

## Antibiotic resistance: causes, consequences and means to limit it.

Over the last century, antibiotics have radically changed the way we treat infections. They are an important tool for modern medicine, but unfortunately their misuse have led to the emergence of bacteria that are resistant to antibiotics. What has caused it and how can the spread of resistance be limited?

### What is the origin of resistance to antibiotics?

The main origin of resistance to antibiotics is their misuse. As underlined by the European Centre for Disease Prevention and Control (ECDC) they are three main types of misuse:

1. The unnecessary prescription of antibiotics for viral infections, against which they have no effect;
2. The too frequent prescription of “broad-spectrum antibiotics”, in place of a better targeted antibiotic, through more precise diagnosis;
3. The inadequate use by the patient, not respecting either dosage or duration of the treatment, which means that some of the bacteria may survive and become resistant.

### How does a bacteria become resistant to antibiotics?

Some bacteria are naturally resistant to certain antibiotics, others can acquire resistance through mutations in some of their genes when they are exposed to an antibiotic. This resistance, natural or acquired, can spread to other bacterial species since bacteria can easily exchange genetic material from one to another, even if they are from different species.

### What are the possible consequences of antibiotic resistance?

Many of the available treatment options for common bacterial infections are becoming more and more ineffective. As a consequence, there are situations where infected patients cannot be treated adequately by any of the available antibiotics. This resistance may delay and hinder treatment, resulting in complications or even death. Moreover, a patient may need more care, as well as the use of alternative and more expensive antibiotics, which may have more severe side effects, or may need

more invasive treatments, such as intravenous injection, to be given in hospitals.

A recent WHO report made a clear case that resistance of common bacteria to antibiotics has reached alarming levels in many parts of the world. In Europe, for example, there is an increase of the resistance to major antibiotics of common bacteria such as *Escherichia coli* which causes, among others, urinary tract infections, and also *Staphylococcus aureus* (the MRSA or methicillin-resistant *Staphylococcus aureus*), *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*.

For WHO, the consequence is that progress in modern medicine, which relies on the availability of effective antibacterial drugs, is now at risk. For instance:

- Common infections such as pneumonia that can run in health care settings, may not respond to available or recommended drugs like penicillin, putting the lives of patients at risk;
- Cystitis, one of the most common of all bacterial infections in women, may become untreatable or need to be treated by injected drugs, imposing also additional costs to the patients and to the health system in general;
- Antibacterial drugs used to prevent infections after surgeries or to treat common infections in neonatal and intensive care may become less effective or ineffective.

One issue stated in the WHO report is that there are very few antibiotics discovered and developed since 1985 to replace those becoming ineffective.

### Which are the main infections becoming resistant to antibiotics ?

Bacteria causing a wide range of common infections may become resistant to one or many antibiotics: urinary tract infection, pneumonia, skin infection, diarrhea, bloodstream infection. The high proportions of resistance to third generation cephalosporins reported for *E. coli* and *K. pneumoniae*, for example, means that treatment of severe infections caused by these bacteria must now rely mainly on another antibiotic family that is more expensive and may not be available in resource-constrained settings. In addition, this can only last as long as these bacteria do not become resistant to this other alternative.

Patients in hospitals are at special risk for infections by resistant and very pathogenic bacteria that can be present in hospitals and clinics, the so-called nosocomial

infections, and which are unrelated to their reason for admission.

### What can be done to limit this increasing resistance to antibiotics?

The first challenge is the significant gaps in surveillance of antibiotic resistance, says the WHO report. In 2001, WHO and the Council of the European Union issued global strategies and guidelines to help countries setting up systems to monitor antibiotic resistance and to implement efficient actions, including public awareness campaigns. Nowadays, the most immediate and urgent concerns relate to antibiotic resistance in common bacteria.

In line with the WHO, the ECDC (European Centre for Disease Prevention and Control) considers that three strategic areas of intervention should be prioritized and that each one can play an important role:

1. Prudent use of available antibiotics and, when possible, infection prevention through appropriate vaccination;
2. Hygienic precautions for the control of cross-transmission of resistant strains between persons, including screening for resistant strains and isolation of carrier patients;
3. Research and development of antibiotics with a novel mechanism of action.

### Does the use of antibiotics in food-producing animals contribute to the problem?

The major cause of antibiotic resistance in humans remains the use of antibiotics in human medicine, and the antibiotics used in food production contribute very little to the problem. However, since antibiotics used to treat and prevent bacterial infections in animals belong to the same chemical groups as those used for humans, animals may acquire bacteria that are resistant to antibiotics also used against human infections.

You can find this summary, along with a more detailed one on the GreenFacts website at:

<http://www.greenfacts.org/en/antimicrobial-resistance/index.htm>

The sources for this summary:

- The initiatives of ECDC on antimicrobial resistance [http://www.ecdc.europa.eu/en/healthtopics/antimicrobial\\_resistance/pages/index.aspx](http://www.ecdc.europa.eu/en/healthtopics/antimicrobial_resistance/pages/index.aspx)

<http://www.ecdc.europa.eu/en/publications/Publications/antimicrobial-resistance-surveillance-europe-2012.pdf>

including the "basic facts" :

[http://www.ecdc.europa.eu/en/healthtopics/antimicrobial\\_resistance/basic\\_facts/Pages/basic\\_facts.aspx](http://www.ecdc.europa.eu/en/healthtopics/antimicrobial_resistance/basic_facts/Pages/basic_facts.aspx)

- Antimicrobial resistance - Global Report on Surveillance - WHO, 2014 <http://www.who.int/drugresistance/documents/surveillancereport/en/>
- Global strategy for containment of antimicrobial resistance. World Health Organization, 2001. [http://www.who.int/drugresistance/WHO\\_Global\\_Strategy\\_English.pdf](http://www.who.int/drugresistance/WHO_Global_Strategy_English.pdf)
- The Antibiotic Resistance Threat in the United States 2013 – US Department for Health and Human Services - U.S. Centers for Disease Control and Prevention <http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf>

Other references on the subject :

- Origins and Evolution of Antibiotic Resistance J. Davies and D. Davies, Microbiology and Molecular Reviews, Vol. 74, No. 3 p. 417–433 Sept. 2010 <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2937522/pdf/0016-10.pdf>
- The evolving threat of antimicrobial resistance - Options for action World Health Organization, 2012 [http://whqlibdoc.who.int/publications/2012/9789241503181\\_eng.pdf?ua=1](http://whqlibdoc.who.int/publications/2012/9789241503181_eng.pdf?ua=1)