

TRANSMISSION OF INFECTIONS IN HEALTHCARE FACILITIES

I. HEALTHCARE ASSOCIATED INFECTIONS

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HAI

introduction

- Occurs in a patient during the process of care in a hospital or other health care facility.
- Is not present and incubating at the time of admission.
- Can also appear after discharge.
- Represents the most frequent adverse event during care delivery.
- Is worthy of a big attention across the world.

Healthcare Associated Infection HAI

Definition

- Healthcare associated infection means diseases or pathologies related to the presence of infectious agents or its products in association with exposure to healthcare facilities or healthcare procedures or treatments.

(definition for the purpose of Recommendation of the Council of the European Union, 2009)



in hospital

in outpatient medical facilities

in long-term care facilities

in day-care centres

in assisted living facilities etc.

HAI definition from:

1) EU law

<http://eur-lex.europa.eu>

2) National Healthcare Safety Network (NHSN)

- A nosocomial infection associated to the current hospital stay is defined as infection that matches one of **the case definitions**
- AND
- — the onset of symptoms was on Day 3 or later (day of admission = Day 1) of the current hospital admission
- OR
- — the patient underwent surgery on day 1 or day 2 and develops symptoms of a Surgical Site Infection before day 3
- OR
- — an invasive device was placed on day 1 or day 2 resulting in an HAI before day 3.

En example of
the case
definition of
„nosocomial“
infection
CRI: CATHETER-
RELATED
INFECTION

**CRI₃-CVC: microbiologically confirmed CVC-related
bloodstream infection**

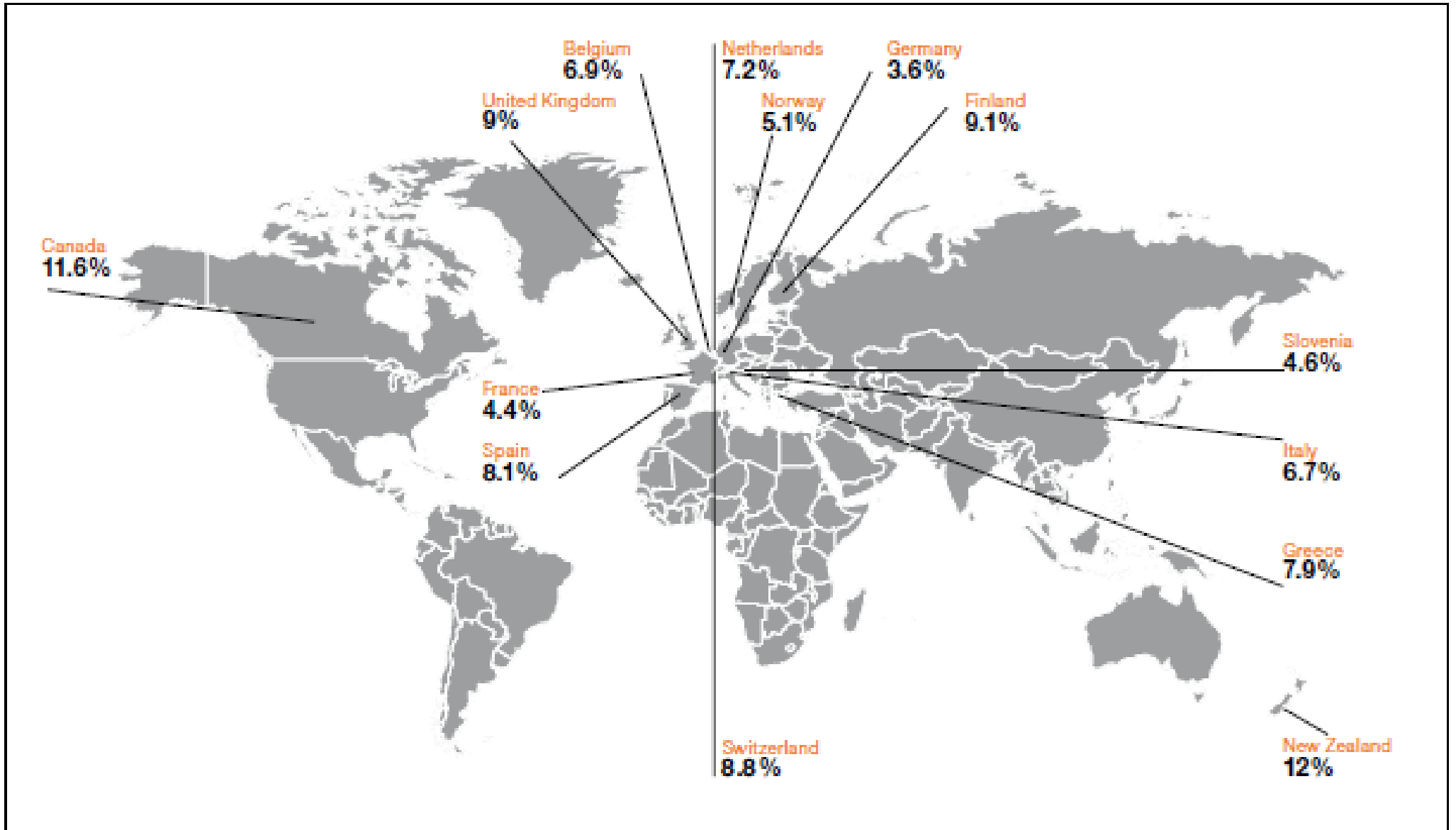
- — BSI occurring 48 hours before or after catheter removal
AND positive culture with the same micro-organism of either:
- — quantitative CVC culture $\geq 10^3$ CFU/ml or semi-quantitative CVC culture > 15 CFU
- — quantitative blood culture ratio CVC blood sample/peripheral blood sample > 5
- — differential delay of positive blood cultures: CVC blood sample culture positive two hours or more before peripheral blood culture (blood samples drawn at the same time)
- — positive culture with the same micro-organism from pus from insertion site.

