Infection prevention and control to combat antimicrobial resistance (AMR) in health care settings

2019
Module outline

Combating antibiotic resistance in health care settings

**Session 1:** introduction to antibiotic-resistant bacteria in health care settings  
60 minutes

**Session 2:** overview of the threat caused by health care-associated infections and antibiotic resistance  
90 minutes

**Session 3:** evidence-based IPC strategies to combat antibiotic resistance  
180 minutes
You are encouraged to participate in discussion questions, where you can use your own experience and prior knowledge

You are encouraged to participate in group activities to drill into key topics

Essential content (not to be missed!)

Key reference for consolidating learning

Some suggested answers to activities/group work

In-depth case study applying learning into practice

Video material to supplement learning

Required reading or reflection outside of the classroom
At the end of this module, the IPC focal point should be able to:

- advocate the importance of addressing antibiotic resistance and its burden;
- promote and use evidence-based IPC practices to prevent the spread of antibiotic-resistant bacteria by way of a multimodal strategy for implementation.
Learning objectives

On completion of this module, the student should be able to:

• describe the principles of microbiology, mechanisms of antibiotic resistance and methods of laboratory detection and testing;

• list important antibiotic-resistant bacteria, including Gram-positive and Gram-negative bacteria, and note key differences;

• explain why the spread of antibiotic resistance is a major threat in all health care facilities worldwide and why urgent action is needed;

• explain factors contributing to emergence and spread of antibiotic-resistant bacteria between health care facilities and communities;

• describe evidence-based IPC practices to prevent and control the spread of antibiotic resistance and a multimodal approach for stepwise implementation;

• describe key IPC implementation strategies, including considerations of behaviour change, and the application of multimodal strategies and campaigning.
Session 1

Introduction to antibiotic-resistant bacteria

Part A: basic concepts of AMR
How would you describe “antimicrobial resistance”? 

How does this differ from antibiotic resistance?
Antimicrobial versus antibiotic resistance (2)

- Anti (-against) micro (-small) bial (-life) resistance
  - AMR is a broad term.
  - All classes of microbes can develop resistance.
  - It applies to: fungi becoming resistant to antifungals, parasites to antiparasitics, bacteria to antibiotics and viruses to antivirals, and is the subject of ongoing scientific discussion and research.

- Anti (-against) biotic (-life) resistance
  - Antibiotic resistance is a specific term that refers to a subset of AMR.
  - It applies only to bacteria becoming resistant to antibiotics.
Antimicrobial versus antibiotic resistance (3)

- In general, resistance develops when microorganisms adapt and grow in the presence of the substance used “against” them (= resist the effects).

- This module covers antibiotic resistance in greatest detail.

- Many actions are equally applicable to combat resistance in other microorganisms causing fungal, viral and parasitic diseases.
How do organisms become resistant to antibiotics?
Mechanisms of antibiotic resistance (2)

1. Lots of germs. A few are drug resistant.
2. Antibiotics kill bacteria causing the illness, as well as good bacteria protecting the body from infection.
3. The drug-resistant bacteria are now allowed to grow and take over.
4. Some bacteria give their drug-resistance to other bacteria, causing more problems.

Source: https://www.cdc.gov/drugresistance/resources/digital_materials.html
Intrinsic resistance

- This relates to natural properties of bacteria and mechanisms of action; for example, Gram-negative bacteria are naturally resistant to vancomycin and enterococci to cephalosporins.

Acquired resistance

- This is acquired by transfer of mobile genetic material (such as plasmid) that can move easily between various bacterial species or by chromosomal mutation.
- It is the most dangerous method for contributing to the spread of antibiotic resistance.
Acquired resistance – transfer of mobile genetic material

Factors contributing to AMR

Session 1

Introduction to antibiotic-resistant bacteria

Part B: types of antibiotic resistance
### WHO priority pathogens list for new antibiotics

<table>
<thead>
<tr>
<th>Critical</th>
<th>High</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <em>Acinetobacter baumannii</em>, carbapenem-resistant</td>
<td>• <em>Enterococcus faecium</em>, vancomycin-resistant</td>
<td>• <em>Streptococcus pneumoniae</em>, penicillin- non-susceptible</td>
</tr>
<tr>
<td>• <em>Pseudomonas aeruginosa</em>, carbapenem-resistant</td>
<td>• <em>Staphylococcus aureus</em>, methicillin- and vancomycin-resistant</td>
<td>• <em>Haemophilus influenzae</em>, ampicillin-resistant</td>
</tr>
<tr>
<td>• Enterobacteriaceae, carbapenem-resistant, extended spectrum beta- lactamase-producing</td>
<td>• <em>Helicobacter pylori</em>, clarithromycin-resistant</td>
<td>• <em>Shigella</em> spp., fluoroquinolone-resistant</td>
</tr>
<tr>
<td></td>
<td>• <em>Campylobacter</em> species (spp.), fluoroquinolone-resistant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• <em>Salmonella</em> spp., fluoroquinolone-resistant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• <em>Neisseria gonorrhoeae</em>, cephalosporin- and fluoroquinolone-resistant</td>
<td></td>
</tr>
</tbody>
</table>

Methicillin-resistant *Staphylococcus aureus* (MRSA) is resistant to methicillin, oxacillin, flucloxacillin and cefoxitin.

Coagulase-negative staphylococci species are multi-resistant.

Vancomycin-resistant enterococci (VRE) are resistant to glycopeptide antibiotics (vancomycin or teicoplanin).

*Streptococcus pneumonia* is penicillin-resistant.
• MRSA first described in 1961, only two years after methicillin was introduced for penicillin-resistant *S. aureus*.

• Pathogenic strains often promote infections by producing virulence factors.

• If not controlled, it can achieve continuous presence or “endemic state” in a health care facility.

• Routine screening of health care workers is not recommended but could be considered as part of outbreak control.
**Staphylococcus aureus carriage in various body sites of healthy adults**

**General population**
- Neck 10%
- Axilla 8%
- Forearm 20%
- Hand 27%
- Nose 27%
- Pharynx 10-20%
- Skin chest 15%
- Skin abdomen 15%
- Perineum 22%
- Vaginal 5%
- Ankle 10%

**Staphylococcus aureus nasal carriers**
- Nose 100%
- Pharynx 25-50%
- Axilla 19%
- Skin chest 45%
- Forearm 45%
- Skin abdomen 40%
- Hand 90%
- Perineum 60%
- Ankle 10%

Enterococci are opportunistic health care-associated microorganisms: they live in our intestines and skin, usually without causing problems, but they can become pathogenic in specific conditions.

They occur not only in humans but also in a range of animals, insects and plants and in the environment.

*Enterococcus faecalis* (90%) and *Enterococcus faecium* (5–10%) are the most prevalent species cultured from humans (>90% of clinical isolates).

Resistance to glycopeptides (vancomycin or teicoplanin) is the most relevant pattern in enterococci. (For this reason they may also be called GRE.)

Vancomycin resistance is most common in *E. faecium*.

Photo credit: U.S. Centers for Disease Control and Prevention (CDC) - Medical Illustrator; Content Providers(s): CDC/James Archer
## Summary: MRSA versus VRE (1)

<table>
<thead>
<tr>
<th>Factor</th>
<th>MRSA</th>
<th>VRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogenicity</td>
<td>High/moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Human reservoirs</td>
<td>Nose, moist and hairy areas of body, such as groin and axillae</td>
<td>Gastrointestinal tract, anterior urethra, vagina, skin and oropharynx</td>
</tr>
<tr>
<td>Modes of transmission</td>
<td>Most frequently direct contact (via hands); also droplets</td>
<td>Most frequently direct and indirect contact (with contaminated objects/equipment, environmental surfaces)</td>
</tr>
<tr>
<td>Infections</td>
<td>• Skin and soft tissue infections</td>
<td>• Urinary tract infection</td>
</tr>
<tr>
<td></td>
<td>• Septic arthritis and osteomyelitis</td>
<td>• Infective endocarditis</td>
</tr>
<tr>
<td></td>
<td>• Sinusitis, pneumonias</td>
<td>• Bloodstream infections</td>
</tr>
<tr>
<td></td>
<td>• Bloodstream infections</td>
<td>• Surgical site infections</td>
</tr>
<tr>
<td></td>
<td>• Infective endocarditis</td>
<td>• Intra-abdominal infections</td>
</tr>
<tr>
<td></td>
<td>• Food poisoning</td>
<td>• Pelvic infections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Meningitis and pleural space infections (rare)</td>
</tr>
</tbody>
</table>

