ANTIMICROBIAL RESISTANCE: A SILENT KILLER PANDEMIC

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Antibiotic-Resistant Infections Threaten Modern Medicine

Millions of people in the United States receive care that can be complicated by bacterial and fungal infections. Without antibiotics, we are not able to safely offer some life-saving medical advances.

Sepsis Treatment

Anyone can get an infection and almost any infection can lead to sepsis — the body's extreme response to an infection. Without timely treatment with antibiotics, sepsis can rapidly lead to tissue damage, organ failure, and death

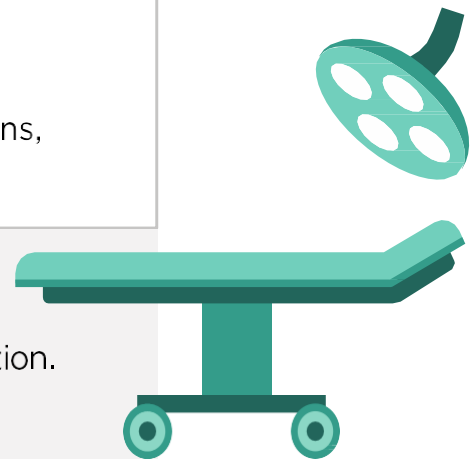
AT LEAST 1.7M adults develop sepsis each year.

Do I need to worry?

Surgery

Patients who have surgery are at risk for surgical site infections. Without effective antibiotics to prevent and treat surgical infections, many surgeries would not be possible today.

1.2M women had a cesarean section (C-section) in 2017. Antibiotics are recommended to help prevent infection.



What about my parents?

Chronic Conditions

Chronic conditions (e.g., diabetes) put people at higher risk for infection. These conditions and some medicines used to treat them can weaken the immune system (how the body fights infection).

MORE THAN 30M people have diabetes. Antibiotics are used to treat common infections in these patients.

Transplant patients?

Antibiotic-Resistant Infections Threaten Modern Medicine

Organ Transplants

Organ transplant recipients are more vulnerable to infections because they undergo complex surgery. Recipients also receive medicine to suppress (weaken) the immune system, increasing risk of infection.

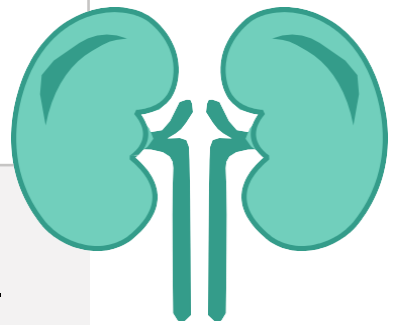
MORE THAN 33,000 organ transplants were performed in 2016. Antibiotics help organ transplants remain possible.

Dialysis patients

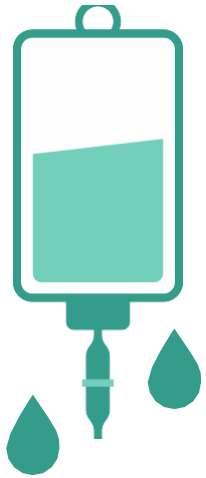
Dialysis for Advanced Kidney Disease

Patients who receive dialysis treatment have a higher risk of infection, the second leading cause of death in dialysis patients.

MORE THAN 500,000 patients received dialysis treatment in 2016. Antibiotics are critical to treat infections in patients receiving life-saving dialysis treatment.



Cancer care compromised?

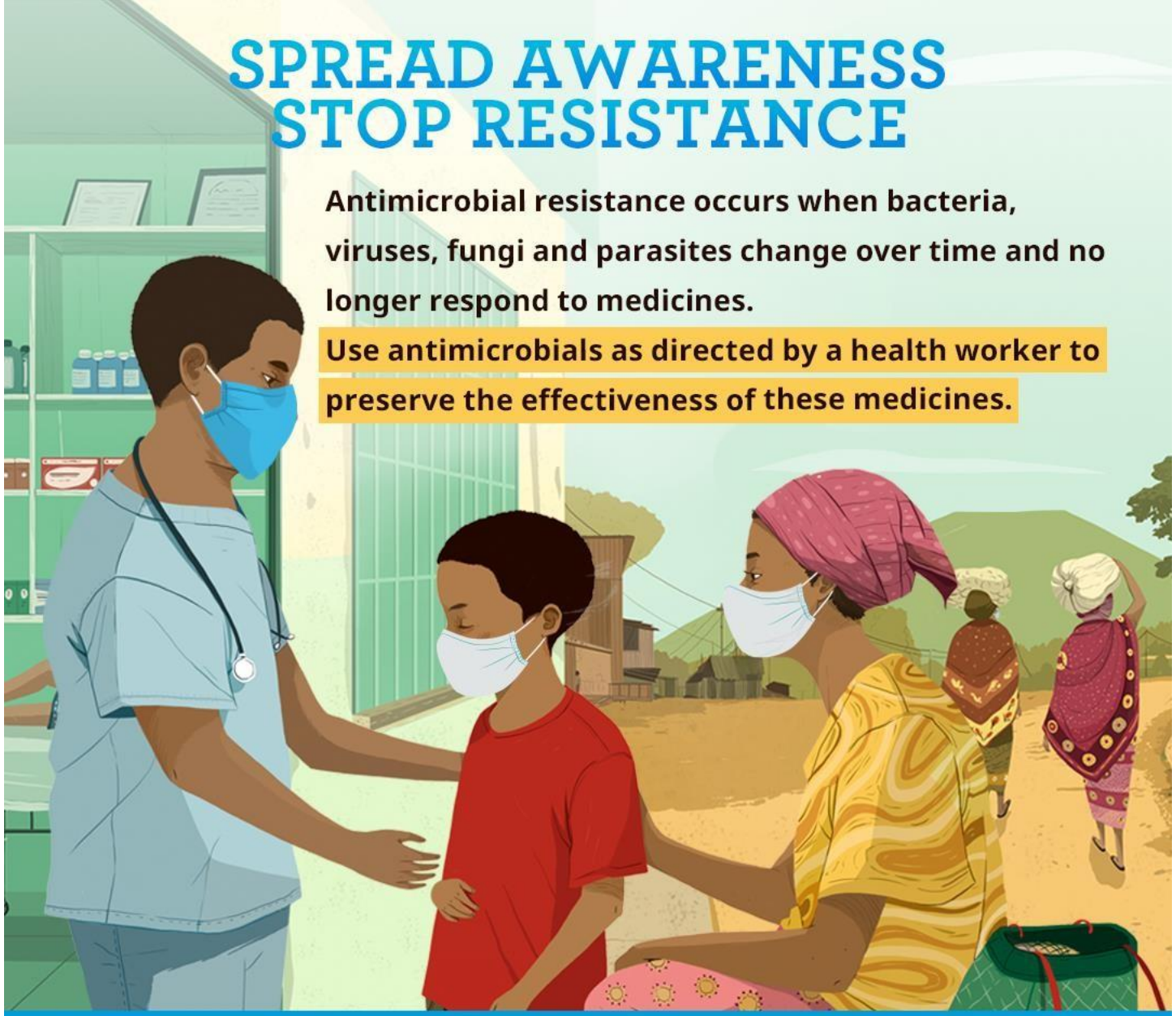


Cancer Care

People receiving chemotherapy for cancer are often at risk for developing an infection during treatment. Infection can quickly become serious for these patients.

AROUND 650,000 people receive outpatient chemotherapy each year. Antibiotics are necessary to protect these patients.

SPREAD AWARENESS
STOP RESISTANCE



Antimicrobial resistance occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to medicines.

Use antimicrobials as directed by a health worker to preserve the effectiveness of these medicines.

World Health Organization

HANDLE ANTIMICROBIALS WITH CARE

- Antibiotics
- Antivirals
- Antifungals
- Antiparasitics

Interconnected world

A ONE HEALTH CHALLENGE

The Interconnected Threat of Antibiotic Resistance

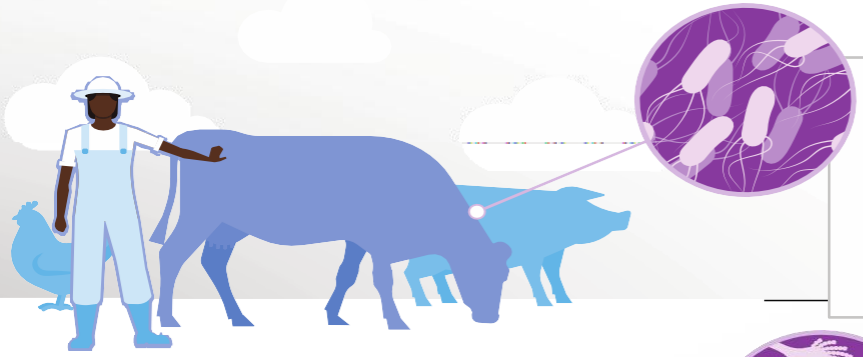
Resistance happens when germs (bacteria and fungi) defeat the drugs designed to kill them. Any antibiotic use—in people, animals, or crops—can lead to resistance. Resistant germs are a One Health problem—they can spread between people, animals, and the environment (e.g., water, soil).

Its not just us?

Examples of How Antibiotic Resistance Affects Humans, Animals & the Environment

People

Some types of antibiotic-resistant germs can spread person to person "Nightmare bacteria" carbapenem-resistant Enterobacteriaceae (CRE) can also survive and grow in sink drains at healthcare facilities and spread to patients and to the environment through the wastewater.



Animals

Resistant germs can spread between animals and people through food or contact with animals. For example, *Salmonella* Heidelberg bacteria can make both cattle and people sick.

Environment

Antibiotic-resistant germs can spread in the environment. *Aspergillus fumigatus*, a common mold, can make people with weak immune systems sick. In 2018, resistant *A. fumigatus* was reported in three patients. It was also found in U.S. crop fields treated with fungicides that are similar to antifungals used in human medicine.

SPREAD AWARENESS
STOP RESISTANCE

1 in 10 patients get an infection while receiving care.

Health workers can reduce the spread of infections by ensuring their hands, instruments and environment are kept clean.

World Health Organization

HANDLE ANTIMICROBIALS WITH CARE

Antibiotics
Antivirals
Antifungals
Antiparasitics

SPREAD AWARENESS
STOP RESISTANCE

Substandard and falsified medicines contribute to antimicrobial resistance.

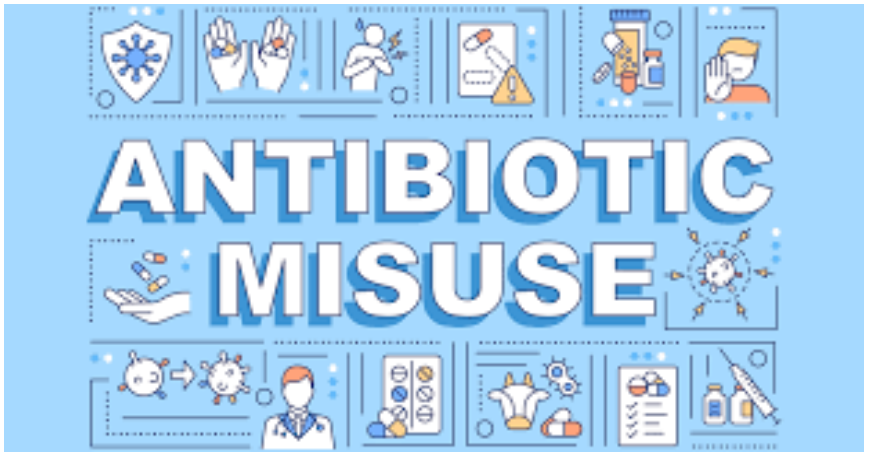
Increased regulation and enforcement promotes availability of quality medicines for all.

World Health Organization

HANDLE ANTIMICROBIALS WITH CARE

Antibiotics
Antivirals
Antifungals
Antiparasitics

Abuse and misuse data



Why should we talk about resistance

"Resistance training is just as important as cardio. Train yourself to resist chocolate, pastries, fried foods, beer, pizza...."

