For general public

AMR dictionary

Disclaimer

The *AMR dictionary* –as physical copies, PDFs, and the website (www.amrdictionary.net)– aims to educate and inform the public about antimicrobial resistance, or AMR.

The *AMR dictionary*'s contents, including its learning point and recommended video clips, are not intended to substitute for professional medical advice, diagnosis, or treatment. If you become sick, we recommend that you always see a local doctor or qualified healthcare provider for any questions about your medical condition.

Medical knowledge, research, and practices change constantly. The *AMR dictionary* will regularly update its PDFs and the website with the latest medical research and scientific findings relating to AMR. In evaluating this information, you should also check the most updated and official recommendations from your country's healthcare providers and government.

The *AMR dictionary* is not sponsored by any private or pharmaceutical organization and does not advertise any product. The *AMR dictionary* is published as open access under a CC BY license (Creative Common Attribution 4.0).

Sincerely,

Working groups for the *AMR dictionary*

PS. If you have any questions, comments, or advice about the *AMR dictionary*, contact us at:
[1] www.amrdictionary.net [2] fb.me/amrdictionary
[3] https://www.surveymonkey.com/r/amrdictionary or [4] email us
ravikanya@tropmedres.ac and direk@tropmedres.ac

Contents

Chapter 1. What is Antimicrobial Resistance (AMR)?

Antimicrobial resistance (AMR)

noun. The ability of microorganisms, including bacteria, viruses, fungi, and parasites, to stop antimicrobial drugs (such as antibiotics, antivirals, antifungal drugs, and antiparasitic drugs) from working against them.

"Bacteria that develop antimicrobial resistance to the majority of antibiotics commonly used today, are sometimes referred to as superbugs."

"Antimicrobial resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses, and fungi."[1]

Related word

Antimicrobial resistant

adjective. Ability of an organism to stop an antimicrobial from working against it.

"Antimicrobial-resistant organisms are germs that can stop an antimicrobial drug from working against them."

" Antimicrobial-resistant infections are infections caused by antimicrobial-resistant organisms."

"Each year, more than 700,000 people worldwide die due to antimicrobial-resistant infections, but we could help."

Learning point

Is AMR a global concern?

Common infections and injuries that were once easily treatable are becoming more dangerous and has the capacity to kill again. This is because many of the life-saving drugs used against infectious diseases are rapidly losing their effectiveness. The germs (i.e., bacteria, viruses, and other microbes) develop resistance to the drugs.[1] [2] The drug-resistant

germs can spread and cause infection. Drug-resistant infections could result in prolonged illness, disability, and death.

For decades, antibiotics have protected us from infection following cuts or traffic injuries. Now antimicrobial resistance (AMR) is putting everyone of us at risk.[3] Even childbirth could once again become very risky; many patients, infants, and mothers would die because of infection, which were once preventable or treatable.[1] It is very important that we take actions, especially with the urgency of antimicrobial resistance that could lead humanity back to the frightening pre-antibiotic age.

In nature, disease-causing germs will undergo adaptations in response to antimicrobials present in the environment. However, when people misuse or overuse antimicrobials, the rate of change becomes faster, antimicrobial-resistant organisms become more common, and the treatment of infections becomes more difficult.

Overuse and misuse of antibiotics occur in both animals and humans. Many common diseases in humans, such as the common cold and 'flu, are caused by viruses and do not require antibiotics. Nonetheless, many people worldwide are unnecessarily consuming antibiotics when suffering from a common cold or 'flu. Antibiotics are also heavily used in animal agriculture worldwide. Large amounts of antibiotics are overused in animals to promote growth or prevent disease in healthy animals instead of being used only on sick ones.

We can solve the problem. We must take action now by protecting ourselves from infectious diseases and stopping the overuse of antibiotics.[4] We can protect ourselves by [1] washing our hands often, [2] drinking and using safe water, [3] preparing food safely, [4] using latrines (i.e. toilets) properly, [5] not sharing personal items, [6] getting vaccinated, [7] coughing or sneezing into our sleeve, and [8] staying home when sick. We should use antibiotics only when we have bacterial infections.

Recommended words for further reading: microorganism, antibiotic literacy

Check out these videos about AMR:

Amala's story: how to prevent antimicrobial resistance

https://youtu.be/Y9WEERSh5G0

Antimicrobial Resistance: What is it?

https://youtu.be/URx6HfGtz34

FAO and Antimicrobial Resistance

https://youtu.be/IiH400W-xnQ

References

[1] WHO. (2018, February 15). Antimicrobial resistance. Retrieved from https://www.who.int/en/news-room/fact-sheets/detail/antimicrobial-resistance

[2] CDC. (2018, September 10). About Antimicrobial Resistance | Antibiotic/Antimicrobial Resistance | CDC. Retrieved from https://www.cdc.gov/drugresistance/about.html

[3] The Wellcome Trust. (2019, October 29). Reframing Resistance, how to communicate about antimicrobial resistance effectively. Retrieved from: https://wellcome.ac.uk/sites/default/files/reframing-resistance-report.pdf

[4] O'Neill, J. (2016, March 19). Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. The Review on Antimicrobial Resistance. Retrieved from https://amr-review.org/sites/default/files/160525_Final paper_with cover.pdf

Microorganism

noun. A microorganism is a small living thing that can only be seen under a microscope. Microorganisms include bacteria, protozoans, certain algae and fungi.

"Microorganisms are found living all around us, on the skin, and even inside our body."

"Any microorganisms that can cause infection and disease are called germs. However, not all microorganisms can cause illness. Some are even helpful to us."

Related words

Microbe

noun. A microbe is another word for a microorganism, a living thing that can only be seen with a microscope.

Germ

noun. Germ refers to a microorganism that can cause infection or disease.

Learning point

Types and abilities of microbes

There are roughly four major types of microbes; fungi, bacteria, viruses, and parasites. Fungi are usually the largest in size. Bacteria are usually smaller than fungi and do not have a cell nucleus. Viruses are the smallest type of microbes that do not have a cell nucleus and a cell wall. Viruses can only reproduce inside a cell or other living organisms. Mushrooms and toadstools are also fungi.

One of the common microscopic parasites that can cause diseases are malaria parasites. Malaria parasites hide inside the human body where they multiply inside our blood cells. The malaria parasites spread when an infected mosquito takes a bite a person for a blood meal.

Though some worms are parasites, they are big and made up of many cells. They are not microbes.

Microbes are everywhere. It is estimated that there could be up to 10 thousand million bacterial cells in a gram of soil (10 thousand million = 10,000,000,000).[1] In our body, there could be up to 39 trillion bacterial cells (39 trillion = 39 million-million or 39,000,000,000,000).[2]

All germs can obtain the ability to resist the effects of medication that was once successfully used against them. This ability is called antimicrobial resistance.[3] For example, antibiotics are being overused in humans and animals, and these antibiotics are increasingly contaminating the environment. Exposure to antibiotics can induce a proportion of bacteria in our bodies, animals, and the environment to become antibiotic-resistant. These antibiotic-resistant bacteria can spread and cause fatal diseases.

Recommended words for further reading: antimicrobial resistance, multidrug resistance

Check out this video about microbes:

Microorganisms| The Dr. Binocs Show| Educational Videos for Kids

https://youtu.be/JZjzQhFG6Ec

References

[1] Ingham, E. R. (2019). Chapter 3: Bacteria. In *Soil Biology*. Retrieved from https://extension.illinois.edu/soil/SoilBiology/bacteria.htm.

[2] Sender, R., Fuchs, S., & Milo, R. (2016). Revised Estimates for the Number of Human and Bacteria Cells in the Body. *PLOS Biology,14*(8). doi:10.1371/journal.pbio.1002533

[3] WHO. (2015). *Global Action Plan on Antimicrobial Resistance*. Geneva, Switzerland: WHO Document Production Services. ISBN: 978 92 4 150976 3

Antibiotic

noun. Antibiotic refers to a substance or medicine (for example, penicillin) that kills or inhibits the growth of bacteria. There are many types of antibiotics. Each type works differently. Like other medicines, antibiotics can cause side effects or interact with other medication.

"The doctor told me that I don't need antibiotics. Antibiotics work only against bacteria."

"Antibiotics don't work for viruses that cause cold and flu. Using them for viral infections will not make you feel better or get back to work." faster."

"He has a severe bacterial infection and needs a prolonged course of antibiotic therapy."

Related word

Antimicrobial

adjective. Containing or using a substance or medicine, for example, penicillin, which kills or inhibits the growth of bacteria. Relating to antibiotics.

Learning point

When antibiotics don't work any more

The antibiotics we used to cure common bacterial infections such as pneumonia, and infected wounds, are becoming useless against some bacteria. The World Health Organization (WHO) Director-General said it was imperative for consumers and medical providers to rely less on antibiotics to treat diseases.

"Based on current trends, a common disease like gonorrhoea may become untreatable," the Director-General warned. He continued that doctors facing patients may one day have to say, "I'm sorry - there's nothing I can do for you."[1]

Antibiotic resistance is one of the most serious global public health threats; and it could potentially kill millions of people and negatively affect the global economy.[2] The United Nations (UN) has adopted a high-level political declaration committing to deal with the increasing numbers of antibiotic resistant infections.[2]

The increasing antimicrobial resistance is hugely worrying, and it is a problem that will affect every one of us and our families. One important example of how antibiotic-resistant bacteria could become risky again is childbirth. Mothers and infants would be at high risk of death from bacterial infections, which was once preventable.

Recommended words for further reading: antimicrobial, antibiotic resistance

Check out these videos about antibiotic:

What causes antibiotic resistance? - Kevin Wu

https://youtu.be/znnp-Ivj2ek

Maryn McKenna: What do we do when antibiotics don't work any more?

https://youtu.be/o3oDpCb7VqI

References

[1] WHO. (2016, August 29). Birth in a time of antibiotic-resistant bacteria. Retrieved from https://www.who.int/mediacentre/commentaries/antibiotic-resistant-bacteria/en/

[2] O'Neill, J. (2016, March 19). Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. The Review on Antimicrobial Resistance. Retrieved from https://amr-review.org/sites/default/files/160525_Final paper_with cover.pdf

Antibiotic misuse

noun. The inappropriate or, improper overuse of antibiotics, often without medical justification, with potentially serious negative effects on health.

"The use of broad-spectrum antibiotics when not needed is an example of antibiotic misuse."

"The misuse of antibiotics for self-limiting viral infections such as common colds are imposing a hefty price on society."

Related words

Antibiotic abuse

noun. The misuse or overuse of antibiotics, with potentially serious effects on health.

Antibiotic overuse

noun. The improper, excessive, frequent use of antibiotics.

"The misuse and overuse of antibiotics is not easy to control."

"Antibiotic resistance is accelerated by the misuse and overuse of antibiotics as well as poor infection prevention and control."

Learning point

Are you harming yourself and others by misusing antibiotics?

Misusing or overusing antibiotics is harmful. Antibiotics are not effective for colds and other viral illnesses and could have dangerous side effects. Misuse and overuse of antibiotics help create bacteria that are harder to kill because they have changed to become resistant to antibiotics. These bacteria may infect you, your family, or others.

What could be a misuse of antibiotics?

[1] Using antibiotics to treat colds or flu.
[2] Using antibiotics without a prescription or recommendation from a certified healthcare worker, or asking for antibiotics against a healthcare worker's recommendation.
[3] Not finishing a prescribed course of antibiotics.
[4] Sharing antibiotics with others.
[5] Using leftover antibiotics.

What should you do?

[1] Don't use antibiotics to treat colds or flu.
[2] Use antibiotics only if prescribed or recommended by a certified healthcare worker. To be certain, ask "Are antibiotics recommended for this condition?"
[3] Always finish the full course of prescribed antibiotics, even if you feel better.
[4] Don't share antibiotics with others.
[5] Don't use leftover antibiotics.

Common examples of antibiotic misuse.

[1] Would it better if I take an antibiotic, just in case?

