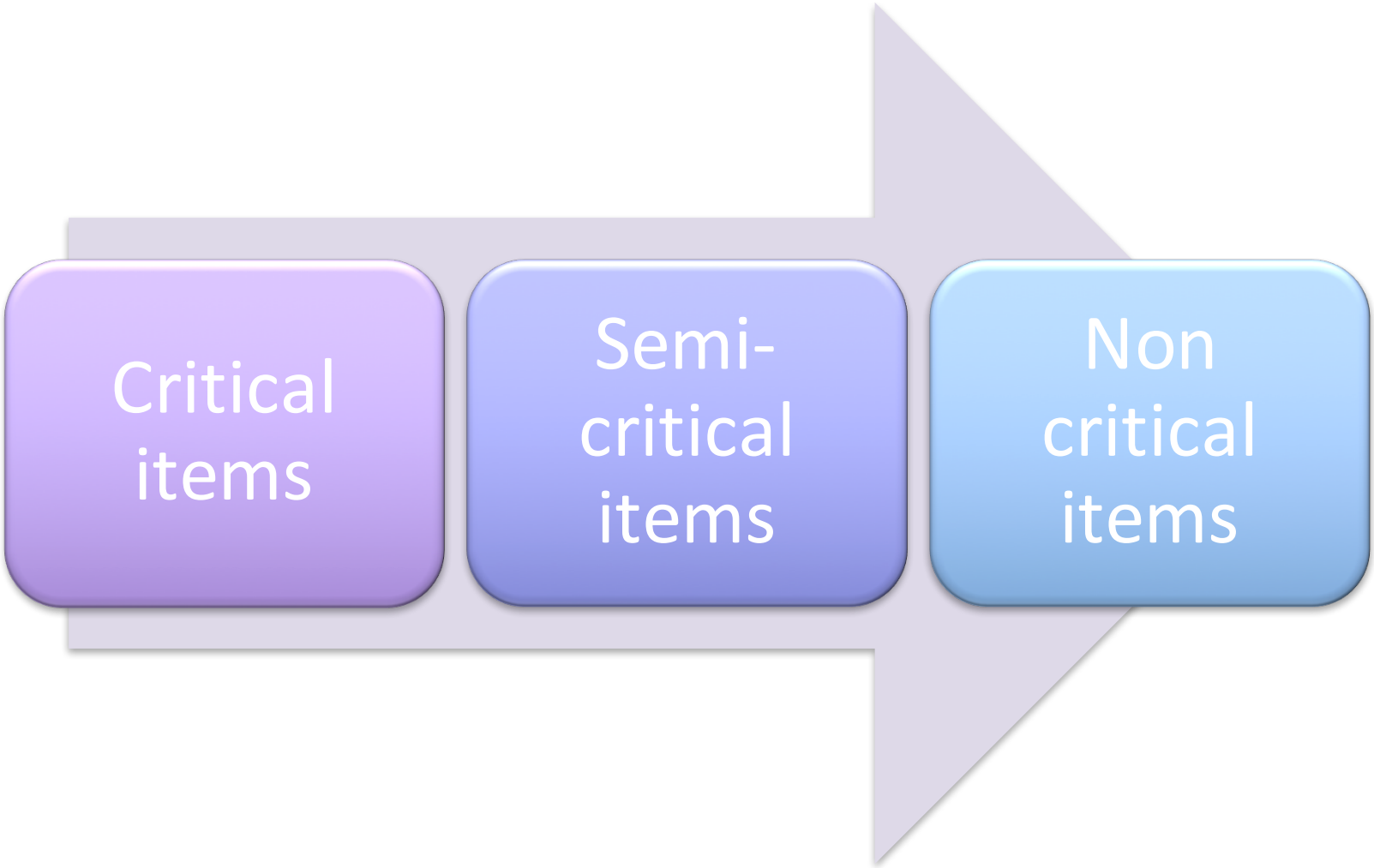
Decision-making process



Decision-making process

Critical	objects that enter sterile tissue or the vascular system must be sterile because any microbial contamination could transmit disease	surgical instruments, cardiac and urinary catheters, implants, and ultrasound probes used in sterile body cavities	sterilization
Semicritical	contact mucous membranes or non intact skin	respiratory therapy and anesthesia equipment, some endoscopes, laryngoscope blades 24, esophageal manometry probes, cystoscopes	High level disinfection
Non critical	those that come in contact with intact skin but not mucous membranes	bedpans, blood pressure cuffs, crutches and computers	Cleaning or low-level disinfection

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Factors Affecting the Efficacy of Antimicrobial Methods

- Site to be treated
- Relative susceptibility of microorganism
- Environmental conditions that pertain

Site to be treated

- Harsh chemicals and extreme heat cannot be used on humans, animals, and fragile objects
- Method of microbial control based on site of medical procedure

Relative susceptibility of microroganism

Germicides classified as high, intermediate, or low effectiveness

- High-level kill all pathogens, including endospores
- Intermediate-level kill fungal spores, protozoan cysts, viruses, and pathogenic bacteria
- Low-level kill vegetative bacteria, fungi, protozoa, and some viruses

Relative susceptibility of microroganism

Most resistant

- Prions
- Bacterial endospores
- Mycobacteria
- Cysts of protozoa
- Active-stage protozoa (trophozoites)
- Most Gram-negative bacteria
- Fungi
- Nonenveloped viruses
- Most Gram-positive bacteria
- Enveloped viruses

Most susceptible

Environmental conditions that pertain

- **Temperature**
  Increasing temperatures increases the efficacy of most chemical antimicrobials. The converse of this statement is that relatively cold temperatures result in relatively poor disinfection

- **Load**
  The fewer organisms present, the shorter the time needed to achieve sterility. Thoroughly cleaning objects before attempting to sterilize them is a practical application of this principle. Clearing objects of tissue debris and blood is also important because such organic matter impairs the effectiveness of many chemical agents.

- **Concentration effects**
  Generally, the use of more disinfectant provides better killing than the use of less disinfectant