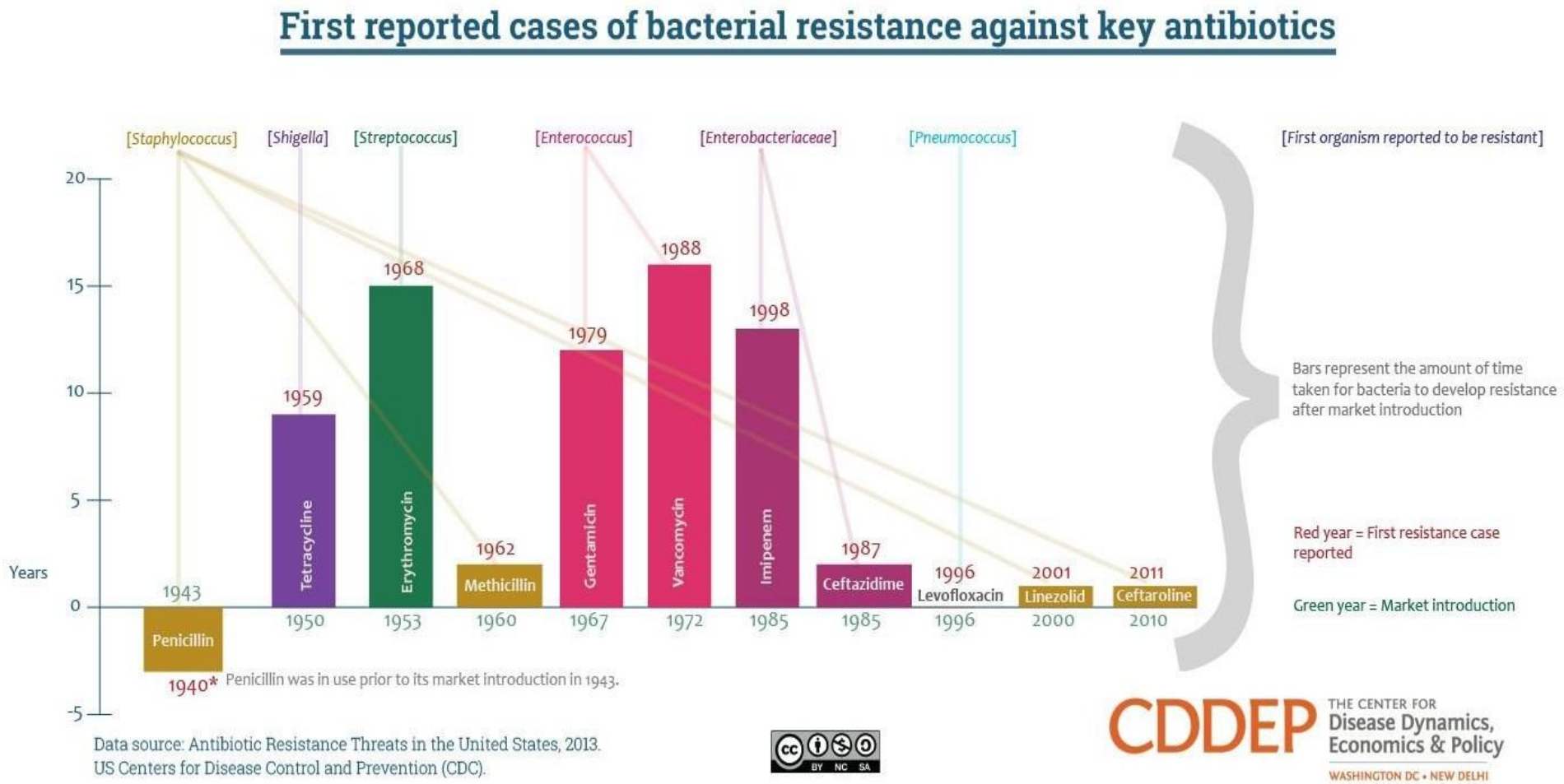
Understanding resistance is Important…

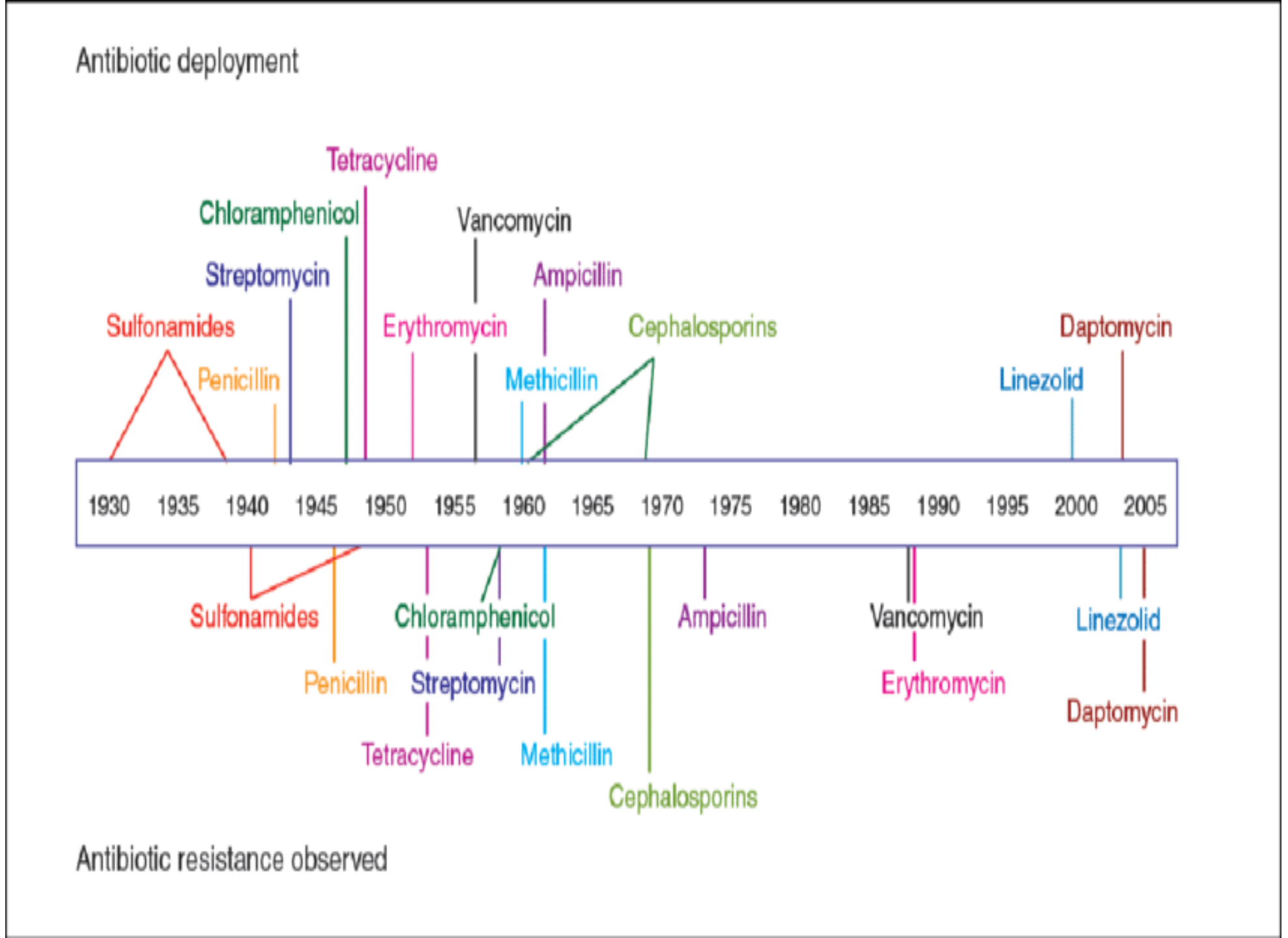
The silent tsunami facing modern medicine

- Has been the topic of numerous international health & political summits
- Great deal of data exists in the form of reports & guidelines to tackle antibiotic resistance
- Still, the problem of resistance, esp MDR- GNB continues to increase with every passing day

Antibiotic Approved or Released	Year Released	Resistant Germ Identified	Year Identified
Penicillin	1943	Penicillin-resistant *Streptococcus pneumoniae*[9,10] Penicillinase-producing *Neisseria gonorrhoeae*[11]	1967 1976
Vancomycin	1958	Plasmid-mediated vancomycin-resistant *Enterococcus faecium*[12,13] Vancomycin-resistant *Staphylococcus aureus*[14]	1988 2002
Amphotericin B	1959	Amphotericin B-resistant *Candida auris*[15]	2016
Methicillin	1960	Methicillin-resistant *Staphylococcus aureus*[16]	1960
Extended-spectrum cephalosporins	1980 (Cefotaxime)	Extended-spectrum beta-lactamase- producing *Escherichia coli*[17]	1983
Azithromycin	1980	Azithromycin-resistant *Neisseria gonorrhoeae*[18]	2011
Imipenem	1985	*Klebsiella pneumoniae* carbapenemase (KPC)-producing *Klebsiella pneumoniae*[19]	1996
Ciprofloxacin	1987	Ciprofloxacin-resistant *Neisseria gonorrhoeae*[20]	2007
Fluconazole	1990 (FDA approved)	Fluconazole-resistant *Candida*[21]	1988
Caspofungin	2001	Caspofungin-resistant *Candida*[22]	2004
Daptomycin	2003	Daptomycin-resistant methicillin-resistant *Staphylococcus aureus*[23]	2004
Ceftazidime-avibactam	2015	Ceftazidime-avibactam-resistant KPC-producing *Klebsiella pneumoniae*[24]	2015

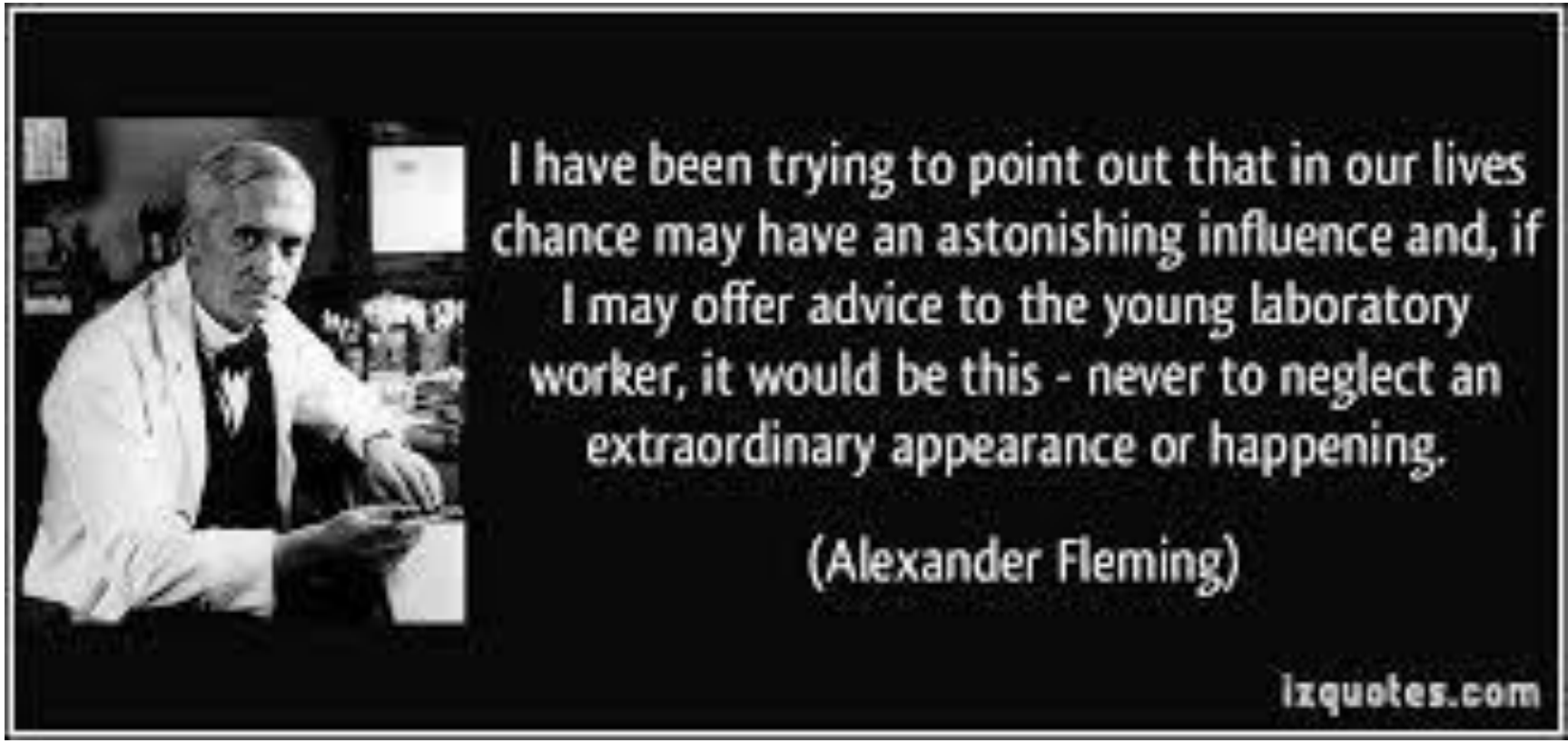
Timeline of Antibiotic Introduction & Resistance




Antibiotic deployment
Tetracycline
Chloramphenicol
Vancomycin
Streptomycin
Ampicillin
Sulfonamides
Erythromycin
Cephalosporins
Daptomycin
Penicillin
Methicillin
Linezolid
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Sulfonamides
Chloramphenicol
Ampicillin
Vancomycin
Linezolid
Penicillin
Streptomycin
Erythromycin
Daptomycin
Tetracycline
Methicillin
Cephalosporins
Antibiotic resistance observed

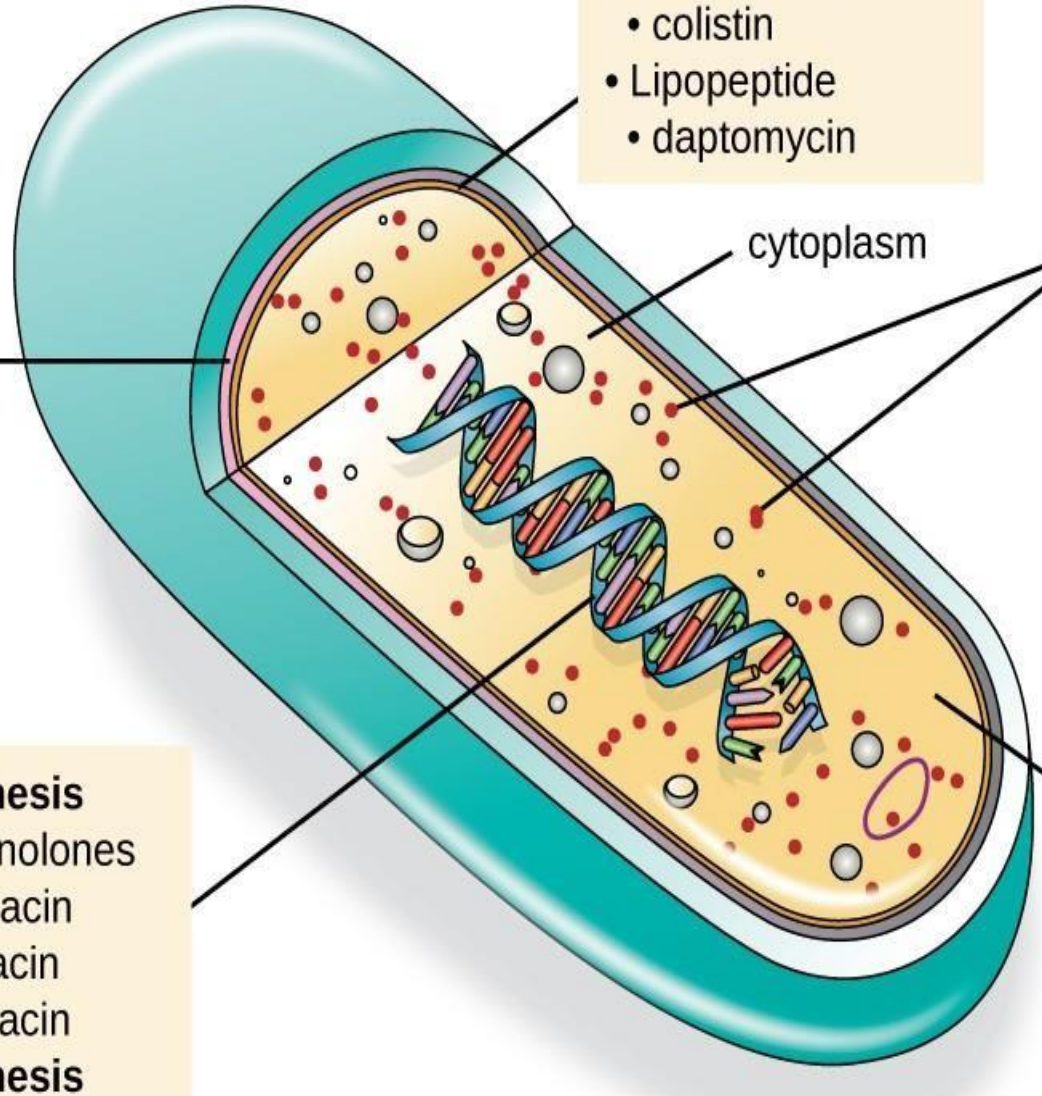

A post-antibiotic era means, in effect, an end to modern medicine as we know it. Things as common as strep throat or a child's scratched knee could once again kill.
Former Dir. Gen- WHO
Dr Margaret Chan

Mechanisms of antibiotic action



Plasma membrane
- Polymyxins
  - polymyxin B
  - colistin
- Lipopeptide
  - daptomycin

Cell wall
- β-lactams
  - penicillins
  - cephalosporins
  - monobactams
  - carbapenems
- Glycopeptides
  - vancomycin
- Bacitracin



Ribosomes
- 30S subunit
  - aminoglycosides
  - tetracyclines
- 50S subunit
  - macrolides
  - lincosamides
  - chloramphenicol
  - oxazolidinones

DNA synthesis
- Fluoroquinolones
  - ciprofloxacin
  - levofloxacin
  - moxifloxacin

RNA synthesis
- Rifamycins
  - rifampin

Metabolic pathways
- Folic acid synthesis
  - sulfonamides
  - sulfones
  - trimethoprim
- Mycolic acid synthesis
  - izoniazid

Antibiotic resistance is when germs (bacteria, fungi) develop the ability to defeat the antibiotics designed to kill them. It does not mean your body is resistant to antibiotics.