Answer: Wrong. Viruses, not bacteria, cause common colds and flu. Bacteria do not cause most acute diarrheal diseases. Taking antibiotics unless recommended by a certified healthcare worker puts you at risk of drug side effects and helps create hard-to-kill antibiotic-resistant bacteria that may infect you, your family, or others causing an antibiotic-resistant bacterial infection.

[2] I took antibiotics for a common cold last time, and I felt better quickly. I plan to take antibiotics next time I have a cold.

Answer: Wrong. Viruses cause common colds and flu, and most people recover in 7-10 days. You would have felt better even without taking antibiotics. Antibiotics do not work against viruses and do not make you feel better or get you back to work faster.

[3] I took this antibiotic last time, with no side effects. So, I won't have side effects this time, right?

Answer: Wrong. Even if you did not have a side effect last time you took antibiotics, you could get one the next time. Repeated use of antibiotics can increase the risk of some side effects, including diarrhoea and yeast infections.

[4] Even if bacteria in my body become resistant to one antibiotic, I can always buy a 'stronger' antibiotic next time that that bacterium infects me.

Answer: Wrong. Many bacteria are now resistant to multiple antibiotics. Some bacterial infections can't be treated with any of our current antibiotics. The misuse and overuse of antibiotics increase everyone's risk of being infected with bacteria resistant to all our available drugs.

[5] Even if the bacteria in my body become antibiotic-resistant and infect me, it's only me and I am not causing anyone else problems or harm.

Answer: Wrong. Antibiotic-resistant bacteria that developed in your body can harm you and then spread to your family, the environment, and to others. Do remember that you are not the one who is resistant to the drug. It's the bacteria that are resistant to the drug. Those drug-resistant bacteria can spread and infect other people. Therefore, the misuse of antibiotics can harm everyone.

Recommended words for further reading: antibiotic literacy, antibiotic stewardship

Check out these videos about antibiotic misuse:

Antibiotics "just-in-case" | Debbie Goff | TEDxColumbus

https://youtu.be/ALryAB_AYiA

Factory farms, antibiotics and superbugs: Lance Price at TEDxManhattan

https://youtu.be/ZwHapgrF99A

Antibiotic literacy

noun. Antibiotic literacy is the ability to understand, evaluate, and apply information about appropriate antibiotic use and prevent antibiotic resistance.

"More than half of the patients we surveyed already knew that antibiotics don't work against viruses, but still took antibiotics 'just in case'."[1]

"High levels of antibiotic resistance and low levels of 'antibiotic literacy' in the general public are on a dangerous collision course."[2]

Learning point

Do you know about antibiotics?

Most of us have used antibiotics at least once in our lives. Antibiotic resistance continues to be a problem worldwide. The connection between drug-resistant bacteria and our body is often misunderstood.

Many people are confused by what antibiotic resistance is and what we can do to prevent it. A global survey of 10,000 respondents from 12 countries, conducted by the WHO, found that two-thirds of participants had low 'antibiotic literacy.'[1] One-third of respondents wrongly believed that it was fine to stop taking antibiotics once they felt better, rather than completing the full course. About three-quarters of participants believed, incorrectly, that 'antibiotic resistance' was defined as a person's body becoming resistant to antibiotics.[1]

People continue to ignore the problem of antibiotic resistance. A popular misconception that a person's body can become resistant to a drug has given rise to another mistaken belief that resistance is only a problem for those who actively take antibiotics.[2] The bacteria have developed antibiotic resistance – not people's bodies – and these antibiotic-resistant bacteria can spread from person to person. You may acquire a drug-resistant infection even if you don't use antibiotics.

Box 1: How much do you know about the appropriate use of antibiotics and antibiotic resistance?

1. Antibiotics can cure the common cold. **[True or False]**
2. Antibiotic resistance happens when my body becomes resistant to antibiotics. **[True or False]**
3. Your antibiotic use can cause antibiotic resistance. **[True or False]**
4. Antibiotic use in animal agriculture can cause antibiotic resistance. **[True or False]**
5. Antibiotic-resistant bacterial infection can spread to humans by contact with a person who has antibiotic-resistant bacteria. **[True or False]**
6. Antibiotic-resistant bacterial infection can spread to humans by contact with a live animal, food or water carrying antibiotic-resistant bacteria. **[True or False]**
7. Keeping my vaccinations up to date, washing my hands properly and regularly, and keeping myself clean and hygienic can support the world tackling antibiotic resistance. **[True or False]**

Correct Answers:

1. **False.** Viruses cause the common cold. Antibiotics cannot kill viruses and do not shorten the duration of illness or improve symptoms.
2. **False.** The overuse of antibiotics does not cause your body to be resistant to antibiotics. It causes the bacteria to become resistant to antibiotics, and the antibiotic-resistant bacteria can then spread from person-to-person.
3. **True.** Both appropriate and inappropriate use of antibiotics can cause antibiotic resistance.
4. **True.** Antibiotic used in animal agriculture can cause antibiotic-resistant organisms in animals, humans, and the environment.
5. **True.** Antibiotic-resistant bacteria can spread to humans by contact with another human carrying them.
6. **True.** Antibiotic-resistant bacteria can spread to humans by direct/indirect contact with animals, via touching, eating, and through the environment.
7. **True.** Prevention of infectious disease is one of the best methods to prevent antimicrobial resistance.

Do educate yourself about the antibiotics that you are taking to understand what organisms they are effective against, their side effects and interactions with other drugs, and their potential impact on society. Antibiotic resistance affects you, your friends, and your family and has a potentially devastating effect on the environment and everyone around the world.

Recommended words for further reading: antibiotic resistance, drug-resistant infection, antibiotic misuse, antibiotic stewardship

References

[1] WHO. (n.d.). Antibiotic Resistance: Multi-Country Public Awareness Survey. www.who.int. ISBN 978 92 4 150981 7

[2] Ramsey, L. (2017, February 23). A growing threat could kill 10 million people a year by 2050. Retrieved from https://www.businessinsider.com/biggest-misconception-about-antibiotic-resistance-2017-2

Chapter 2. Rise of antibiotic resistance

Antibiotic resistance

noun. The ability of bacteria to change or adapt in response to antibiotics designed to kill them, making those antibiotics less effective or ineffective in killing the bacteria.

"The overuse and misuse of antibiotics can lead to resistance."

"Even when used appropriately and as prescribed, antibiotics can drive bacteria to become antibiotic-resistant. However, the unnecessary and are excessive use of antibiotics has made antibiotic-resistant bacteria are increasingly common."

Related word

Antibiotic resistant

noun. (A microorganism is) able to stop an antibiotic from working against it.

"Antibiotic-resistant bacterial infections currently claim at least 50,000 lives each year across UK, Europe and the US alone."

Learning point

What causes antibiotic resistance?

Some antibiotic resistance occurs naturally. Antibiotics, such as penicillin, originally came from fungi or bacteria found naturally in the soil. Sensitive bacteria in the soil may adapt over time and become antibiotic-resistant. Usually, the level of antibiotics in the environment is very low and in the 1930s (just after the development of penicillin), infections caused by antibiotic-resistant bacteria were rare.

Overuse and misuse of antibiotics have increased the rate at which the resistance is developing and spreading worldwide. It is estimated that around 200,000 to 250,000 tons of antimicrobials are being produced and consumed worldwide each year.[1] [2] About 70% of these antimicrobials are consumed by animals, and 30% by humans.

Most antibiotics consumed by humans and animals are excreted in urine and faeces and enter sewage systems, contaminating the environment. When exposed to antibiotics, bacteria living in humans and animals could also develop antibiotic resistance, and those antibiotic-resistant bacteria can spread to other people and the environment.[2] [3]

Those who have a bacterial infection needs to be treated with antibiotics. However, those who do not have bacterial infections should not take antibiotics. Sir Alexander Fleming, who discovered penicillin, predicted antibiotic resistance from the start and said:

"The thoughtless person playing with penicillin treatment is morally responsible for the death of a man who succumbs to infection with the penicillin-resistant organism."

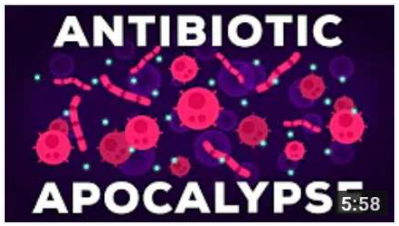
Nowadays, penicillin is rarely used to treat common infectious diseases in humans and animals, because common pathogens are already penicillin resistant. Currently, a variety of antibiotics are being used instead of penicillin. It is estimated that about 700,000 people die of antimicrobial-resistant infections yearly, and the number could rise to 10,000,000 deaths per year in 2050.[1] We have not seen a truly new class of antibiotics for decades.

"We need a global public awareness campaign to educate all of us about drug resistance. I see this as an urgent priority," Lord Jim O'Neill.[1]

Recommended words for further reading: antibiotic, bacteria, penicillin, antibiotic misuse

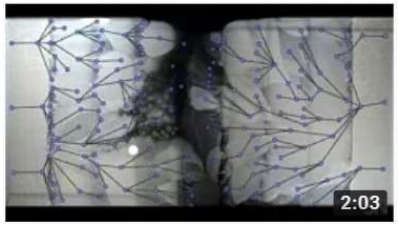
Check out these videos about antibiotic resistance:

The Antibiotic Apocalypse Explained



https://youtu.be/xZbcwi7SfZE

What Antibiotic Resistance Evolve | Science News



https://youtu.be/yybsSqcB7mE

References

[1] O'Neill, J. (2016). Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. The Review on Antimicrobial Resistance. Retrieved from https://amr-review.org/sites/default/files/160525_Final paper_with cover.pdf

[2] Sarmah, A. K., Meyer, M. T., & Boxall, A. B. (2006). A global perspective on the use, sales, exposure pathways, occurrence, fate and effects of veterinary antibiotics (VAs) in the environment. *Chemosphere,65*(5), 725-759. doi:10.1016/j.chemosphere.2006.03.026

[3] Boeckel, T. P., Brower, C., Gilbert, M., Grenfell, B. T., Levin, S. A., Robinson, T. P., . . . Laxminarayan, R. (2015). Global trends in antimicrobial use in food animals. *Proceedings of the National Academy of Sciences,112*(18), 5649-5654. doi:10.1073/pnas.1503141112

Drug-resistant infection (DRI)

noun. An infection caused by an antimicrobial-resistant organism. The organisms include bacteria, virus, fungi and other microbes.

"Drug-resistant infection is caused by many different reasons, such as, overuse of antibiotics or taking them unnecessarily. It is also possible to get a drug-resistant infection from other people because antimicrobial-resistant organisms can pass from person to person."

"Hospital-acquired drug-resistant infections are increasing in many countries worldwide."

Learning point

It's the bug, not your body, that becomes resistant to antibiotics

Your body does not develop antibiotic resistance; it is the bacteria that become resistant to antibiotics through genetic changes. Generally, antibiotics target bacteria, killing or weakening them, and helping you to fight off infections.

If you get an antibiotic-resistant bacterial infection, the antibiotics usually used to fight it are no longer effective. A less accessible or last resort antibiotic will then need to be used, and in some cases, options for potential active antibiotics could run out. In addition, the antibiotic-resistant bacteria in your body can infect your family and others.

Antibiotic resistance mainly arises from the overuse and misuse of antimicrobial drugs. Patients get antibiotics from their doctors, buy them over the counter, or, in some cases, consume them wrongly (e.g., by taking antibiotics when having a viral, rather than a bacterial infection). Antibiotics are also used in farming and spread into the environment. Poor community control of antibiotics use, and the growth of drug-resistant infections may leave us without any effective treatment.[1]

Recommended words for further reading: antituberculous, antiparasitic

Check out these videos about drug-resistant infections:

Drug-resistant infections: Bitter pills to swallow

https://youtu.be/hORCLShmKEU

Misuse of antibiotics creating drug-resistant infections?

https://youtu.be/_ouBFiNFfZI

References

[1] WHO. (2015). *Worldwide country situation analysis: Response to antimicrobial resistance*. www.who.int. ISBN 978 92 4 156494 6

Superbugs

noun. A strain or type of bacterium that has become resistant to the majority of current antibiotics is called a superbug.