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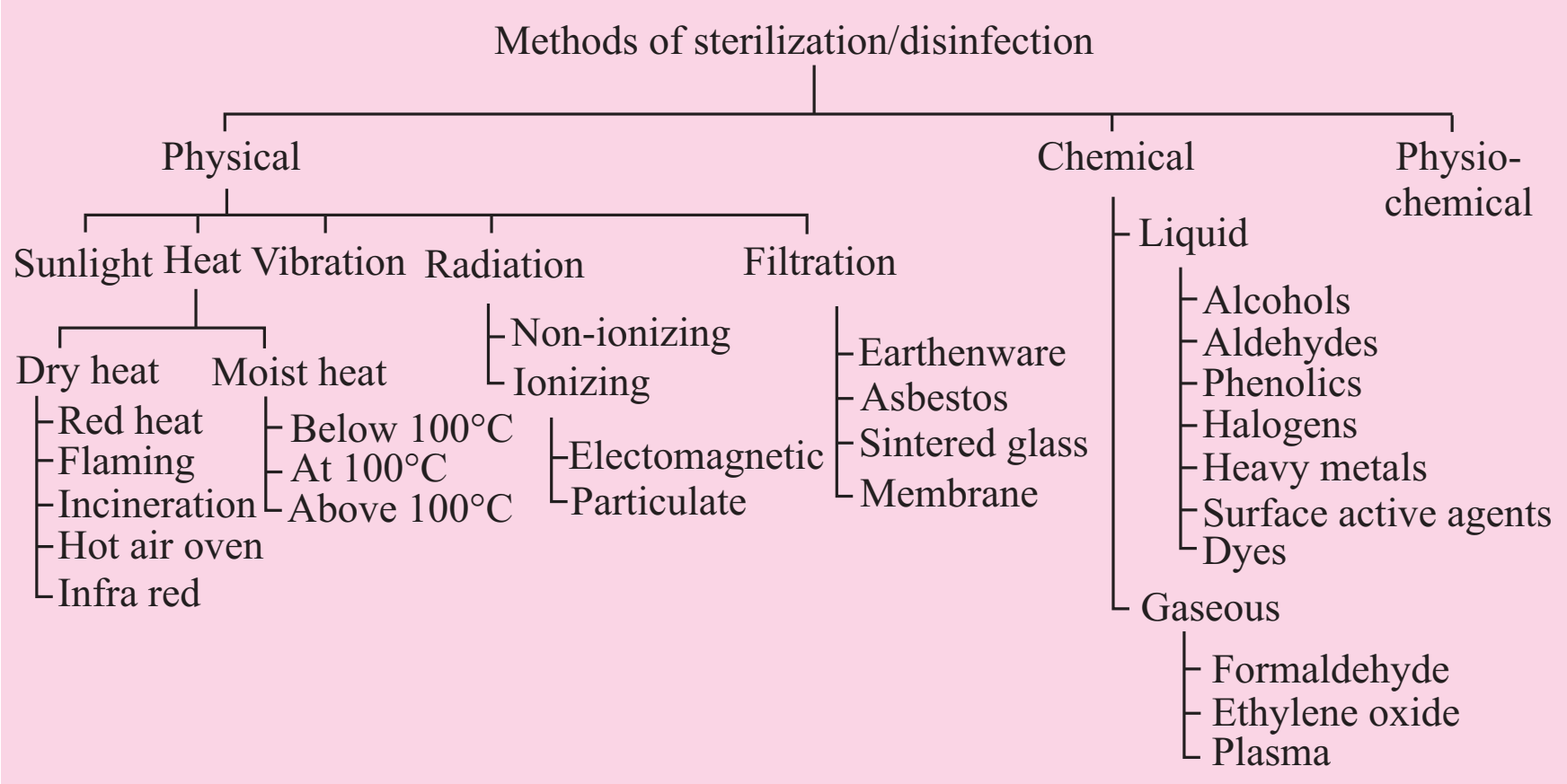
Methods of Microbial Control



Physical Methods of Microbial Control

Heat-Related Methods

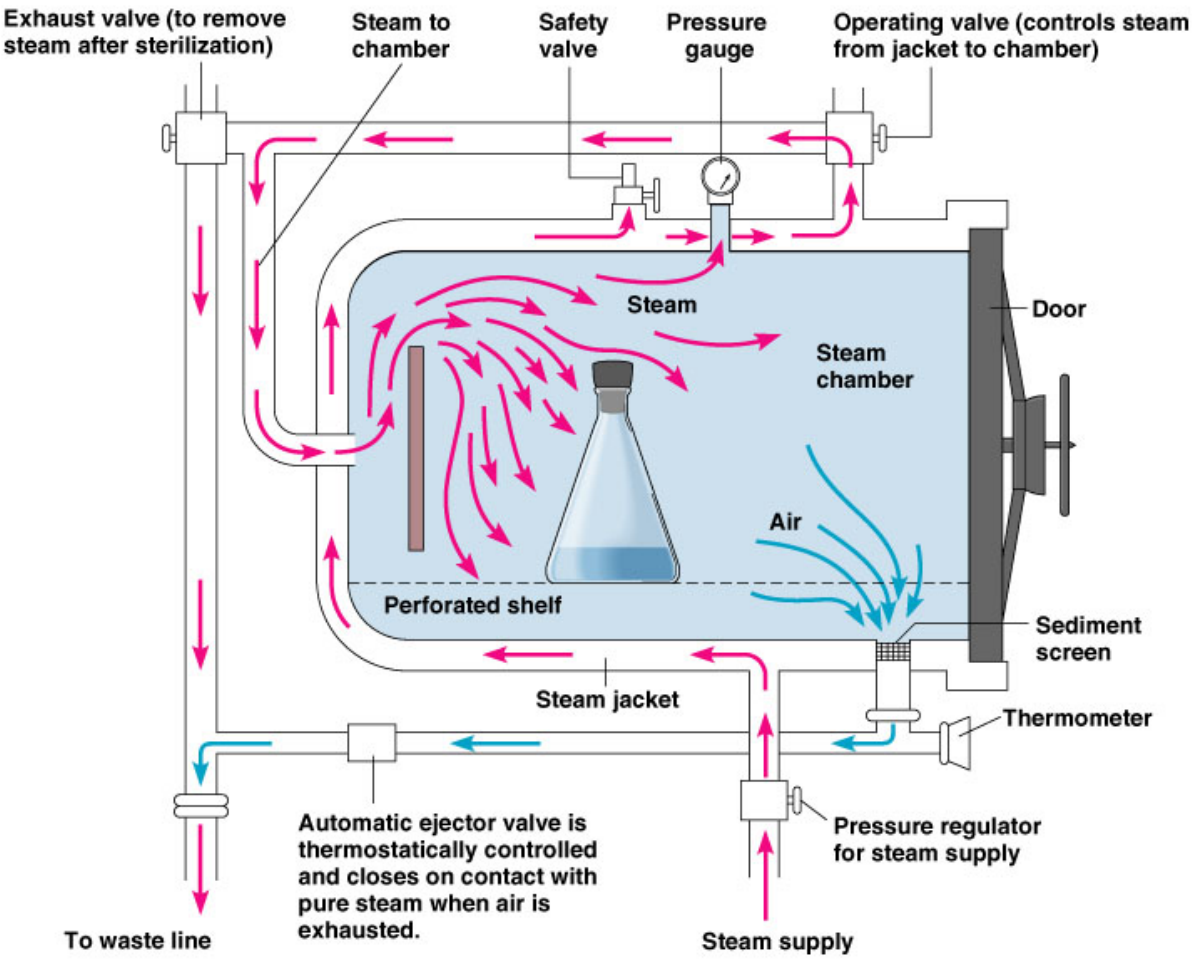
- Effects of high temperatures
  - Denature proteins
  - Interfere with integrity of cytoplasmic membrane and cell wall
  - Disrupt structure and function of nucleic acids
- Thermal death point
  - Lowest temperature that kills all cells in broth in 10 min
- Thermal death time
  - Time to sterilize volume of liquid at set temperature