Development of Antibiotic Resistance

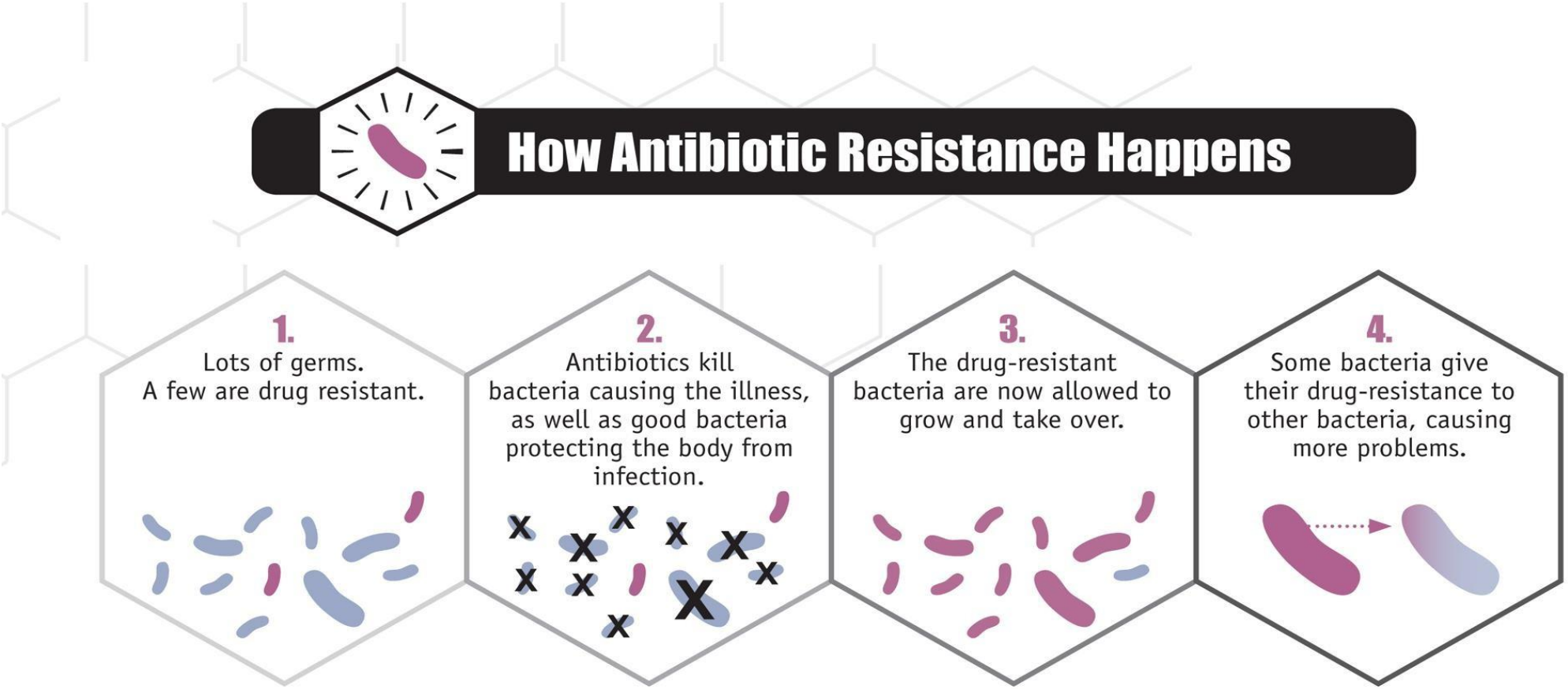
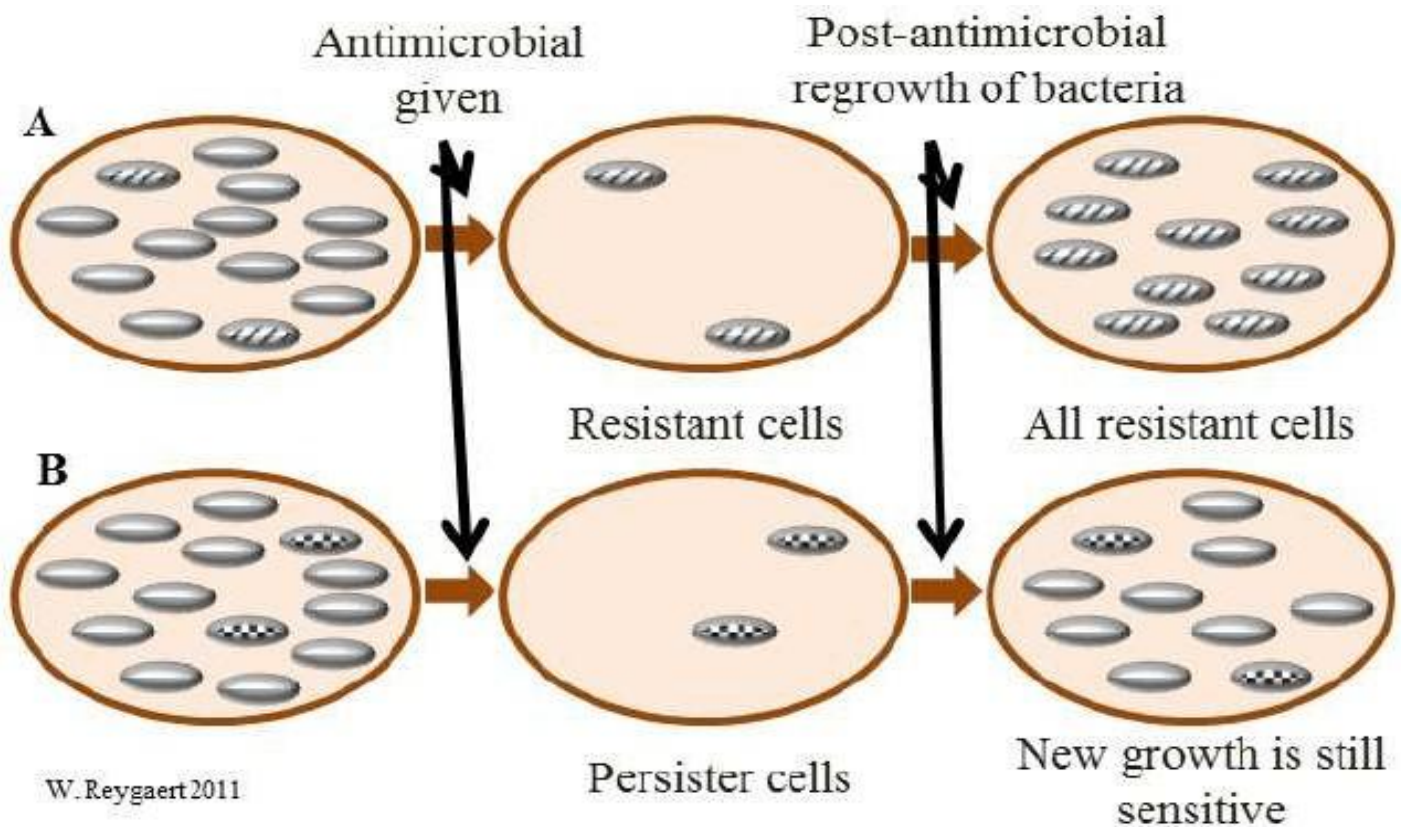


Image courtesy of CDC / Melissa Brower
Centers for Disease Control and Prevention Public Health Image Library
http://phil.cdc.gov/phil/home.asp

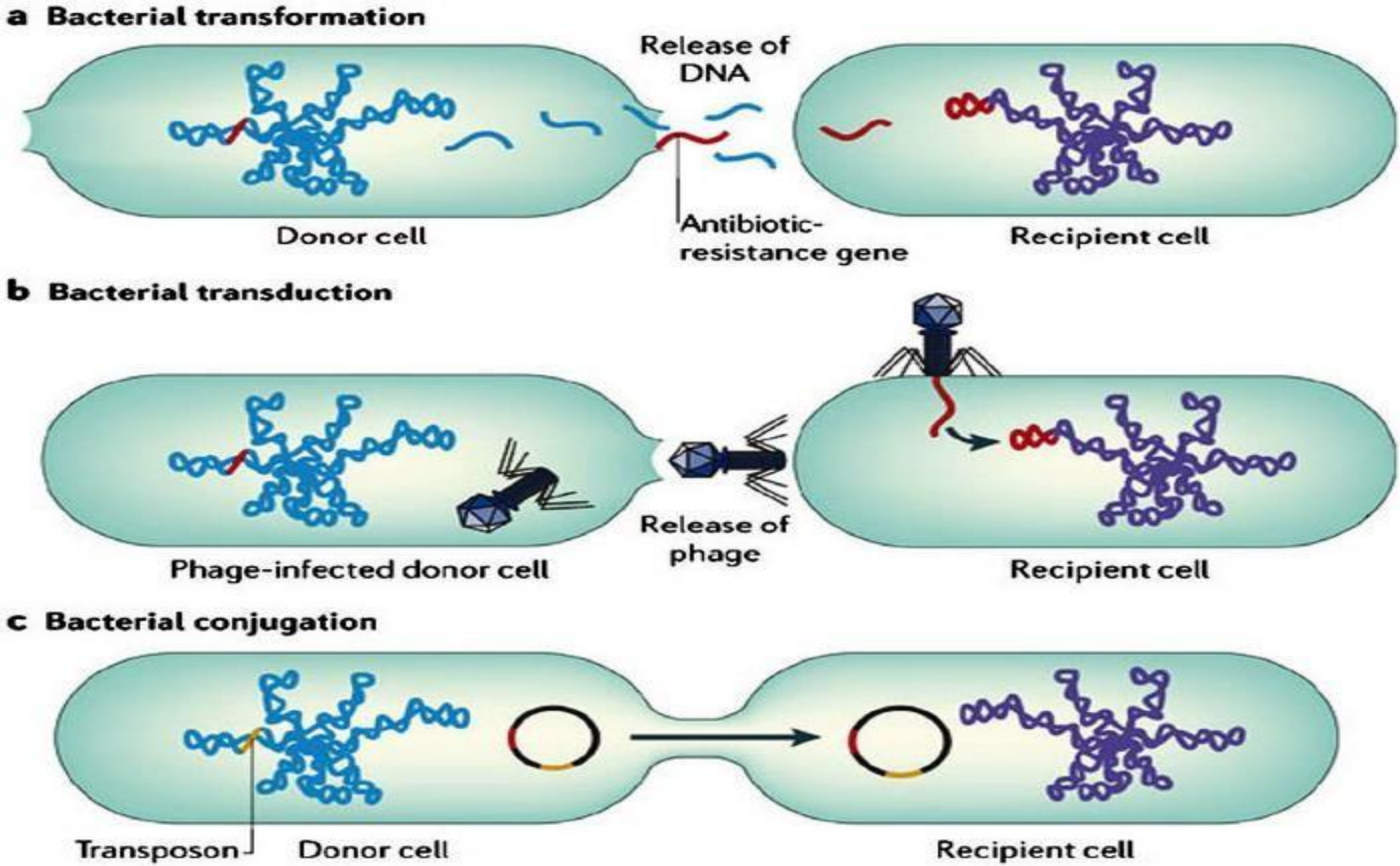
Persistance *vs* resistance ?



Development of Antibiotic Resistance

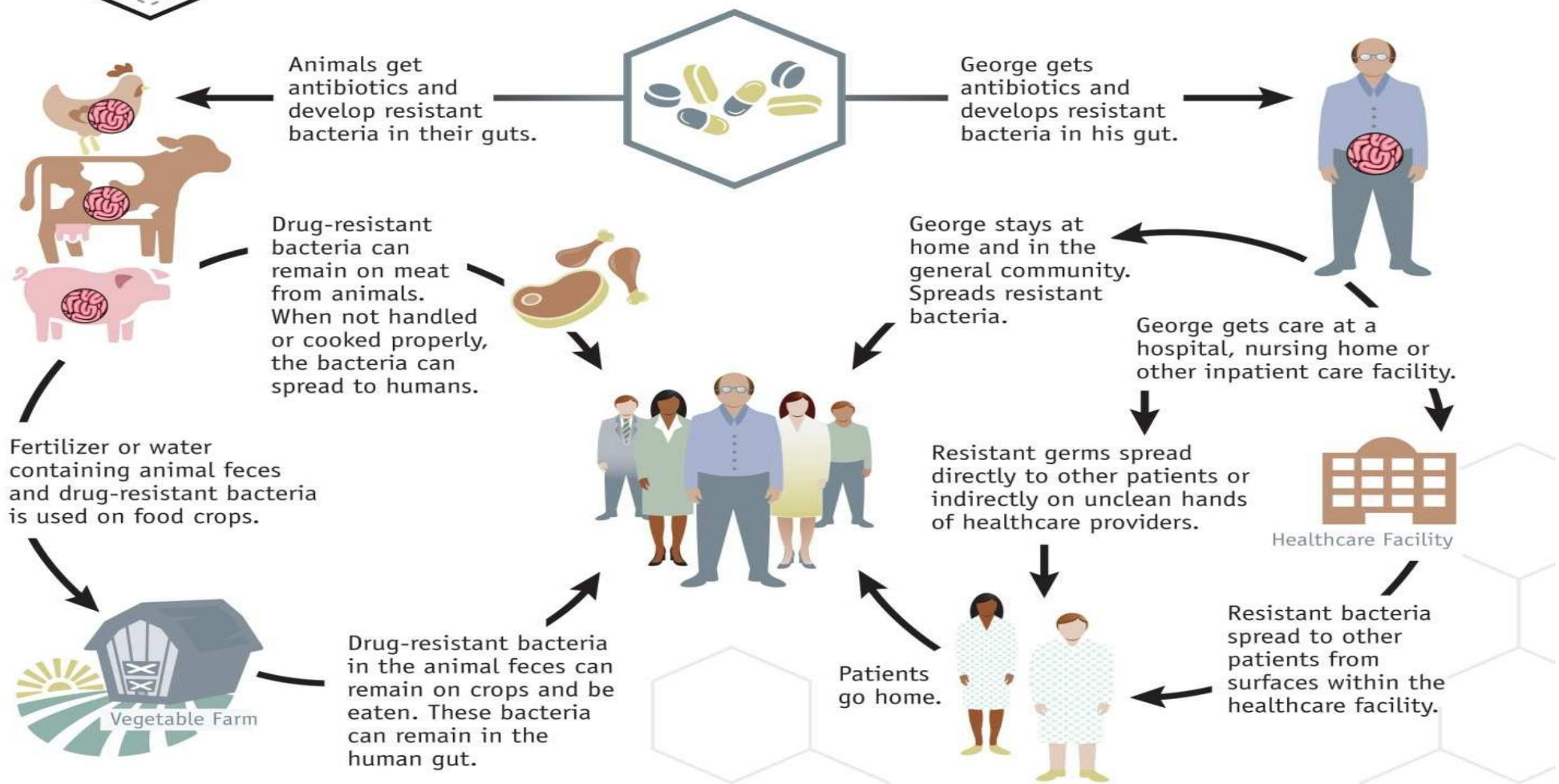
- **Selective advantage**
  - Bacteria that contain resistance mechanisms can survive and multiply when exposed to antibiotics
- **Gene transfer**
  - Allows bacteria to share genes that cause antibiotic resistance
- **Cross-resistance**
  - Changes in bacteria which create resistance to one antibiotic may cause resistance to other antibiotics as well

Collignon, 2002



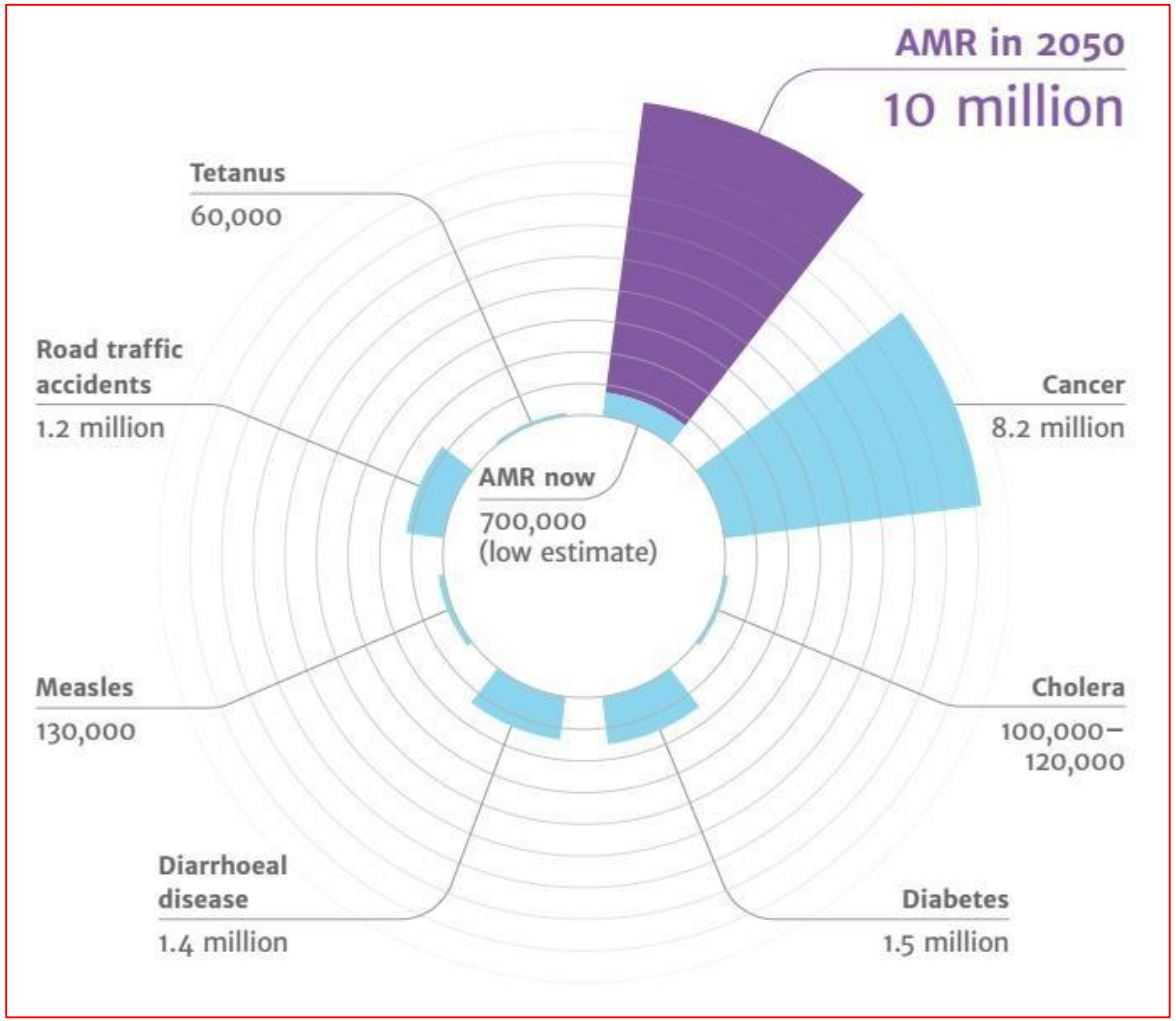
Nature Reviews | Microbiology

Examples of How Antibiotic Resistance Spreads



Simply using antibiotics creates resistance. These drugs should only be used to treat infections.