"The threat of superbugs come from the overuse of antibiotics by humans.'

"To save yourself from superbug infections, wash your hands regularly."

"Superbugs could render even the most routine procedures deadly."

"If we don't act now, superbugs will kill us before climate change does."

Learning point

The rise of superbugs

The word 'Superbug' was first used in the popular press sometime after 1970 to describe pollution-eating germs.[3] Superbug now describes bacteria that have evolved to resist many types of antibiotics, making them difficult to treat.

The media can reflect the public's view and attitudes.[4] In 1996 in the UK, BBC Panorama made a program on drug resistance called "superbugs" about the emergence of vancomycin (a type of antibiotic) resistance in *Enterococcus* bacteria. This movie led to close monitoring of media use of the word "superbugs".

Later, in 2005, in the UK, superbugs, especially MRSA (methicillin or multi-resistant *Staphylococcus aureus*) became a big debate between the two main political parties during the UK General Election.[4] Although there was much news and media coverage about MRSA, interested readers were often confused about the cause of the MRSA problem and what they could do about it.

It is now critical for people to know how to combat the problem of "superbugs".

Recommended words for further reading: antibiotic misuse, antibiotic literacy, antibiotic footprint, antibiotic stewardship

Check out these videos about superbugs:

Rise of Superbugs

https://youtu.be/fyRyZ1zKtyA

Rise of the superbugs - Antibiotic-resistant bacteria: Dr. Karl Klose at TEDxSanAntonio

https://youtu.be/ikZQPB45Zbw

References

[1] Nuki, P., & Gulland, A. (2018, May 22). Superbugs: Millions will die if we don't tackle antibiotic resistance. Retrieved from https://www.telegraph.co.uk/news/2018/05/22/superbugs-could-render-even-routine-procedures-deadly-warns/

[2] Armstrong, S. (2017, November 04). If we don't act now, superbugs will kill us before climate change does. Retrieved from https://www.wired.co.uk/article/antibiotic-resistance-innovation-dame-sally-davies-nhs

[3] Mosher, D. (2012, December 29). What is a Superbug? Retrieved from https://www.livescience.com/32370-what-is-a-superbug.html

[4] Reynolds, L. A., & Tansey, E. M. (2008). *Superbugs and Superdrugs: A History of MRSA* (Vol. 32, Wellcome Witness to Twentieth Century Medicine). Wellcome Trust Centre for the History of Medicine at UCL. ISBN 978 085484 114 1

Multidrug Resistance (MDR)

Noun. Resistant to more than one type of antimicrobial, whether antibiotics, antivirals, antifungal, or antiparasitic drugs; thus, few or no effective treatments are available for MDR infections.

"Multidrug-resistant (MDR) bacteria are dangerous, and they are a threat to public health, as they may bare resistant to many types of antibiotics."

"The new regimen takes 9 to 11 months to treat multidrug-resistant (MDR) tuberculosis."

Related words

Multidrug resistant (MDR)

Adjective. The ability of microorganisms to stop multiple antimicrobials from working against them.

"The malaria parasites can develop multidrug resistance (MDR) to first-line treatment extremely rapidly, particularly if patients do not complete the treatment course."

"The combination of increased virulence and multidrug resistance makes the situation worse."

Extensively drug-resistant (XDR)

adjective. The ability of microorganisms to stop most antimicrobials from working against them. XDR microorganisms are susceptible to only one or two antimicrobial categories.

Pan drug-resistant (PDR)

adjective. An ability of microorganisms to stop all classes of antimicrobials from working against them. The microorganisms are resistant to all antimicrobials.

Learning point

Multidrug resistance is a man-made problem

Multidrug resistance is mainly a human-made problem. For example, multidrug-resistant (MDR) tuberculosis is caused by non-compliance or inadequate administration of tuberculosis drugs.[1] Because of the length of treatment required for tuberculosis and drug

side effects, improper drug use is common in this condition. As patients feel better, they wrongly stop taking their medication. The tuberculosis bacteria are still not eradicated from the body and build resistance to the first-line drugs that the patient has already taken. When the patients fall ill again, the bacteria will be unresponsive to the first-line drugs and they will be highly contagious, and deadly.

Carbapenem-resistant *Enterobacteriaceae* (CRE) belong to a family of MDR bacteria. They have evolved so that most antibiotics cannot kill them, causing CRE to be referred to as "superbugs". Colistin is a (potentially toxic) antibiotic used as a last resort treatment for CRE and for many MDR Gram-negative bacterial infections. The overuse of antibiotics in hospital settings and the community promotes the growth of bacteria like CRE. MDR bacteria can spread and infect many people.

Multidrug-resistant (MDR) *Acinetobacter* is an important antibiotic-resistant pathogen in healthcare settings. Historically, carbapenem drugs have been the most effective treatment for infections caused by MDR *Acinetobacter*. The overuse and misuse of many antibiotics, such as carbapenems contributed to the development and spread of carbapenem-resistant *Acinetobacter*. MDR *Acinetobacter* can cause serious infections and is hard to treat.

To tackle MDR, hospitals must improve their hygiene and practices, for example by ensuring that everyone washes their hands before and after touching patients and their environment. Hospitals must also implement and enforce an antibiotic stewardship program to ensure that antibiotic are used effectively. People in the community must wash their hands, keep themselves hygienic, and stop overusing or misusing antimicrobials.

Recommended words for further reading: antibiotic, antibiotic resistant, drug-resistance infection

Check out these videos about MDR:

Multidrug-Resistant Tuberculosis: No Promises, by Ron Haviv in Tajikistan

https://youtu.be/kEOmYXRFp10

References

[1] Huber, C. (2017, March 20). The Causes of Multi-Drug Resistant Tuberculosis. The Borgen Project. Retrieved from https://borgenproject.org/causes-multi-drug-resistant-tuberculosis/

Chapter 3. Antibiotic use

Antibiotic prophylaxis

noun. The use of antibiotics to prevent disease or complications from infection.

> "Antibiotic prophylaxis is usually used before performing major surgery, especially, when there is a risk associated with the bacteria entering the body, specifically through open wounds."

Related word

Preventative Antibiotics

noun. The practice of using antibiotics to prevent a disease or infection.

Learning point

Only a single dose of antibiotic prophylaxis is enough in human

Antibiotic prophylaxis – using antibiotics to prevent disease – has long been extensively used in humans and animals. After penicillin was introduced in 1928, it became apparent that administering antibiotics could reduce wound infection rates in many surgical procedures.[1] At first, prophylaxis was prescribed in a way that lacked organization. As antibiotic use increased, resistance to antibiotics and hospital-acquired infections caused by bacteria became an increasing problem. In livestock production, farmers use antibiotics to prevent the loss of animals and, in some countries, to promote growth in healthy animals.

Today, less antibiotics are used for prophylaxis than ten years ago. The current use of antibiotics has led to a rise in resistance, changes in bacteria that cause infections, and advances in technology to detect bacterial infections.

Professional guidelines still recommend using antibiotics before major surgery with a high risk of bacterial infection, but in most cases, only suggests only a single dose of antibiotics is recommended at the time of surgery. The WHO recommends against the prolongation of antibiotics after surgery to prevent infection.[2] Antibiotic prophylaxis is also no longer recommended before dental procedures unless the patient has artificial heart valves or rheumatic heart disease.

In 2017, the WHO strongly recommended an overall reduction in the use of all classes of medically important antibiotics in food-producing animals, including complete restriction of these antibiotics to promote growth and prevent disease without a prior diagnosis.[3] Healthy animals should not receive antibiotics to prevent disease, only if there has been a diagnosis of sick animals in the same flock, herd, or fish.

It is noteworthy that countries promoting the campaign to stop using antibiotics as growth promoters may find that farmers respond by increasing antibiotic prophylaxis – causing the total amount of antibiotics used in animal agriculture to remain the same or even increase.[4] Therefore, it is crucial to follow the WHO recommendation to restrict antibiotic prophylaxis without a diagnosis.

Alternative options to using antibiotics for disease prevention in animals include improving hygiene, better use of vaccination, and changes in animal housing and husbandry (farming) practices.

Recommended words for further reading: antibiotic, antibiotic-fed

References

[1] Westerman, E. L. (1984). Antibiotic prophylaxis in surgery: Historical background, rationa1e, and relationship to prospective payment. *American Journal of Infection Control,12*(6), 339-343. doi:10.1016/0196-6553(84)90007-5

[2] WHO. (2018). Global guidelines for the prevention of surgical site infection, second edition. Geneva, Switzerland: World Health Organization. ISBN 978 92 4 155047 5

[3] WHO. (2017, November 7). Stop using antibiotics in healthy animals to preserve their effectiveness. Retrieved from https://www.who.int/news-room/detail/07-11-2017-stop-using-antibiotics-in-healthy-animals-to-prevent-the-spread-of-antibiotic-resistance

[4] Mevius, D., & Heederik, D. (2014). Reduction of antibiotic use in animals "let's go Dutch". *Journal Für Verbraucherschutz Und Lebensmittelsicherheit,9*(2), 177-181. doi:10.1007/s00003-014-0874-z

Over-the-counter (OTC)

Adverb. Bought or sold without prescription or supervision by a certified healthcare provider.

"Over-the-counter (OTC) drugs are also known as nonprescription drugs. OTC drugs refers to drugs that you can buy without a prescription."

"In high-income countries, you cannot buy antibiotics over-the-counter. However, in most developing countries, you can buy antibiotics over-the-counter at pharmacies or even at grocery stores."

"Over-the-counter antibiotics might be an important mechanism of access for people who need them. Nonetheless, overuse of over-the-counter antibiotics among those who do not need them is a major concern."

Learning point

Dangers of over-the-counter antibiotics

Self-medication can be very dangerous to anyone who does not understand a drug's side-effects and the consequence of its overuse. In most countries, a regulatory agency selects OTC drugs to ensure that they are safe and effective when used without a physician's input. For example, paracetamol can be bought over-the-counter worldwide. However, since an overdose of paracetamol can be lethal, some countries limit the number of tablets sold.

In many parts of the world, antibiotics are sold over the counter, with few or no restrictions on quantities sold. OTC antibiotics are often misused, for example being taken for a non-bacterial disease – and therefore ineffective.[1] Also, the drugs are dispensed without knowledge of a patient's allergies. An OTC drug provider may give a short course or lower doses of antibiotics than recommended. Thus, OTC further worsens the problem of drug-resistant infections.

This easy access to the OTC antibiotics combined with misconceptions about when it's appropriate to use them has created a vicious cycle of overconsumption that has driven growing drug-resistant infections. Studies have shown that drug-resistant bacterial infections are common in communities with frequent use of OTC antibiotics.[1]

OTC antibiotics are still widely available in most developing countries because it is felt that making them readily available to the sick is more important than the consequences of over-use. In addition, public opinion, attitudes, and misconceptions about antibiotics hinder changing the current over-the-counter system.

For example, Malaysia, an upper-middle-income country, prohibits OTC sales of antibiotics.[2] Under the Malaysian Poisons Act, the purchase of antibiotics requires a prescription from physicians. Even though OTC antibiotic sales are controlled, antibiotic prescribing rates are still high in public and private primary care settings.[2] This finding suggests that the next step to reduce antibiotic misuse must include regulating antibiotic prescriptions by physicians, and the sale of OTC antibiotics.

Recommended word for further reading: infection

References

[1] Morgan, D. J., Okeke, I. N., Laxminarayan, R., Perencevich, E. N., & Weisenberg, S. (2011). Non-prescription antimicrobial use worldwide: A systematic review. *The Lancet Infectious Diseases,11*(9), 692-701. doi:10.1016/s1473-3099(11)70054-8

[2] Rahman, N. A., Teng, C. L., & Sivasampu, S. (2016). Antibiotic prescribing in public and private practice: A cross-sectional study in primary care clinics in Malaysia. *BMC Infectious Diseases,16*(1). doi:10.1186/s12879-016-1530-2

Rational use of medicine (RUM)

noun. The act of using medicine that is appropriate to the patients' clinical needs, in doses that meet their treatment requirements, for a suitable period, and at the lowest cost to the patient and their community.