Methods for Sterilization

- Physical methods
  - Autoclaving: use of steam under pressure (moist heat)
  - Dry heat: relatively slow and requiring higher temperature compared to moist heat
- Use of chemical sterilants
  - Ethylene oxide
- Others: low-temperature plasma with hydrogen peroxide gas, radiation sterilization, germicidal ultraviolet irradiation

Autoclaving

- Autoclave: Steam under pressure
- 15 min at 121°C at 15 psi



Autoclaving video

Chemical Methods of Microbial Control

- Affect microbes' cell walls, cytoplasmic membranes, proteins, or DNA
- **Effect varies with temperature, length of exposure, and amount of organic matter**
- Also varies with pH, concentration, and age of chemical
- **Tend to be more effective against enveloped viruses and vegetative cells of bacteria, fungi, and protozoa**

Chemical Methods of Microbial Control

- Adsorption on the microbes' surface
- Diffusion through the surface
- Binding to the vulnerable sites (e.g. plasma membrane, cytoplasmic proteins, nucleic acids, and so on)
- Disruption of the vulnerable sites
- Injury and death of the microbes

Methods for Disinfection

- There is no ideal disinfectant
- The more active disinfectants are automatically the more toxic ones
- The principal requirements for a good antiseptic: cost, absence of toxicity, rapidity and effectiveness of the action

Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Alcohols (60–90%) including ethanol or isopropanol	Low to intermediate-level disinfectant	• Used for some semi critical and noncritical items (e.g. oral and rectal thermometers and stethoscopes) • Used to disinfect small surfaces such as rubber stoppers of multi-dose vials • Alcohols with detergent are safe and effective for spot disinfection of countertops, floors and other surfaces	• Fast acting • No residue • No staining • Low cost • Readily available in all countries	• Volatile, flammable, and irritant to mucous membranes • Inactivated by organic matter • May harden rubber, cause glue to deteriorate, or crack acrylate plastic
Chlorine and chlorine compounds: the most widely used is an aqueous solution of sodium hypochlorite 5.25–6.15% (house bleach) at a concentration of 100–5000 ppm free chlorine	Low to high-level disinfectant	• Used for disinfecting tonometers and for spot disinfection of countertops and floors • Can be used for decontaminating blood spills • Concentrated hypochlorite or chlorine gas is used to disinfect large and small water-distribution systems such as dental appliances, hydrotherapy tanks, and water-distribution systems in haemodialysis centres	• Low cost, fast acting • Readily available in most settings • Available as liquid, tablets or powders	• Corrosive to metals in high concentrations (>500 ppm) • Inactivated by organic material • Causes discoloration or bleaching of fabrics • Releases toxic chlorine gas when mixed with ammonia • Irritant to skin and mucous membranes • Unstable if left uncovered, exposed to light or diluted; store in an opaque container

Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Aldehydes ***glutaraldehyde:*** ≥2% aqueous solutions buffered to pH 7.5–8.5 with sodium bicarbonate There are novel glutaraldehyde formulations	High-level disinfectant/ sterilant	• Most widely used as high-level disinfectant for heat-sensitive semi critical items such as endoscopes (for 20 minutes at 20 °C)	• Good material compatibility	• Allergenic and its fumes are irritating to skin and respiratory tract • Causes severe injury to skin and mucous membranes on direct contact • Relatively slow activity against some mycobacterial species • Must be monitored for continuing efficacy levels
Peracetic acid (0.2–0.35%) **and** **other stabilized organic**	High-level disinfectant/ sterilant	• Used in automated endoscope reprocessors • Can be used for cold sterilization of heat-sensitive critical items (e.g. haemodialysers) • Also suitable for manual instrument processing (depending on the formulation)	• Rapid sterilization cycle time at low temperature (30–45 min. at 50–55 °C) • Active in presence of organic matter • Environment friendly by-products (oxygen, water, acetic acid)	• Corrosive to some metals • Unstable when activated • May be irritating to skin, conjunctive and mucous membranes

Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Orthophthalaldehyde (OPA) 0.55%	High-level disinfectant/ sterilant	• High-level disinfectant for endoscopes	• Excellent stability over wide pH range, no need for activation • Superior mycobactericidal activity compared to glutaraldehyde • Does not require activation	• Expensive • Stains skin and mucous membranes • May stain items that are not cleaned thoroughly • Eye irritation with contact • May cause hypersensitivity reactions in bladder cancer patients following repeated exposure to manually processed urological instruments • Slow sporicidal activity • Must be monitored for continuing efficacy levels
Hydrogen peroxide (7.5%)	High-level disinfectant/ sterilant	• Can be used for cold sterilization of heat-sensitive critical items • Requires 30 min at 20 °C	• No odour • Environment friendly by-products (oxygen, water)	• Material compatibility concerns with brass, copper, zinc, nickel/silver plating
Hydrogen peroxide (7.5%) and peracetic acid 0.23%	High-level disinfectant/ sterilant	• For disinfecting haemodialysers	• Fast-acting (high-level disinfection in 15 min) • No activation required • No odour	• Material compatibility concerns with brass, copper, zinc and lead • Potential for eye and skin damage

Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Glucoprotamin	High-level disinfectant	• Manual reprocessing of endoscopes • Requires 15 min at 20 °C	• Highly effective against mycobacteria • High cleansing performance • No odour	• Lack of effectiveness against some enteroviruses and spores
Phenolics	Low to intermediate-level disinfectant	• Have been used for decontaminating environmental surfaces and non-critical surfaces • Should be avoided	• Not inactived by organic matter	• Leaves residual film on surfaces • Harmful to the environment • No activity against viruses • Use in nurseries should be avoided due to reports of hyberbilirubinemia in infants
Iodophores (30–50 ppm free iodine)	Low-level disinfectant	• Have been used for disinfecting some non-critical items (e.g. hydrotherapy tanks); however, it is used mainly as an antiseptic (2–3 ppm free iodine) • Phenolics	• Relatively free of toxicity or irritancy	• Inactivated by organic matter • Adversely affects silicone tubing • May stain some fabrics

Main Chemical Disinfectants

Disinfectants	Bactericidal activity	Tuberculocidal activity	Fungicidal activity	Virucidal activity	Sporicidal activity	Local human toxicity	Applications
Chlorhexidine	Less active against Gram-negative bacilli	Not active	Less active	Not active	Not active	Low	• Skin and wound antisepsis