HAI

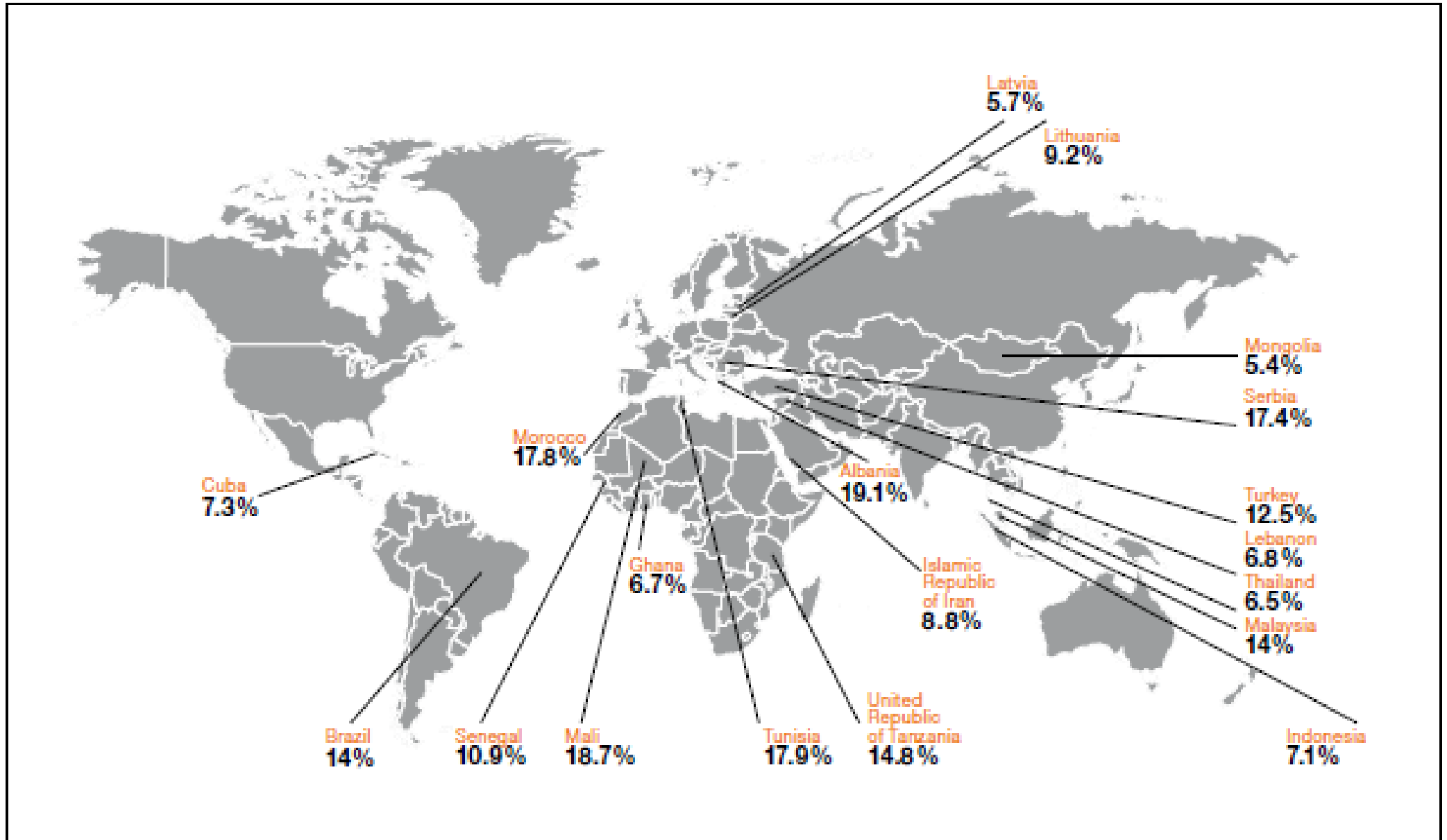
frequency

- **Frequency of HAIs from WHO datas:**
 - In developed countries in average at least **7%** of hospitalized patients, among critically ill and vulnerable patients in intensive care units (ICUs) around **30%**.
 - In developing countries in average **15,5%** of hospitalized patients.
- **The CDC** (Centre of disease control and prevention, USA) estimated that about **75 000** hospital patients with an HAI die during their hospitalization.
- **ECDC** - Point prevalence survey of healthcareassociated infections and antimicrobial use in European acute care hospitals 2011–2012:
 - Prevalence of HAI in acute care hospitals in the PPS sample was **6.0%** (country range 2.3%–10.8%).
 - HAI prevalence was highest in patients admitted to ICU, where **19.5%** patients had at least one HAI.

- Prevalence of the HAIs in high-income countries,
- WHO
- 1995 - 2010



- Prevalence of the HAIs in middle- and low-income countries,
- WHO
- 1995 - 2010



HAI

consequences

- Prolonged hospital stay
- Long-term disability
- Unnecessary death
- Increased additional cost for care
- High cost for patient and his family
- Increased resistance of microorganisms to antimicrobials
- Occupational hazards for healthcare workers (exposition to infected patient or contaminated environment)



"The patient in the next bed is highly infectious. Thank God for these curtains."



Prevention of HAIs is worthy of a big attention across the world.

HAI

epidemiological distribution

NON- SPECIFIC

- Common community-acquired infections brought by patient or other person.
- Primary pathogens
- e.g. respiratory or gastrointestinal infection

SPECIFIC

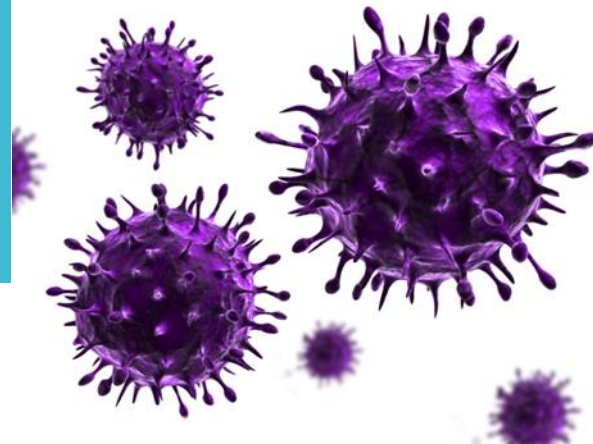
- Infection associated with specific procedures in health care facilities.
- Often caused by resistant mikroorganisms (**superbugs**) or opportunistic pathogens.
- e.g. urinary tract infection, blood-stream infection, ventilator-associated pneumonia,...

HAI

causative agens



- A. Bacteria (Gram – positive, Gram- negative – enteric and non-enteric, Mycobacteria,...)
- B. Yeast and molds (Candida, Aspergillus)
- C. Viruses (rotavirus, norovirus, viruses of hepatitis A,B,C,..)
- D. Parazites

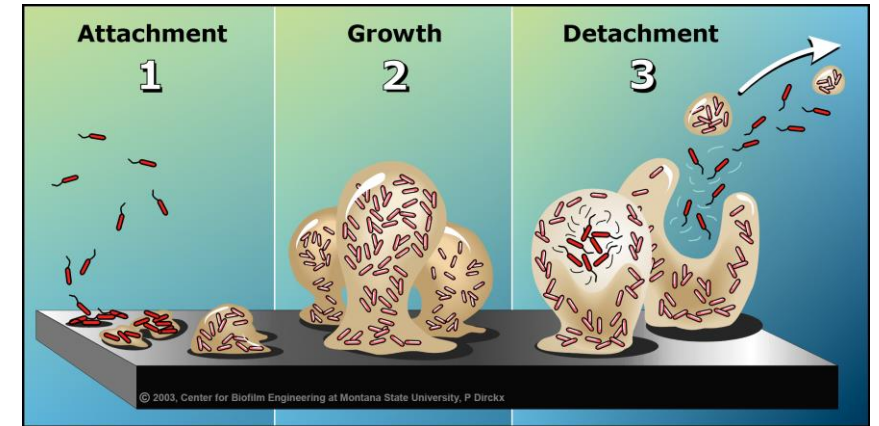


HAI

The commonest pathogens

(Multistate point-prevalence survey of HAIs, USA, 2014)

1. *Clostridium difficile* (CDI)
2. *Staphylococcus aureus*
3. *Klebsiella spp.*
4. *Escherichia coli*
5. *Enterococcus spp.*
6. *Pseudomonas aeruginosa*
7. *Candida spp.*
8. Streptococcal spp.
9. Coagulase-negative staphylococci
10. *Enterobacter spp.*