Deaths Attributable to AMR Every Year



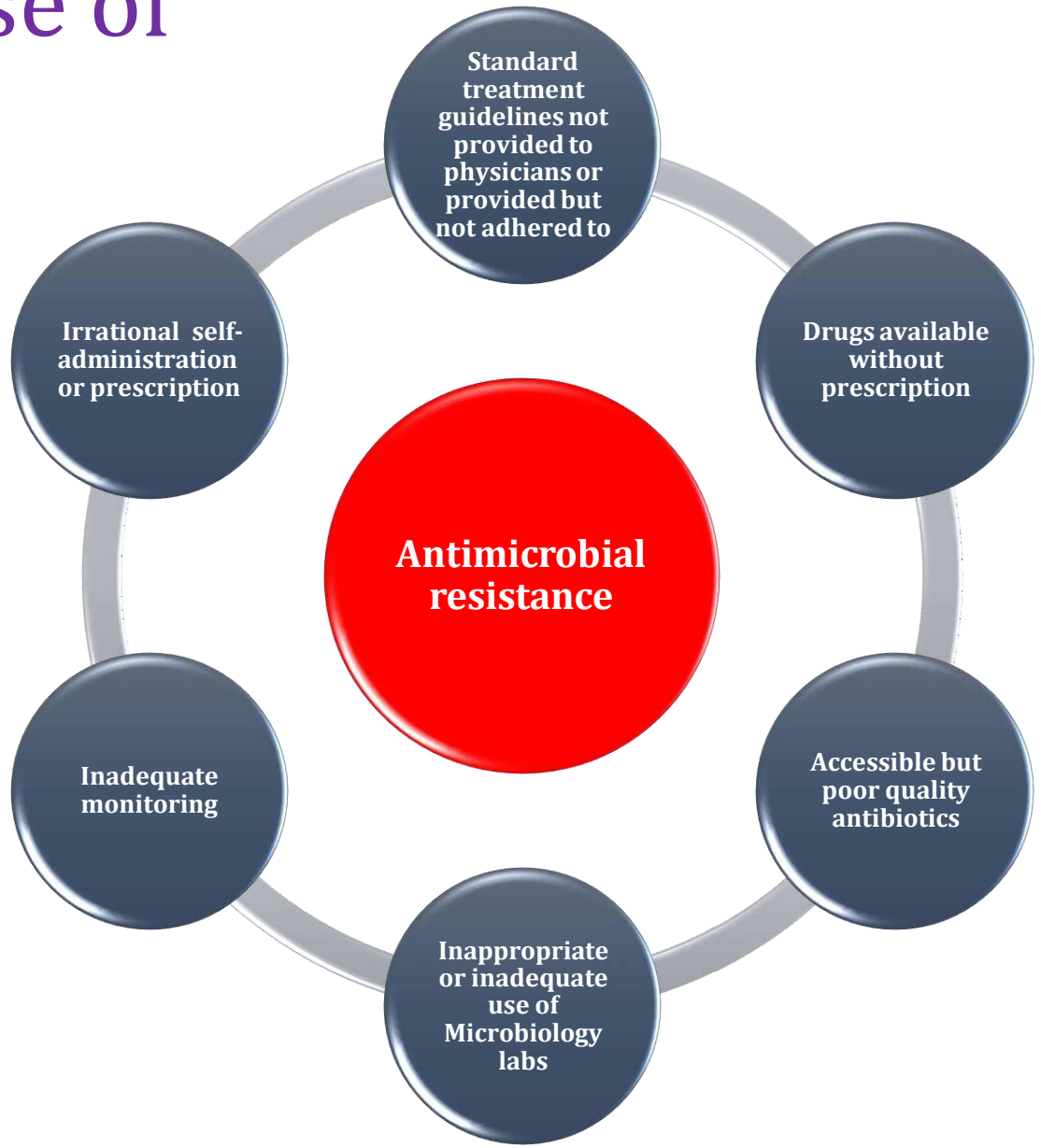
AMR, antimicrobial resistance

O'Neill J (Chair). Review on Antimicrobial Resistance. May 2016. Available from: http://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf [Accessed August 2016].

Resistance in microbes is a natural phenomenon

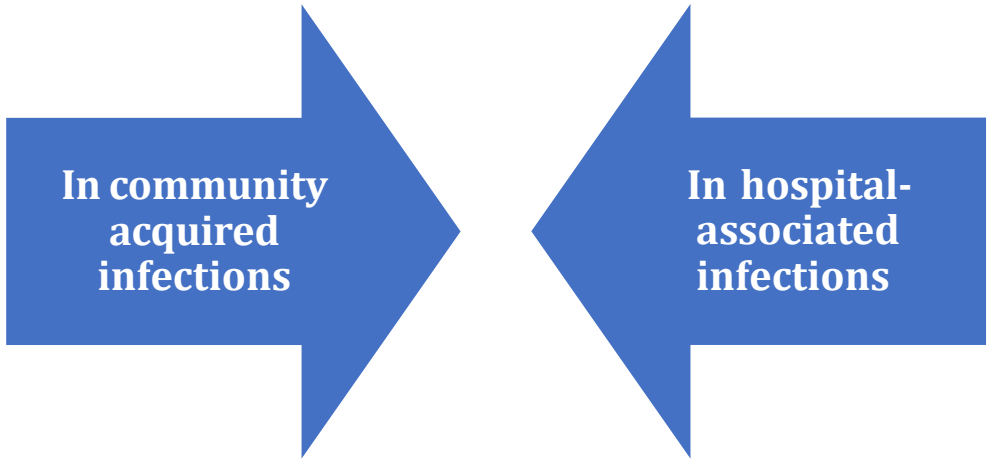
- Resistance is unresponsiveness to antimicrobial agents in standard doses
- A natural biological unstoppable phenomenon
- Resistance is generally slow to reverse or irreversible
- All antimicrobial agents have the potential to select drug-resistant subpopulations of microorganisms

Resistance is accelerated through inappropriate use of antimicrobials



Resistance is fallout of inappropriate use of antimicrobials in different settings

Therapeutic and non-therapeutic (e.g. as growth promoters)



- Irrational use of antibiotics is the greatest driver of resistance
  - **50%** of antibiotics are prescribed inappropriately
  - **50%** of patients have poor compliance
  - **50%** of populations do not have access to essential antibiotics

Data is Patchy

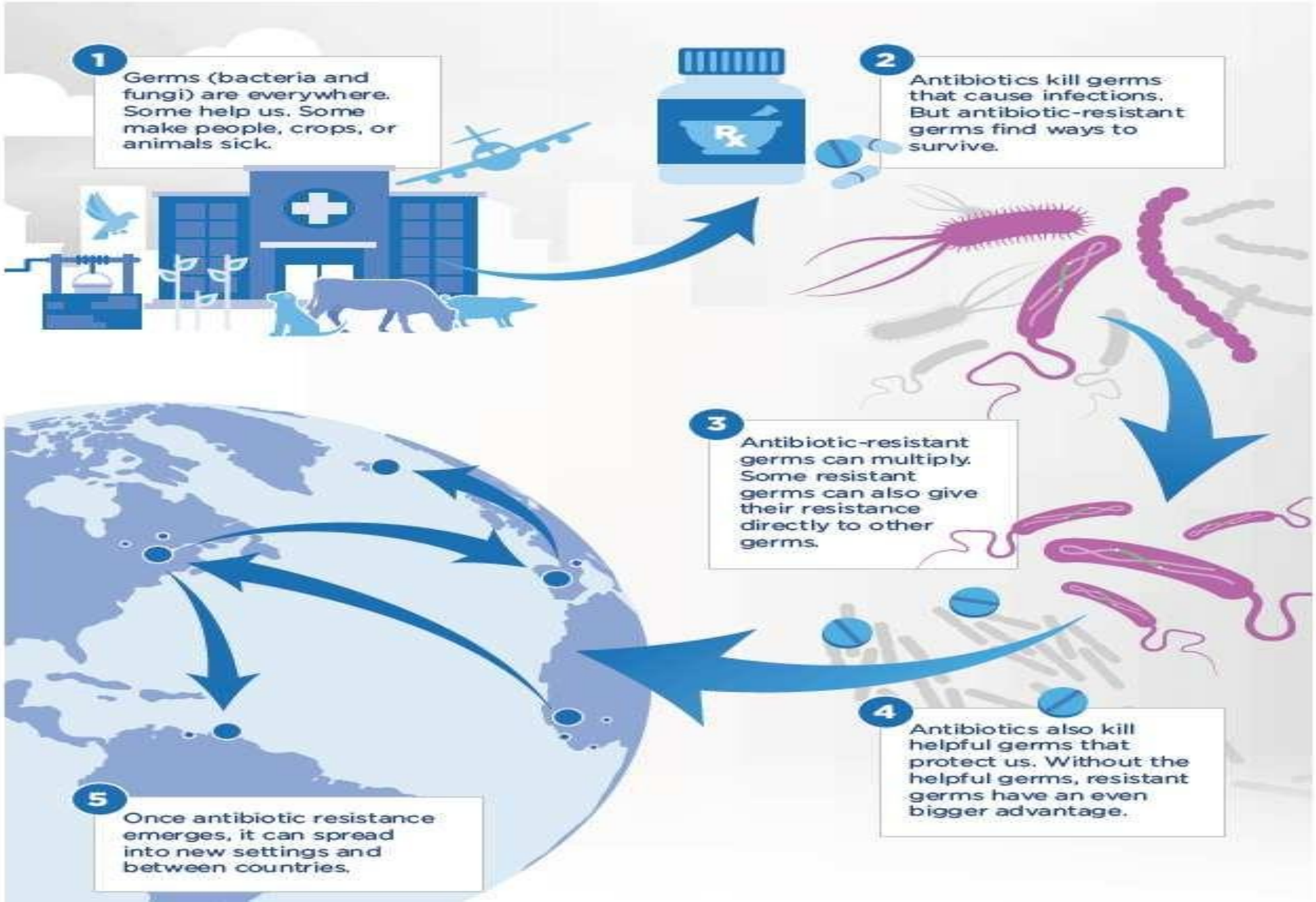
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Health Statistics and Information Systems (HSI)
World Health Organization

World Health Organization

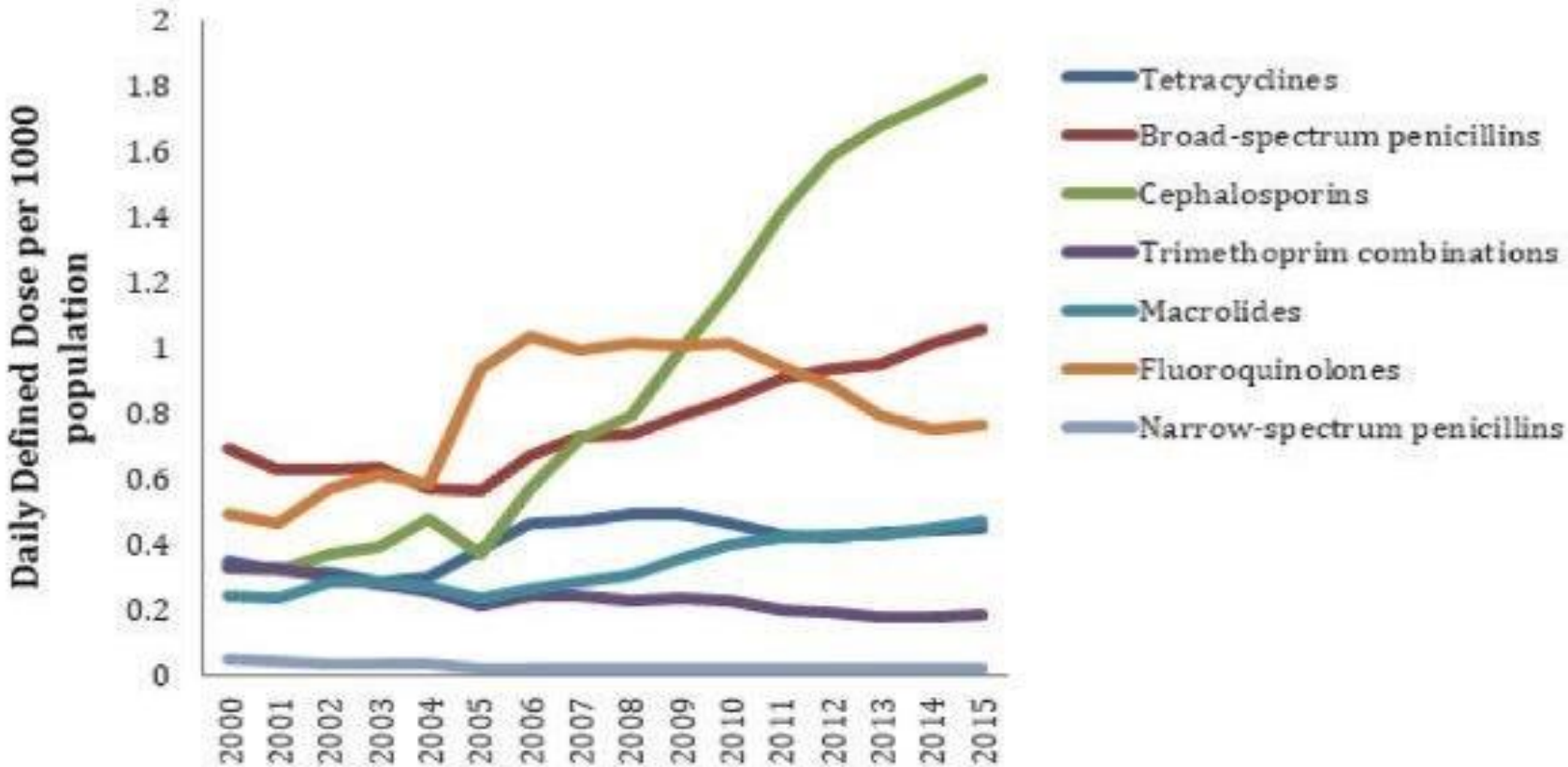
Available National Data* on Resistance for Nine Selected Bacteria/Antibacterial Drug Combinations, 2013

How Antibiotic Resistance Spreads



Impact on current and future patients

- **Antibiotic use contributes to the development of antibiotic resistance**
  - For most medicines, side effects are limited to the individual patient
  - Resistance developed from exposure to an antibiotic may affect the patient, but also affects future patients and the wider community
  - This reduces the number of effective antibiotics available to treat infections


Daily Defined Dose per 1000 population
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Tetracyclines
Broad-spectrum penicillins
Cephalosporins
Trimethoprim combinations
Macrolides
Fluoroquinolones
Narrow-spectrum penicillins

Origins of resistance

3.1. Natural resistance

3.2. Acquired resistance

Intrinsic resistance?

Intrinsic resistance: Large numbers of bacteria, both commensals and pathogens, naturally tend to be resistant to certain classes of antimicrobial agents

Table 2. Examples of bacteria with intrinsic resistance.