Ethilen oxyd video

Gas plasma video

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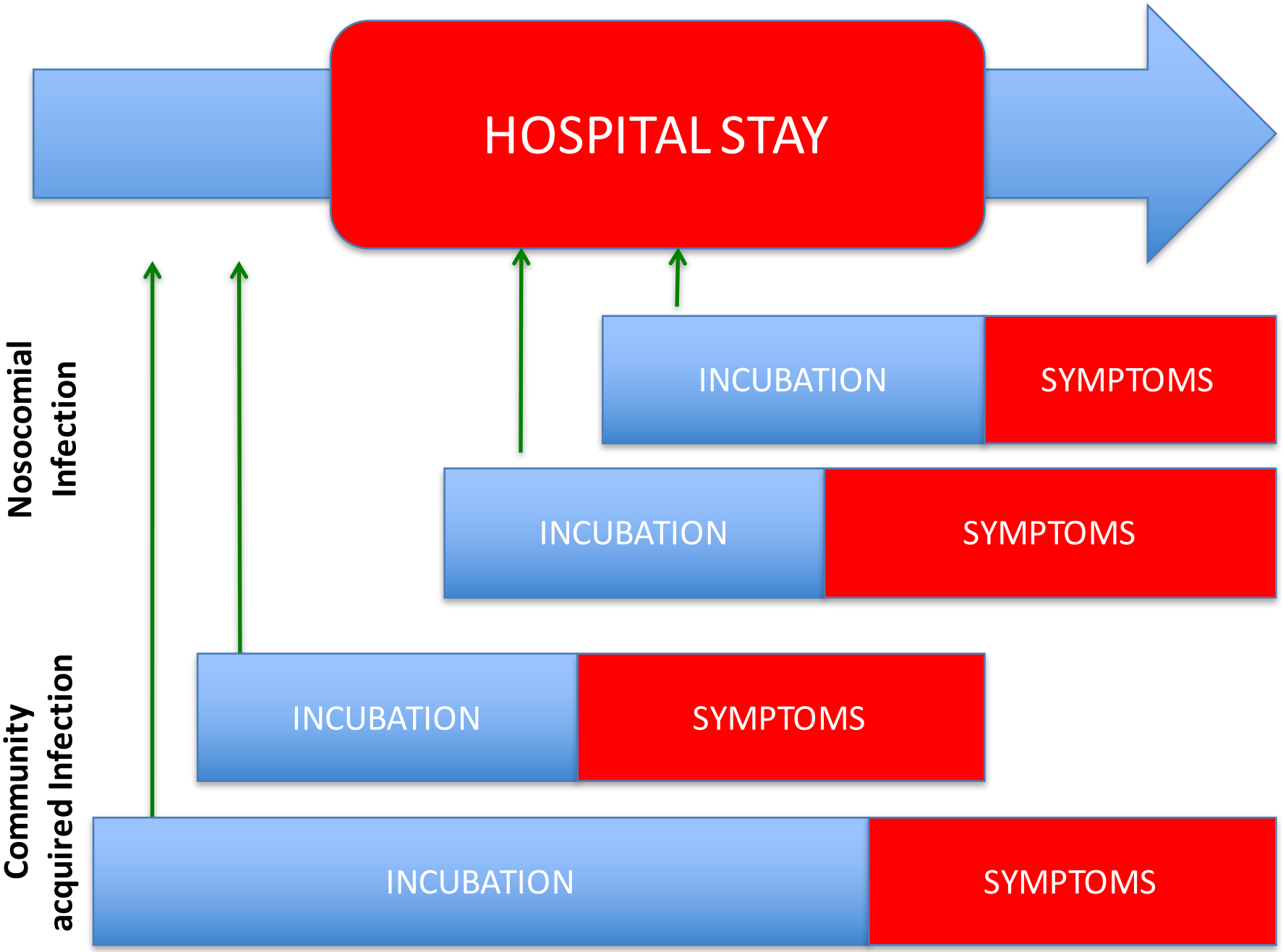
Health Care-Associated Infections (HAI)

- Definition
- Determinants
- Surveillance
- Epidemiology
- Prevention Strategies

Health Care-Associated Infections (HAI)

According to WHO:

- HAI is also called “nosocomial”.
- HAI is defined as:
  - an infection acquired in hospital by a patient who was admitted for a reason other than that infection.
  - an infection occurring in a patient in a hospital or other health-care facility in whom the infection was not present or incubating at the time of admission.



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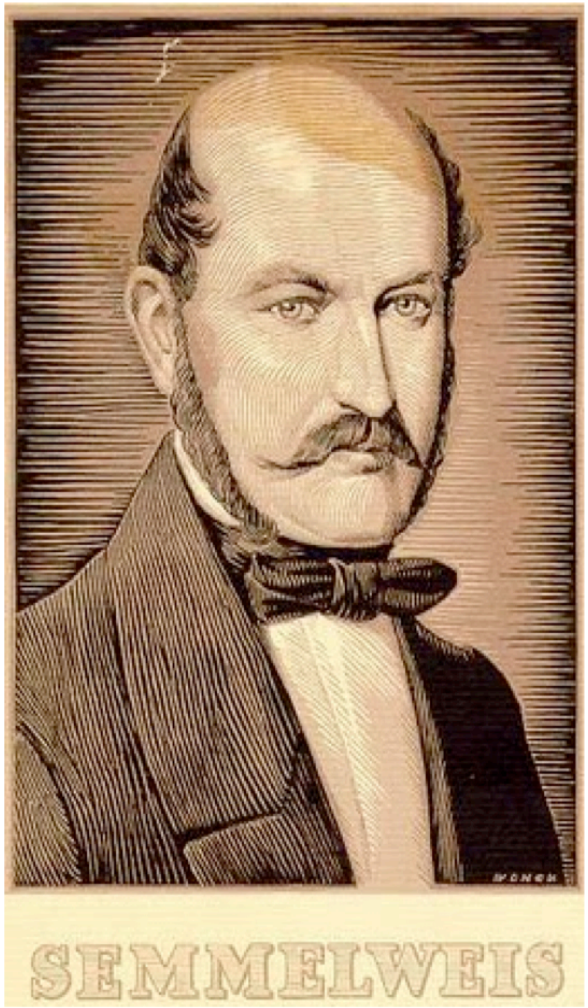
Health Care-Associated Infections (HAI)



- pioneer of antiseptic procedures
- the "savior of mothers”
- In 1846 Ignaz Semmelweis realized that puerperal sepsis was transferred through the hands of doctors and students who attended childbirth after practicing autopsies with unwashed hands

"Eureka moment": Hand Hygiene

- the incidence of puerperal fever could be drastically cut by the use of hand disinfection in obstetrical clinics

1846 **4000** births **459** deaths for puerperal sepsis (11%)

1847 **3490** births **176** deaths for puerperal sepsis (5%)

1848 Proportion of deaths for puerperal sepsis decrease to 1%

HAI determinants

Hospital

Patient

Microorganism

Probability of infection

IP= D*S*T*V / Hd

IP= probability of infection

D= infective dose transmitted by antigen

S= microbial agent's contact surface

V= virulence

Hd= host defenses

Hospital determinants

- **Structural aspects**

✓ Architectural structure
✓ Intra-hospital mobility
✓ Services

- **Management aspects**

✓ Length of stay
✓ Number of HCWs for a patient
✓ Visits regulation
✓ Diagnostic and therapeutic procedures
✓ Protocols for disinfection and antibiotic prophylaxis and therapy