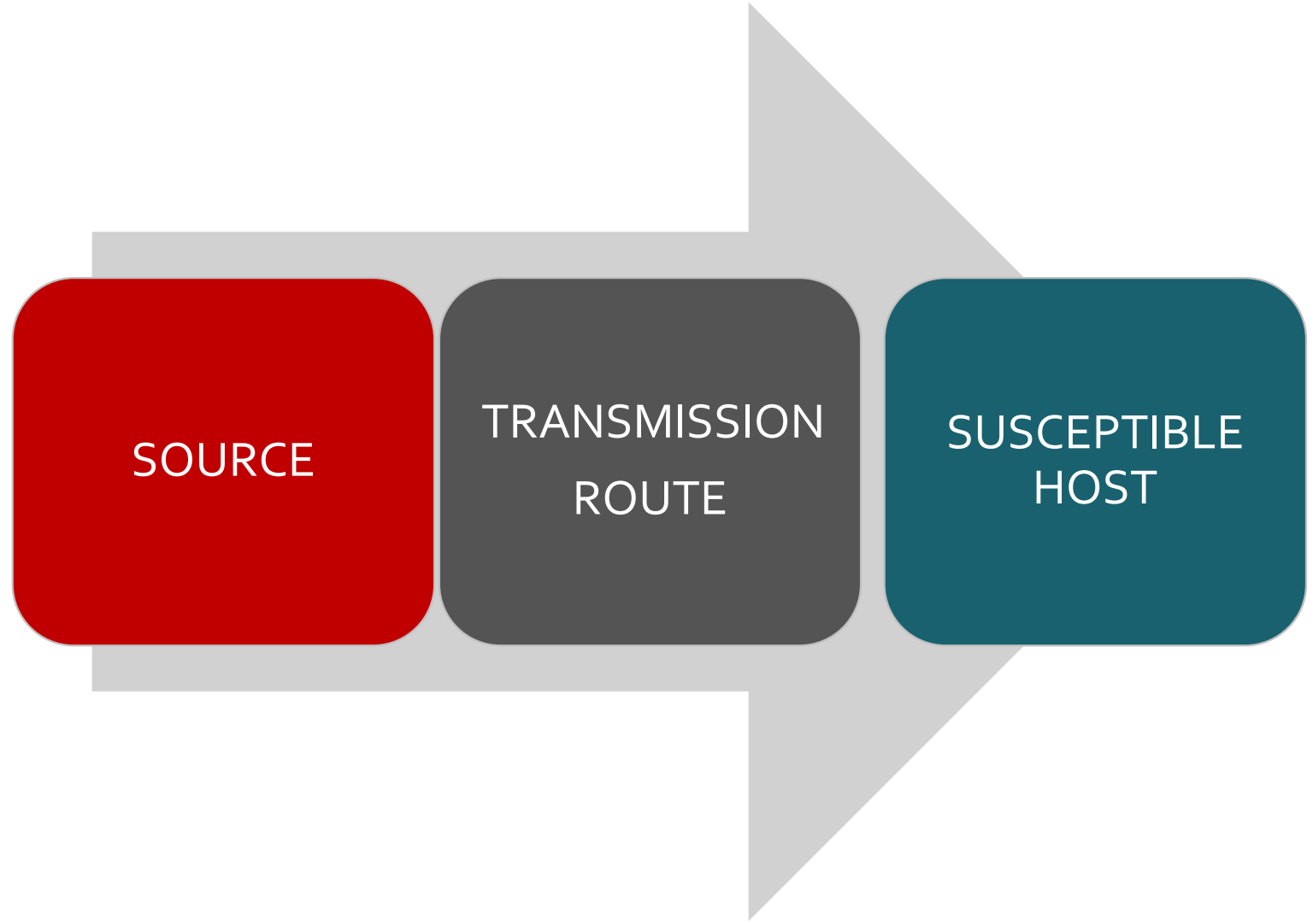
Pathogens vary among different types of HAIs!

CHAIN OF INFECTION

SOURCE

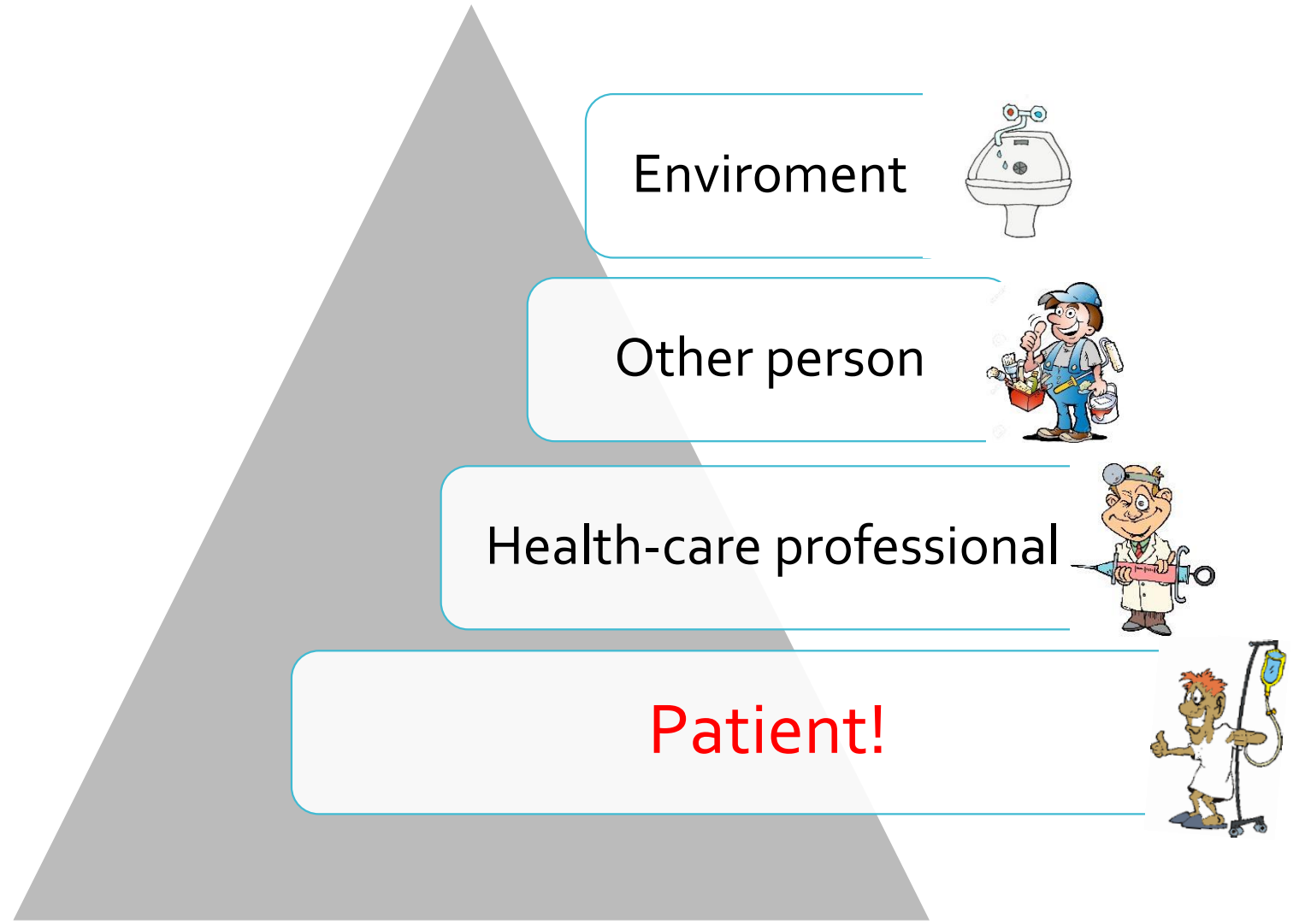
TRANSMISSION
ROUTE

SUSCEPTIBLE
HOST



HAI

source
in healthcare



PATIENT as a source

- **WHEN:**
 - misdiagnosed
 - in incubation period
 - abortive or latent form of infection
 - underestimation of risk
 - carrier of resistant agent (MRSA),
TBC, VHB, VHC,...



You are certainly not healthy,
because medicine is so advanced
today that a healthy person
basically does not exist!

EACH PATIENT SHOULD BE SUSPECTED TO BE INFECTIOUS!!!