"Rational Use of Medicine can help individuals save on their medical bills, and receive the right amount of treatment, resulting in maintaining the effectiveness of the antibiotics."

Learning point

Why do we use the drugs irrationally?

The WHO estimates that 50% of all medicines are prescribed, distributed, or sold inappropriately.[1] This includes patients who take antibiotics incorrectly. Also, one-third of the population does not have proper access to basic medicines. WHO guidelines say the most common types of irrational drug use are:

- The use of too many medicines per patient
- Overuse of antibiotics often for non-bacterial infections
- Inadequate dosage to combat an infection
- Overuse of injections when oral formulation would be more appropriate
- Inappropriate self-medication
- Certified healthcare workers failing to prescribe in line with clinical guidelines

Overuse of antibiotics can lead to serious problems, including death. Some chronic diseases that might be affected by the overuse of antibiotics are hypertension, diabetes, epilepsy, and mental disorders. Overuse of antibiotics is a waste of resources – often in out-of-pocket payments by patients – and may result in significant patient harm or poor patient outcomes and adverse drug reactions.

Irrational use or overuse of antimicrobials drugs is leading to increased antimicrobial resistance. Inappropriate use of antibiotics can stimulate inappropriate patient demand, and lead to reduced access to regulated healthcare facilities and loss of patient confidence in the health system. This loss of confidence could then lead to a vicious cycle of buying antibiotics over the counter, and demanding 'strong,' 'stronger' or 'strongest' antibiotics from drug stores or healthcare settings.

To stop irrational drug use, core policies to promote more rational use of medicines should be implemented. These include but are not limited to: a national body to coordinate medicinal use policies, clinical guidelines, independent medicine information, and public education about medicines.

Recommended words for further reading: antibiotic literacy, antibiotic stewardship

Check out these videos about RDU:

Why is antimicrobial stewardship important?

https://youtu.be/-G4cEYQBVu4

References

[1] WHO. (2002, September). Promoting Rational Use of Medicines: Core Components - WHO Policy Perspectives on Medicines, No. 005. Retrieved from https://apps.who.int/medicinedocs/pdf/h3011e/h3011e.pdf

Chapter 4. Antibiotic use in animal agriculture

Antibiotic-fed

adjective. Given antibiotics at any time point over their lifetime, usually to describe livestock that was given antibiotics in their feed or water for any purpose, or the food generated from such animals.

"Manure from antibiotic-fed animals may be contaminated with antibiotics and antibiotic-resistant bacteria."

"Most packaged meat that we eat is from antibiotic-fed animals. Antibiotics are usually given to food-producing animals to make them grow faster and bigger, and to prevent infections."[1]

Learning point

Should we be concerned about antibiotic use in livestock?

Antibiotics are fed to livestock, including cattle, chickens, pigs, fish, and shrimp worldwide daily.[2] Farmers use antibiotics to promote growth and for prevention (prophylaxis) or therapy. Using antibiotics to promote animal growth is increasingly banned worldwide. However, the total amount of antibiotics used in animals in many countries is unknown, but probably increasing due to growing demands for foods of animal origin.

An estimated 200,000 to 250,000 tonnes of antimicrobials are produced and consumed worldwide each year.[3] Animals consume about 70% of these antimicrobials, and humans by 30%. Most antibiotics consumed by humans and animals are excreted in urine and faeces, entering the sewage systems and contaminating the environment. When exposed to antibiotics, bacteria living in humans and animals can develop antibiotic resistance. Those antibiotic-resistant bacteria may spread to other people and into the environment, causing infections and death (Figure 1).

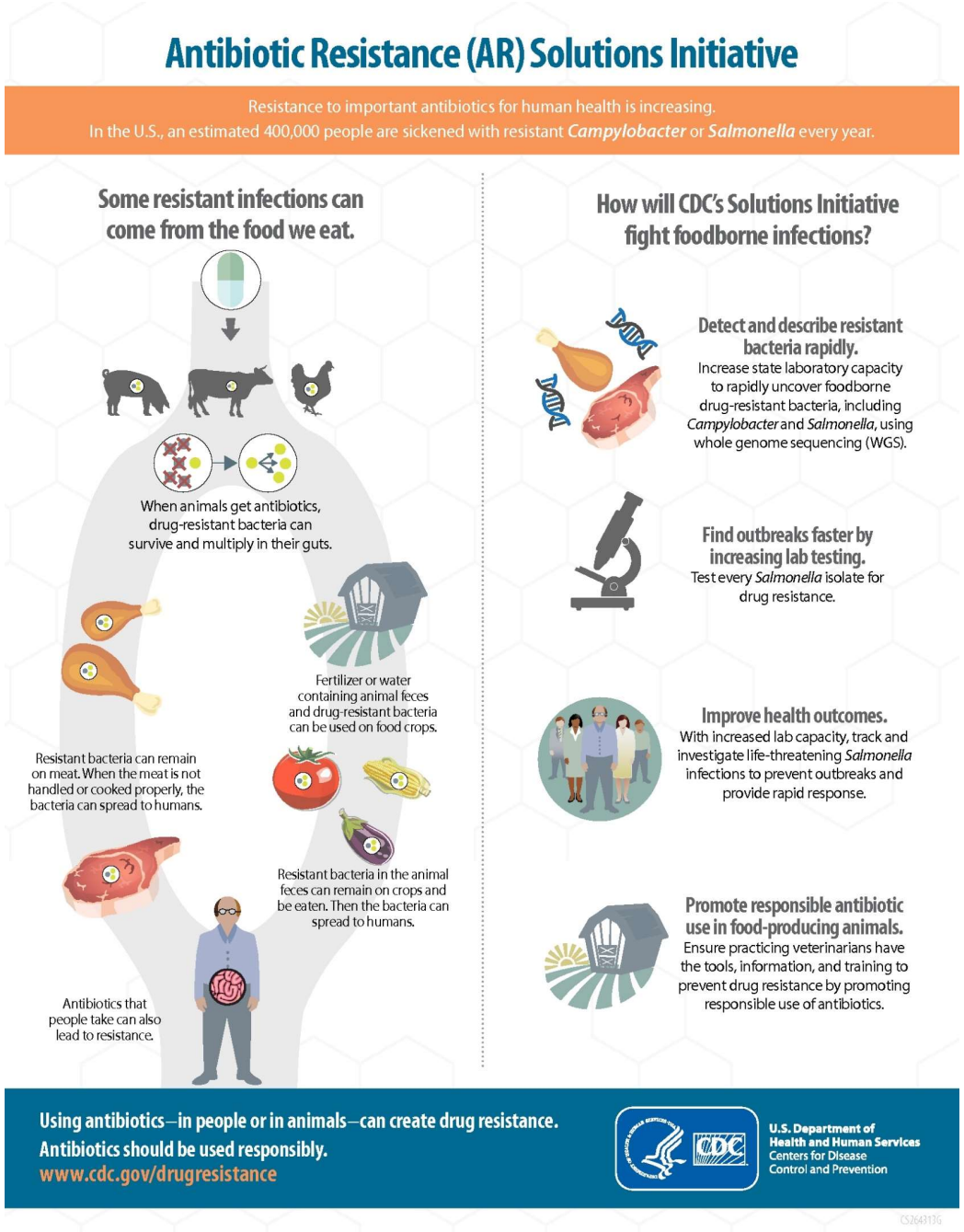


Figure 1: Antibiotic resistance: from the farm to the table.[4]

It is important to note that it is safe to consume meat from antibiotic-fed animals raised in good standard farms if antibiotics were not given to that animal during the last 10-20 days of its life. Withdrawing antibiotics before slaughter ensures that there are no antibiotics in the meat – and reduces the risk of meat being contaminated by drug-resistant bacteria. .

The WHO recommends that farmers and the food industry stop the routine use of antibiotics to promote animal growth and prevent disease in healthy animals.[5] Healthy animals should only receive antibiotics to prevent disease if the disease has been diagnosed in other animals in the same flock, herd, or fish population.

Understanding interconnection between people, animals and their shared environments is important to achieve optimal health outcome. This interconnection is called "One Health".

Recommended words for further reading: antibiotic-free, raised without antibiotics, critically important antibiotics

Check out these videos about antibiotic fed:

Antimicrobial resistance: antibiotics in the livestock sector and their impact on public health

https://youtu.be/N06gmbzs-Pc

Factory farms, antibiotics and superbugs: Lance Price at TEDxManhattan

https://youtu.be/ZwHapgrF99A

Tackling AMR in Bangladesh- a One Health approach

https://youtu.be/YmOey7FGrfE

References

[1] Arsenault, C. (2015, March 24). A huge spike in antibiotic-fed livestock is bringing the superbug epidemic even faster than feared. Retrieved from https://www.businessinsider.com/r-soaring-antibiotic-use-in-animals-fuels-super-bug-fears-2015-3

[2] Food Print Organization. (2019). Antibiotics in Our Food System. Retrieved from http://www.sustainabletable.org/257/antibiotics

[3] O'Neill, J. (2015). *Antimicrobials in Agriculture and The Environment: Reducing Unnecessary Use and Waste*. The Review on Antimicrobial Resistance. Retrieved from https://ec.europa.eu/health/amr/sites/amr/files/amr_studies_2015_am-in-agri-and-env.pdf

[4] CDC. (2013). Antibiotic Resistance [Picture]. In *www.cdc.gov*. Retrieved from https://www.cdc.gov/drugresistance/pdf/AR-and-Food.pdf

[5] WHO. (2017). Stop using antibiotics in healthy animals to preserve their effectiveness. Retrieved from https://www.who.int/news-room/detail/07-11-2017-stop-using-antibiotics-in-healthy-animals-to-prevent-the-spread-of-antibiotic-resistance

Antibiotic-free

adjective. Containing no residual antibiotics, particularly for meat products.

"The terms 'organic' and 'antibiotic-free' need clarification."

"Most packaged meat that we eat is from antibiotic-fed animals. However, those animals should not have been fed with antibiotics during their last two weeks. Therefore, meat is antibiotic-free."

"There is no global standard or certification for the word or label 'antibiotic free'."

Learning point

'Antibiotic-free' meat is misleading

Meat and meat products labelled 'antibiotic-free' usually contain no - or at least no detectable - residual antibiotics. Consumers may believe, often incorrectly, that labelled meat comes from animals that were raised without antibiotics.

In developed countries, all use of antibiotics in farm animals is strictly regulated. They enforce withdrawal periods (the time between last dose of antibiotics and the time when the animals are slaughtered). Withdrawal periods are chosen to avoid antibiotic residues in meat and meat-related products.

In the USA, an 'antibiotic-free' claim is not allowed on the labels of meat and poultry products.[1] However, the 'antibiotic-free' claim is allowed on dairy product labels, such as milk cartons, which are regulated by the Food and Drug Administration (FDA). The FDA has no regulatory definition for the 'antibiotic-free' claim but expects it to mean no antibiotic residues in the product. The FDA does not verify the 'antibiotic-free' claim, nor does the agency require certified verification. The 'antibiotic-free' claim does not guarantee that the cows were never treated with antibiotics or other drugs. Please note that there is no global standard or regulatory definition for the 'antibiotic-free' claim.

Choosing animal products from animals raised without any antibiotics is proposed as an important step that consumers can take to help address the public health crisis of antibiotic resistance. Raising animals without antibiotics is possible if sanitation is improved, and management practices to prevent illness are implemented.

Recommended words for further reading: raised without antibiotics, antibiotic fed

Check out these videos about antibiotic-free:

https://6abc.com/health/consumer-reports-foods-that-claim-no-antibiotics/2203039/

References

[1] Greener Choices. (2017, November 16). What does Antibiotic Free mean? Retrieved from http://greenerchoices.org/2017/11/16/antibiotic-free-mean/

Critically important antibiotics (CIA)

noun. Antibiotics that are the single or one of the few alternatives for treating serious bacterial infections in humans. The list of these antibiotics is made by the World Health Organization (WHO).