## Summary: MRSA versus VRE (2)

<table>
<thead>
<tr>
<th>Factor</th>
<th>MRSA</th>
<th>VRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening swabs</td>
<td>• Swab from nose, axilla and perianal/groin area</td>
<td>• Deep rectal swab, faeces or specimen from colostomy</td>
</tr>
<tr>
<td></td>
<td>• Skin lesions, wounds, incisions, ulcers and exit sites of indwelling devices</td>
<td>• Swab from broken skin such as wounds, incisions, ulcers and exit sites of indwelling devices</td>
</tr>
<tr>
<td></td>
<td>• Newborn umbilicus swab</td>
<td>• Newborn umbilicus swab</td>
</tr>
<tr>
<td>De-colonization therapy (to reduce carriage)</td>
<td>Yes: feasible in patients who are colonized with MRSA</td>
<td>No: reliable means for decolonization does not exist</td>
</tr>
</tbody>
</table>
Types of antibiotic-resistant Gram-negative organisms

- Extended-spectrum beta-lactamase-producing enterobacteriaceae: **ESBL-PE**
- Carbapenem-resistant enterobacteriaceae: **CRE**
- Carbapenem-resistant *Acinetobacter baumannii*: **CRAB**
- Carbapenem-resistant *Pseudomonas aeruginosa*: **CRPsA**
- These can cause serious nosocomial infections, which have been found to be associated with increased mortality, prolonged hospital stays and higher health care costs.

Outcomes associated with Gram-negative organisms

Bloodstream infections
Especially in immunocompromised patients, indwelling devices

Skin colonization

Gram-negative organisms

Gastrointestinal infections
Post-surgical infections, intra-abdominal sepsis

Note: gut colonization can result in other various infections.

Urinary tract infections
Colonization/infection

Especially in immunocompromised patients, indwelling devices

Note: gut colonization can result in other various infections.
Enterobacteriaceae (family) (1)

- Enterobacteriaceae are a large family of Gram-negative "enteric" bacteria.
- They include many harmless symbionts/organisms.
- Disease-causing bacteria in this family include *Proteus*, *Enterobacter*, *Serratia*, *Salmonella*, *Shigella*, *Yersinia pestis*, *Escherichia coli*, *Klebsiella* and *Citrobacter* (among others)
- They can produce enzymes – extended-spectrum beta-lactamases (ESBLs) – that provide multiresistance to beta-lactam antibiotics such as penicillins, cephalosporins, aztreonam and possibly some carbapenems (ertapenem).
- These are mostly treated with intravenous carbapenems.
Enterobacteriaceae (family) (2)

- Enterobacteriaceae can even be resistant to carbapenems. CRE are mostly *E. coli*, *Enterobacter* and *Klebsiella*.

- Resistance can be acquired through several mechanisms, including:
  - active transport of antibiotics out of the cell
  - preventing antibiotics from entering the cell
  - production of enzymes disabling the drug molecule: carbapenemases

- CRE can be treated with intravenous colistin (mostly in combination with others), which is an antibiotic of last resort.

**2015:** Discovery of first colistin resistance (plasmid-mediated mcr-1) in *E. coli* (animals/humans) in China

**2016:** Bacteria found in United Kingdom and USA
Acinetobacter baumannii (species)  
(Acinetobacter = genus)

• Acinetobacter baumannii is now recognized as significant nosocomial pathogen, especially in critically ill patients, for example those in intensive care units and with wound infections (trauma patients).

• It is present in soil, water and sewage but is mostly isolated from hospital environments.

• Transmission occurs through direct and indirect contact (such as with contaminated surfaces), through water or through medication (common vehicle).

• It can rapidly acquire resistance to a wide range of antibiotics. Resistance to aminoglycosides and carbapenems is rapidly increasing.

• According to EARS-Net, in 2018 carbapenem-resistant A. baumannii ranged from 1.7% to 95.5% of isolates tested in European countries.

• Once endemic, A. baumannii is difficult to eradicate because of its remarkable ability to survive and spread in the hospital environment.

Sources:  
Pseudomonas aeruginosa (species) (Pseudomonas = genus)

- Pseudomonas aeruginosa is found in soil, water and plants.
- Transmission occurs through direct and indirect contact and through water (common vehicle).
- This highlights the important role of potential environmental reservoirs, such as a handwash basin and hospital water supplies, especially in high-risk areas (such as intensive care, neonatal care and burns units).
- It is responsible for causing a wide variety of infections, especially in patients with compromised host defence mechanisms, such as bloodstream, urinary tract, otitis externa and media, endocarditis, bacterial keratitis, endophthalmitis and skin infections.
- It can rapidly acquire resistance to a wide range of antibiotics. Resistance to ceftazidime, aminoglycosides and carbapenems is rapidly increasing.
- According to EARS-Net, in 2018 P. aeruginosa resistant to carbapenems varied across European countries from 0% to 55.1% in 2018.

## Antibiotic-resistant Gram-negative bacteria

<table>
<thead>
<tr>
<th>Factor</th>
<th>CRE, CRAB and CRPsA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening swabs</td>
<td>• Deep rectal swab, faeces or specimen from colostomy</td>
</tr>
<tr>
<td></td>
<td>• Swab from broken skin such as wounds, incisions, ulcers and exit sites of indwelling devices</td>
</tr>
<tr>
<td></td>
<td>• Newborn umbilicus swab</td>
</tr>
<tr>
<td>Decolonization therapy (to reduce carriage)</td>
<td>• Not effective</td>
</tr>
</tbody>
</table>


**Abbreviations:**
- CRE: carbapenem-resistant Enterobacteriaceae
- CRAB: carbapenem-resistant *Acinetobacter baumanii*
- CRPsA: carbapenem-resistant *Pseudomonas aeruginosa*
Session 2

Overview of the threat caused by health care-associated infections (HAIs) and antibiotic resistance

Part A: global patterns of AMR in hospitals
Burden of antibiotic resistance/AMR

• Do you know the frequency of antibiotic resistance/AMR and the most common health care-associated pathogens in your facility? And in your country?

• Do you think there is a difference in rates between high-income and low-income countries?
## Bacteria commonly causing infections in hospitals and in the community

<table>
<thead>
<tr>
<th>Name of bacterium/resistance</th>
<th>Examples of typical diseases</th>
<th>No. out of 194 Member States providing data</th>
<th>No. of WHO regions with national reports of 50% resistance or more</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td>Urinary tract infections, bloodstream infections</td>
<td>86, 92</td>
<td>5/6, 5/6</td>
</tr>
<tr>
<td>- vs 3rd gen. cephalosporins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- vs fluoroquinolones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>Pneumonia, bloodstream infections, urinary tract infections</td>
<td>87, 71</td>
<td>6/6, 2/6</td>
</tr>
<tr>
<td>- vs 3rd gen. cephalosporins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- vs 3rd carbapenems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>Wound infections, bloodstream infections</td>
<td>85</td>
<td>5/6</td>
</tr>
<tr>
<td>- vs methicillin “MRSA”</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Causes of HAI by infection site

<table>
<thead>
<tr>
<th>Pathogens</th>
<th>Number of isolates (%) (total number of studies: 36)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BSI (5 studies)</td>
<td>%</td>
</tr>
<tr>
<td>S. aureus</td>
<td>62</td>
<td>14.5</td>
</tr>
<tr>
<td>Coagulase Neg Staph</td>
<td>92</td>
<td>21.5</td>
</tr>
<tr>
<td>Enterococcus spp.</td>
<td>48</td>
<td>11.2</td>
</tr>
<tr>
<td>E. coli</td>
<td>25</td>
<td>5.8</td>
</tr>
<tr>
<td>Pseudomonas spp.</td>
<td>52</td>
<td>12.1</td>
</tr>
<tr>
<td>Enterobacteriaceae (excluding E. coli)</td>
<td>49</td>
<td>11.4</td>
</tr>
<tr>
<td>Acinebacter spp.</td>
<td>53</td>
<td>12.4</td>
</tr>
<tr>
<td>Candida spp.</td>
<td>30</td>
<td>7.0</td>
</tr>
<tr>
<td>Other</td>
<td>17</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>428</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

**MRSA: 54.5% of S. aureus isolates**

Clean Care is Safer Care

5 May 2014 - Global Surveys

Antimicrobial resistance (AMR) is of global concern and WHO is committed to combating it. A large part of the burden of AMR is due to the emergence, substantial rise and spread of antibiotic-resistant bacteria in health-care facilities.