TRANSMISSION in healthcare facilities

- The most frequent route is **a contact**, as direct or **mostly indirect way** of transmission.
- **The most of contact transmissions of pathogens happen via healthcare workers hands!**




(WHO Guidelines on Hand Hygiene in Health Care)

HAI

susceptible
host

Intrinsic risk factors


Patient related

- 
- Extremes of age
 - Obesity or malnutrition
 - Smoking, alcoholism,...
 - Comorbidity (diabetes, heart failure,...)

NON-MODIFIABLE

Extrinsic risk factors

Procedur related

- 
- Invasive procedures (aplying invasive device, surgery, ...)
 - Endoskopy
 - Treating by specific medicaments (ATB, immunosupresive,...).
 - Duration of hospitalization, re-hospitalization.
 - Artificial implants

MODIFIABLE

HAI

The most frequent
=
The most important

USA

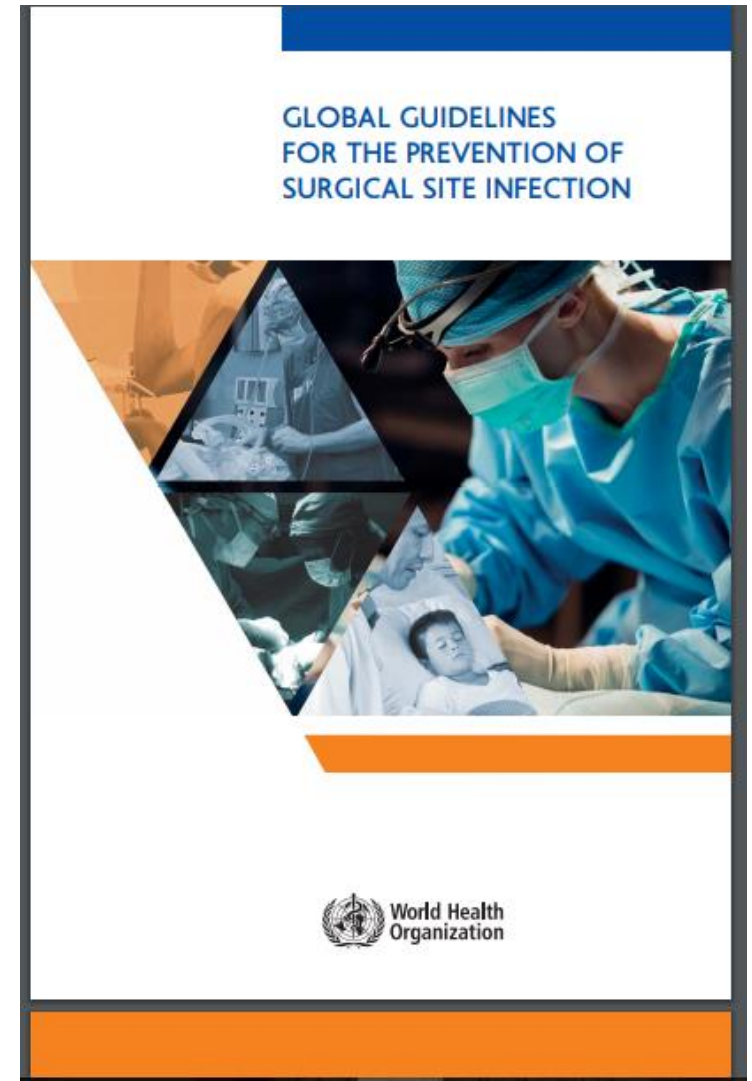
- 1. Urinary tract infections (36%)
- 2. Surgical site infections (20%)
- 3. – 4. Ventilator-associated pneumonias (11%)
- 3. – 4. Catheter-associated blood-stream infections (11%)
- Clostridium difficile infections (epidemic and virulent ribotype 027 strain)

Europe

- 1. Urinary tract infections (27%)
- 2. Ventilator-associated pneumonias (24%)
- 3. Surgical site infections (17%)
- 4. Catheter-associated blood-stream infections (10,5%)
- Clostridium difficile infections

HAI

Guidelines



HAI
Influencing
factors
of transmission
risks among the
various
healthcare
settings

1. the population characteristics (e.g., increased susceptibility to infections, type and prevalence of indwelling devices),
2. intensity of care,
3. exposure to environmental sources,
4. length of stay,
5. frequency of interaction between patients/residents with each other and with HCWs,
6. organizational characteristics : organizational priorities, goals, and resources, influence how different healthcare settings adapt transmission prevention guidelines to meet their specific needs.

HAI

Specific risks in various wards

- Intensive care units (ICUs) – for **patients immunocompromised** by disease state and/or by treatment modalities, as well as patients with major trauma, respiratory failure and other life-threatening conditions.
- Burn units – **burn wounds** can provide **optimal conditions** for colonization, infection, and transmission of pathogens.
- Pediatrics - a high prevalence of **communityacquired infections** among hospitalized infants and young children who have not yet become immune either by vaccination or by natural infection. Pediatric intensive care unit patients and the lowest birthweight babies have **high rates of central venous catheter-associated bloodstream infections**.

Possibilities of prevention

Standard precautions

the basic level of infection control precautions

to be used, as a minimum, in the care of all patients.

prevent transmission from both recognized and unrecognized sources

Isolation precautions

In specific situation

mostly aimed on recogni pathogen

differ from the way of transmission

TRANSMISSION OF INFECTIONS IN HEALTHCARE FACILITIES

II. Standard precautions

STANDARD PRECAUTIONS

- a group of infection prevention practices that apply to all patients, regardless of suspected or confirmed diagnosis or presumed infection status.
- based on the principle that all blood, body fluids, secretions, excretions except sweat, nonintact skin, and mucous membranes may contain transmissible infectious agents.

STANDARD PRECAUTIONS

WHO

1. Hand hygiene
2. Personal protective equipment - PPE (gloves, facial protection for eyes, nose, and mouth, gowns)
3. Respiratory hygiene and cough etiquette
4. Prevention of needle stick and injuries from other sharp instruments
5. Environmental cleaning
6. Linen - safe handling, transport, and processing of used linen
7. Safe waste disposal
8. Safe patient care equipment

Personal protective equipment

PPE

1. **Gloves**
2. **Mask (have to cover mouth and nose)**
3. **Face shield (eye protection)**
4. **Gown (disposable)**
5. **Respirator**
 - Used PPEs are disposed off as wastes with infection risks.
 - PPEs have to be put off immediately after finishing their use.
 - Disposable PPEs need not be used repeatedly.
 - PPEs have to be individualized.
 - PPEs at the operating theatres have to cover also beard of surgeon.

STANDARD PRECAUTIONS

Respiratory hygiene and cough etiquette |

- Covering mouth and nose when coughing or sneezing.
- Hand hygiene after contact with respiratory secretions.
- Spatial separation of persons with acute febrile respiratory symptoms.
- Education of health workers, patients and visitors.



STANDARD PRECAUTIONS

Respiratory hygiene and cough etiquette II

Health-care facilities should:

- Place acute febrile respiratory symptomatic patients at least 1 metre (3 feet) away from others **in common waiting areas**, if possible.
- **Post visual alerts** at the entrance to health-care facilities instructing persons with respiratory symptoms to practise respiratory hygiene/cough etiquette.
- Consider making **hand hygiene resources, tissues and masks available** in common areas and areas used for the evaluation of patients with respiratory illnesses.

STANDARD PRECAUTIONS

Prevention of needle stick and injuries from other sharp instruments

I

- Protection especially from bloodborn pathogens transmission .
- Most exposures are preventable.
- Each sharp item (e.g., needle, scalpel,...) that is contaminated with patient blood and saliva is potentially infective!!!
- Basic methods to reduce exposures to pathogens from sharp instruments and needles are engineering and work-practice controls.