Organism	Intrinsic resistance
Bacteroides (anaerobes)	aminoglycosides, many β-lactams, quinolones
All gram positives	aztreonam
Enterococci	aminoglycosides, cephalosporins, lincosamides
Listeria monocytogenes	cephalosporins
All gram negatives	glycopeptides, lipopeptides
Escherichia coli	macrolides
Klebsiella spp.	ampicillin
Serratia marcescens	macrolides
Pseudomonas aeruginosa	sulfonamides, ampicillin, 1st and 2nd generation cephalosporins, chloramphenicol, tetracycline
Stenotrophomonas maltophilia	aminoglycosides, β-lactams, carbapenems, quinolones
Acinetobacter spp.	ampicillin, glycopeptides

Name of the Organism	Antibiotics
Citrobacter freundii	A, AUG, CZ, CEF
Citrobacter koseri	A
Klebsiella aerogenes	A, AUG, CZ, CEF
Enterobacter cloacae complex	A, AUG, CZ, CEF
Klebsiella pneumonia	A
Morganella morganii	A, AUG, CZ, COLI,CEF, TGC, NIF
Proteus mirabilis	TGC, NIF, COLI
Proteus penneri	A, CZ,CEF,TGC, NIF,COLI
Proteus vulgaris	A, CZ, CEF ,TGC, NIF, COLI
Providencia rettgeri	A,AUG,CZ,TGC,NIF,COLI
Providencia stuartii	A, AUG,CZ,TGC,NIF,COLI
Serratia marcescens	A, AUG,CZ,CEF,NIF,COLI
Enterococcus gallinarum and *cassiliflavus*	V
Candida glabrata	FLU

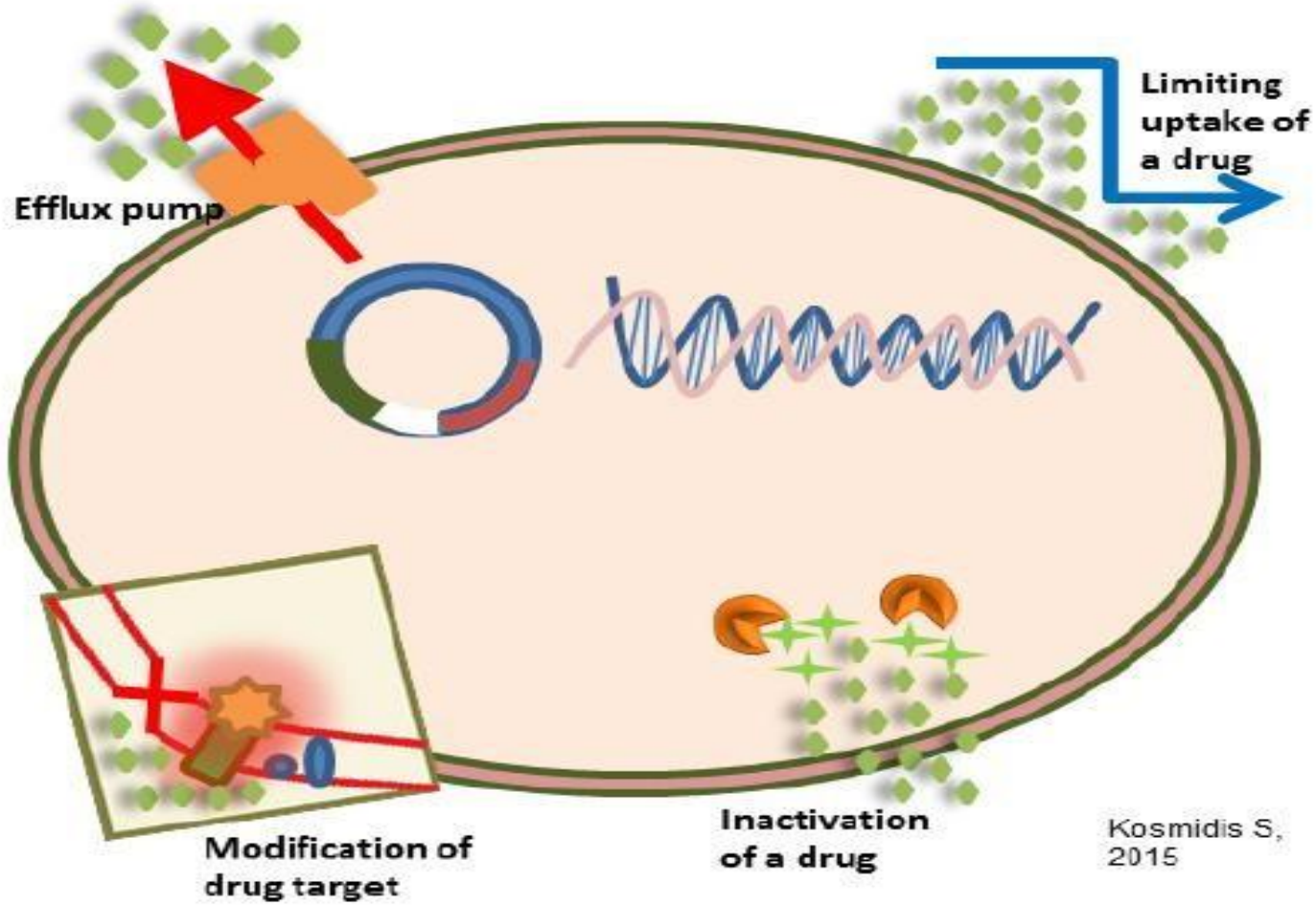


Figure 2. General antimicrobial resistance mechanisms.

What should we worry about?

Urgent Threats

- Carbapenem-resistant *Acinetobacter*
- *Candida auris (C. auris)*
- *Clostridioides difficile (C. difficile)*
- Carbapenem-resistant Enterobacteriaceae (CRE)
- Drug-resistant *Neisseria gonorrhoeae (N. gonorrhoeae)*

Serious Threats

- Drug-resistant *Campylobacter*
- Drug-resistant *Candida*
- Extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae
- Vancomycin-resistant *Enterococci* (VRE)
- Multidrug-resistant *Pseudomonas aeruginosa (P. aeruginosa)*
- Drug-resistant nontyphoidal *Salmonella*
- Drug-resistant *Salmonella* serotype Typhi
- Drug-resistant *Shigella*
- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Drug-resistant *Streptococcus pneumoniae (S. pneumoniae)*
- Drug-resistant Tuberculosis (TB)

Concerning Threats

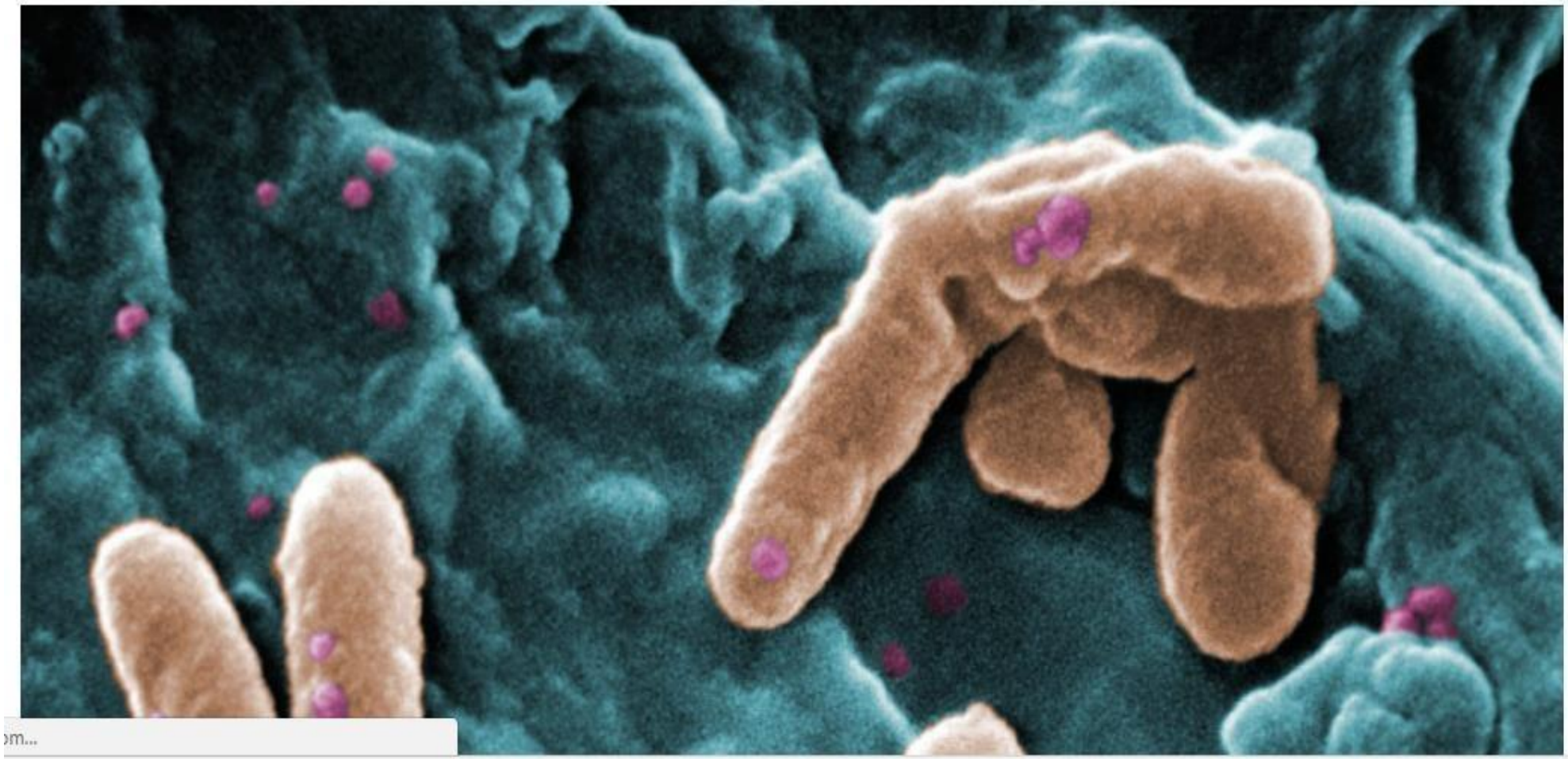
- Erythromycin-resistant group A *Streptococcus*
- Clindamycin-resistant group B *Streptococcus*

Watch List

- Azole-resistant *Aspergillus fumigatus (A. fumigatus)*
- Drug-resistant *Mycoplasma genitalium (M. genitalium)*
- Drug-resistant *Bordetella pertussis (B. pertussis)*

HEALTH

WHO releases list of world's most dangerous superbugs



- **Priority 1: Critical**
  1. *Acinetobacter baumannii*, carbapenem-resistant
  2. *Pseudomonas aeruginosa*, carbapenem-resistant
  3. *Enterobacteriaceae*, carbapenem-resistant, ESBL-producing
- **Priority 2: High**
  4. *Enterococcus faecium*, vancomycin-resistant
  5. *Staphylococcus aureus*, methicillin-resistant, vancomycin-intermediate and resistant
  6. *Helicobacter pylori*, clarithromycin-resistant
  7. *Campylobacter spp*., fluoroquinolone-resistant
  8. *Salmonellae*, fluoroquinolone-resistant
  9. *Neisseria gonorrhoeae*, cephalosporin-resistant, fluoroquinolone-resistant
- **Priority 3: Medium**
  10. *Streptococcus pneumoniae*, penicillin-non-susceptible
  11. *Haemophilus influenzae*, ampicillin-resistant
  12. *Shigella* spp., fluoroquinolone-resistant

HABITATS AND RESERVOIRS OF (ANTIBIOTIC-RESISTANT) GNB

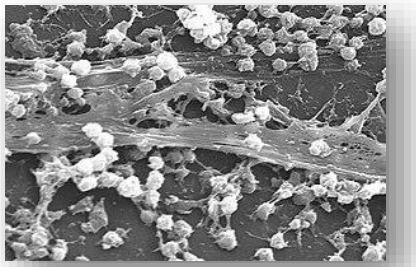
Name of pathogen	Natural reservoirs and sites of colonization	Transmission paths	Types of infection
Klebsiella spp.	Gastrointestinal (GI) and respiratory tract of humans and animals; fruit, vegetables, dairy products; wood pulp, paper mills, water storage tanks, surface water, sinks/drainage [196]	Contact, ingestion of contaminated food and water, bathing, aerosols/ droplets (inhalation)	Sepsis, urinary tract infections, pneumonia, endocarditis, intraabdomial infections, skin and soft tissue infections, ocular infections, meniningitis/brain abscess
Other *Enterobacteriaceae* spp. (rod-shaped)	Lower GI tract of humans and animals; plants; dairy products, raw meat; soil, water, sewage, sinks/ drainage; also dry surfaces [196, 197]	Contact, faecal/oral, ingestion of contaminated food and water, aerosols/droplets, contaminated infusions/ parenteral	Urinary tract infections, GI infections (diarrhoea), sepsis, intraabdominal infections
Acinetobacter spp.	Human skin and mucous membranes, pets/animals; vegetables, fish and shrimp farms; sewage, dump sites, waste water treatment plants, sinks/drainage; petroleum hydrocarbons; soil; warm and humid environments, but also able to survive in a dry environment [198, 199, 200]	Contact, ingestion of contaminated water and food, aerosols/droplets	Suppurative infections in any organ system, dominating respiratory infections, and soft tissue infections, rarely meningitis, ocular infections, native or prosthetic valve endocarditis, osteomyelitis; septic arthritis, pancreatic and liver abscesses, sepsis
P. aeruginosa	Human skin, upper respiratory system, GI tract; raw milk; moist environments including water (sinks/drainage), soil, plants [201]	Contact, ingestion of contaminated water, aerosols/droplets (inhalation)	Usually do not cause infections in healthy people; infections in any organ system, dominating sepsis, acute and chronic lung infections, ocular infections

Exner et al. GMS Hyg Infect Control. 2017; 12: Doc05.

INSIDE HOSPITALS, THEY CAN BE LURKING….

Colonized patients

Hosp Linen



Biofilms

Keyboards

Handwash Basins

Toilet Rims

Endoscopes

Exner et al. GMS Hyg Infect Control. 2017; 12: Doc05.

Problem

- Rising incomes and increasing access to antibiotics are saving lives (although lack of access still kills more people than antibiotic resistance)

- But are not a good substitute for public health

SIX CORE MEASURES FOR PREVENTION OF CARBAPENEM-RESISTANT *ENTEROBACTERIACEAE* IN ACUTE AND LONG-TERM CARE FACILITIES

1. Hand Hygiene
2. Contact Precautions
3. Patient and staff cohorting
4. Minimize use of invasive devices
5. Promote antimicrobial stewardship
6. Screening

For more information:
CDC 2012 CRE Toolkit: http://www.cdc.gov/hai/organisms/cre/cre-toolkit/

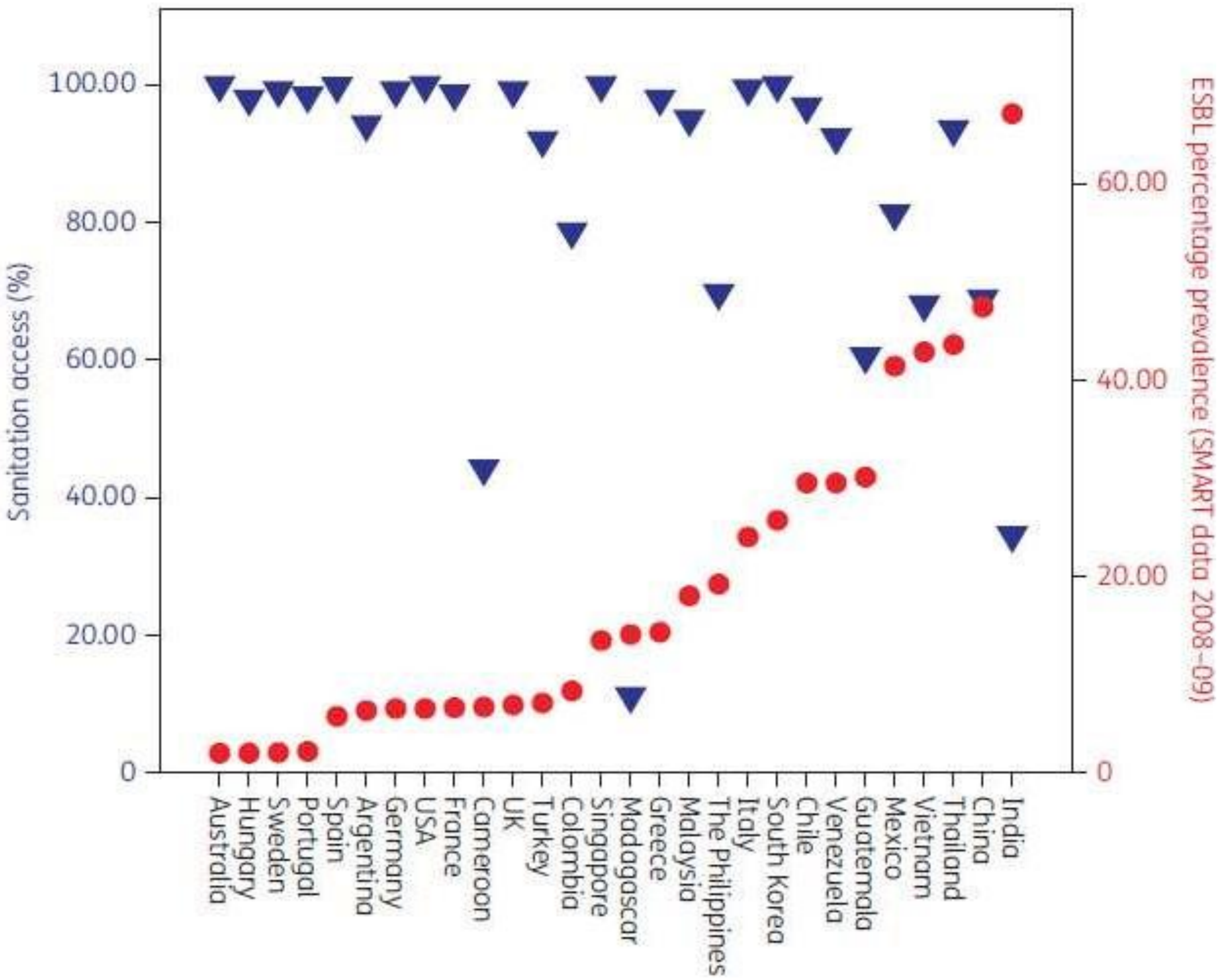
Infection prevention and control: Prevent infections and reduce the spread of germs