On the occasion of its SAVE LIVES: Clean Your Hands global campaign, every year on 5 May, WHO is launching a call to action to implement and sustain hand hygiene improvement in health-care settings worldwide. The focus of the 2014 call is the role of hand hygiene in reducing the spread of AMR.

Drug resistance website

Among the activities to support the 5 May 2014 call focused on the role of hand hygiene in reducing the spread of AMR, WHO is inviting health-care facilities to participate in two global surveys:

1. WHO Global Laboratory-based Survey on MULTIDRUG-RESISTANT ORGANISMS (MDROs) in Health Care - to assess and raise awareness of the prevalence of the five main health care-associated MDROs that have been identified at the global level.

2. WHO Global Prevalence Survey on use of SURGICAL ANTIBiotic PROPHYLAXIS - to assess surgical antibiotic prophylaxis prescribing in a wide range of acute health-care facilities.

Deadline extended to 3 May 2014!

Health-care facilities registered for SAVE LIVES: Clean Your Hands will receive a personal email invitation to participate, including specific links to the online systems.
WHO laboratory-based global survey on multidrug-resistant organisms in health care

- **Objectives:**
  - to have a snapshot of multidrug-resistant organism prevalence among inpatients in a wide range of health care facilities worldwide
  - to collect information about the microbiological methods used for isolation and detection of resistance

- **Design:** an online survey (1 March to 30 June 2014) based on routine collection of clinical blood and urine culture specimens (only the first isolate from inpatients during one week)

- **Participants:** health-care settings registered for the WHO SAVE LIVES: Clean Your Hands global campaign and other WHO networks

- **Main targeted resistance patterns:** MRSA, VRE, ESBL and carbapenem resistance in *E. coli* and *Klebsiella* spp., multidrug-resistance in *A. baumannii*
67 countries and 420 laboratories participated

Prevalence of multidrug resistance from inpatient clinical blood and urine specimens (2014)

<table>
<thead>
<tr>
<th></th>
<th>MRSA</th>
<th>VRE</th>
<th>ESBL-PE</th>
<th>CRE</th>
<th>MRAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence</td>
<td>262</td>
<td>147</td>
<td>482</td>
<td>482</td>
<td>50</td>
</tr>
<tr>
<td>(median)</td>
<td>145</td>
<td>65</td>
<td>1239</td>
<td>1239</td>
<td>40</td>
</tr>
<tr>
<td>High income</td>
<td>133</td>
<td>46</td>
<td>973</td>
<td>966</td>
<td>2797</td>
</tr>
<tr>
<td>Middle/low</td>
<td>45</td>
<td>192</td>
<td>2797</td>
<td>2797</td>
<td>50</td>
</tr>
<tr>
<td>income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>MRSA</th>
<th>VRE</th>
<th>ESBL-PE</th>
<th>CRE</th>
<th>MRAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence</td>
<td>262</td>
<td>147</td>
<td>482</td>
<td>482</td>
<td>50</td>
</tr>
<tr>
<td>(median)</td>
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<td>income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ESBL-PE and CRE prevalence from blood cultures, and VRE, ESBL-PE and CRE prevalence from urine specimens significantly higher in low- and middle-income countries.

Acinetobacter spp: percentage resistant among tested in Europe

Escherichia coli: percentage resistant among tested in Europe

**Klebsiella pneumoniae**: percentage resistant among tested in Europe

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Staphylococcus aureus: percentage resistant among tested in Europe

Session 2

Overview of the threat caused by HAIs and antibiotic resistance
Part B: the impact of AMR on people and health systems
Impact of antibiotic-resistant bacteria (1)

What would you say is the impact of antibiotic-resistant bacteria on the…

• individual patient?
• health care facility?
• health care system in general?
Increased morbidity and mortality due to:
- failure to respond to the first or second-line of empirical antibiotics
- delayed treatment
- vulnerable patients at higher risk of exposure

Limited choice in selection of older “tried and tested” antibiotics, well known for their efficacy and side-effect profiles

Restricted licensing conditions of newer agents due to limited availability of clinical data on their efficacy and known side-effects

Longer hospital stays due to HAIs; some preparations only available in intravenous formulations
Impact of antibiotic-resistant bacteria (3)

- Increased costs and use of limited resources to deliver care due to:
  - costs of newer expensive antibiotics and other drugs
  - supplies needed for isolation/precautions
  - costs of additional investigations or other complications
  - increased lengths of stay, leading to lower numbers of available beds for other patients

- Collateral damage – increased use of antibiotics (including broad-spectrum) is associated with:
  - alterations of patients’ flora (microbiomes), i.e. microbes essential for human functioning are being killed
  - increased incidence of Clostridium difficile infections
CDC estimates of antibiotic resistance/AMR in the USA (2017)

New National Estimate*

Each year, antibiotic-resistant bacteria and fungi cause at least an estimated:

- **2,868,700** infections
- **35,900** deaths

*Clostridioides difficile* is related to antibiotic use and antibiotic resistance:

- **223,900** cases
- **12,800** deaths

**Urgent Threats**

These germs are public health threats that require urgent and aggressive action:

- **Carbapenem-Resistant Acinetobacter**
- **Candida Auris**
- **Clostridioides Difficile**
- **Carbapenem-Resistant Enterobacteriaceae**
- **Drug-Resistant Neisseria Gonorrhoeae**

**Serious Threats**

These germs are public health threats that require prompt and sustained action:

- **Drug-Resistant Campylobacter**
- **Drug-Resistant Candida**
- **ESBL-Producing Enterobacteriaceae**
- **Vancomycin-Resistant Enterococci**
- **Multidrug-Resistant *Pseudomonas aeruginosa***
- **Drug-Resistant Nontyphoidal *Salmonella***
- **Drug-Resistant *Salmonella* Serotype Typhi**
- **Drug-Resistant *Shigella***
- **Methicillin-Resistant *Staphylococcus aureus***
- **Drug-Resistant *Streptococcus pneumoniae***
- **Drug-Resistant *Tuberculosis***

Comparing the burden of HAIs with other infectious diseases

HAIs account for twice the burden of 31 other infectious diseases

The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.

Composite index of AMR in HAIs from acute care hospitals

(% of isolates resistant to first-level AMR markers in HAIs, MRSA, VRE, enterobacteriaceae resistant to third-generation cephalosporins, and P. aeruginosa and A. baumannii resistant to carbapenems)

Estimated burden of infections with antibiotic-resistant bacteria

671,689 infections with antibiotic-resistant bacteria in EU/EEA countries, 2015
33,110 attributable deaths
170 DALYs per 100,000

- 63% of cases were HAIs, representing 75% of total burden population (DALYs)
- 70% due to four top-ranking antibiotic-resistant bacteria
- 39% due to carbapenem and/or colistin resistance

The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.

HAIs represent the highest burden:
63% of HAIs represent 75% of the burden of AMR

DALY: Disability-Adjusted Life Year

Burden is comparable to the combined burden of influenza, tuberculosis and HIV/AIDS

1. Third-generation cephalosporin-resistant *E. coli* and *K. pneumoniae*; aminoglycoside- and fluoroquinolone-resistant *Acinetobacter* spp.; three or more antimicrobial groups-resistant *P. aeruginosa*
2. Carbapenem- and/or colistin-resistant *E. coli*, *K. pneumoniae*, *Acinetobacter* spp. and *P. aeruginosa*
3. Meticillin-resistant *S. aureus*
4. Vancomycin-resistant *E. faecalis* and *E. faecium*
5. Penicillin-resistant and combined penicillin and macrolide-resistant *S. pneumoniae*

DALY: Disability-Adjusted Life Year

Burden of infections with antibiotic-resistant bacteria, EU/EEA, 2007-2015 (1)

2007 to 2015:
Number of deaths more than doubled

Number of deaths due to:
- carbapenem-resistant *K. pneumoniae* increased six-fold
- third-generation cephalosporin-resistant *E. coli* increased four-fold

2007 to 2015:

**Number of deaths more than doubled**

Number of deaths due to:
- carbapenem-resistant *K. pneumoniae* increased **six-fold**
- third-generation cephalosporin-resistant *E. coli* increased **four-fold**

Antibiotic discovery void

For treatment of multidrug-resistant Gram-positive bacteria only

Lack of available antibiotics to treat Gram-negative organisms

No new classes of antibiotics discovered after 1987

Case study: preterm child in a tertiary referral hospital

In groups of 5–7 people, please refer to your handbook. Go through the instructions for group work 1. Answer the questions presented at the end.