STANDARD PRECAUTIONS

Prevention of needle stick and injuries from other sharp instruments

II

- **Engineering controls** should be used as the primary method ((e.g., self-sheathing anesthetic needles, safety scalpels, and needleless IV ports).
- **Work-practice** controls are behavior-based and should be used when engineering controls are not available.



STANDARD PRECAUTIONS

Prevention of
needle stick and
injuries from
other sharp
instruments



- Place used disposable syringes and needles, scalpel blades, and other sharp items **in appropriate puncture-resistant containers** located as close as possible to the area where the items are used.



New cases of HIV+ persons in Czech Republic

(data from „National Institute of Public Health“)

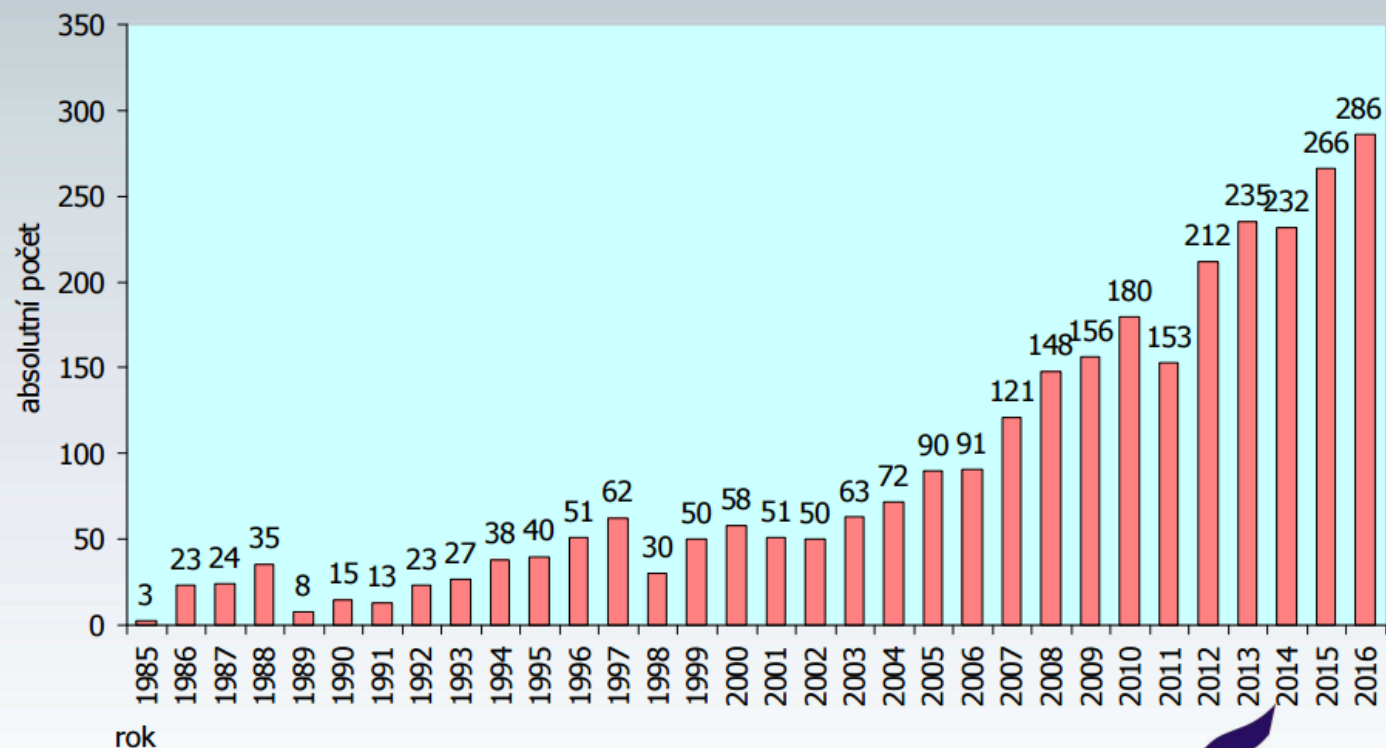
NOVÉ PŘÍPADY INFEKCE HIV V ČESKÉ REPUBLICE

V JEDNOTLIVÝCH LETECH

(občané ČR a cizinci s dlouhodobým pobytem)

Absolutní údaje ke dni

31.12.2016



NRL AIDS

Graf 1



After exposure
blood sampling
in
Czech Republic

		Till 72 hours	Afted 90 days	After 180 days
HBV	Anti - HBs	+	+ -	+ -
	HBs Ag (pouze u neočkovaných)	+	+ -	+ -
HCV	Anti - HCV	+	+	+
HIV	Anti – HIV 1,2	+	+	-
Liver tests	ALT, AST	+	+	+

STANDARD PRECAUTIONS

Safe patient- care items

- A. **Critical items** - surgical instruments, periodontal scalers (penetrate soft tissue or bone) **should always be sterilized.**
- B. **Semicritical items** (e.g. laryngoscope,) come in contact with mucous membranes or non-intact skin **should be also sterilized**, or if impossible, at a minimum, be processed using **high-level disinfection.**
- C. **Noncritical items** (e.g. blood pressure cuff, thermometers), contact intact skin cleaning, or if visibly soiled, **cleaning followed by disinfection** with registered hospital disinfectant is adequate.

Antiepidemic measures on the day of hospitalization

- identification of a potentially infectious patient (epidemiological anamnesis, microbiological screening – MRSA, VRE,...)
- implementation of prevention measures, including prompt separation of potentially infectious patients and
- implementation of appropriate control measures (e.g., Respiratory Hygiene/Cough Etiquette and Transmission-Based Precautions)



HELP DECREASE TRANSMISSION RISKS

TRANSMISSION OF INFECTIONS IN HEALTHCARE FACILITIES

III. Isolation precautions

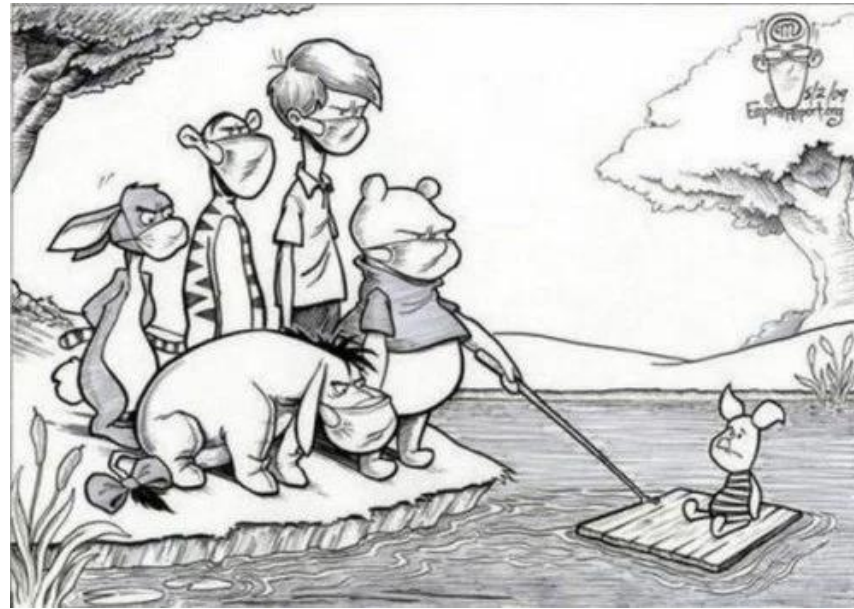
Isolation precaution

- Syndromic or empiric application (likely pathogene) of transmission-based precautions.
- Based on supposed transmission way:
 1. Contact transmission – direct, indirect
 2. Droplet transmission
 3. Airborn transmission
- Indicated individually regarding the compliance capability of the patient and local proposition.
- Other possibilities: cohorting, keeping the patient with an existing roommate, ...
- For all persons in a contact with patient or medical equipment!!!