Pazient risk factors

- Age
- Sex
- Comorbidities
- Severity of clinical conditions
- Invasive procedures
- Pharmacological treatments

Patients at major risk of HAI

Routes of Transmission of Nosocomial Infections

- Contact transmission
  - Direct contact (e.g., surgeon with infected wound in the finger performing a wound dressing)
  - Indirect contact (e.g., secretion from one patient transferred to another through **hands** in contact with contaminated waste)
  - Fecal-oral transmission via food
- Bloodborne transmission
  - E.g., needle-stick injury – hepatitis B and C, HIV/AIDS
- Vector transmission
  - E.g., insects or other pests in contact with excreta or secretions from infected patients and transmitted to other patients

Routes of Transmission of Nosocomial Infections

- Droplet transmission (droplets from sneezing, coughing or vomiting are expelled to surfaces or to the air and fall typically within 2 meters of the source)
  - Direct droplet transmission (droplets reach mucous membranes or are inhaled by others)
  - Indirect droplet-to-contact transmission (droplets contaminate surfaces/hands and are transmitted to mucous membranes or other sites) – cold virus, respiratory syncytial virus
- Airborne transmission (small contaminated particles as aerosols carried by air currents >2 meters from source)
  - E.g., Varicella zoster suspended in air and spread by inhalation, *Staphylococcus aureus* depositing in wounds

Examples of Sources of Nosocomial Infections

- Hospital environment
  - *Salmonella*, *Shigella* spp., or *Escherichia coli* O157:H7 in food
  - Waterborne infections from the water distribution system
  - *Legionella pneumophilia* in water cooling of air conditioning
- Healthcare workers
  - Methicillin-resistant *Staphylococcus aureus* (MRSA) carried in the nasal passages of healthcare personnel
- Other patients
  - Chicken pox spread through the air or contact with freshly soiled contaminated items

Examples of Microrganisms

- **Opportunistic pathogens:**

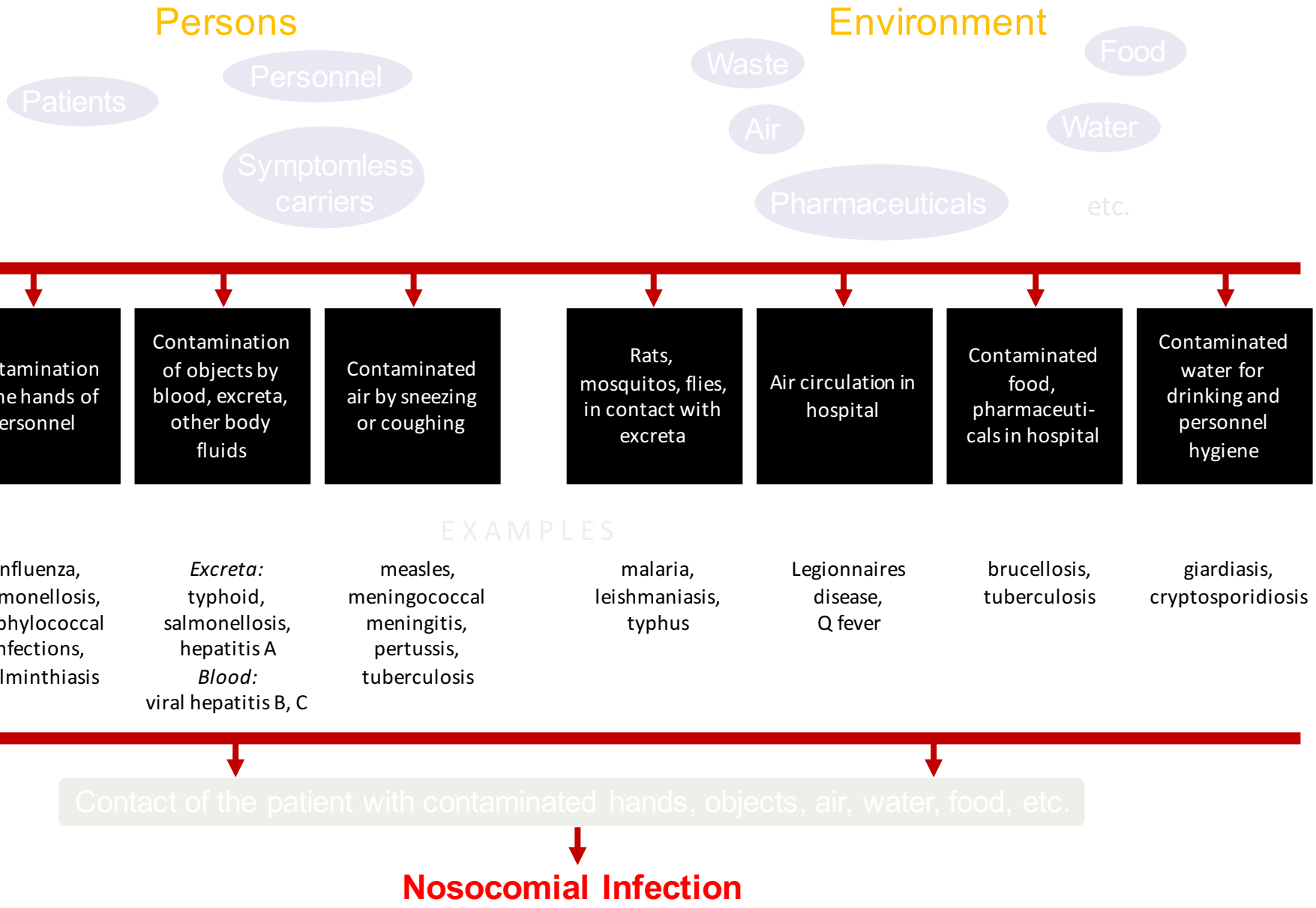
✓ MRSA

✓ Klebsiella pneumoniae

✓ Acinetobacter baumannii

✓ Pseudomonas aeruginosa

Spread of Nosocomial Infections



HAI surveillance systems

- laboratory-based surveillance
- through repeated prevalence studies
- continuous surveillance in the ICUs
- oriented for problems surveillance

Through repeated prevalence studies

"One Day Study" Protocol:

- patients admitted in the same ward in the same day or in the same week on the basis of clinical documentation and/or interviews

CDC Atlanta

World Health Organization | Patient Safety
A World Alliance for Safer Health Care

*WHO Patient Safety is actively working towards establishing effective ways of improving global health care and s**ave lives lost to health care-associated infections**.*

*WHO Patient Safety works in collaboration with other **WHO programmes**, including regional and country offices supporting Member States, to reduce HAI by assisting with the **assessment, planning, and implementation of infection prevention and control policies**, and timely actions at national and institutional levels*

WHO 2011

Impacts of Health Care-Associated Infections (HAI)

HAI can:

- Increase patients' suffering
- Lead to permanent disability
- Lead to death
- Prolong hospital stay
- Increase need for a higher level of care
- Increase the costs to patients and hospitals