1. The problem
   In your groups, discuss the origin of CRE. How did the organism get into the baby’s blood? What is the likely source?

2. Identifying key IPC elements
   Discuss the key IPC elements to prevent and control antibiotic-resistant bacteria and HAIs you know of so far. What action would you take (have taken) in this case?
Group work 1: answers

Present your answers to the case study questions:

1. The problem
   • In your groups, discuss the origin of CRE. How did the organism get into the baby’s blood? What is the likely source?

2. Identifying key IPC elements
   • Discuss the key IPC elements to prevent and control antibiotic-resistant bacteria and HAIs you know of so far.
   • What action would you take (have taken) in this case?
Occurrences of this type of resistant infection, which cannot be treated effectively, are increasing.

With increasing resistance, more patients will die of such infections and it will not be possible to provide safe delivery of health care.
Overview of the threat caused by HAI and antibiotic resistance
Part C: risk factors for AMR acquisition and spread
What are the risk factors that contribute to the emergence of antibiotic-resistant bacteria?
Risk factors for antibiotic-resistant bacteria in the healthcare setting (2)

- **Increased use/misuse of antibiotics for both prevention and treatment** (such as broad-spectrum antibiotics, cephalosporins, carbapenems, quinolones, glycopeptides)

- **Patients with severe/chronic underlying disease** (past exposure to health care and antibiotic treatment)

- **Critically ill patients with prolonged hospital stays:**
  - patients undergoing intensive care/therapy or immunocompromised
  - those in special care baby and neonatal units
  - patients receiving oncology treatments
  - transplant patients
  - those on burns wards and in hemodialysis
Risk factors for antibiotic-resistant bacteria in the health care setting (3)

- **High-risk units** can have a high burden of antibiotic-resistant bacteria due to:
  - increased use of antibiotics exerting selective pressure on bacteria
  - Immunocompromised patients being more susceptible to infections
  - increased patient contact, resulting in more cross-infection due to breaches in IPC practices
  - presence of indwelling devices, such as intravenous lines, urinary catheters, endotracheal intubation, surgical drains, nasogastric and PEG (gastrostomy and jejunostomy) tubes
Exposure to antibiotic-resistant bacteria

- Antibiotic exposure may influence frequency/persistence of colonization/carriage (i.e. presence of bacteria on the body without causing disease)

- Colonization precedes infection: **IPC should prevent colonization**

What are the risk factors that contribute to the spread of antibiotic-resistant bacteria?
ANTIBIOTIC RESISTANCE

HOW IT SPREADS

Antibiotics are given to patients, which can result in drug-resistant bacteria developing in the gut.

Antibiotics are given to food producing animals and crops.

Animals develop drug-resistant bacteria in their gut.

Drug-resistant bacteria reaches humans through food, the environment (water, soil, air) or by direct human-animal contact.

Patient attends hospital or clinic.

Drug-resistant bacteria spreads to other patients through poor hygiene and unclean facilities.

Drug-resistant bacteria spreads to the general public.

Antibiotic resistance happens when bacteria change and become resistant to the antibiotics used to treat the infections they cause.

Source: http://www.who.int/mediacentre/events/2015/world-antibiotic-awareness-week/
Spread of antibiotic-resistant bacteria in facilities (1)

System-related shortcomings

- Lack of availability and/or accessibility of up-to-date IPC guidelines
- Lack of isolation facilities, side wards (especially with ensuite toilets) and facilities to cohort colonized/infected patients
- Lack of good water, sanitation and hygiene (WASH) in health care facilities
- Lack of good microbiology support/capacity to identify antibiotic-resistant bacteria accurately

- Lack of local surveillance for antibiotic-resistant bacteria
- Transfers from other health care facilities where antibiotic-resistant bacteria are endemic
- Increased bed occupancy
- Increased workload
- Reduced staffing levels
Health worker-related shortcomings

- Defective IPC practices: low/zero compliance with hand hygiene requirements, contaminated environment, items and medical equipment, defective aseptic techniques and similar.

Mixture of system-related and health worker-related shortcomings

- Suboptimal or lacking implementation of IPC guidelines.
- Failure of identification at the time of admission due to lack of:
  - triage and screening of suspected/confirmed patients;
  - flagging of notes for patients known to be positive carriers.
- Failure to isolate suspected/confirmed patients in a side room with contact precautions.
- Increased (unnecessary) movement of patient.

Spread of antibiotic-resistant bacteria in facilities (2)
The role of IPC in AMR prevention

Visualizing how IPC programmes support AMR risk reduction

“The spread of AMR is just like a bushfire – yes, we need new firetraps and new helicopters (i.e. new antibiotics), but they’re 5 or 10 years away. In the meantime we need a firebreak, and that firebreak is good infection prevention and control.”

https://www.youtube.com/watch?v=LZapz2L6J1Q&feature=youtu.be
Preventing the emergence and spread of antibiotic-resistant bacteria (1)

What are key actions to prevent the emergence and spread of antibiotic-resistant bacteria?
Preventing the emergence and spread of antibiotic-resistant bacteria (2)

- **Prevention of infections** that entail the necessity of treatment (e.g. vaccination or hygiene measures).

- Antimicrobial **stewardship** to prevent **emergence** of antibiotic-resistant bacteria.

- Implementation of effective **IPC measures** to prevent **spread** in healthcare facilities.

- Provision of clean **water, basic sanitation and good hygiene** to stop **SPREAD** in communities
  - More than 1.5 billion people had no sanitation service at their healthcare facility
  - 2.4 billion people lack access to basic sanitation services, such as toilets or latrines

The One Health approach to combat antibiotic resistance

WHO global AMR report and action plan

Evidence-based IPC strategies to combat antibiotic resistance

Introduction
Correlations between IPC and composite index of AMR

Investing €1.50 per capita per year in three packages of public health interventions would avoid about 27,000 deaths per year in EU/EEA countries.

**Package 1**, for hospitals: hand hygiene, antibiotic stewardship programmes and enhanced environmental hygiene = 85%

**Package 2**, for community settings: delayed antibiotic prescriptions, mass media campaigns and use of rapid diagnostic tests = 23%

**Package 3**, a mix of interventions = 73%

Savings of €3.00 (package 1), €0.70 (package 2) and €2.00 (package 3) per capita per year

Key IPC elements to combat antibiotic resistance

- Antibiotic stewardship and monitoring of antibiotic consumption
- Triage and identification of patients, contact precautions, patient isolation, hand hygiene
- Cleaning and disinfection of environment, decontamination of items and equipment
- Advocacy, leadership and policies to promote IPC and combat AMR
- Surveillance of antibiotic-resistant bacteria, monitoring of IPC practices
- IPC education/training of all health care workers
Vertical versus horizontal interventions (1)

**VERTICAL INTERVENTIONS:** organism-specific measures

- **Screening** for antibiotic-resistant organisms
- Placement of patient in isolation room, with application of contact precautions
- Targeted decolonization
Vertical versus horizontal interventions (2)

HORIZONTAL INTERVENTIONS: non-organism-specific control measures

- hand hygiene
- minimum use of invasive devices
- decontamination of items and equipment
- cleaning and/or disinfection of environment etc.
- antimicrobial stewardship
Evidence-based IPC strategies to combat antibiotic resistance

Part A: antimicrobial stewardship (AMS) and monitoring of antibiotic consumption
Antimicrobial stewardship

What is antimicrobial stewardship?
Antimicrobial stewardship is

- The optimal selection, dosage and duration of antimicrobial treatment that results in:
  - the best clinical outcome for the treatment or prevention of infection;
  - minimal toxicity to the patient;
  - minimal impact on subsequent resistance.

What are the goals of antimicrobial stewardship?
Goals of antimicrobial stewardship (2)

• A coherent set of actions which promote responsible use of antimicrobials.

• The main goal is the responsible use of antimicrobials/antibiotics.

• Objectives are:
  • behavior change in physicians’ antibiotic prescribing practices;
  • behavior change in how patients use antibiotics;
  • improving patient outcomes;
  • slowing down the development of AMR;
  • prolonging the lifespan of existing antibiotics; and
  • reducing health care costs.