Isolation precaution

Impact on the patient

- anxiety, depression and other mood disturbances,
- perceptions of stigma,
- reduced contact with clinical staff.



Isolation precaution

Impact on the hospital ward

- Specific cleaning precaution
- Dedicated staff
- Organization of wards (last in the sequence)
and e.g. last position in patient day schedule of surgery
- Individualized patient-care items
- Increased costs

Contact precautions

- Prevent transmission of infectious agents which are spread by direct or indirect contact with the patient or the patient's environment (MDROs, CLD, norovirus, ...)
- Patient placement: a single-patient room or in multi-patient rooms, ≥ 1 m spatial separation between beds.
- PPE: gowns, gloves



Droplet precautions

- Prevent transmission of pathogens spread through close respiratory or mucous membrane contact with respiratory secretions (B. pertussis, influenza virus, adenovirus, rhinovirus, N. meningitides, and group A Streptococcus).
- Patient placement: a single patient room or spatial separation of 1,5 m and the curtain between patient beds.
- PPE: mask,....
- Patient transported outside the room: mask (if tolerated) and following Respiratory hygiene/Cough etiquette .

Airborne precautions

- Prevent transmission of infectious agents that remain infectious over long distances when suspended in the air (e.g., rubeola virus [measles], varicella virus [chickenpox], *M. tuberculosis*, and possibly SARS-CoV)
- Patient placement: a single-patient room that is equipped with special air handling and ventilation capacity (HEPA,...).
- Mask or respirator or other PPE, depending on the disease-specific recommendations.

TRANSMISSION OF INFECTIONS IN HEALTHCARE FACILITIES

IV. Hand hygiene

Microflora of the hand skin



- **Resident flora (resident microbiota)** - microorganisms residing under the superficial cells of the stratum corneum and also found on the surface of the skin (*Staphylococcus epidermidis*, Streptococci, *S. hominis* and other coagulase-negative staphylococci, followed by coryneform bacteria - *propionibacteria*, *corynebacteria*, dermobacteria, and micrococci).
- **! Persistent colonization by pathogenic flora** such as *S. aureus*, Gram-negative bacilli, or yeast !
- **Transient flora (transient microbiota)** - microorganisms that colonize the superficial layers of the skin and are more amenable to removal by routine handwashing (*Staphylococcus aureus*, *Proteus mirabilis*, *Klebsiella spp.*,.....).
- Often acquired by HCWs during direct contact with patients or contaminated environmental surfaces adjacent to the patient.

WHO



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



Definitions



Hygienic handrub

- Treatment of hands with an antiseptic handrub to reduce the transient flora without necessarily affecting the resident skin flora. These preparations are broad spectrum and fast-acting, and persistent activity is not necessary.

Hygienic handwash.

- Treatment of hands with an antiseptic handwash and water to reduce the transient flora without necessarily affecting the resident skin flora. It is broad spectrum, but is usually less efficacious and acts more slowly than the hygienic handrub.

Surgical hand antisepsis/surgical hand preparation/ presurgical hand preparation

- Antiseptic handwash or antiseptic handrub performed preoperatively by the surgical team to eliminate transient flora and reduce resident skin flora.

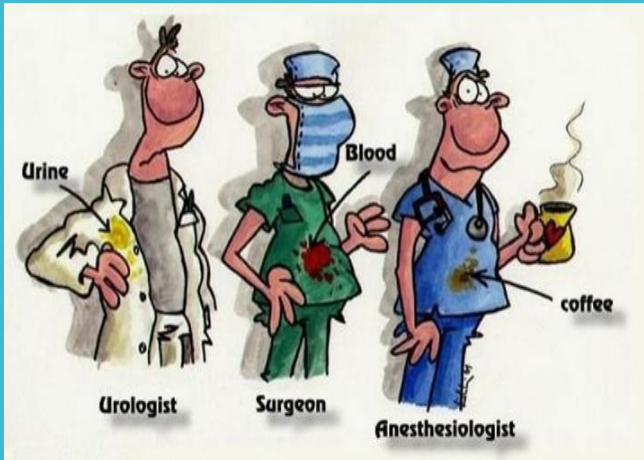
History



Studies by Ignaz Semmelweis in Vienna in the mid-1800s:

- maternal mortality rates, mostly attributable to puerperal fever, were substantially higher in one clinic compared with the other (**16%** versus 7%),
- doctors and medical students often went directly to the delivery suite after performing autopsies and had a disagreeable odour on their hands despite handwashing with soap and water before entering the clinic.
- His hypothesis: “cadaverous particles” were transmitted via the hands of doctors and students from the autopsy room to the delivery theatre and caused the puerperal fever.
- Semmelweis recommended that hands be scrubbed in a chlorinated lime solution before every patient contact and particularly after leaving the autopsy room.
- Following the implementation of this measure, the mortality rate **fell dramatically to 3%!!!**

Transmission of pathogenes by hands



- pathogens can be recovered not only from infected or draining wounds, but also from frequently colonized areas of normal, intact patient skin,
- diabetics, patients undergoing dialysis for chronic renal failure, and those with chronic dermatitis are particularly likely to have skin areas colonized with *S. aureus*,
- patient gowns, bed linen, bedside furniture and other objects in the immediate environment of the patient become contaminated with patient flora.
- certain microorganisms can also play an important role in environmental contamination due to their long-time survival capacities (G+ - *Acinetobacte baumanii*,....)

Jewellery!!!

- Several studies have shown that skin underneath rings is more heavily colonized than comparable areas of skin on fingers without rings.
- WHO: *„The consensus recommendation is to strongly discourage the wearing of rings or other jewellery during health care. If religious or cultural influences strongly condition the HCW’s attitude, the wearing of a simple wedding ring (band) during routine care may be acceptable, but in high-risk settings, such as the operating theatre, all rings or other jewellery should be removed.“*

Fingernails???



Artificial fingernails

- WHO: „*Consensus recommendations are that HCWs do not wear artificial fingernails or extenders when having direct contact with patients and natural nails should be kept short (0.5 cm long or approximately 1/4 inch long)*“

Nail polish

- WHO: „*Freshly applied nail polish does not increase the number of bacteria recovered from periungual skin, but chipped nail polish may support the growth of larger numbers of organisms on fingernails*“.

Solutions for handrubbing

Aqueous solution

- the need of immersion of hands
- dilution, stability?
- the need of drying
- irritating
- colouring
- frequent use causes damage of hand skin

Alcohol-based disinfectant

- comfortable use
- application on dry hands
- quick drying
- content of protecting substances
- perfumed
- availability at the point of care (within arm's reach)
- Risk: flammable



Alcohol antiseptics and their efficacy

|

- contain either ethanol, isopropanol or n-propanol, or a combination of two of these products,
- solutions containing **60–80% alcohol** are most effective, with higher concentrations being less potent,
- ethanol is less efficacious than isopropanol, and the latter is less active than n-propanol,
- against Gram-positive and Gram-negative vegetative bacteria (including multidrug-resistant pathogens such as MRSA and VRE), M. tuberculosis, and a variety of fungi,
- **no activity against bacterial spores or protozoan oocysts**, and very poor activity against some non-enveloped (non-lipophilic) viruses.

Alcohol antiseptics and their efficacy

II

- non-enveloped viruses (hepatitis A and enteroviruses -poliovirus) may require 70–80% alcohol to be reliably inactivated.