HAI epidemiology

- Of every 100 hospitalized patients at any given time, acquire at least one HAI
  - **7** in developed countries
  - **10** in developing countries
- **30%** of patients in ICUs are affected by HAI
- **>50%** newborns in Neonatology are affected by HAI
- Most frequent HAI localization
  - Urinary tract in high-income countries
  - Surgical site in low-income countries

Impact of HAI

In Europe

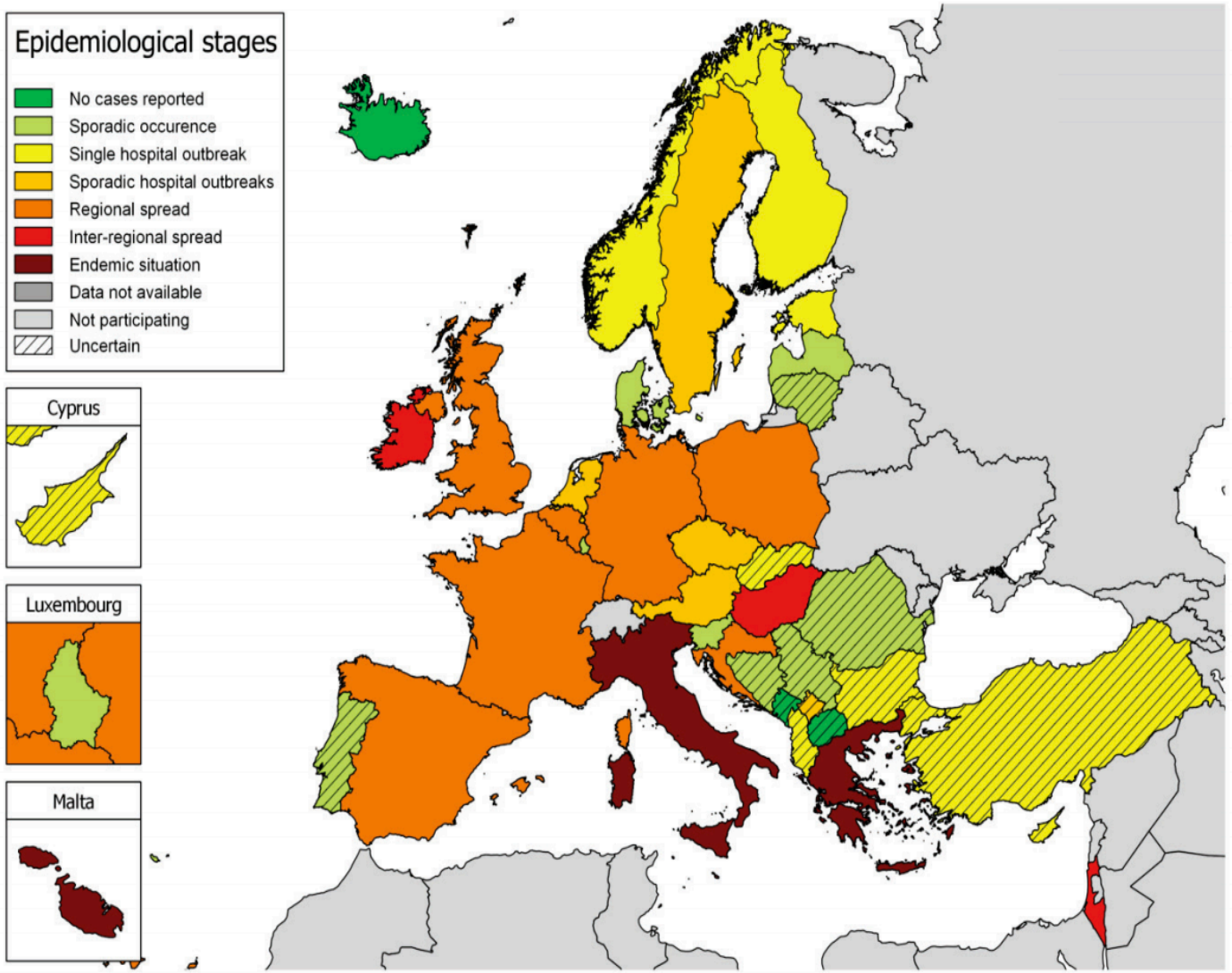
- 37,000 deaths every year
- Estimated costs: 7 billion euros per year
- 16 million additional days of hospitalization

In the U.S.

- 99,000 deaths every year
- Estimated costs: 6,5 billion dollars per year

WHO 2011

Figure 3 Occurrence of carbapenemase-producing *Enterobacteriaceae* in 38 European countries based on self-assessment by the national experts, March 2013



In some countries, the epidemiological stage might not represent the exact extent of the spread of CPE as it is a subjective judgment by national experts. Results presented here reflect the uncertainty at the time of the survey.

ECDC, 2015

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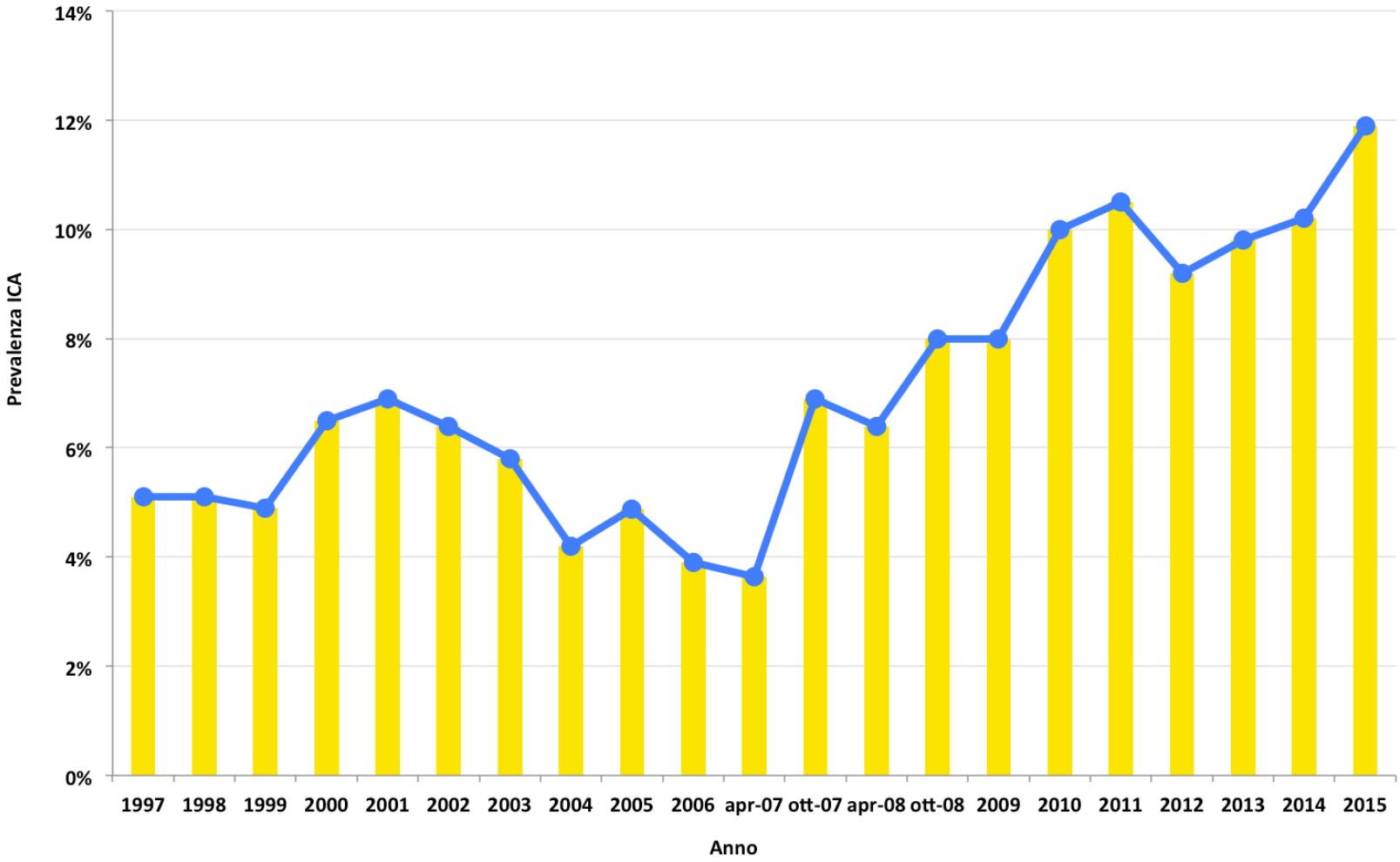
HAI prevalence: Policlinico Hospital, Bari