Autors in antimicrobial stewardship (1)

Who is engaged in antimicrobial stewardship?
Actors in antimicrobial stewardship (2)

- It requires **multidisciplinary teamwork**: creating an effective team within the facility’s resources.

- Most AMS stewardship teams include an infectious disease physician and/or a pharmacist and/or nurse.

- They also include, either as active members or working in close collaboration with the team:
  - a microbiologist or microbiology laboratory;
  - an infection prevention specialist (or focal IPC person);
  - a hospital epidemiologist;
  - the hospital administration;
  - the clinician/prescriber.
Monitoring antibiotic consumption (1)

• Surveillance of antibiotic consumption is an essential step in the antibiotic stewardship strategy.

• In some countries surveillance of antimicrobial consumption is already mandatory.

Sources:
Monitoring antibiotic consumption (2)

Countries and areas submitting national data on antimicrobial consumption to WHO based on the WHO methodology or a comparable methodology

<table>
<thead>
<tr>
<th>WHO Region</th>
<th>Countries and areas in the region</th>
<th>Countries and areas submitting data</th>
<th>Countries and areas included in the report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>No.</td>
<td>No.</td>
</tr>
<tr>
<td>African Region</td>
<td>47</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Region of the Americas</td>
<td>35</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>South-East Asia Region</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>European Region</td>
<td>54</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>Eastern Mediterranean Region</td>
<td>21</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Western Pacific Region</td>
<td>27</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>

Antimicrobial stewardship and monitoring antibiotic consumption

Evidence-based IPC strategies to combat antibiotic resistance

Part B: triage and identification of patients, contact precautions, patient isolation and hand hygiene
Triage and identification of patients

- Triage of a patient is very important
- Identify on admission previously known positive patients with antibiotic-resistant bacteria
- Identify “high-risk” patients using a triage risk assessment form
- Flag the information in the patient’s notes (manually and/or via electronic record)

### Triage Form

**Infection Prevention and Control risk assessment**

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Date of Birth</th>
<th>Gender</th>
<th>#</th>
</tr>
</thead>
</table>

**Is the patient known positive for multidrug resistant organisms (MDROs)?**
- Carbapenem-resistant Enterobacteriaceae/organisms (CRE/CRO)
- Extended Spectrum Beta-Lactamase-producing Enterobacteriaceae (ESBL-Es)
- Vancomycin-/glycopeptide-resistant enterococci (VRE/GRE)
- Methicillin-resistant Staphylococcus aureus (MRSA)

**Has the patient been in contact with MDRO cases?**
- Previous contact to CRE/CRO cases?
- Previous contact to other MDRO cases?
- Comes from a setting/hospital where MDROs are endemic?

**Travel history (past 12 months)?**
- If yes, dates of travel?
- Where to? Country and city?
- Received treatment in healthcare facility?
- Admitted to hospital? If yes, dates of hospitalization?
- Diagnosis, contact history, treatment received:

**Does the patient have signs of infection?**
- Diarrhea and/or vomiting
- Upper respiratory symptoms / Flu-like illness
- Rash suspected to be due to infection
- Fever / traveler’s fever (with or without rash)
- Meningitis (suspected/confirmed)
- Tuberculosis (suspected/confirmed)

**Next action steps**

- Admit patient (if yes, circle as appropriate)
- Open ward
- Side ward
- Side ward with ensuite toilet
- Negative pressure ventilation
- Ward informed
- If transfer to another facility, clinical team informed? Name: Ward:
- If transfer, ambulance informed?

Assessor’s Name: Time: Date: Signature:
Flag notes/records of patients with antibiotic-resistant bacteria

**ALERT**

- Put alert sticker on the front of patient’s notes

**MRSA**

- Isolate patient
- Implement contact IPC precautions
- Inform IPC nurse

Put name of microorganisms inside the patient’s notes to prevent breach of confidentiality
Precautions to be used depend on modes of transmission.
Modes of transmission (1)

Contact

- Direct: person-to-person spread through actual physical contact.
- Indirect: contaminated intermediate object, equipment or fomites.
- Applies to: MRSA, *Clostridium difficile*, *Pseudomonas* spp.

Droplets

- Large droplets discharged during coughing, sneezing, talking.
- Propelled a short distance less than 3 feet (1 m) and deposited on a susceptible host’s eyes, nasal mucosa or mouth.
- Applies to: pertussis, influenza.
Modes of transmission (2)

Airborne

- Tiny droplet nuclei <5 microns discharged and suspended in air on dust particles, respiratory or water droplets.
- Aerosolized during procedures (such as suctioning or bronchoscopy) and travelling further.
- Applies to: tuberculosis, measles, chickenpox.

Common vehicle

- Contaminated inanimate vehicle (food, water or medication).
- Applies to: *Salmonella* spp., *Pseudomonas aeruginosa*.

Vector (uncommon in hospitals)

- Transfer of microorganisms through insects, mosquitos, flies, rats, fleas.
- Applies to: malaria, yellow fever via mosquitos.
Modes of transmission (3)

What is the mode of transmission for each of the pathogens below?

- *Clostridium difficile*
- Influenza virus
- Norovirus
- *Pseudomonas aeruginosa*
- Chickenpox
- Measles
- Ebola virus disease
- Middle East respiratory syndrome coronavirus (MERS-CoV)
- Malaria
Modes of transmission (4)

- *Clostridium difficile* (contact)
- Influenza virus (droplet)
- Norovirus (contact and droplet possible)
- *Pseudomonas aeruginosa* (contact & common vehicle)
- Chickenpox (airborne)
- Measles (airborne)
- Ebola virus disease (contact)
- MERS-CoV (droplet)
- Malaria (vector)
After identification of patients during triage:

- Isolate patients **known** for being infected or colonised with resistant microorganisms;
- Isolate **suspected** patients, take appropriate screening swabs and keep under isolation until microbiological culture results are available;
- Isolate patients and implement **contact precautions** with dedicated toilet (if available).

What can you do if no single isolation rooms are available?
Cohorting (1)

• The practice of grouping together patients (a cohort) who are **colonized or infected with the same organism** to confine their care to one area and prevent contact with other susceptible patients (for example, all patients infected or colonized with a carbapenem-resistant Enterobacteriaceae in a specific cohort and all patients colonized with methicillin-resistant Staphylococcus aureus in a different cohort).

• Cohorts are created based on clinical diagnosis, microbiologic confirmation when available, epidemiology and mode of transmission of the infection agent.


Cohorting (2)

- Dedicated area
- Dedicated staff
- Restrictions on number of visitors
- Use of single-use items and disposable items, if possible
- Dedicated patient items: thermometer, stethoscope, sphygmomanometer etc.
- Increased frequency of cleaning and/or disinfection
- Decontamination of items/equipment between uses

Contact precautions

Measures intended to prevent transmission of infectious agents, which are spread by direct or indirect contact with the patient or the patient’s environment:

- ensuring appropriate patient placement;
- use of personal protective equipment (PPE), including gloves and gowns;
- limiting transport and movement of patients;
- use of disposable or dedicated patient-care equipment
  - if not single-use items, decontamination of items/equipment between uses;
- prioritizing cleaning and disinfection of rooms.

# Standard versus contact precautions (1)

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>STANDARD</th>
<th>CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand hygiene</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Aseptic technique</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Decontamination of patient-care items and equipment</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Environment cleaning and disinfection</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Waste disposal</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Safe handle and transport of linens</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Patient isolation</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>STANDARD</th>
<th>CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERSONAL PROTECTIVE EQUIPMENT (PPE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gloves</td>
<td><em>Only</em> when likely to touch blood/body fluids and contaminated equipment and surfaces</td>
<td>Yes – upon entering room to provide patient care, when likely to touch blood/body fluids and contaminated equipment and surfaces</td>
</tr>
<tr>
<td>Apron/gown</td>
<td><em>Only</em> during procedures likely to generate contamination from blood and body fluids (soiling)</td>
<td>Yes – upon entering room if clothing will have substantial contact with patient, surfaces or other items in room</td>
</tr>
<tr>
<td>Face protection</td>
<td><em>Only</em> during procedures likely to generate aerosols&lt;sup&gt;a&lt;/sup&gt;</td>
<td>During procedures likely to generate aerosols&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(Surgical face mask)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye protection/ face-shields</td>
<td><em>Only</em> during procedures likely to generate contamination with blood/body fluids</td>
<td>During procedures likely to generate contamination with blood and body fluids</td>
</tr>
</tbody>
</table>

<sup>a</sup> Only for situations that may provoke contamination of mucous membrane (mouth and nose), and procedures that are likely to create significant aerosols; suctioning, dentistry, intubation, chest physiotherapy and similar.