Activity against viruses (German Association for the Control of Virus Diseases [DVV])	Virucidal against enveloped viruses (incl. HBV, HIV, HCV)	15 sec
Tested for activity against enveloped viruses (following the DVV)	Influenza A virus (avian)	15 sec
	Influenza A virus (human)	15 sec
Tested for activity against non-enveloped viruses (DVV)	Adenovirus	1 min
	Poliovirus	3 min
Tested for activity against non-enveloped viruses (following the DVV)	MNV	15 sec
	Rotavirus	15 sec

!

CDC
Patient Safety

CLEAN HANDS SAVE LIVES

Protect patients, protect yourself

Influenza
Staphylococcus
Candida
Klebsiella
Pseudomonas
RSV
Enterococcus

Alcohol-rub or wash
before and after *EVERY* contact.

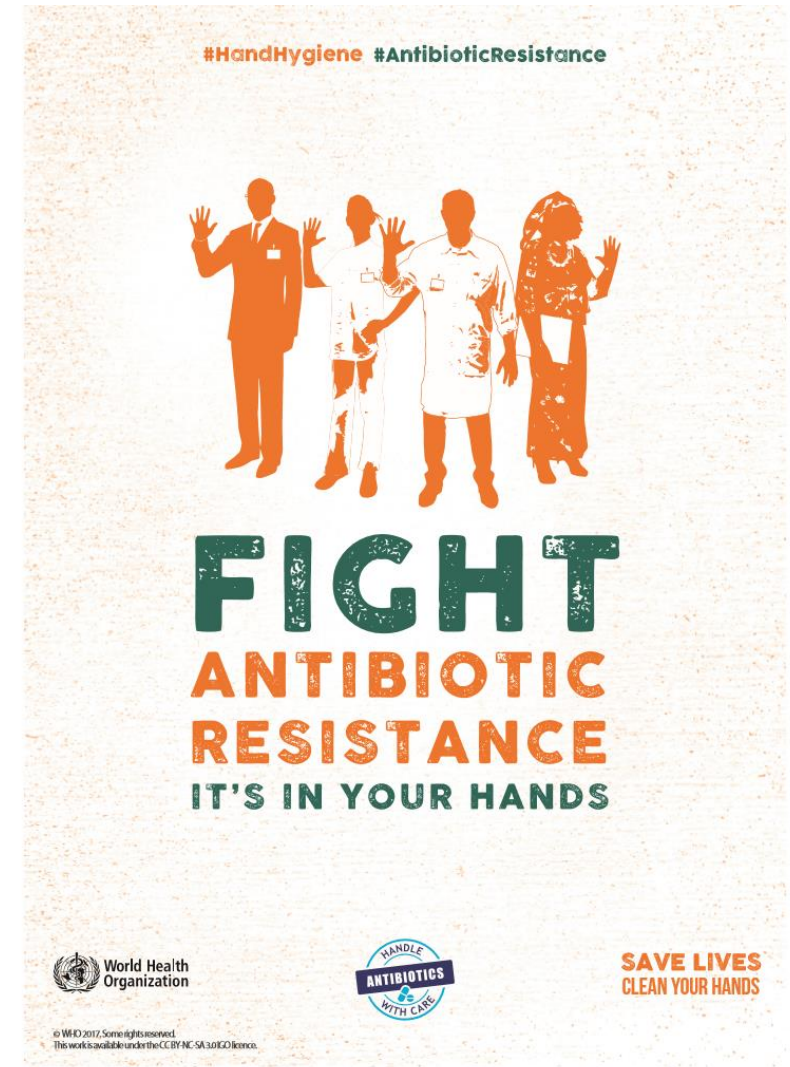
hand hygiene saves lives

www.cdc.gov/handhygiene

5th May

International
hand hygiene
day

<https://youtu.be/K-2XWtEjfl8>



Handwashing

WHEN?



- When hands are visibly dirty, contaminated with proteinaceous material, or visibly soiled with blood or body fluids (also before eating or after using the toilet!)
- The only method of decontamination of hands in exposure of spore-forming pathogens (e.g., *Clostridium difficile*).
- Use an alcohol-based handrub as the preferred means for routine hand antisepsis in all other clinical situations

How to handwash

by WHO

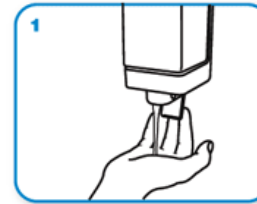


- Wet hands with water and apply the amount of product necessary to cover all surfaces.
- Rinse hands with water and dry thoroughly with **a single-use towel**.
- Use clean, running water whenever possible.
- **Avoid using hot water**, as repeated exposure to hot water may increase the risk of dermatitis.

The technique for handwashing



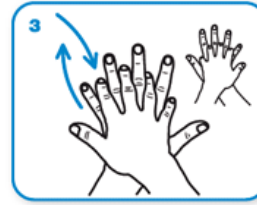
Wet hands with water



apply enough soap to cover all hand surfaces.



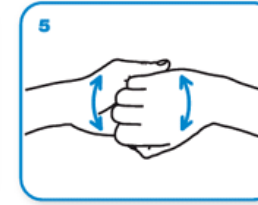
Rub hands palm to palm



right palm over left dorsum with interlaced fingers and vice versa



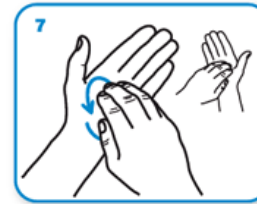
palm to palm with fingers interlaced



backs of fingers to opposing palms with fingers interlocked



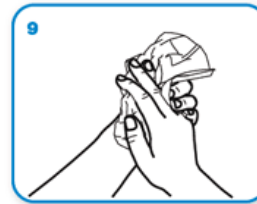
rotational rubbing of left thumb clasped in right palm and vice versa



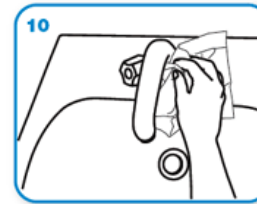
rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa.