"In developed countries, more and more farms have stopped using the highest priority critically important antibiotics completely."

"Meat suppliers are requested to begin phasing out the use of antibiotics defined by the World Health Organization as the highest priority critically important antibiotics."

Related word

Medically important antibiotics

noun. Antibiotics that are classified as essential for human health, listed by the World Health Organization.

Learning point

Antibiotics critically important for human health are being widely used

Since 2005, the WHO has produced a regularly updated list of all antimicrobial drugs currently used for human medicine. Most are also used in veterinary medicine. They are grouped into 3 categories (critically important, highly important and important) based on their importance to human medicine. The list is intended to assist in managing drug-resistant infections, ensuring that all antimicrobial drugs, especially critically important antimicrobials, are used prudently in human and veterinary medicine.

In 2019, the sixth revision of *Critically Important Antimicrobials* for human medicine was released by the WHO.[1] The conclusions from the expert workshops organized by WHO are:

1. There is clear evidence of adverse human health consequences due to antimicrobial-resistant organisms, resulting from non-human usage of antimicrobials.
2. The amount and pattern of non-human usage of antimicrobials affect the occurrence of resistant bacteria in animals and food commodities, thereby exposing humans to these drug-resistant bacteria.

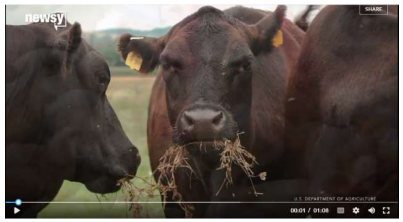
The consequences of antimicrobial resistance are particularly severe when pathogens are resistant to antimicrobials that are critically important in humans.

It is noteworthy that some drugs used in animals, for example tilmicosin, are not used in humans but are also considered critically important antibiotics. This is because tilmicosin is in the same class (macrolides) as other antibiotics used in humans, to which bacteria that develop resistance to tilmicosin may also be resistant. Overuse and misuse of tilmicosin in animal agriculture may lead to the emergence and spread of macrolide-resistant bacteria.

Colistin is commonly used in animals; however, colistin is now considered a last resort antibiotic to cure human infections caused by multidrug-resistant bacteria. China recently banned the use of colistin as a growth promoter and released a mandate to control colistin use in the treatment of disease in animals.

Recommended words for further reading: antibiotic-fed, antibiotic footprint

Check out this video about CIA:



https://www.newsy.com/stories/who-stop-unnecessary-use-of-antibiotics-in-healthy-animals/

References

[1] WHO. (2019). *Critically important antimicrobials for human medicine, 6th revision.* ISBN 978-92-4-151552-8

[2] Branswell, H. (2016, May 26). The world's worst superbug has made its way to the US. Retrieved from http://www.businessinsider.com/superbug-resistant-to-colistin-found-in-us-2016-5

Raised without antibiotic (RWA)

adjective. Describing livestock, particularly food-producing animals, or meat and animal products from livestock that have NEVER been given any antibiotics in their lifetime.

"A number of fast food restaurants in developed countries serve only meat raised without antibiotics."

"The cost of meat obtained from animals raised without antibiotics is higher, at least in developing countries. It is unclear if many people would willingly pay 20 percent more for meat raised without antibiotics meat."

Related word

No antibiotics ever (NAE)

adjective. Synonym for 'raised without antibiotics'.

"Sick animals that required antibiotics would be removed from the 'no antibiotics ever' line, and sent for processing with animals raised under conventional circumstances."

Learning point

Raised without antibiotics: past, present and future

In 2007, many poultry companies in the USA began marketing 'raised without any antibiotics' products.[1] Though it is costly, the companies do so because consumers in rich countries such as the USA are willing to pay a premium price for these process-based characteristics.

In 2015, many fast-food chains in the USA announced that their U.S. restaurants would serve only animal proteins that had never been treated with antibiotics. This is a bold statement, as consumer and public health groups have pressured fast food chains to reduce antibiotic use in their sourced animals.[2]

Raising animals without antibiotics requires a good management system. Farmers must improve sanitation and management practices to prevent illness and death. These include: improving animal housing conditions, reducing population density, and providing probiotics and herbs in the feed. Achieving this is also possible under ecological ways of farming. It includes a wide range of crop and livestock management systems that seek to increase yields

and incomes and maximize sustainable use of local natural resources while protecting the environment and minimizing the need for external inputs and land competition.

Currently, raised without antibiotics products are expensive or not available in low and middle-income countries. Moving to raise without antibiotics without proper management may lead to additional animal deaths. Also, it is possible that consumers' awareness or buying power in low and middle-income countries is not high enough for the investment necessary to improve sanitation and management practices. It is likely that support from governments, non-governmental organizations (NGOs), and society are critically needed before raised without antibiotics products are widely available in these countries.

Recommended words for further reading: antibiotic-free, antibiotic-fed

Check out these videos about raised without antibiotics (RWA):

Broilers Raised Without Antibiotics in Canada

https://youtu.be/mWsKAGJQ9Fo

The economic reason this chicken producer gave up antibiotics

https://youtu.be/mgV0Eo5eTy0

References

[1] Ritchie, H. (2014, September 10). Perdue Foods Sets New Standard for Antibiotic-Free Chicken. Retrieved from http://www.sustainablebrands.com/news_and_views/supply_chain/hannah_ritchie/perdue_foods_sets_new_standard_antibiotic-free_chicken?utm_source=Twitter&utm_medium=schtweets&utm_campaign=editorial

[2] Smith, T. C. (2015, October 28). What does 'meat raised without antibiotics' mean - and why is it important? Retrieved from https://www.washingtonpost.com/news/speaking-of-science/wp/2015/10/28/what-does-raised-without-antibiotics-mean-and-why-is-it-important/?utm_term=.16618f6863fa

Chapter 5. Campaign on antimicrobial resistance

World Antibiotic Awareness Week

noun. An annual global campaign organized by the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE) to make the public, healthcare workers, and policymakers aware of their antibiotic use and practices, in response to the emergence of global antibiotic resistance.

"In 2019, World Antibiotic Awareness Week took place on November 18-24."

Learning point

Handle antibiotics with care

During World Antibiotic Awareness Week, the WHO and partners reach out to the public to raise awareness about antibiotic use via social media, workshops, quizzes, and success stories. The FAO, WHO, and OIE together call for the responsible use of antibiotics in both humans and animals to reduce the growing threat to health caused by the spread of antibiotic resistance. In 2017, the theme was "Seek advice from a qualified healthcare professional before taking antibiotics."[1] In 2018, the theme was 'Change can't wait. Our time with antibiotics is running out."[2] In 2019, the theme was #BeAntibioticSmart.

Since antibiotics are a precious resource, you must get the right advice from doctors and healthcare providers before using them. This protects you, your family, and your community and helps reduce the spread of antibiotic resistance. Therefore, says the WHO, the campaign aims to:

- Make antibiotic resistance a globally recognized health issue;
- Raise awareness of the need to preserve the power of antibiotics through appropriate use;
- Increase the recognition that individuals, health and agricultural professionals, and governments must all play a role in tackling antibiotic resistance; and
- Encourage behaviour change and convey the message that simple actions can make a difference.

You can follow the campaign and keep updated on #AntibioticResistance and #StopSuperbugs on Twitter, Facebook, and Instagram.

Figure 1: Poster for World Antibiotic Awareness Week 2019 by WHO- misuse of antibiotics. [3]

Figure 2: Poster for World Antibiotic Awareness Week 2019- Think twice seek advice. [3]

Figure 3: Advocacy pictures for World Antibiotic Awareness Week 2019. [3]

Check out these videos about World Antibiotics Week:

WHO: Antibiotics - handle with care

https://youtu.be/-ZX97bIbZBQ

Antibiotics just don't work on the flu virus. (Chinese subtitles)

https://youtu.be/ew00C5n9IIo

References

[1] WHO. (2017, November 10). World Antibiotic Awareness Week 2017. Retrieved from http://www.who.int/campaigns/world-antibiotic-awareness-week/2017/event/en/

[2] WHO. (2018). World Antibiotic Awareness Week 2018. Retrieved from https://www.who.int/campaigns/world-antibiotic-awareness-week/world-antibiotic-awareness-week-2018

[3] WHO. (2019). World Antibiotic Awareness Week 2019. Retrieved from: https://www.who.int/campaigns/world-antibiotic-awareness-week/world-antibiotic-awareness-week-2019/landing

Antibiotic footprint

noun. A tool to communicate the total magnitude of antibiotic use in all human activities, including direct and indirect consumption by humans and animals in agricultural production.

"Antibiotic Footprint can be used to help you understand the total amount of antibiotics consumed around the world."[1]

"How can we minimize our antibiotic footprint?"

Learning point

What is antibiotic footprint?

The antibiotic footprint has been proposed as a global tool to communicate the total magnitude of antibiotic use by humans and livestock and its effects on the ecology.[1,2] There is considerable similarity between the carbon footprint and antibiotic footprint (Figure 1). People need to use energy to live, but using too much energy has been driving climate change globally. Likewise, people and animals need antibiotics if they are infected with bacteria. However, overuse and misuse of antibiotics in humans and animals are fostering antibiotic-resistant bacteria and will increase the global number of human and animal deaths they cause over time.[1]

The antibiotic footprint could be estimated by combining the total amount of antibiotics consumed by humans and animals in a given country (Figure 2). Agricultural use of antibiotics is an important part of our antibiotic footprint because most of the antibiotics fed to animals are excreted un-metabolized into sewage systems and water sources, thereby fostering antibiotic-resistant bacteria in the local environment.

Similar to the carbon footprint, each country's antibiotic footprint with official data could be presented and compared (Figure 3). This information would inform both policymakers and the community. For example, people might ask, "How much antibiotic is being used in countries without official data?" or "'I didn't know that so much antibiotic was used in humans and food production in my country—is this being reduced?'

Figure 1: The carbon footprint (*left*) and antibiotic footprint (*right*).

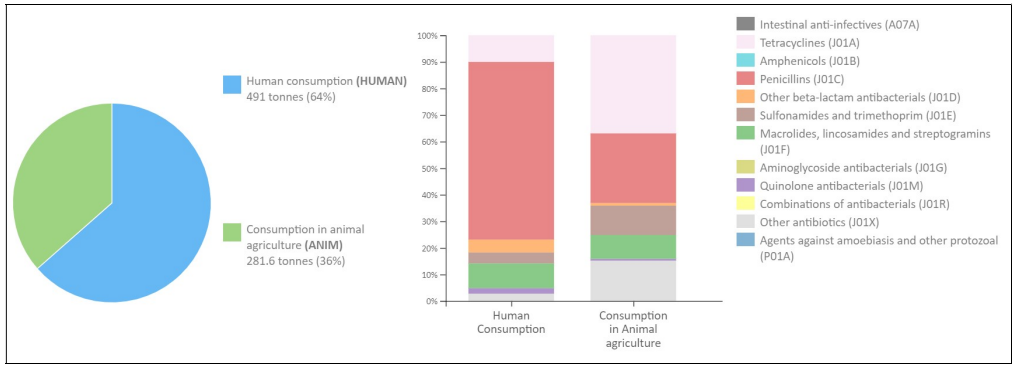


Figure 2: An example of the antibiotic footprint of a country based on antibiotic consumption in the UK in 2017.[2]