Examples of signage on doors of isolation rooms

Non-specific sign

Specific sign

Photo credit (non-specific): Nizam Damani
Patient transfer

• Limit movement and transfer of the patient from the ward/room to essential purposes only.

• If the patient is transported out of room/ward, ensure that IPC precautions are maintained to minimize risk of transmission of antibiotic-resistant bacteria: inform staff about IPC precautions.

• If patient is transferred to another health care facility, inform the nurse in change.
Why is hand hygiene important for preventing antibiotic resistance?

Source: https://www.who.int/gpsc/5may/2017/en/
It takes just 5 Moments to change the world

Clean your hands, stop the spread of drug-resistant germs!

Source: https://www.who.int/infection-prevention/tools/hand-hygiene/5moments-posters/en/
What are good practices with sinks and handwashing basins?

Photo credit: Nizam Damani
Best practices for handwash stations to minimize risk of multidrug-resistant Gram-negative contamination

• Use handwash stations for washing hands **only**.

• **Do not** dispose of body fluids, beverages or foods at handwash basins – use dedicated (e.g. dirty utility) areas.

• **Do not** wash any patient equipment in handwash basins or use basins to store equipment awaiting decontamination.

• Ensure cleaning staff have been trained in correct cleaning procedures for taps and sinks, paying particular attention to limescale deposits.

• Identify any problems or concerns related to safety, maintenance and cleanliness of handwash stations to the IPC team and facilities department.
Hand hygiene in health care settings in low- and middle-income countries

• Issues with availability of:
  • running water, 24 hours a day
  • clean water
  • soap and antiseptic handwash for sterile procedures
  • drying materials, such as single-use paper towels or single-use cloth towels

How do you overcome this problem?
Handrubbing is also more effective

PART A: GUIDE TO LOCAL PRODUCTION

Here is a guide to advice on local production of the formulation.

**Materials required (small volume production)**

<table>
<thead>
<tr>
<th>REAGENTS FOR FORMULATION 1</th>
<th>REAGENTS FOR FORMULATION 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol 96%</td>
<td>Isopropyl alcohol 90.8%</td>
</tr>
<tr>
<td>Hydrogen peroxide 3%</td>
<td>Hydrogen peroxide 3%</td>
</tr>
<tr>
<td>Glycerol 88%</td>
<td>Glycerol 96%</td>
</tr>
<tr>
<td>Sterile distilled or boiled cold water</td>
<td>Sterile distilled or boiled cold water</td>
</tr>
</tbody>
</table>

- 10-litre glass or plastic bottles with screw-threaded stoppers
- 50-litre plastic tanks (preferably in polypropylene or high density polyethylene, transparent so as to see the liquid level)
- Stainless steel tanks with a capacity of 80–100 litres (for mixing without overflow)
- Wooden, plastic or metal paddles for mixing
- Measuring cylinders and measuring jugs
- Plastic or metal funnel
- 100 ml plastic bottles with leak-proof tops
- 500 ml glass or plastic bottles with screw tops
- An alcoholometer: the temperature scale is at the bottom and the ethanol concentration (percentage v/v) at the top

**NOTE**

- **Glycerol**: used as humectant, but other emollients may be used for skin care, provided that they are cheap, easily available and miscible in water and alcohol and do not add to toxicity or promote allergy.
- **Hydrogen peroxide**: used to inactivate contaminating bacterial spores in the solution and is not an active substance for hand antiseptics.
- **Any further additive to both formulations should be clearly labelled and be non-toxic in case of accidental ingestion.**
- A colourant may be added to allow differentiation from other fluids, but should not add to toxicity, promote allergy, or interfere with antimicrobial properties. The addition of perfumes or dyes is not recommended due to risk of allergic reactions.

**METHOD: 10-LITRE PREPARATIONS**

These can be prepared in 10-litre glass or plastic bottles with screw-threaded stoppers.

<table>
<thead>
<tr>
<th>RECOMMENDED AMOUNTS OF PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORMULATION 1</td>
</tr>
<tr>
<td>Ethanol 96%: 8333 ml</td>
</tr>
<tr>
<td>Hydrogen peroxide 3%: 417 ml</td>
</tr>
<tr>
<td>Glycerol 96%: 145 ml</td>
</tr>
</tbody>
</table>

**Step by step preparation:**

1. The bottle/tank is then tapped up to the 10-litre mark with sterile distilled or boiled water.
2. The lid or the screw cap is placed on the bottle/tank and then mixed.
3. The solution is mixed by shaking gently where appropriate or by using a paddle.

Evidence-based IPC strategies to combat antibiotic resistance

Part C: cleaning and disinfection of environment, decontamination of items and equipment
Environmental cleaning (1)

Why is a clean environment important in combating antibiotic resistance?
Environment cleaning (2)

KEY POINT
If your environment is contaminated, there is a greater risk of spreading all types of infectious agents, including those resistant to antibiotics.

Keep the environment **clean, dry and dust free**
Basic principles of environmental cleaning (1)

Always start with

1. Clean area first
2. Dirtiest last

1. Clean **top** first
2. **Bottom** last
Basic principles of environmental cleaning (2)

- Provide education and practical training to cleaning staff
- Appropriate PPE must be worn
- Clean and disinfect all environmental surfaces with special emphasis on “hand-touch” surfaces
- Use detergent only for cleaning floors; use of disinfectant is not necessary
## Survival time, infectious dose and prior occupancy risk by pathogen

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Survival time</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>7 days to &gt;12 months</td>
</tr>
<tr>
<td>VRE</td>
<td>5 days to &gt;46 months</td>
</tr>
<tr>
<td><em>Clostridium difficile</em></td>
<td>&gt;5 months</td>
</tr>
<tr>
<td><em>A. baumannii</em></td>
<td>3 days to 5 months</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>2 hours to 16 months</td>
</tr>
<tr>
<td><em>Klebsiella spp.</em></td>
<td>2 hours to 30 months</td>
</tr>
<tr>
<td>Norovirus</td>
<td>8 hours to 7 days</td>
</tr>
</tbody>
</table>

Low- and high-touch surfaces

What is the difference between low- and high-touch surfaces?
Examples of high-touch items and surfaces in health care environments (1)

**NOTE:** Red dots indicate areas of highest contamination and touch

Examples of high-touch items and surfaces in health care environments (2)

NOTE: Red dots indicate areas of highest contamination and touch

Patient and environmental sources of MRSA and VRE in an intensive care unit room

# Cleaning and disinfection

<table>
<thead>
<tr>
<th>Type of surface</th>
<th>Definition</th>
<th>Cleaning needs</th>
</tr>
</thead>
</table>
| **High-touch surfaces** | • Surfaces that have frequent contact with hands  
• Surfaces at high risk of touch as near the patient, e.g. bedrail, bed surface, supply cart, overbed table, intravenous pump, call bell, telephone, computer keyboard, light switch, doorknob. | • Require more frequent cleaning and decontamination with appropriate disinfectants  
• Require cleaning at least daily and more frequently if risk of environmental contamination is higher, e.g. in intensive care units, during outbreaks |
| **Low-touch surfaces** | • Surfaces that have minimal contact with hands  
• Items not in close contact with the patient or immediate surroundings, e.g. floor, wall, ceiling, window sill | • Require cleaning on a regular basis (but not necessarily daily)  
• Require cleaning when soiling or spills occur, and when patient/resident is discharged from health care setting |
Medical equipment cleaning

• Depends on type of equipment: clean according to the manufacturer’s instructions and written protocols (e.g. after each patient use, daily or weekly)

• Refer to the manufacturer’s instructions to ensure that the item will not be damaged by use of disinfectants

• Schedules and procedures should be consistent and updated on a regular basis

• Education and practical training must be provided to all cleaning staff

• Assign clear responsibility: who is going to clean/disinfect which items and equipment (cleaning staff or nurses)?