Tracking and data: Share data and improve data collection

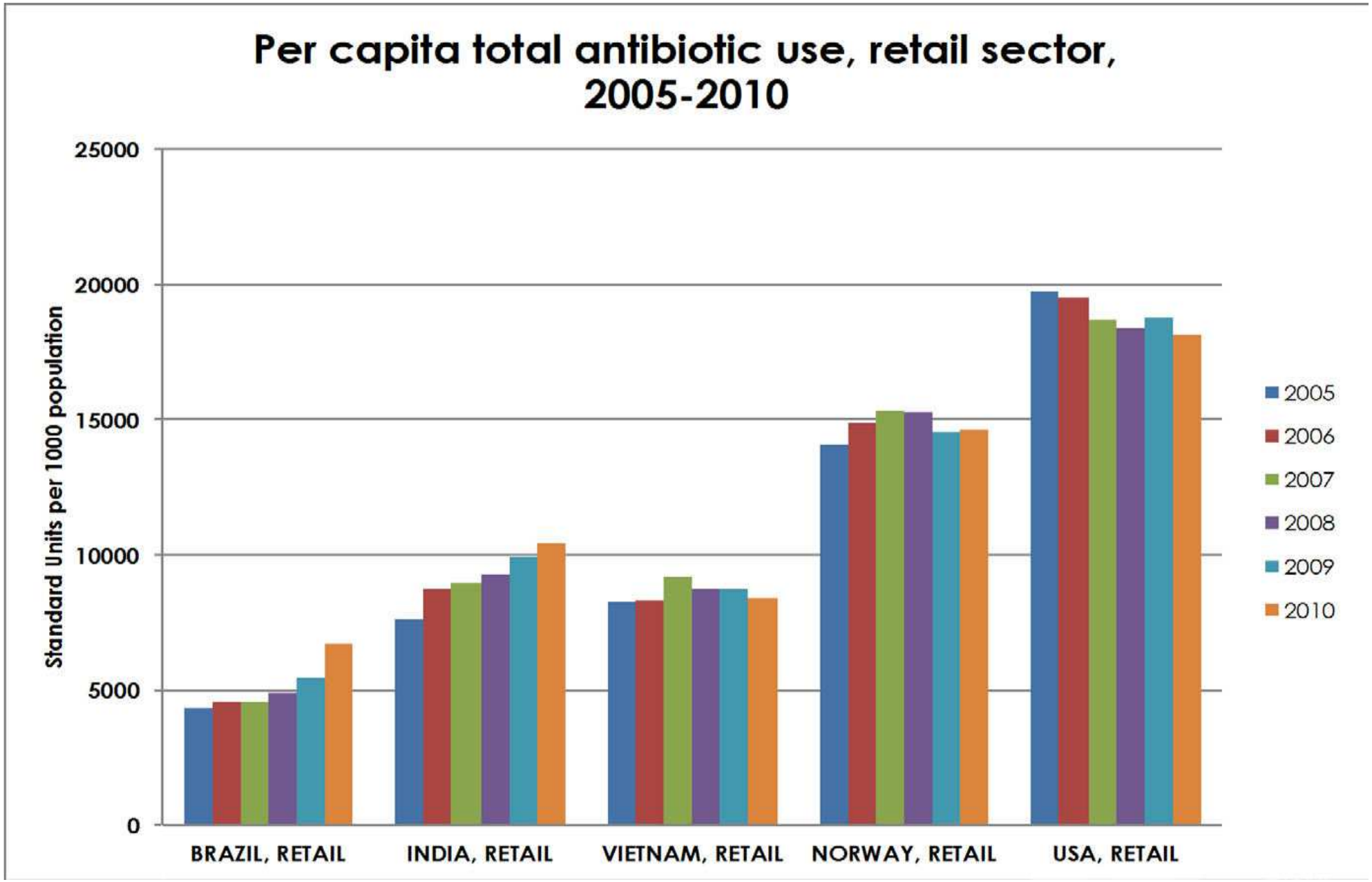
Antibiotic use and access: Improve appropriate use of antibiotics, reduce unnecessary use (called antibiotic stewardship), and ensure improved access to antibiotics

Vaccines, therapeutics, and diagnostics: Invest in development and improved access to vaccines, therapeutics, and diagnostics for better prevention, treatment, and detection

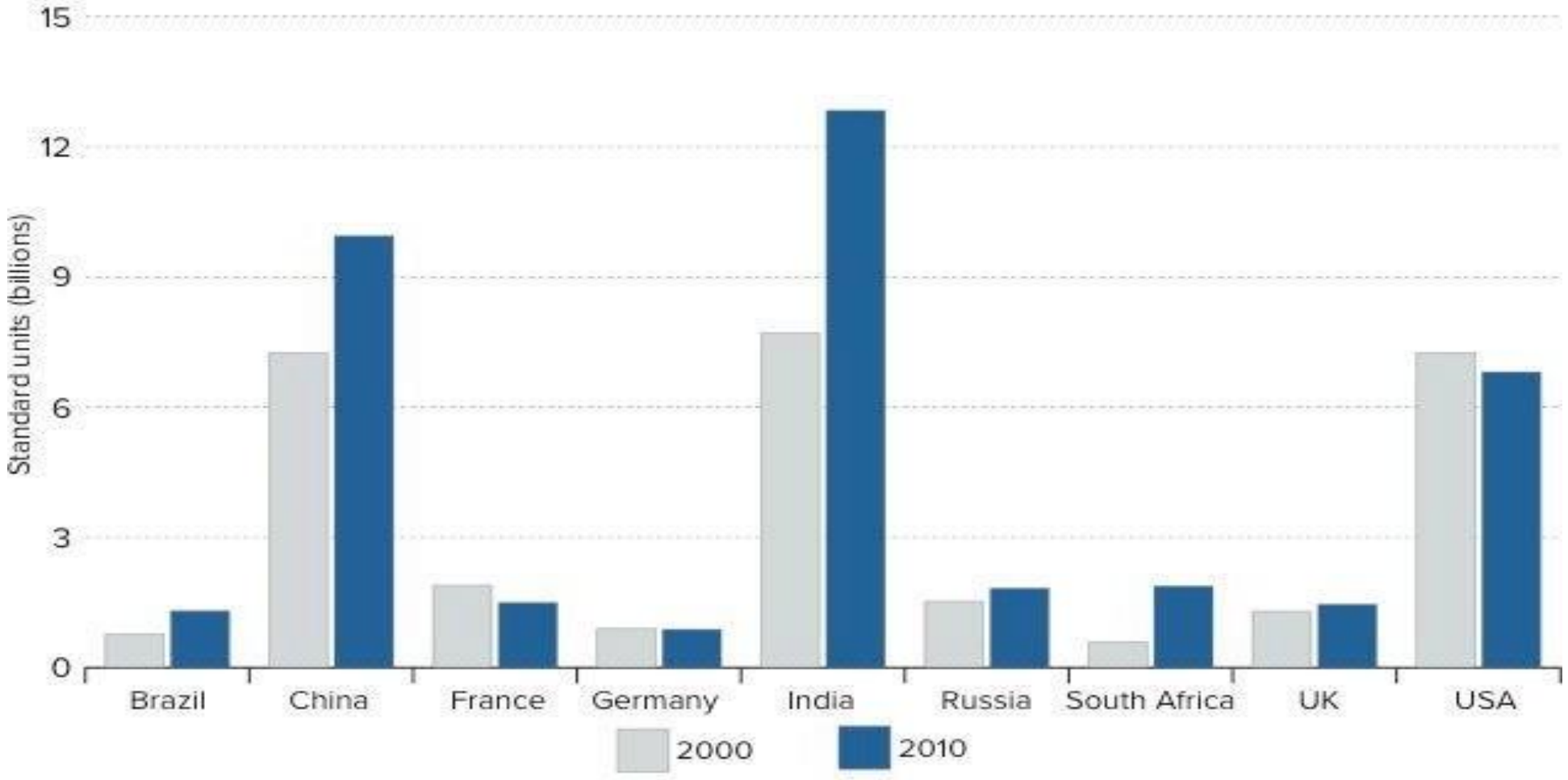
Environment and sanitation: Keep antibiotics and antibiotic-resistant threats from entering the environment through actions like improving sanitation and improving access to safe water



Sanitation access (%)
100.00
80.00
60.00
40.00
20.00
0
ESBL percentage prevalence (SMART data 2008–09)
60.00
40.00
20.00
0
Australia
Hungary
Sweden
Portugal
Spain
Argentina
Germany
USA
France
Cameroon
UK
Turkey
Colombia
Singapore
Madagascar
Greece
Malaysia
The Philippines
Italy
South Korea
Chile
Venezuela
Guatemala
Mexico
Vietnam
Thailand
China
India

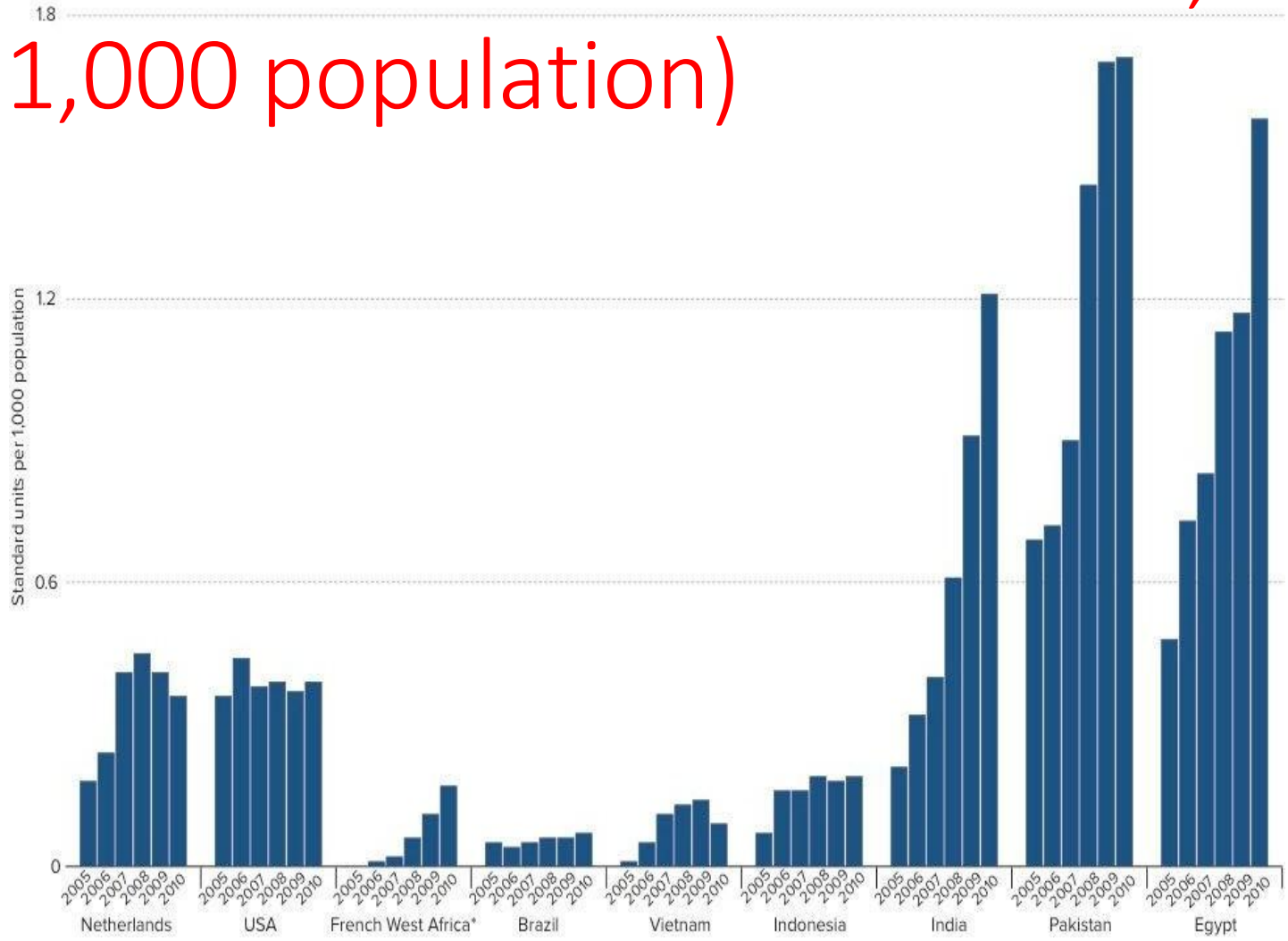

Per capita total antibiotic use, retail sector, 2005-2010
Standard Units per 1000 population
25000
20000
15000
10000
5000
0
BRAZIL, RETAIL
INDIA, RETAIL
VIETNAM, RETAIL
NORWAY, RETAIL
USA, RETAIL
2005
2006
2007
2008
2009
2010