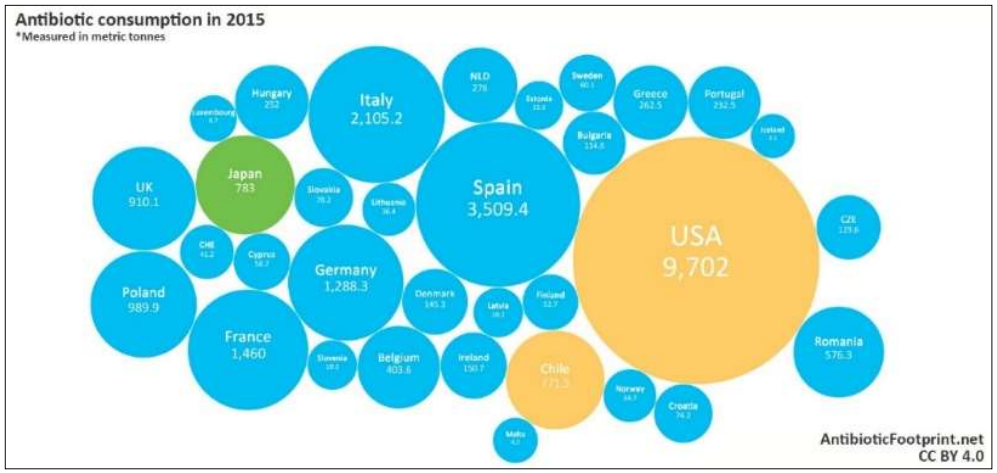


Figure 3: Examples of antibiotic footprint by country (metric tonnes) in 2015.[2]
Find out more about the 'antibiotic footprint' at www.antibioticfootprint.net

Recommended word for further reading: antibiotic misuse

References

[1] Limmathurotsakul, D., Sandoe, J. A., Barrett, D. C., Corley, M., Hsu, L. Y., Mendelson, M., Howard, P. (2019). 'Antibiotic footprint' as a communication tool to aid reduction of antibiotic consumption. *Journal of Antimicrobial Chemotherapy*. doi:10.1093/jac/dkz185

[2] Antibiotic Footprint. (n.d.). Retrieved from http://www.antibioticfootprint.net/

Antibiotic stewardship

noun. A coordinated set of actions to promote the appropriate use of antibiotics to improve the patient's recovery, reduce the chances of bacteria becoming resistant, and decrease the spread of bacteria resistant to multiple antibiotics.[1]

"Implementing antibiotic stewardship in hospitals and communities could save many lives."

"Antibiotic stewardship programs should be recommended to hospitals, pharmacies, and communities."

Learning point

How to practise antibiotic stewardship?

Antibiotic stewardship aims to reduce the misuse and overuse of antibiotics. Correct use of antibiotics could keep antibiotics working longer, reduce antibiotic-resistant infections among patients, and help patients avoid unnecessary side effects. Many hospitals and organizations, such as CDC and WHO, have implemented guidelines to diagnose illnesses to ensure appropriate treatment for viral and bacterial infections.

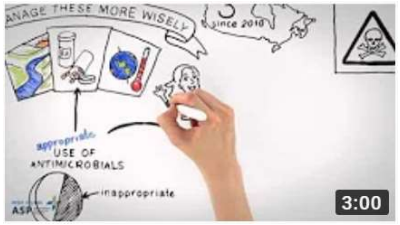
It is not just the healthcare provider who plays a role in antibiotic stewardship; the public also has an important role. You can help to promote the appropriate use of antibiotics by:[2]

- Understanding the cause or probable causes of your illness and not asking for antibiotics if they are not necessary.
- Practising good sanitation and hygiene.
- Avoiding contaminated food and water.
- Making sure that you and your family have received the recommended vaccinations.
- Following doctors' recommendations and taking antibiotics as prescribed.
- Not taking leftover antibiotics.
- Not sharing antibiotics with other people.

Recommended words for further reading: antibiotic misuse, antibiotic stewardship, rational use of medicine, antibiotic literacy

Check out these videos about antibiotic stewardship:

Why is Antimicrobial Stewardship Important?



https://youtu.be/-G4cEYQBVu4

Antibiotic Stewardship| Paul Green| TEDxErie

https://youtu.be/z4zBLsN4aek

References

[1] APIC. (n.d.). Antimicrobial stewardship. Retrieved from https://apic.org/professional-practice/practice-resources/antimicrobial-stewardship/

[2] Mayo Clinic. (2018, January 18). Antibiotics: Are you misusing them? Retrieved from https://www.mayoclinic.org/healthy-lifestyle/consumer-health/in-depth/antibiotics/art-20045720

Chapter 6. Microbes

Fungus

noun. Simple, small living microorganisms that generally cannot be seen by the naked eye. However, many fungi form moulds (or moulds in American English) that can be seen by the naked eye. A fungus is a life form that is made of cells with a nucleus.

"Mushrooms, moulds, yeasts, and mildews are examples of fungi."

"Some species of fungi are pathogenic to animals, human and plants."

Related words

Fungi

noun. The plural of fungus.

Fungal

adjective. Of or caused by a fungus.

Learning point

How do antibiotics affect fungal infection?

The most common fungal infections affecting humans are athlete's foot, ringworm, and vaginal yeast infection. A fungus is a primitive organism. Fungi live in the air, in soil, on plants, and in water. Some fungi reproduce through tiny spores in the air. You can inhale the spores, or they can land on you.

You are more likely to get severe fungal infections if you have a weakened immune system (e.g., HIV infection) or take antibiotics. Antibiotics do not kill fungi – they kill bacteria. The natural bacteria in the vagina, for example, protect you from harm and balance themselves with the local fungi to keep it healthy. When antibiotics kill the natural bacteria in the vagina, fungi (yeasts) can proliferate, causing an infection which is often known as 'thrush'.

Vaginal yeast infection is a common complication of antibiotic usage. A vaginal yeast infection may develop during or after consuming antibiotics taken to treat other conditions such as strep throat. Therefore, we should take antibiotics only when we need them.

Fungal lung infections can be serious and may cause symptoms similar to other illnesses, such as 'flu or tuberculosis. Early testing for fungal infections reduces unnecessary antibiotic use and allows people to start treatment with antifungal medication.

Recommended words for further reading: antifungal, penicillin, antibiotic misuse

Check out this video about fungi:

Fungi: Death Becomes Them - CrashCourse Biology #39

https://youtu.be/m4DUZhnNo4s

References

[1] CDC. (2017). Fungal Infections - Protect Your Health | Features | CDC. Retrieved from https://www.cdc.gov/features/fungalinfections/index.html

Parasite

noun. An organism that lives in or takes its food source/nourishments from other organism, (refer to as the host); which could cause harm and possibly death to the host. In microbiology the term is usually reserved for parasites that are not bacteria, fungi or viruses.

Parasitic diseases are geographically specific, depending on where the parasite can be found in soil, food, water or surfaces that have been contaminated with faeces of infected humans or animals.

Learning point

What are some of the parasitic diseases?

Diseases that are caused by parasites are particularly responsible for sickness and death in tropical developing countries. The main cause of these widespread infections is the climate in the tropics, which includes high temperature and humidity. These are ideal for parasite survival and growth. In addition, parasites also flourish in conditions where there are poor living standards, poor sanitation, and a lack of personal hygiene.

Since parasites are organisms that live off other organisms to survive, they can make the host sick and can be passed on to another host. Parasites also vary considerably in size: some tapeworms can reach over 30 meters in length, whereas others are not detectable by the human eye, for example *Plasmodium,* which are protozoan parasites that cause malaria.

Malaria is one of the biggest killers among the parasitic diseases. In 2018, WHO estimated 228 million cases and 405,000 deaths from malaria worldwide. Most cases occur in Africa and the South-East Asian regions.[1]

There are many ways to prevent yourself from getting parasitic infections, which include:[2]

- When travelling, find out what kind of parasites are most prevalent at your destination
- Take precautions when travelling, such as insect repellent or mosquito nets
- Make sure that your food is well-cooked, especially fish and meat
- Drink water from certified and sealed water bottles

Be careful where you are swimming, such as swimming in fresh-water lakes, pond, or rivers

Recommended word for further reading: antiparasitic

Check out this video about parasites:

Malaria…on the road to the elimination - Tropical Medicine [By Mahidol]

https://youtu.be/gSascTpm0Qg

References

[1] WHO. (2019). The "World Malaria report 2019". Retrieved from: https://www.who.int/publications/i/item/world-malaria-report-2019

[2] Medical News Today. (2018). What to know about parasites. Retrieved from: https://www.medicalnewstoday.com/articles/220302

Bacteria

noun. Simple, small living microorganisms that are found everywhere and cannot be seen by the naked eyes. Bacteria are life forms that consist of single cells that do not have a nucleus.

"Bacteria can multiply rapidly. Once inside our bodies, bacteria can release poisons or toxins that make us feel ill. Diseases caused by bacteria include blood infection, pneumonia, and food poisoning."

"Good bacteria, such as those naturally found on our skin or in our guts, can protect us from bad bacteria. Some good bacteria produce vitamins such as vitamin K."

"Bacteria are used to produce cheese and yogurt through fermentation. Bacteria are also used for the manufacture of antibiotics and other chemicals."

Related words

Bacterium

noun. The singular form for bacteria

Bacterial

adjective. Of, or caused, by bacteria

Learning point

The good and the bad bacteria

Bacteria were one of the first life forms to appear on Earth. Primitive organisms, bacteria live in soil, on plants, in and on water, and the surface of basically everything. You can even become contaminated by bacteria by handshaking or touching doorknobs.

There are many good bacteria that cause no harm to humans and are actually useful in a range of different ways. Bacteria help recycle dead animals and plants. In industry, bacteria are important in sewage treatment and the breakdown of oil spills. Gut bacteria help us to digest food, destroy germs, and provide nutrients. Good bacteria also keep the bad (harmful) bacteria in check.

Harmful bacteria can cause many diseases, including pneumonia (for example *Streptococcus pneumoniae*), meningitis (for example *Streptococcus pneumoniae, Haemophilus influenzae* and *Neisseria meningitidis*), strep throat (Group A *Streptococcus*), and food poisoning (for example *Escherichia coli* and *Salmonella*). These "bad" bacteria are why we need to wash our hands and clean our kitchens and bathrooms properly. In general, bacteria live in complex communities. Some bacteria and fungi produce antibiotics to kill or inhibit the growth of other bacteria, which are competitors within their habitat and communities.

Some bacteria can naturally undergo adaptations to become antibiotic-resistant so that they can survive in the presence of antibiotics in their natural environments. When people misuse or overuse antibiotics, however, some bad bacteria can adapt quickly to become resistant, whilst some good bacteria may die. These drug-resistant infections become more common, and the treatment of diseases becomes more difficult. We need to reduce the risk of drug-resistant bacterial infections by reducing the overuse and misuse of antibiotics and, more importantly, preventing infection in the first place.

It is essential that we don't kill good bacteria by overuse or misuse of antibiotics.

Recommended words for further reading: antibiotic, antibiotic resistant, antibiotic misuse

Check out these videos about bacteria:

What are Bacteria?

https://youtu.be/YGY_gFSTmrc

How bacteria "talk" – Bonnie Bassler

https://youtu.be/KXWurAmtf78

Lowered risk of antibiotic-related diarrhoeal

https://youtu.be/bkWCWv7_oiI

Virus

noun. A simple, small microorganism found everywhere that cannot be seen by the naked eye. They are smaller than bacteria. Viruses have no cell structure and cannot live or replicate independently but only inside the cells of other organisms, but in doing so they often cause damage to the host cells.

"Antibiotics have no effect on viruses. Some antiviral drugs are available that can be used to treat severe viral infection, and sometimes viruses can become resistant to these antiviral drugs."

"Examples of diseases caused by viruses are common cold, influenza, chickenpox, and measles."

Related words

Virion

noun. A virus particle outside its host cell, made up of nucleic acid (DNA or RNA) inside a protein coat.

Viral

adjective. Of or caused by virus.

Learning point

Why do antibiotics not work on viruses?