• Refer to the WHO decontamination module for further reading
Evidence-based IPC strategies to combat antibiotic resistance

Part D: surveillance of antibiotic-resistant bacteria and monitoring of IPC practices
Surveillance and monitoring

- Hand hygiene compliance
- Environmental cleaning protocol compliance

**Monitoring of IPC structural and process indicators**
(aiming to ensure that the right infrastructure and processes are in place to prevent HAIs and antibiotic resistance)

- Compliance with device insertion, management and removal protocols (e.g. catheters)
- Availability of alcohol hand gel at the point of care; number of isolation rooms

**Surveillance of HAI outcomes**
(aiming to track the burden of infections and resistance)
Hand Hygiene Self-Assessment Framework 2010

Introduction and user instructions

The Hand Hygiene Self-Assessment Framework is a systematic tool with which to obtain a situation analysis of hand hygiene promotion and practices within an individual health-care facility.

What is its purpose?
While providing an opportunity to reflect on existing resources and achievements, the Hand Hygiene Self-Assessment Framework also helps to focus on future plans and challenges. In particular, it acts as a diagnostic tool, identifying key issues requiring attention and improvement. The results can be used to facilitate development of an action plan for the facility's hand hygiene promotion programme. Repeated use of the Hand Hygiene Self-Assessment Framework will also allow documentation of progress with time.

Intermediate: an appropriate hand hygiene promotion strategy is in place and hand hygiene practices have improved. It is now crucial to develop long-term plans to ensure that improvement is sustained and progresses.

Advanced: hand hygiene promotion and optimal hand hygiene practices have been sustained and/or improved, helping to embed a culture of safety in the health-care setting.

Leadership criteria have also been identified to recognise facilities that are considered a reference centre and contribute to the promotion of hand hygiene through research, innovation and information sharing. The assessment according to leadership criteria should only be undertaken by facilities having reached the Advanced level.

How does it work?
While completing each component of the Hand Hygiene Self-

Monitoring methods of cleaning

- Direct observation
- Visual assessment
- Observation of performance

Measurements of cleanliness

- Environmental markers to measure residual bioburden
- Adenosine triphosphate (ATP) bioluminescence
- Environmental cultures
  - Do not perform routine environmental swabbing

Source: https://www.cdc.gov/hai/pdfs/toolkits/environmental-cleaning-checklist-10-6-2010.pdf
Facility-level assessment tool

- Supports facility-level implementation of the WHO guidelines on core components of IPC programmes
- Assesses existing IPC activities/resources and identify strengths and gaps
- Assigns hospitals a score and position on a continuum of improvement from “inadequate” to “advanced”

**Surveillance of HAI/antibiotic resistance**

Definition: ongoing, systematic collection, analysis, interpretation and dissemination of data about HAI and resistance to help guide clinical and public health decision-making and action.

Surveillance is used to:

- provide baseline information on infection occurrence
- develop benchmarks of infections in healthcare settings
- describe the microbiological profile of pathogens causing HAI
- detect changes in endemicity of an HAI over time
- detect hospital outbreaks
- provide data for decision-making, policy, and research
- set priorities and target activities based on findings
- evaluate the impact of IPC measures
- reinforce appropriate IPC and patient management practices
WHO Global Antimicrobial Resistance Surveillance System (GLASS)

WHO IPC antibiotic resistance guidance

- Implementation of multimodal IPC strategies
- Hand hygiene compliance
- CRE surveillance cultures for asymptomatic/colonized/infected patients
- Contact precautions
- Patient isolation
- Environmental cleaning
- Environmental cultures when epidemiologically indicated
- Monitoring, audit and feedback

Chapter 1: National strategy
Chapter 2: Key principles for implementation at facility level

Table 1. Chapters 3-5 at-a-glance

<table>
<thead>
<tr>
<th></th>
<th>Chapter 3</th>
<th>Chapter 4</th>
<th>Chapter 5</th>
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<tbody>
<tr>
<td>Title</td>
<td>Surveillance</td>
<td>Contact precautions, including hand hygiene and isolation</td>
<td>Environmental cleaning, including surveillance cultures of the environment</td>
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<tr>
<td>Guideline recommendation(s) addressed</td>
<td>• Recommendations 1, 3, 7, 8. • Recommendation 8 is addressed within the section on multimodal strategies.</td>
<td>• Recommendations 1, 2, 4, 5, 8. Recommendation 8 is addressed within the section on multimodal strategies.</td>
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Source: Implementation manual to prevent and control the spread of carbapenem-resistant organisms at the national and health care facility level
Core components of IPC programmes at the national and acute health care facility level

Core component 1
IPC programme

Core component 2
IPC guidelines

Core component 3
IPC training/education

Core component 4
HAI surveillance

Core component 5
multimodal strategies

Core component 6
monitoring, audit and feedback

Core component 7
workload, staffing and bed occupancy

Core component 8
built environment, materials and equipment for IPC

National-level key points to support CRO prevention and control

Implementation Manual Chapter 1

1. Having a National IPC programme
2. Awareness-raising/advocacy about the problem
3. Legislation/regulation and accreditation
4. Governance/coordination
5. Laboratory capacity
6. Surveillance
7. System change
8. Education
9. Endemic versus outbreak contexts
Session 3

Evidence-based IPC strategies to combat antibiotic resistance

Part E: multimodal strategies for implementing IPC activities
Combating antibiotic resistance in the context of WHO IPC core components

Multimodal strategies for combating antibiotic resistance

• Targeting only one area (i.e. unimodal) for AMR prevention – such as offering one training session – is highly likely to be less effective.

• Instead, a multimodal strategy is highly recommended, which:
  • consists of several elements (three or more; usually five);
  • is implemented in an integrated way in the local context;
  • aims to improve outcomes and change behaviour.

• Multimodal strategies include bundles (an implementation tool to improve the care process and patient outcomes in a structured manner).

• WHO identifies five elements for IPC multimodal strategies in the health care context.
Bundle examples: reduction of catheter-related bloodstream infections

Taking it a step further: multimodal strategies for combating antibiotic resistance

1. Build it
   (system change)
   What infrastructure, equipment and supplies are needed?

2. Teach it
   (training & education)
   Who needs training? What type? How frequently?

3. Check it
   (monitoring & feedback)
   How can you identify gaps to prioritize actions, track progress and feed back to drive change?

4. Sell it
   (reminders & communications)
   How do you promote and reinforce the appropriate messages?

5. Live it
   (culture change)
   Do senior managers support the intervention? Are others willing to be champions?

Campaigns as good opportunities to invigorate multimodal strategies: WHO Hand Hygiene campaign

SAVE LIVES: Clean Your Hands

WHO’s global annual call to action for health workers

SAVE LIVES: Clean Your Hands 5 May 2017 - Fight antibiotic resistance - it’s in your hands

Our calls to action are:

- Health workers: “Clean your hands at the right times and stop the spread of antibiotic resistance.”
- Hospital Chief Executive Officers and Administrators: “Lead a year-round infection prevention and control programme to protect your patients from resistant infections.”
- Policy makers: “Stop antibiotic resistance spread by making infection prevention and hand hygiene a national policy priority.”
- IPC leaders: “Implement WHO’s Core Components for infection prevention, including hand hygiene, to combat antibiotic resistance.”

Read more about 5 May 2017 here

Campaigns as good opportunities to invigorate multimodal strategies: WHO antibiotic awareness week

World Antibiotic Awareness Week

Save the date: World Antibiotic Awareness Week 2017

This year, World Antibiotic Awareness Week will be held from 13 to 19 November. WHO is encouraging all Member States, health partners and students, and the public to join this campaign and help raise awareness of antibiotic resistance.

For more information, click here

Steps of implementation


## Objectives of implementation steps

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<th>OBJECTIVE</th>
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<tr>
<td>1. Prepare for action</td>
<td>Ensure all the prerequisites that need to be in place for success (planning and coordination of activities) are addressed, including: • necessary human and financial resources; • identification of roles and responsibilities, including key leaders and “champions”, an overall coordinator and deputy; • infrastructures in place.</td>
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<td>2. Conduct baseline assessment</td>
<td>Conduct an exploratory baseline evaluation of the current situation, including identification of existing strengths and weaknesses.</td>
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<td>3. Develop and execute action plan</td>
<td>Use the results of the baseline assessment to develop and execute an action plan based around a multimodal improvement strategy.</td>
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<td>4. Evaluate impact</td>
<td>Conduct a follow-up evaluation to assess the effectiveness of the plan, with a focus on its impact, acceptability and cost–effectiveness.</td>
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<td>5. Sustain programme over the long term</td>
<td>Develop an ongoing action plan and review cycle to support the long-term impact and benefits of the programme and the extent to which it is embedded across the health system and country, thus contributing to its overall impact and sustainability.</td>
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Who can give an example of a multimodal approach to reduce HAIs and improve infection control?
Multimodal strategies to combat antibiotic resistance (2)

• In 2007 the National Children’s Hospital in Costa Rica started working with WHO on a pilot study to reduce HAIs, including antibiotic-resistant bacteria.