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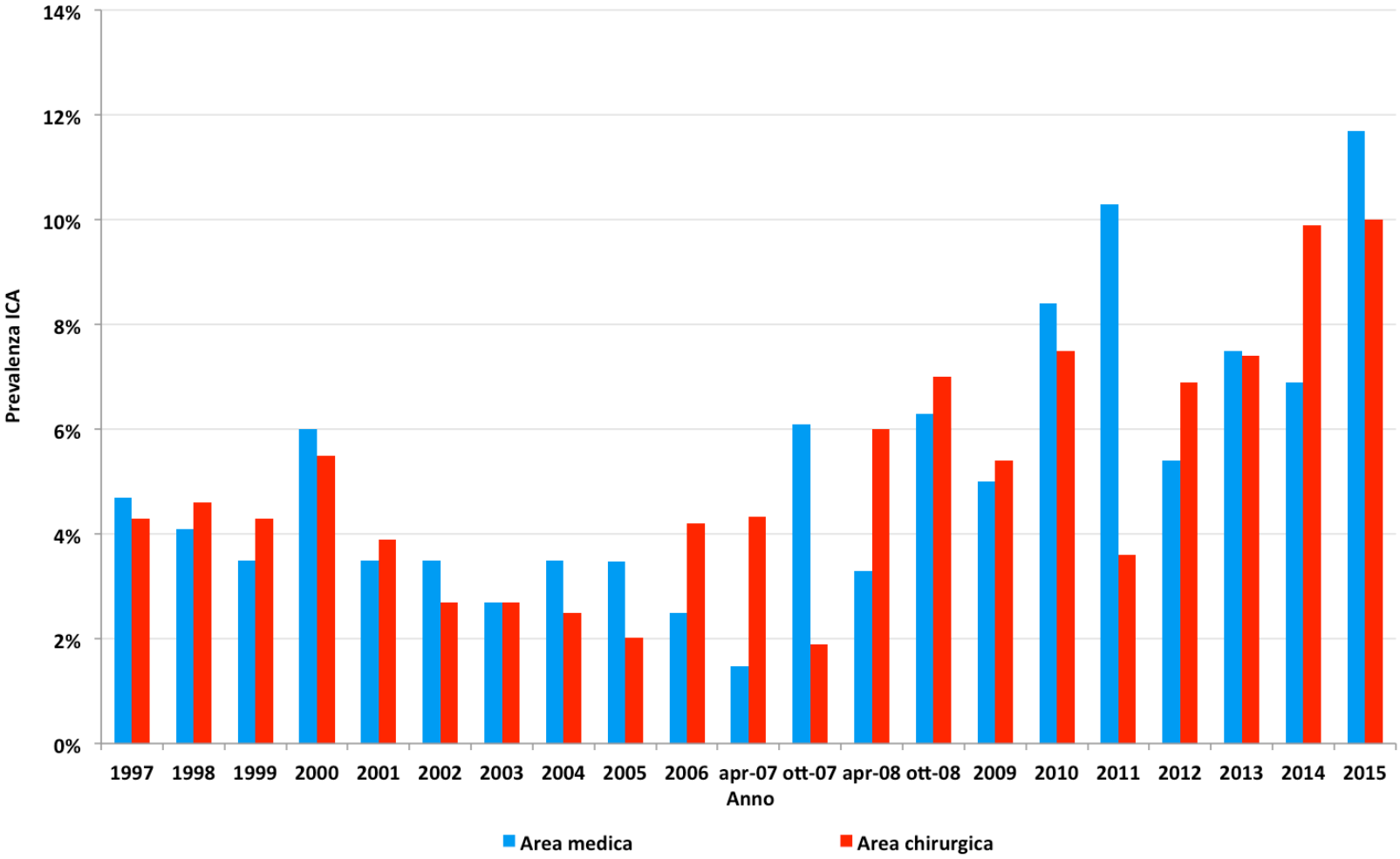
HAI prevalence: Policlinico Hospital, Bari



Standard Precautions

- Basic level of infection control to be used in the care of all patients
- Key components
  - Hand hygiene
  - Use of PPE (gloves, face protection, gown)
  - Safe injection practices
  - Respiratory hygiene and cough etiquette
  - Safe handling of contaminated equipment and surfaces in the patient environment
  - Environmental cleaning
  - Handling and processing of used linens
  - Proper waste management

Some Standards of Hospital Hygiene

- The hospital environment must be visibly clean, free from dust and soilage, and acceptable to patients, visitors and staff.
- Increased levels of cleaning, including the use of hypochlorite and detergent, should be considered in outbreaks where the pathogen survives in the environment and environmental contamination may contribute to spread.
- Shared equipment in the clinical environment must be decontaminated appropriately after each use.
- All healthcare workers need to be aware of their individual responsibilities for maintaining a safe environment for patients and staff.
- Regular cleaning will not guarantee complete elimination of microorganisms, so hand decontamination is required.

Measures for Improving Infection Control

Low-cost measures: cost-effective practices:

- **provide education and practical training in standard infection control** (e.g. hand hygiene, aseptic technique, appropriate use of PPE, use and disposal of sharps)
- provide **hand-washing material throughout a health-care facility** (e.g. soap and alcoholic hand disinfectants)
- **use single-use disposable sterile needles and syringes**
- use sterile items for invasive procedures

Measures for Improving Infection Control

Low-cost measures: cost-effective practices (Contd.,):

- avoid sharing multi-dose vials and containers between patients
- **ensure equipment is thoroughly decontaminated between patients**
- provide hepatitis B immunization for health-care workers
- develop a post-exposure management plan for health-care workers
- dispose of sharps in robust containers.