Antibiotics are drugs used to treat infections caused by bacteria. They only target the cell structures present in bacteria. Viruses are structurally different from bacteria. They live and replicate inside cells (which may be human, animal, or even bacterial) as they cannot multiply outside of the host cells. Some antibiotics disrupt bacterial cell walls, and others inhibit their protein synthesis. Viruses don't have cell walls, and they depend on the host (human or animal cells) for protein synthesis.[1]

Currently only some viral infections can be successfully treated with antiviral drugs. Examples are the varicella-zoster virus (which causes chicken pox and shingles) and the hepatitis C virus. For other viruses, like hepatitis B and HIV, we have drugs that do not kill them but can suppress them, make them less harmful for the patient, and prevent them spreading to others.

There are, however, many vaccines against specific viruses. Vaccines stimulate the body's immune system to produce antibodies specific for a particular virus. These antibodies recognize the virus in the body and inactivate it before it can cause disease. The best way to help prevent diseases like measles and rabies is with a vaccine.

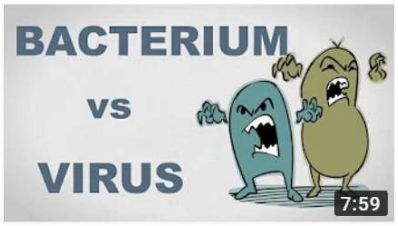
Recommended word for further reading: antiviral

Check out these videos about virus:

Viruses

https://youtu.be/0h5Jd7sgQWY

Viruses and Bacteria: What's the difference and who cares anyway? - Plain and simple



https://youtu.be/O7iaPos8a90

References

[1] Carson C.&Roper R. Medical Xpress (2020, May 08). *Why are there so many drugs to kill bacteria, but so few to kill tackle viruses*? Retrieved from https://medicalxpress.com/news/2020-05-drugs-bacteria-tackle-viruses.html

Chapter 7. Fight against germs, and the germs fight back

Antifungal

adjective. Having the ability to kill or inhibit the growth of fungi.

"Antifungal medicines are used to treat fungal infections, such as ringworm. Some antifungal medicines are available over-the-counter."

"Athlete's foot can be treated with an antifungal cream."

Learning point

The threat of antifungal resistance

The public health threat of antibiotic-resistant bacteria is fairly well known. However, the impact of antifungal resistance and its burden is under-recognized and under-appreciated.

A few antifungal medications have been developed over the years, giving physicians the ability to combat fungal infections. Similar to bacteria, some fungi have developed resistance. One of the most common fungal infections is yeast infection caused by *Candida*. If not treated, yeasts can enter the bloodstream, causing candidemia, particularly in people whose immune systems are not working properly or who are in hospital with multiple devices such as intravenous drips. Of concern is that some of the *Candida* strains causing candidemia are now becoming resistant to the first- and second-line antifungal drugs.[1]

Like bacteria, fungi will naturally become resistant to antifungal medicine due to frequent or improper use. Examples of improper use are administering antifungal medication in a lower dose, or for a shorter period than necessary to cure the infection.

In addition to problems with fungi that cause disease in humans, growing levels of antifungal resistance could have an impact on global food security.[2] Crop-destroying fungi are estimated to account for a loss of 20% of global crop yields each year. The overuse of antifungal chemicals in intensive agriculture is also driving antifungal resistance. Resistant strains of fungi may spread quickly and could destroy our ability to produce food globally.

Recommended words for further reading: fungus, antimicrobial resistance

Check out this video about antifungal resistance:

The Rise of Antifungal Resistance

https://www.medscape.com/viewarticle/861041

References

[1] CDC. (2018, September 27). Antifungal Resistance | Fungal Diseases | CDC. Retrieved from https://www.cdc.gov/fungal/antifungal-resistance.html

[2] Fisher, M. C., Hawkins, N. J., Sanglard, D., & Gurr, S. J. (2018). Worldwide emergence of resistance to antifungal drugs challenges human health and food security. *Science,360*(6390), 739-742. doi:10.1126/science.aap7999

Antiparasitic

adjective. Having the ability to kill or inhibit the growth of a parasite. Examples of antiparasitic drugs are antimalarials.

"For travelers, no antimalarial drug is 100% protective. Medication must be combined with personal protective measures such as insect repellent, long sleeves, long pants, sleeping in a mosquito-free setting, or insecticide-treated bed nets." [1]

"Misuse of antimalarial drugs is widespread, and that is driving antimalarial resistance worldwide."

"Fake antimalarial drugs are common in many developing countries. Patients should be alert to this fact, seek treatment with official healthcare providers, and follow their recommendations."

Learning point

'Super malaria' is spreading

In 400 BC, Hippocrates believed that malaria was caused by bad air, especially at places near the swamps and lakes. The name "malaria", meaning "bad air" in Italian, was derived from the miasma theory.[1] However, malaria has nothing to do with bad air. Malaria is all about where mosquitoes carrying the malaria parasite live (often near swamps and lakes) and the parasites inside those mosquitoes. Female mosquitoes usually carry the malaria parasites and inject them into the body when they bite for a blood meal.

The rapid spread of drug-resistant malaria in South-East Asia is a global concern. Malaria is the most important parasitic disease affecting humans. Although most malaria deaths occur in Africa, drug resistance has emerged repeatedly from South-East Asia. Artemisinin and its derivatives, plant-derived anti-malaria compounds, originally from China, are today the best treatment for malaria. However, in 2008, medical researchers found a strain of malaria resistant to artemisinin in South-East Asia.

About 212 million people are infected with malaria each year. If the drug-resistant strain spreads to Africa, where 92% of all malaria deaths occur, it could worsen what is already a major crisis there.[2]

Mosquito control and stopping the inappropriate use of antimalarial drugs are the keys to control malaria and drug-resistant malaria. People who are at risk of malaria should use insecticide-treated mosquito nets and spray indoors. All patients suspected of malaria should be confirmed using a rapid diagnostic test (RDT) or a microscope before receiving treatment.[3] Otherwise, the overuse of antimalarial drugs will keep driving the problem of antimalarial resistance.

Recommended words for further reading: drug-resistant infection, parasite

Check out these videos about malaria and antimalarial resistance:

Herbs and Empires: A Brief History of Malaria Drugs

https://youtu.be/IrNL27eWKOI

Drug-Resistant Malaria Spreads in South-East Asia

https://youtu.be/vhlEf9LClik

U.S. Health Partnerships in the Mekong: Eliminating Artemisinin Resistant Malaria

https://youtu.be/sbc4Za5LOys

References

[1] Bierhoff, M. (2018, June 29). Malaria? I don't smell anything. Retrieved from https://bierhoffgoesviral.com/2017/12/01/malaria-i-dont-smell-anything/

[2] Uwimana, A., Legrand, E., Stokes, B.H. *et al.* Emergence and clonal expansion of in vitro artemisinin-resistant *Plasmodium falciparum kelch13* R561H mutant parasites in Rwanda. *Nat Med* (2020). https://doi.org/10.1038/s41591-020-1005-2

[3] White, N. J. (n.d.). Nick White: Artemisinin therapy for malaria. Retrieved from https://www.tropmedres.ac/researcher-podcasts/podcasts/nick-white-artemisinin-therapy-for-malaria

[4] WHO. (2019, March 27). Fact sheet about Malaria. Retrieved from http://www.who.int/news-room/fact-sheets/detail/malaria

Penicillin

noun. One of the first antibiotics discovered, which is able to kill bacteria by disrupting their cell walls. Penicillin is an example of an antibiotic naturally produced by a blue mould, and is used to treat and prevent a variety of bacterial infections.

"Penicillin was discovered in 1928, and widely used during WWII. It had a huge impact on the world."

"Gonorrhea can be effectively treated with penicillin. Almost all *Streptococcus pneumoniae*, the most common cause of bacterial pneumonia, and *Staphylococcus aureus* used to be susceptible to penicillin. Now, penicillin is ineffective against these infections."

"In many countries anyone can buy penicillin and it may be considered normal to do so. Then, there is the danger that people may under-dose themselves, and exposing their microbes to non-lethal quantities of the drug, which may enable them to become resistant."[1]

Learning point

The discovery of penicillin

In the early 1900s, deaths from infectious diseases, such as tuberculosis and pneumonia, were common. Scratches, cuts, or dental work could become life-threatening if they became infected. Luckily, in 1928, Alexander Fleming accidentally discovered the first antibiotic when he noticed a blue mould called *Penicillium notatum* which had contaminated his experiments on bacteria. When he looked more closely, Fleming noted that the 'mould juice' killed some of the bacteria. The extracted antibiotic is called penicillin.

During World War II, penicillin changed the way healthcare providers treated illnesses and wounds. As a result, infection killed less than 1% of the soldiers, compared to World War I, where it killed 18% of the soldiers.

Fleming won the Nobel Prize in 1954 for discovering penicillin or the 'Wonder Drug'. However, Fleming warned the public that doctors were abusing penicillin by using it in patients who did not need it. He said, "The microbes are educated to resist penicillin. A host of penicillin-fast organisms is bred out, which can be passed to other individuals and perhaps from there to others until they reach someone who gets septicaemia or pneumonia, who cannot be saved by penicillin. In such cases, the thoughtless person playing with penicillin is morally responsible for the man's death, who finally succumbs to infection with the penicillin-resistant organism. I hope this evil can be averted." [1]

More recently a large number of other antibiotics, which are related to penicillin and work in a similar way, have been produced. However, resistance to these is also growing.

Recommended words for further reading: antibiotic, antibiotic resistance, fungus, antituberculous

Check out these videos about penicillin:

Alexander Fleming and the Accidental Mould Juice – The Serendipity of Science

https://youtu.be/0ZWjzcsTd5M

References

[1] Fleming, A. (1945, June 26). PENICILLIN'S FINDER ASSAYS ITS FUTURE; Sir Alexander Fleming Says Improved Dosage Method Is Needed to Extend Use Other Scientists Praised Self-Medication Decried. Retrieved from https://www.nytimes.com/1945/06/26/archives/penicillins-finder-assays-its-future-sir-alexander-fleming-says.html

Antituberculous drugs

adjective. Having the ability to kill or inhibit the growth of *Mycobacterium tuberculosis*, the bacteria that cause tuberculosis (TB).

"TB patients should complete a treatment regimen with antituberculous drugs for a minimum period of 6 months."

"Development of antituberculous resistance is a tragedy for both the patient and others."

"Multidrug-resistant tuberculosis occurs when patients inappropriately use or prematurely stop antituberculousdrugs."

Learning point

Battle against drug-resistant TB

Tuberculosis (TB) is caused by a bacterium called *Mycobacterium tuberculosis*. The bacteria can spread from people to people through tiny droplets released into the air via coughing, sneezing, spitting, and talking. Patients with underlying diseases that weaken the immune system, such as HIV, malnutrition, diabetes, and people who smoke have a higher risk of getting TB.[1]

Any person who has a chronic cough for longer than 2 or 3 weeks, which is the most common primary symptoms of tuberculosis should see a doctor.

Sometimes drug-resistant TB occurs when the infecting bacteria have become resistant to antituberculous drugs. These drugs can no longer kill the TB bacteria.

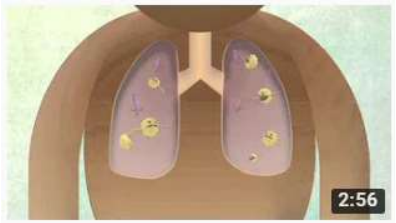
The most important way to prevent the emergence of drug-resistant TB is to take all TB drugs exactly as prescribed by the health care provider. No doses should be missed, and treatment should not be stopped early. People receiving treatment for TB disease should tell their health care providers if they are having trouble taking the drugs.[2]

It is also crucial for every country to take preventive measures now, as it is still possible to reverse the development and transmission of multidrug-resistant tuberculosis.

Recommended words for further reading: drug-resistance infection, multidrug resistance

Check out these videos about TB:

How the body reacts to tuberculosis



https://youtu.be/IGZLkRN76Dc

References

[1] WHO. (2018, January 18). What is TB? How is it treated? Retrieved from http://www.who.int/features/qa/08/en/

[2] WebMD. (n.d.). What are the symptoms of Tuberculosis?. Retrieved from https://www.webmd.com/lung/understanding-tuberculosis-symptoms

Antiviral

noun. Having the ability to kill or inhibit the growth of viruses.