Rinse hands with water



dry thoroughly with a single use towel



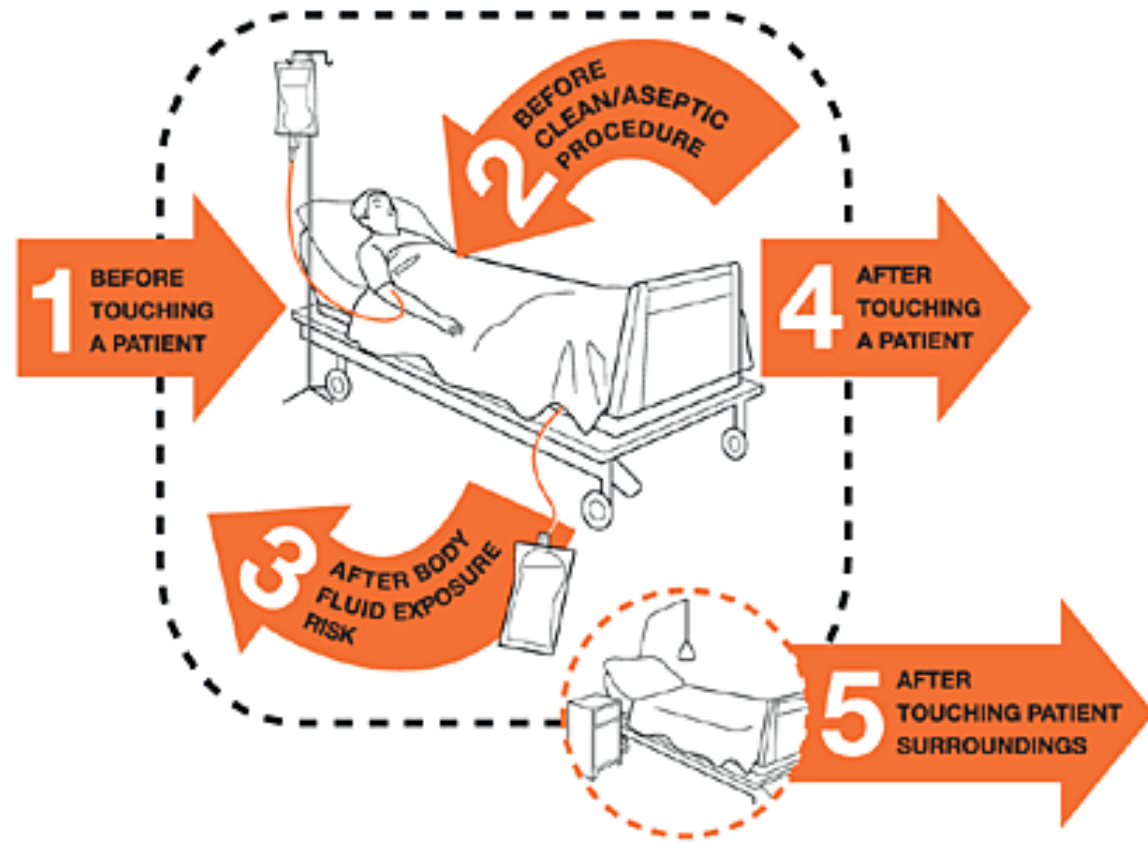
use towel to turn off faucet



...and your hands are safe.

Handrubbing

WHEN?



How to handrub by WHO

- Apply a palmful of alcohol-based handrub and cover all surfaces of the hands. Rub hands until dry.



The technique for handrubbing

Hand Hygiene Technique with Alcohol-Based Formulation

⌚ Duration of the entire procedure: 20-30 seconds

1a



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

1b



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 finger to opposing palms with finger interlocked;

6



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

7



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

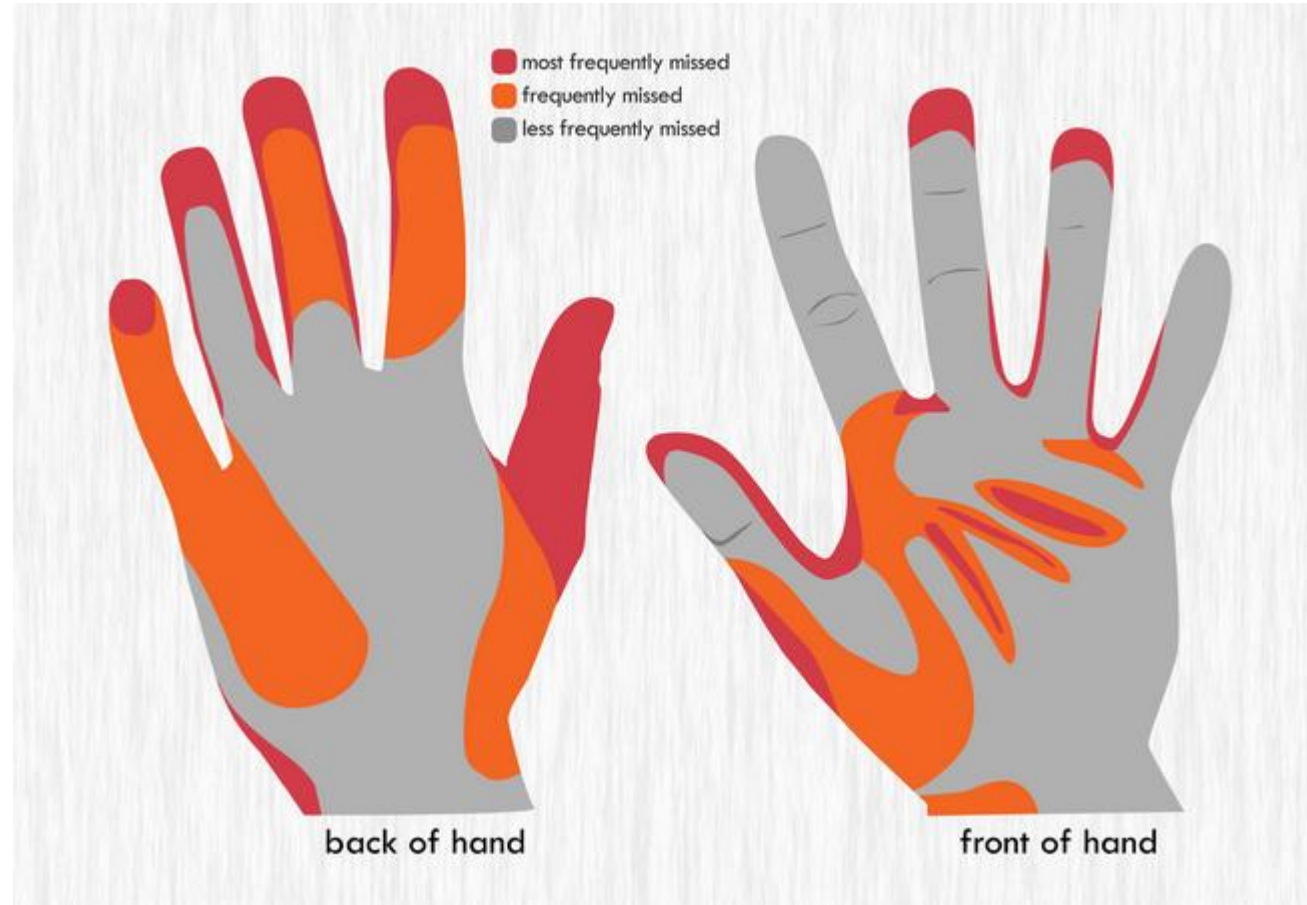
8



Once dry, your hands are safe.

Frequently missed areas

(by CDC)



BBE

BBE = Bare Below the Elbows

(Initiative of SHEA, Special Report, Medscape Infectious Diseases, 2014)

- Preventive strategy to improve the effectiveness of hand hygiene.
- Hands and forearms are free of jewellery and sleeves are above the elbow.
- Long sleeves have been found to be contaminated with pathogens (MRSA), and can impede appropriate hand hygiene.



Use of examination gloves

Indications



DIRECT PATIENT EXPOSURE:

- contact with blood;
- contact with mucous membrane and with non-intact skin;
- potential presence of highly infectious and dangerous organism;
- epidemic or emergency situations;
- IV insertion and removal; drawing blood; discontinuation of venous line;
- pelvic and vaginal examination;
- suctioning non-closed systems of endotracheal tubes.

INDIRECT PATIENT EXPOSURE:

- emptying emesis basins;
- handling/cleaning instruments; handling waste; cleaning up spills of body fluids.

Use of sterile gloves

Indication

- Any surgical procedure;
- Vaginal delivery;
- Invasive radiological procedures;
- Performing vascular access and procedures (central lines);
- Preparing total parental nutrition and chemotherapeutic agents.

Rules for use of gloves!!!

1. Handwashing or handrubbing must be performed before donning gloves to prevent glove contamination and possible cross-transmission in case of glove damage or improper use/efficacy.
2. Gloves must be removed to perform handwashing or handrubbing to protect a body site from the flora from another body site or skin area previously touched within the same patient.
3. Hand hygiene must be performed immediately after glove removal to prevent HCW contamination and further transmission and dissemination of microorganisms.

THE END