Infection Control Program

- Infection Control Committee
- Should be multidisciplinary with representation from management, doctors, nurses, other health workers, clinical microbiology, pharmacy, central supply, maintenance, housekeeping and waste management coordinator

Infection Control Program

- Role of the Infection Control Committee
  - Annual work program of activities for surveillance and prevention
  - Periodic review of epidemiological surveillance data and identification of areas for intervention
  - Review of risks of new technologies, devices, and products
  - Assessment of cleaning, disinfection and sterilization
  - Review of antibiotic use and antibiotic resistance
  - Promotion of improved practices
  - Provision of staff training in infection control and prevention
  - Integration of healthcare waste management
  - Response to outbreaks

Hand Hygiene

- The most important prevention strategy because the hands of health-care workers are the most frequent vehicle of hospital infections

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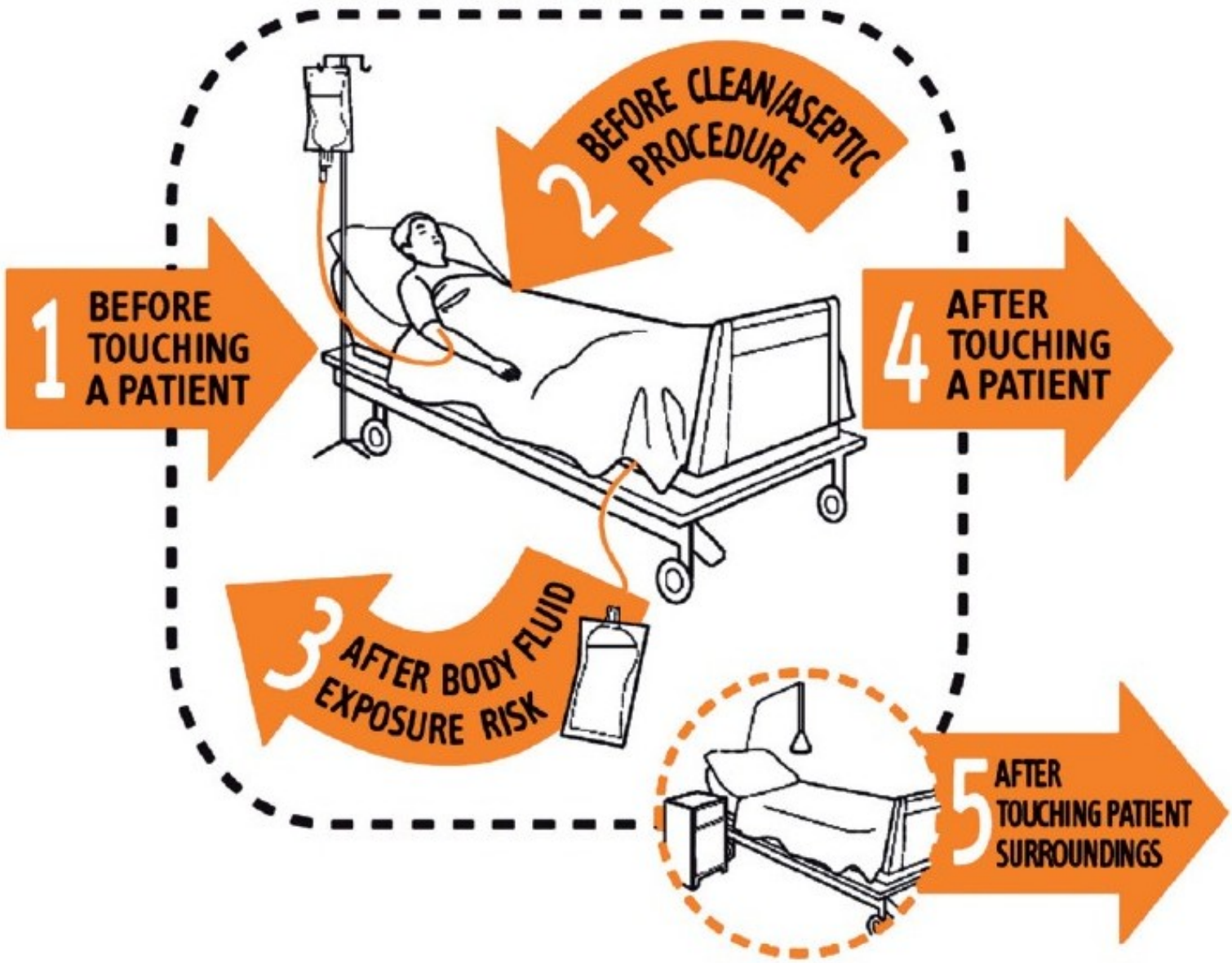
World Health Organization | Patient Safety

A World Alliance for Safer Health Care

WHO Guidelines on Hand Hygiene in Health Care

First Global Patient Safety Challenge
Clean Care is Safer Care

My 5 moments for HAND HYGIENE



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Hand Hygiene Technique with Soap and Water
Recommended Duration: 40-60 seconds

0

Wet hands with water;

1

Apply enough soap to cover all hand surfaces;

2

Rub hands palm to palm;

3

Right palm over left dorsum with interlaced fingers and vice versa;

4

Palm to palm with fingers interlaced;

5

Backs of fingers to opposing palms with fingers interlocked;

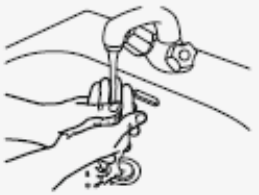
6

Rotational rubbing of left thumb clasped in right palm and vice versa;

7

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

8

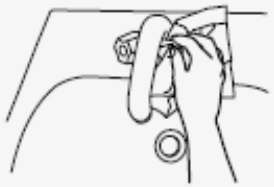


Rinse hands with water;

9

Dry hands thoroughly with a single use towel;

10



Use towel to turn off faucet;

11

Your hands are now safe.

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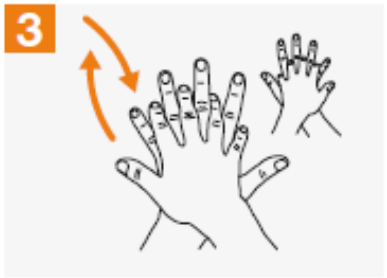
Hand Hygiene Technique with Alcohol-Based Formulation
Recommended Duration: 20-30 seconds

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

Rub hands palm to palm;



Right palm over left dorsum with interlaced fingers and vice versa;

Palm to palm with fingers interlaced;

Backs of fingers to opposing palms with fingers interlocked;

Rotational rubbing of left thumb clasped in right palm and vice versa;

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

Once dry, your hands are safe.

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Hand hygiene video