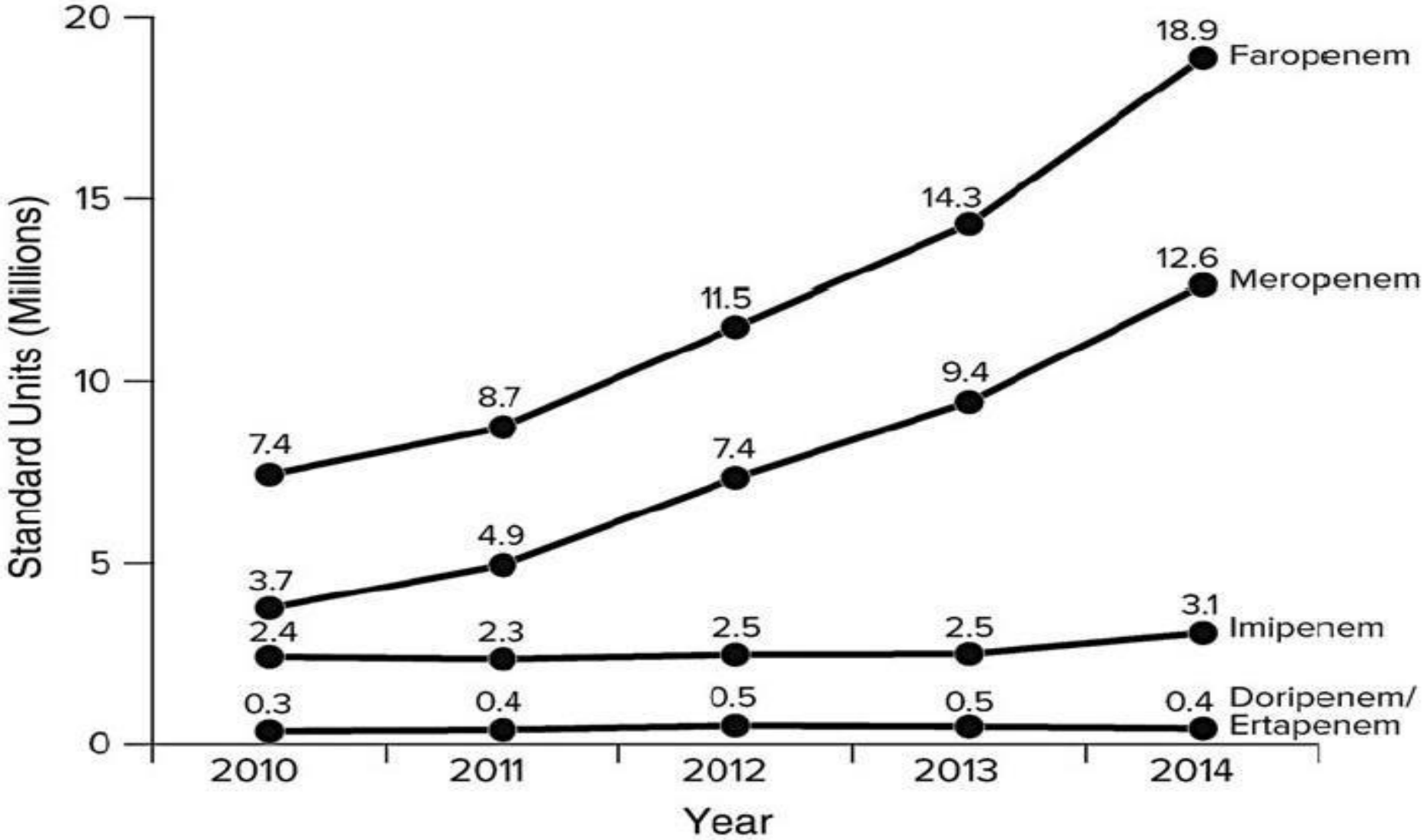
Total antibiotic consumption in selected countries, 2000 and 2010



Van Boeckel et al. 2014 (based on IMS MIDAS)

Carbapenem retail sales in selected countries, 2005–2010 (per 1,000 population)





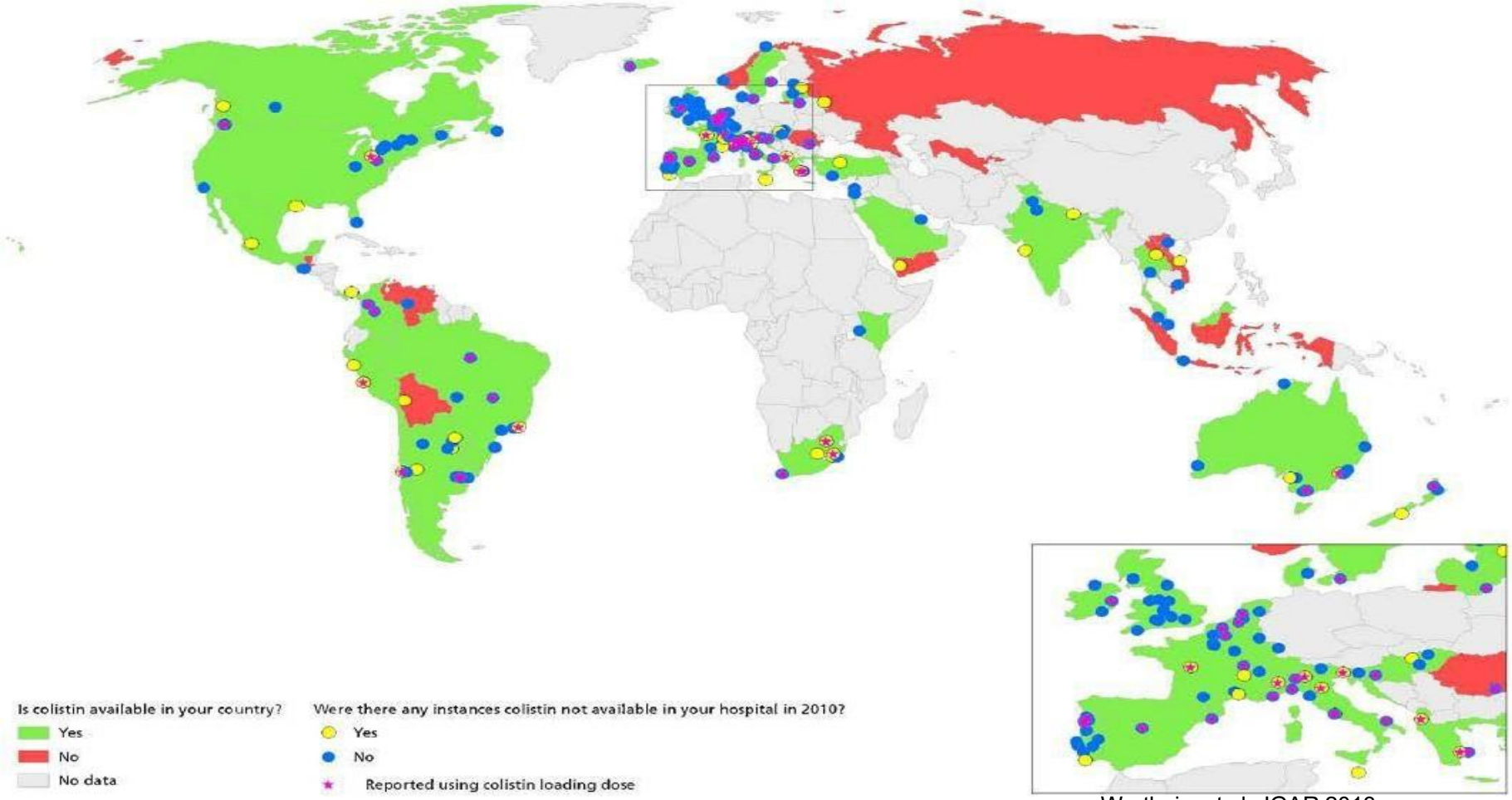
Gandra et al, Clin Inf Dis, 2016

But epidemiology can be local!

- Resistance trends are often local

- Resistance can vary by
  - Country and region
  - Hospital unit
  - Pathogen

Global availability of colistin



Wertheim et al, JGAR 2013

Emergence of plasmid-mediated colistin resistance mechanism MCR-1 in animals and human beings in China: a microbiological and molecular biological study

Yi-Yun Liu, Yang Wang*, Timothy R Walsh, Ling-Xian Yi, Rong Zhang, James Spencer, Yohei Doi, Guobao Tian, Baolei Dong, Xianhui Huang, Lin-Feng Yu, Danxia Gu, Hongwei Ren, Xiaojie Chen, Luchao Lv, Dandan He, Hongwei Zhou, Zisen Liang, Jian-Hua Liu, Jianzhong Shen*

Summary

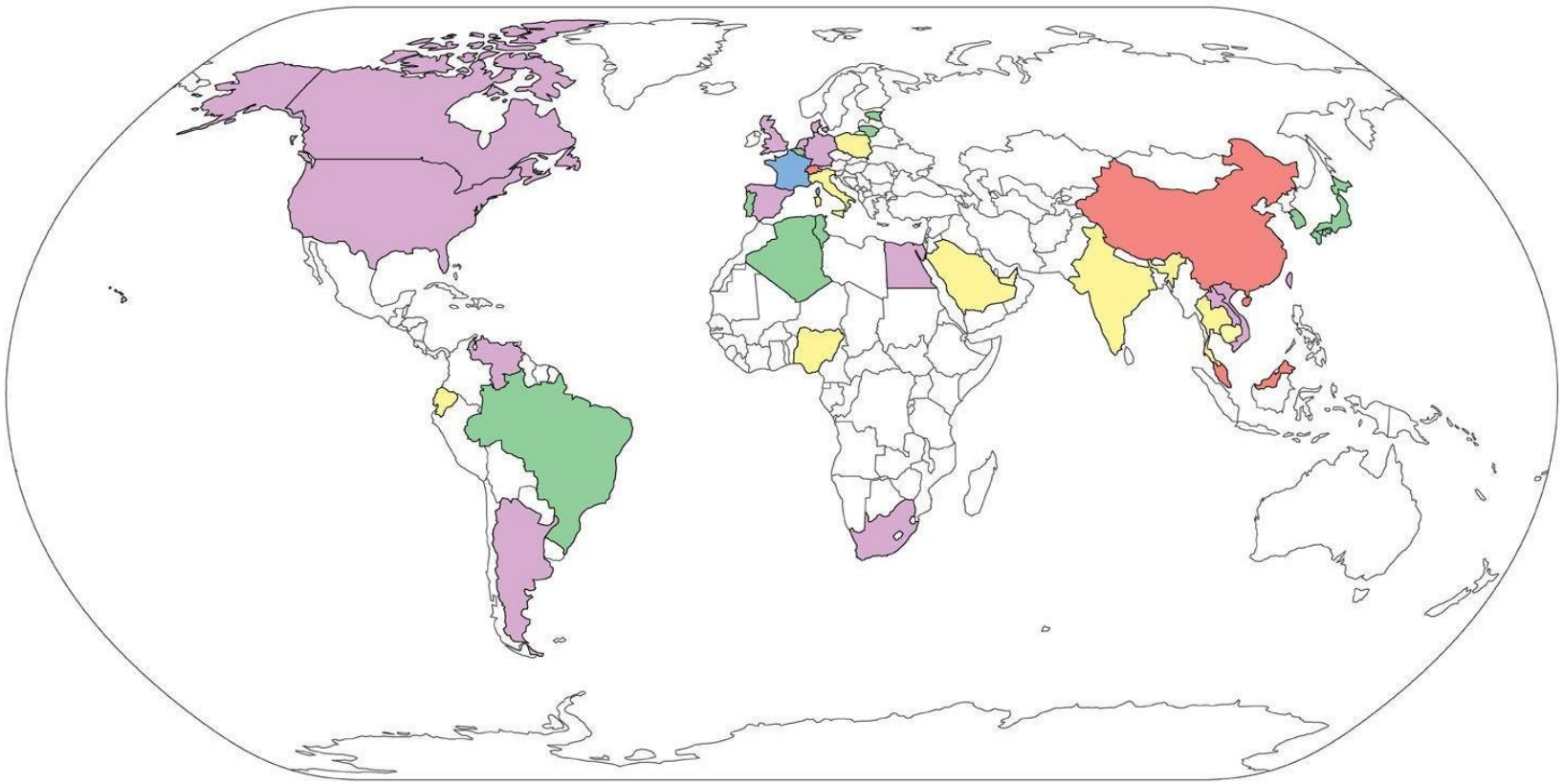
Background Until now, polymyxin resistance has involved chromosomal mutations but has never been reported via horizontal gene transfer. During a routine surveillance project on antimicrobial resistance in commensal *Escherichia coli* from food animals in China, a major increase of colistin resistance was observed. When an *E coli* strain, SHP45, possessing colistin resistance that could be transferred to another strain, was isolated from a pig, we conducted further analysis of possible plasmid-mediated polymyxin resistance. Herein, we report the emergence of the first plasmid-mediated polymyxin resistance mechanism, MCR-1, in Enterobacteriaceae.

Lancet Infect Dis 2015

Published Online
November 18, 2015
http://dx.doi.org/10.1016/S1473-3099(15)00424-7

See Online/Articles
http://dx.doi.org/10.1016/S1473-3099(15)00463-6

Countries reporting plasmid-mediated colistin resistance encoded by *mcr-1*



Isolate source(s):

- Animals
- Humans
- Animals and humans
- Animals and environment
- Animals, humans and environment

Data source: Al-Tawfiq, J. A., Laxminarayan, R. & Mendelson, M. How should we respond to the emergence of plasmid-mediated colistin resistance in humans and animals? Int. J. Infect. Dis. (2016). doi:10.1016/j.ijid.2016.11.415

CDDEP THE CENTER FOR Disease Dynamics, Economics & Policy
WASHINGTON DC • NEW DELHI

ANTIBIOTIC RESISTANCE
WHAT YOU CAN DO

HANDLE ANTIBIOTICS WITH CARE

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

1. Only use antibiotics when **prescribed** by a certified health professional
2. Always take the **full prescription**, even if you feel better
3. **Never use left over** antibiotics
4. **Never share** antibiotics with others
5. **Prevent infections** by regularly washing your hands, avoiding contact with sick people and keeping your vaccinations up to date

www.who.int/drugresistance

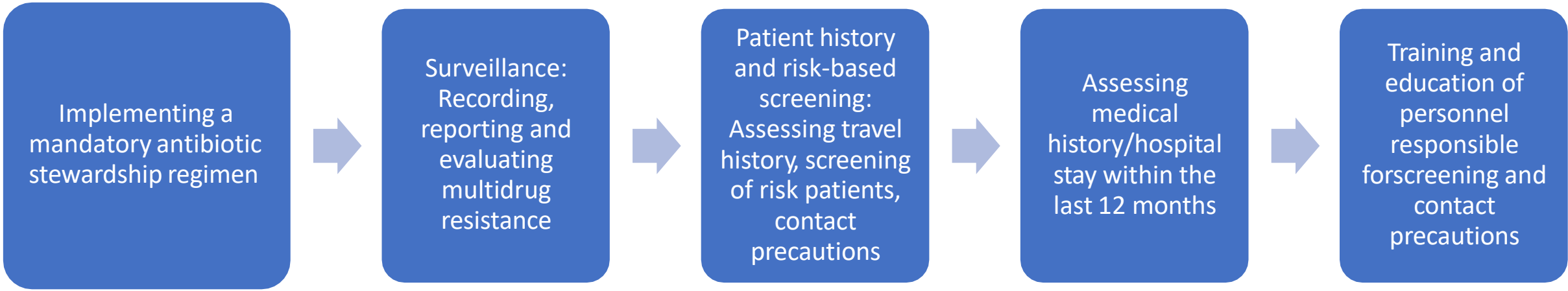
#AntibioticResistance

World Health Organization

Preventive strategies

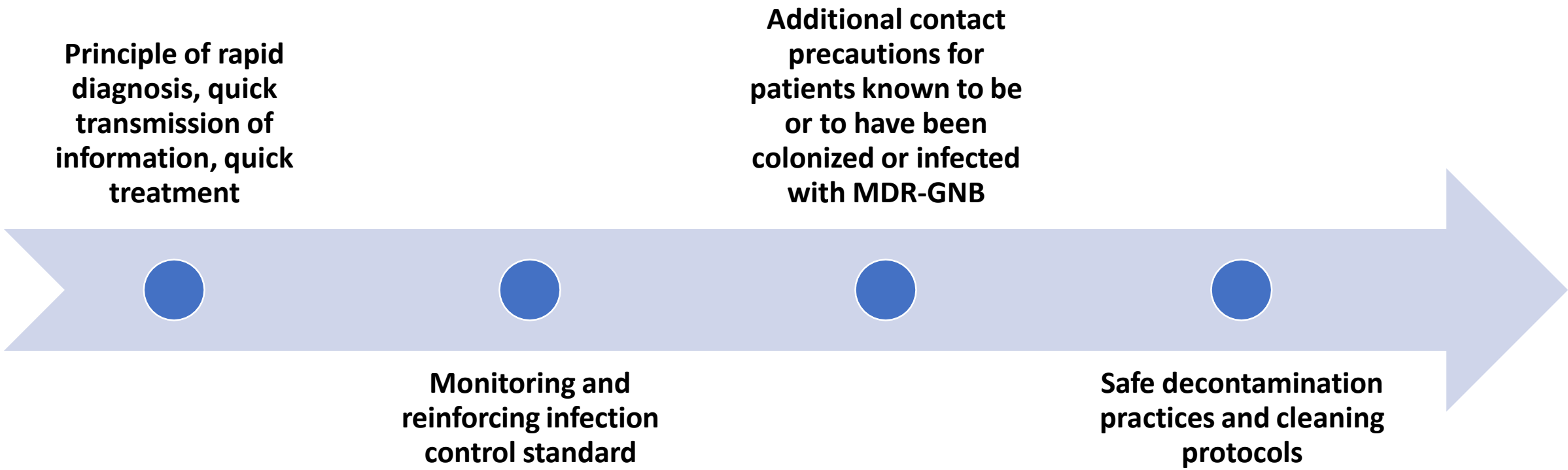
- **Curtail production, prescription and consumption of antibiotics both in human & veterinary medicine**
- **Education of the general population, of healthcare personnel, veterinarians and pharmacists about means of prevention and proper Rx of infections**
- **Offering access to clean, affordable water and sanitation to all people**
- **Promoting vaccination, and by introducing animal breeding and food-production processes which render the use of antibiotics unnecessary**