• The Ministry of Health provided initial support and a local private company donated alcohol-based handrub for first year.

• Using a multimodal approach, this is what happened in Costa Rica…

Multimodal strategies to combat antibiotic resistance (3)

- Below you see the five crucial elements of the multimodal approach.
- In groups of 5–7 people, please refer to your handbook. Go through the instructions for group work 2.

- Building the right system
- Teaching the right things
- Checking the right things
- Selling the right messages
- Living IPC throughout the health system
Applying the multimodal strategy to preventing carbapenem resistance spread

**Focus on 3 recommendations:** Contact Precautions, Including Hand Hygiene and Isolation

- **Recommendation 2:** importance of hand hygiene compliance for the control of CRE-CRAB-CRPsA: Hand hygiene best practices according to the WHO guidelines on hand hygiene in health care should be implemented. *(Strong recommendation)*

- **Recommendation 4:** contact precautions: Contact precautions should be implemented when providing care for patients colonized or infected with CRE-CRAB-CRPsA. *(Strong recommendation)*

- **Recommendation 5:** patient isolation: Patients colonized or infected with CRE-CRAB-CRPsA should be physically separated from non-colonized or noninfected patients using (a) single room isolation or (b) by cohorting patients with the same resistant pathogen. *(Strong recommendation)*

Build it

The infrastructure, equipment, supplies, and other resources (including human) required to implement the intervention.

- Put in place/improve a sustainable system to reliably procure and deliver necessary supplies needed to enable: (a) compliance with hand hygiene at the ‘Five Moments’, that is, alcohol-based handrub at the point of care, water, soap and hand drying materials; (b) compliance with recommended contact precautions, that is, PPE, with a focus on the need for a range of sizes.
- In settings where water access/quality are not readily available, develop a plan for improving water access and quality.
- In settings where bar soaps are used for handwashing, they should be kept dry; hand drying materials should be single use.
- For special considerations relating to clinical handwash basins/sinks, including location and design, see the system change section in chapter 5 (environmental cleaning).
- Develop/adapt enforceable protocols/standard operating protocols available at the point of care on: (a) who decides about patient isolation (that is, designate nurses as decision-makers on isolation as they are 24/7 on the wards and it can be done in a more timely manner; (b) which organisms require the implementation of contact precautions and isolation; (c) criteria for ward closure, for example, outbreaks; (d) when is it acceptable to care for patients with different CROs in the same cohort and how the geographical separation should be done (that is, where there is no availability of separate rooms and influenced by local epidemiology); (e) what supplies need to be procured and distributed regularly.
- Define and agree on roles and responsibilities for effective procurement systems with strong IPC involvement.
- In settings where single rooms are in short supply/unavailable, consider using coloured tape on the floor to reinforce contact precautions and the geographical separation of cohorted patients.

Source: Implementation manual to prevent and control the spread of carbapenem-resistant organisms at the national and health care facility level
# Teach it

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<th>Training the appropriate health staff to ensure that interventions are implemented in line with evidence-based policies.</th>
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<td>• Assess local training needs.</td>
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<td>• Put in place/improve a reliable mechanism for producing/using updated training resources and information for staff on these recommendations with a focus on: (a) the use of risk assessment; (b) practical hands-on/real-life demonstrations (for example, PPE use); (c) training materials in the local language.</td>
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<td>• Reinforce application of the ‘Five Moments’ for hand hygiene for patients with invasive devices (see hand hygiene Tools and Resources).</td>
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<td>• Ensure that senior management and hospital administrators fully understand all aspects of CROs, including the importance of the moments for hand hygiene, the use of PPE, and the indications for contact precautions and isolation.</td>
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<td>• Secure sign-off of training plans by senior managers (for example, by the IPC committee or equivalent)</td>
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<td>• Train staff on a regular schedule on all aspects of these recommendations (focus on pre-employment/orientation and periodic updates) and enable staff to train others.</td>
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<tr>
<td>• Develop information/educational resources using a range of media for patients and carers with a focus on the implications of infection/colonization and psychological support. Those performing training should be competent in the subject matter.</td>
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Identifying gaps in IPC practices or other indicators to prioritize interventions and tracking practices to ensure that they are being done appropriately. Giving feedback to target audience and managers.

- Put in place/improve a monitoring, reporting and feedback mechanism (including roles and responsibilities) regarding:
  - reliable availability of hand hygiene infrastructures and products, for example, clinical handwash basins, soap, water, hand drying products, alcohol-based handrub;
  - percentage of staff compliant with standard operating procedures/protocols, for example, hand hygiene compliance according to the ‘Five Moments’; (b) use of contact precautions, including a mechanism for reporting shortages, stockouts and failure of PPE;
  - reliable availability of isolation and cohorting facilities;
  - appropriate use of isolation and cohorting facilities;
  - availability and use of patient and visitor information materials;
  - correct and timely implementation of contact precautions and isolation or cohort (that is, isolation of all patients with positive results for CRO in the last 24 hours).

- Ensure that monitoring, reporting and feedback mechanism address decision makers in addition to health care workers.

- Consider the development/use of daily/weekly checklists.

Sell it

Promoting interventions, including through promotional and advocacy messages and materials.

- In collaboration with staff, develop/adapt:
  - bedside identification reminders that respect the patient’s rights to privacy and dignity;
  - awareness-raising messages (for example, posters) placed appropriately to remind staff of correct practices;
  - scripts/prompts for local champions to use when communicating on necessary IPC measures for CROs (for example, strict use of contact precautions);
  - memos (electronic/paper) to communicate rapidly and on a large scale, for example, during outbreaks;
  - videos on the appropriate use of PPE;
  - patient information materials (leaflets and visual resources to account for low literacy).

- Support and strengthen communications between different team members (laboratory, microbiology, IPC, clinicians).

Source: Implementation manual to prevent and control the spread of carbapenem-resistant organisms at the national and health care facility level
**Live it**

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<th>Support for interventions at every level of the health system. For example, senior managers providing funding for equipment and other necessary resources and being champions and role models for IPC improvement.</th>
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<tr>
<td>• Encourage senior management to use relevant opportunities to explain that the facility is supportive of tackling AMR/CROs and to promote and reinforce protocols/standard operating procedures.</td>
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<td>• Engage senior clinicians and nurses to explain to colleagues the importance of hand hygiene, contact precautions and isolation/cohorting.</td>
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<tr>
<td>• Identify champions to be role models for the correct use of PPE.</td>
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<td>• Put in place visible signage showing key leader commitment to hand hygiene and contact precautions.</td>
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Control through good IPC is possible

Containment of a countrywide outbreak of Carbapenem-resistant *K. pneumoniae* in Israeli hospitals through a nationally implemented intervention

Further reading and references (1)

WHO Antibiotic Resistance:  

Guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in health care facilities  

CDC Antibiotic Resistance and CRE:  
https://www.cdc.gov/drugresistance/index.html  
https://www.cdc.gov/hai/organisms/cre/index.html

Evidence of hand hygiene to reduce transmission and infections by multidrug-resistant organisms in health care settings  
http://www.who.int/gpsc/5may/MDRO_literature-review.pdf

Best practices for environmental cleaning in healthcare facilities in resource-limited settings.  
https://www.cdc.gov/hai/prevent/resource-limited/environmental-cleaning.html
Further reading and references (2)


WHO WASH: water sanitation hygiene https://www.who.int/water_sanitation_health/en/
Further reading and references (3)

CDC Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings
https://www.cdc.gov/infectioncontrol/guidelines/isolation/index.html

WHO Hand hygiene self assessment framework

WHO Core components for IPC – implementation tools and resources
https://www.who.int/infection-prevention/tools/core-components/en/

WHO Infection Prevention and Control Assessment Framework (IPCAF) at the facility level:
https://www.who.int/infection-prevention/tools/core-components/IPCAF-facility.PDF

Guide to local production: WHO-recommended handrub formulations
https://www.who.int/gpsc/information_centre/handrub-formulations/en/

WHO Global framework for development and stewardship to combat antimicrobial resistance

Antimicrobial stewardship programmes in health care facilities in low- and middle-income countries. A WHO practical toolkit
https://apps.who.int/iris/bitstream/handle/10665/329404/9789241515481-eng.pdf
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