Reservoir- and transmission-based prevention strategies in healthcare & long-term care facilities

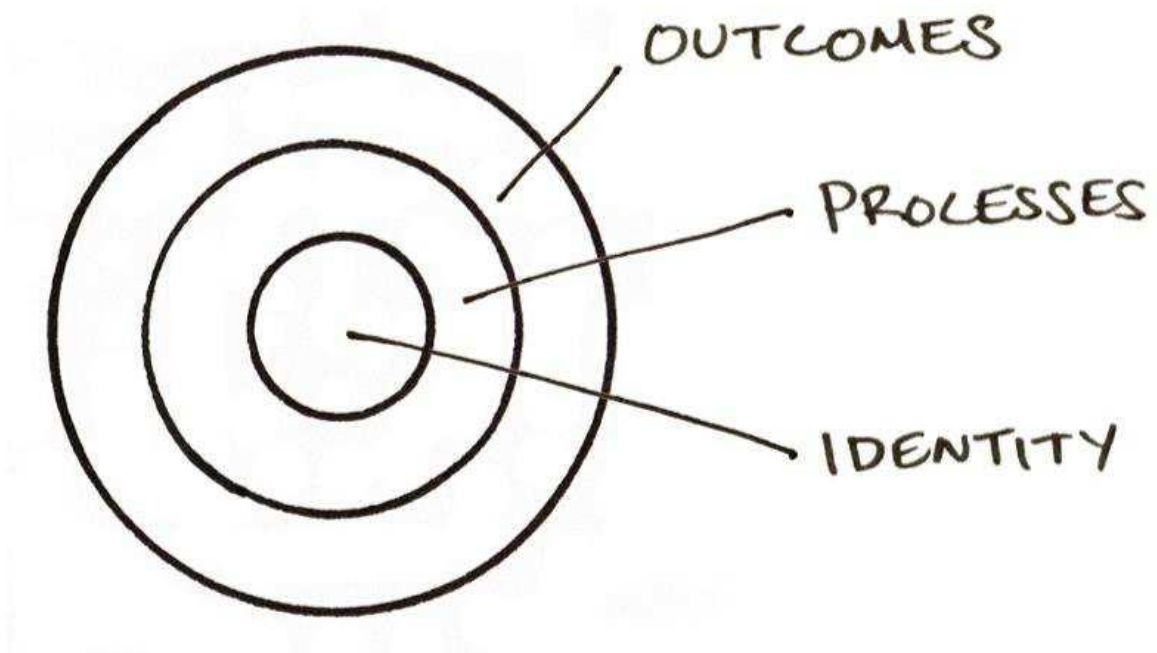


Exner et al. GMS Hyg Infect Control. 2017; 12: Doc05.

Reservoir- and transmission-based prevention strategies in healthcare & long-term care facilities



THREE LAYERS OF BEHAVIOR CHANGE



SPREAD AWARENESS
STOP RESISTANCE

Always get advice from a health worker when taking antimicrobial medicines such as antibiotics, antivirals, antifungals and antiparasitics.

World Health Organization

HANDLE ANTIMICROBIALS WITH CARE

Antibiotics
Antivirals
Antifungals
Antiparasitics

SPREAD AWARENESS
STOP RESISTANCE

Drug resistance is increasing in post-operative infections, making surgeries including caesarean sections, organ transplants, and joint replacements riskier.

World Health Organization

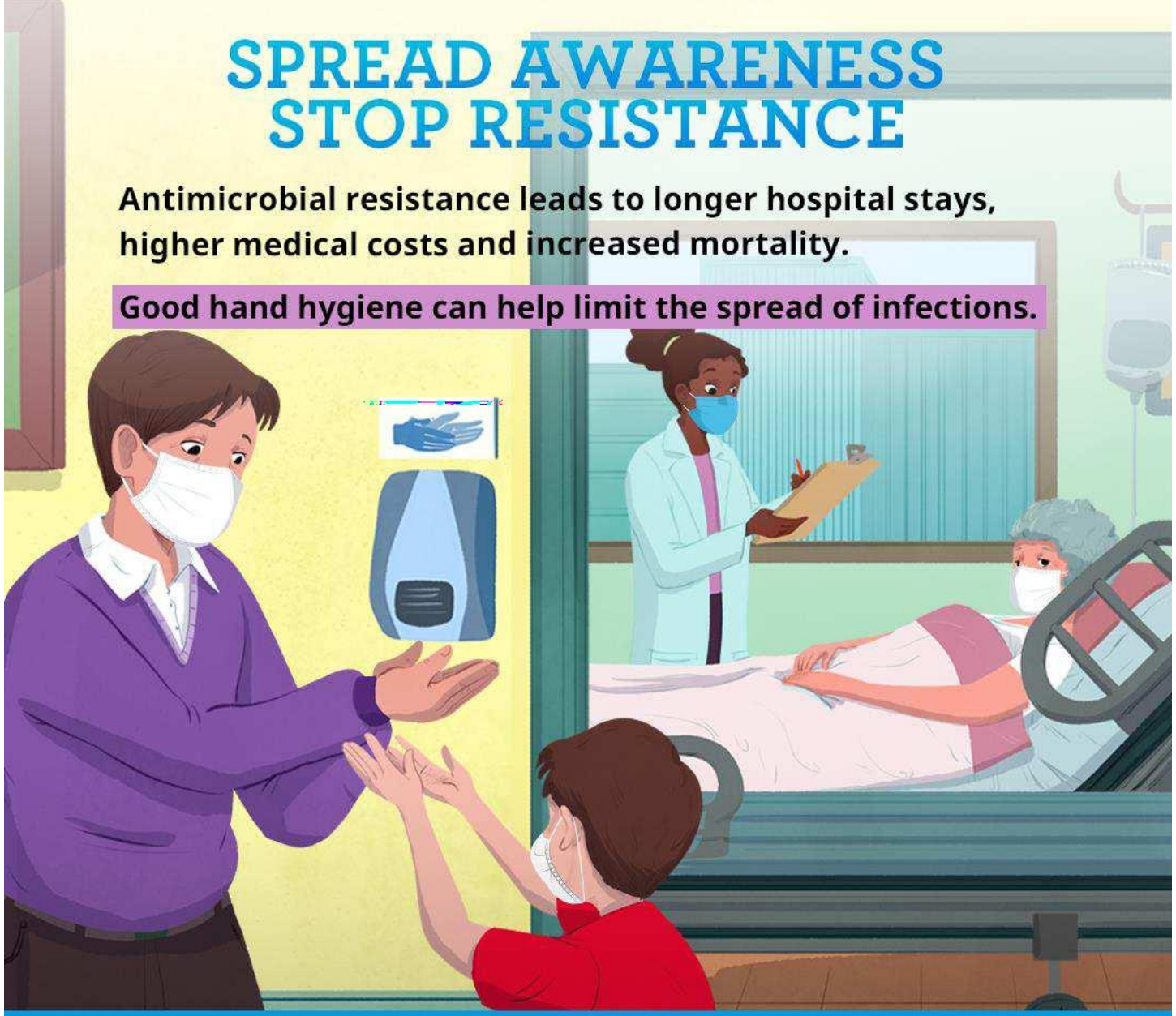
HANDLE ANTIMICROBIALS WITH CARE

Antibiotics
Antivirals
Antifungals
Antiparasitics

SPREAD AWARENESS
STOP RESISTANCE

Antimicrobial resistance leads to longer hospital stays, higher medical costs and increased mortality.

Good hand hygiene can help limit the spread of infections.



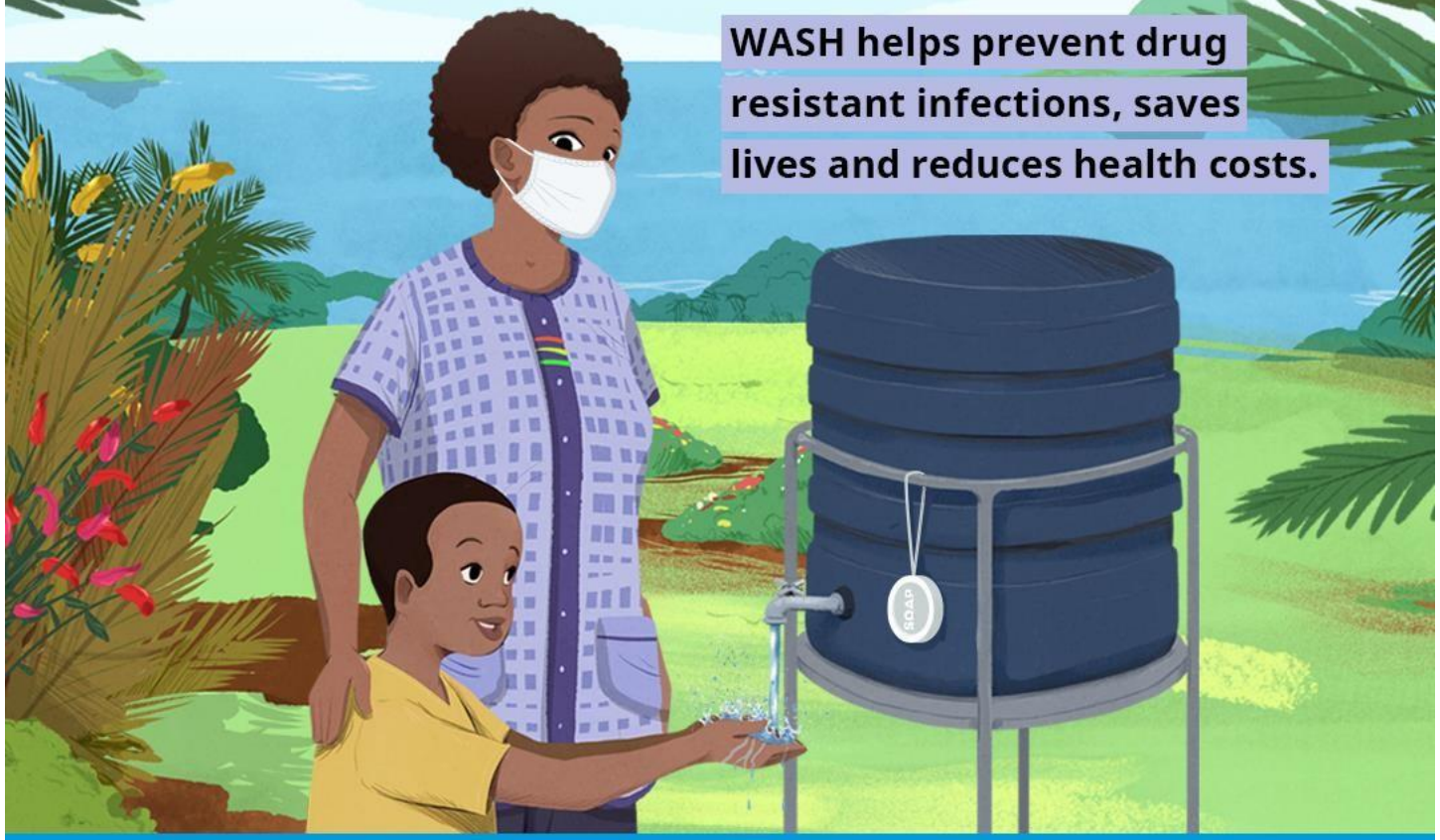
World Health Organization

HANDLE ANTIMICROBIALS WITH CARE

Antibiotics
Antivirals
Antifungals
Antiparasitics

SPREAD AWARENESS
STOP RESISTANCE

Access to safe water, sanitation and hygiene (WASH) in homes and health facilities can reduce antibiotic use to treat diarrhoea by up to 60%.



WASH helps prevent drug resistant infections, saves lives and reduces health costs.

World Health Organization

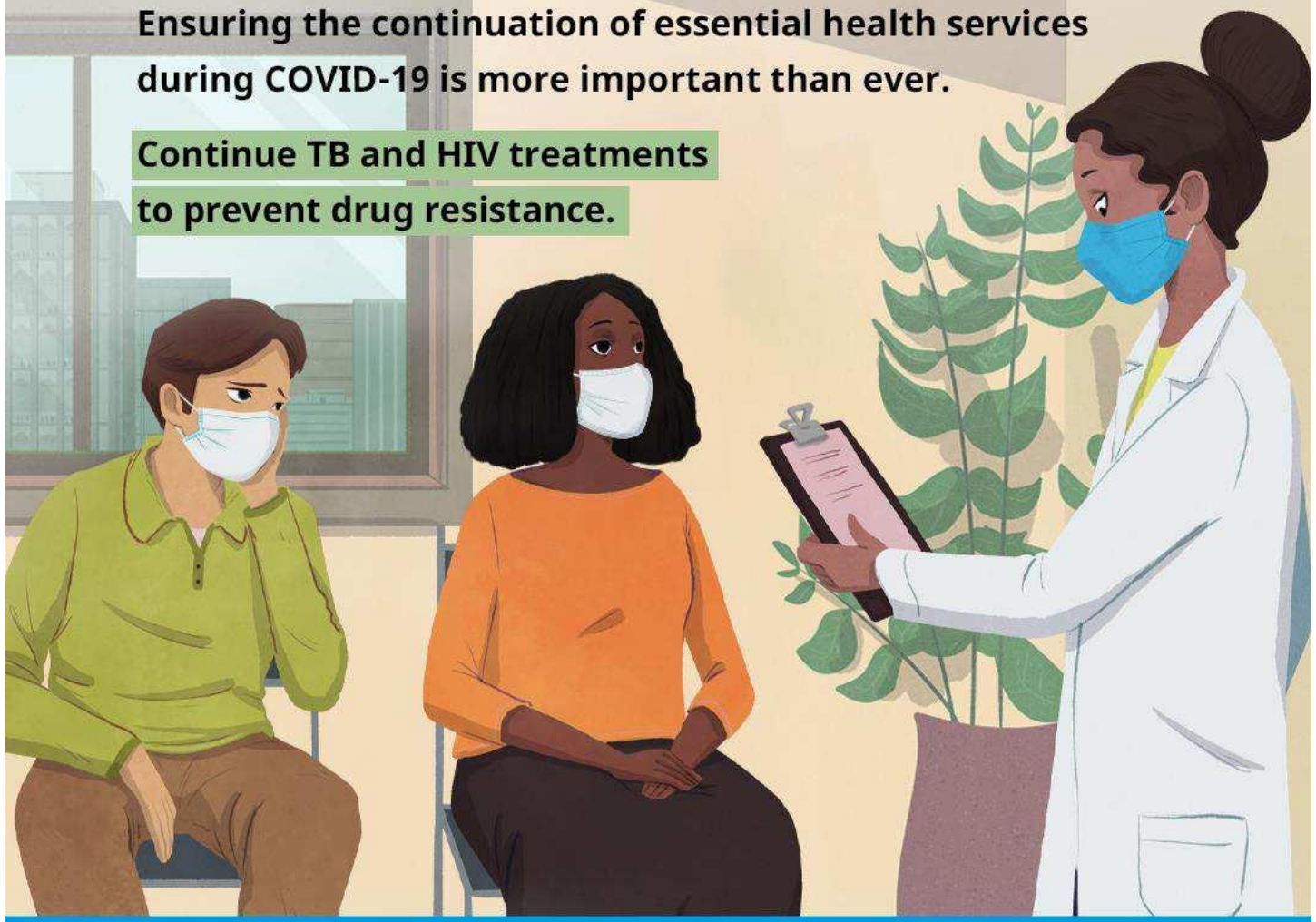
HANDLE ANTIMICROBIALS WITH CARE

Antibiotics
Antivirals
Antifungals
Antiparasitics

SPREAD AWARENESS
STOP RESISTANCE

Ensuring the continuation of essential health services during COVID-19 is more important than ever.

Continue TB and HIV treatments to prevent drug resistance.



World Health Organization

HANDLE ANTIMICROBIALS WITH CARE

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THANK YOU

ANTIBIOTICS
USE - RESPONSIBLY

Hospital wastes seed carbapenem-resistance pathogens to Indian urban water systems