"Usually, you'll need nothing more than bed rest and plenty of fluids to treat the flu. However, in some cases with severe influenza, or to reduce the spread of infection, your doctor may prescribe an antiviral

"Antiviral medications are available for HIV, hepatitis B, hepatitis C, and shingles."

Learning point

How are antiviral drugs and antibiotics different?

Antibiotics are not effective against viral infections, and antiviral drugs are not effective against bacterial infections. Most common viral infections, such as the flu or common cold, will usually go away by themselves without antiviral treatment.[1] Antivirals are available for some specific viral infections, such as influenza, HIV/AIDS, and Hepatitis B.

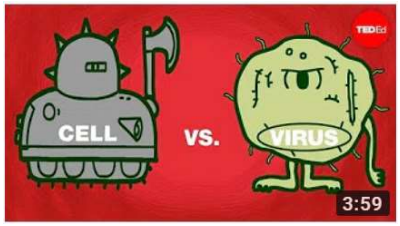
Some viral and bacterial illnesses have similar symptoms, such as pneumonia and diarrhoea, and it is difficult to know which the cause is. Doctors distinguish viral from bacterial diseases by taking a medical history, performing a physical examination, and ordering diagnostic tests such as blood or rapid diagnostic tests (although they are often not very good at distinguishing them). For influenza, a swab is typically used to collect specimens from your throat or nose which are then tested for the influenza virus.

Like bacteria, viruses change and adapt over time and can develop resistance to antiviral drugs. Antiviral drug resistance is particularly an increasing problem in HIV/AIDS patients.

Recommended words for further reading: virus, drug-resistant infection, infection, vaccine

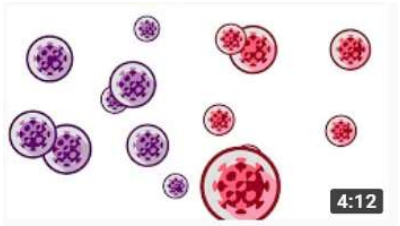
Check out these videos about antibiotic virus and antiviral drugs:

Cell vs. virus: A battle for health- Shannon Stiles



https://youtu.be/oqGuJhOeMek

WHO: Action against HIV drug resistance threat



https://youtu.be/VCVjHSuYqto

References

[1] HealthyMePA. (2018, October 25). Do I Need An Antibiotic? Know the Difference Between Viral and Bacterial Infections. Retrieved from https://www.healthymepa.com/2017/02/21/do-you-need-antibiotics/

Chapter 8. Other drugs

Anti-inflammatory drug

noun. Any drug that reduces inflammation (when a part of body becomes red, sore and swollen).

"Inflammation is a body response to an infection, injury, or autoimmune disease, where a part of the body becomes red, sore, irritated, and swollen."

"Non-steroidal anti-inflammatory drugs, commonly known as NSAIDs, are drugs that help reduce inflammation, which often helps to relieve pain. Many NSAIDs are available over-the-counter; for example, aspirin and ibuprofen."

Learning point

How is inflammation different from infection?

Inflammation and infection are entirely different things, although they often occur together. Inflammation represents the body's response to an injury or infection, whereas infection refers to the invasion and multiplication of harmful germs within the body. However, although infection can cause inflammation, the presence of inflammation does not necessarily mean that there is an infection.

During infection, our body develops inflammation in an attempt to kill the germs, and begin the healing process. Inflammation is part of the body's immune response. Some signs of inflammation include:

- Heat in the area
- Redness
- Swelling
- Pain
- Immobility

Inflammation will often disappear after the causes of inflammation have been removed and the body has produced a protective response and recovered.

Anti-inflammatory drugs such as aspirin (e.g., Bayer®, Bufferin®, Excedrin®), ibuprofen (e.g., Advil®, Motrin IB®) and naproxen (e.g., Aleve®), can help heal, prevent more damage, and also mask pain in inflammation resulting from both infections and injury. However, anti-inflammatory drugs cannot kill or inhibit the growth of germs.

Antimicrobials such as antibiotics, antiviral drugs, antifungal drugs, and antiparasitic drugs can kill or prevent the growth of germs, the cause of the infections. Killing or preventing the growth of the microbes can stop the process of the infection and reduce the inflammation caused by the body fighting against them. However, antimicrobial drugs cannot reduce inflammation caused by injuries such as wounds, trauma, car accidents, or fractures.

Recommended word for further reading: infection

Check out these videos about anti-inflammatory drugs:

Non-steroidal anti-inflammatory drugs (NSAIDs): Mayo Clinic Radio

https://youtu.be/3_kdBPzLsMc

Antiseptic

noun. A substance applied to the body that prevents infection by killing microorganisms or preventing their growth.

adjective. Able to kill or prevent the growth of microorganisms.

"Commonly used antiseptics are alcohol, Dettol®, and Iodine (e.g., ,Betadine®)."

"Antiseptics are commonly available in a First Aid box. When you get a cut or a wound, you should clean the wound with normal saline or tap water, and then apply antiseptics, such as alcohol, on the wound."

"Antiseptic creams, also known as first-aid creams, are commonly sold over-the-counter."

"During the bird flu outbreak, officials need to monitor and use antiseptic sprays in the affected area two or three times a day."

Related word

Disinfectant

noun. Similar to antiseptic, a substance applied to non-living surfaces that kills or inhibits the growth of disease-causing microorganisms.

Learning point

What are the differences between antibiotic and antiseptic?

Unlike antibiotics, antiseptics are also effective on other microorganisms such as viruses and fungi, making them potentially beneficial in fighting other infections. Antibiotics can be taken by mouth or injected into the body to kill the bacteria causing infection; however, antiseptics can ONLY be used to kill bacteria on body surfaces such as the skin or open wounds.

Antiseptic	**Antibiotic**
Used externally on the skin, e.g., wounds, scrapes or cuts	Taken orally or injected into the body
Some common types of antiseptic include: **Alcohol**: Effective against a broad range of microbes, it can be diluted for optimal killing of microbe. **Povidone-iodine solution**: Used for surgical scrubs, wounds or scrapes (e.g., **Betadine®**) **Hydrogen peroxide**: Cleans and deodorizes wounds and ulcers, and can be used as first aid for scrapes **Boric acid**: Can be used in eyewash or applied as a cream for burns	Some common types of antibiotics include: **Penicillin group**: Antibiotics such as amoxicillin are used for common bacterial infections such as bacterial pneumonia or Strep sore throat. **Cephalosporins**: Antibiotics like cephalexin (Keflex®) are used for skin infections, and urinary tract infection. **Fluroquinolones**: Antibiotics such as norfloxacin, which is used for acute diarrhoea caused by a bacterial infection
Resistance to antiseptics is rare.	Resistance to antibiotics is common.

Recommended words for further reading: microorganisms, antibiotic

Vaccine

noun. A biological substance put into the body that induces the body's immune system to protect the body from disease.

"Not only children need vaccines, but adults may also need vaccines as well. Some recommendations include 'flu and whooping cough vaccine."

"Vaccines have an important role in the fight against antimicrobial resistance. Vaccines can stop the spread of many infectious diseases and reduce the overuse and misuse of antibiotics."

Related word

Vaccination

noun. Giving a person or animal a vaccine to produce immunity against a disease and protect them against that disease.

"Vaccination, prepares the body's immunity to fight against a particular disease, such as influenza."

"'Vaccination stimulates the body immune system to recognize and remember the germs as 'foreign'. So next time you encounter them, you will not get sick."

Learning point

The discovery of vaccines and their effectiveness

The history of vaccinations dates back to the early 10th century China. Chinese physicians smeared smallpox samples on the skin to confer immunity. This practice spread to Africa and Turkey, and decades later to Europe and America. Edward Jenner later inoculated cowpox material into humans and demonstrated that this was effective in protecting against smallpox.[1] Jenner's innovation opened the door to modern vaccination practices.

Jenner initially noticed that milkmaids often did not contract smallpox. This observation led him, in 1796, to inoculate material from cowpox lesions from a milkmaid's hands to James Phipps, his gardener's son, by scraping the boy's arm with the cowpox infected metal (similar to vaccination). Later Jenner demonstrated that James did not contract smallpox when he was in contact with the disease. He named his discovery 'vaccination', from the Latin for a cow ('*vacca*'), and 'vaccinia,' which means cowpox.

The main difference between administering antibiotics and vaccination is that an antibiotic is designed to kill germs in the body, either during an infection or at the time of initial exposure to infection, whereas vaccination is usually administered before exposure to the disease occurs and depends on stimulating the host's response to infection. This is a more sustainable approach, as the vaccine strengthens the immune system, so that it remembers the germs and fights against them should the body re-encounter them again at a later time.

In addition, vaccination can reduce the incidence of bacterial and viral infections in a population, thus reducing the overall use of antibiotics. Therefore, vaccines also have a role in fighting against antimicrobial resistance.[2]

Recommended words for further reading: antibiotic, antimicrobial resistance

Check out these videos about vaccines:

Our Best Short: The importance of Vaccines for Older Adults

https://youtu.be/hodb65EkorM

Measles: To vaccinate or not?

https://youtu.be/yQG07nq8ia0

References

[1] Riedel, S. (2005). Edward Jenner and the History of Smallpox and Vaccination. *Baylor University Medical Center Proceedings,18*(1), 21-25. doi:10.1080/08998280.2005.11928028

[2] Bloom, D. E., Black, S., Salisbury, D., & Rappuoli, R. (2018). Antimicrobial resistance and the role of vaccines. *Proceedings of the National Academy of Sciences,115*(51), 12868-12871. doi:10.1073/pnas.1717157115

Chapter 9. Infections

Community-acquired infection

noun. An infection acquired in the community or environment (and not from a hospital or healthcare facility).

"Infections can be simply categorized into community-acquired infections and hospital-acquired infections. This categorization is used as proxy to define where the infection has been contracted."

"Rates of antibiotic resistance in bacteria causing community-acquired infections is increasing."

"If you come to the hospital because of an infectious disease such as pneumonia, urinary tract infection, and sepsis, and you have not stayed in a hospital recently (e.g. during the last 30 days), we can assume that your infection is community-acquired."

Learning point

Why do we distinguish between community-acquired and hospital-acquired infections?

It is crucial to separate community-acquired from hospital-acquired infections since prevention and interventions to reduce the burden of drug-resistant infections in these two settings are largely different. It is also to critically decide on the allocation of resources for interventions and monitor the intervention's effectiveness in the community and hospitals separately.

Overuse and misuse of antibiotics in the community may drive community-acquired AMR infections more than hospital-acquired AMR infections. Practices such as poor handwashing, poor hygiene or wastewater management, or high levels of antimicrobial drugs in wastewater, may expose people to an environmental source of AMR infections. Those communities are at higher risk of community-acquired AMR infections.

Overuse and misuse of antibiotics in hospitals tends to drive hospital-acquired AMR infections more than community-acquired AMR infections. People exposed to AMR bacteria in the hospital will be at higher risk of getting hospital-acquired AMR infections. For example, this can occur if hospital healthcare workers, patients, and relatives do not wash their hands frequently and adequately enough. However, it's also possible for AMR bacteria acquired in hospital to be transmitted to contacts in the community.

The treatment options and interventions for hospital-acquired and community-acquired infections are different as these infections are often associated with different microbes. To reduce the burden of community-acquired AMR infections, antibiotic stewardship, prevention, and intervention must focus on educating the community and the general population. On the other hand, to reduce the burden of hospital-acquired AMR infections, antibiotic stewardship, prevention, and intervention should focus on healthcare workers, patients, relatives, and the hospital environment.

Doctors can sometimes determine whether a patient is likely to have a had community-acquired infection or a hospital-acquired infection using careful history taking and individual judgment. Nonetheless, for simplicity, a proxy definition is often used. For example, if microorganisms are isolated from clinical specimens (such as blood and urine) collected from patients at outpatient clinics or patients within two calendar days of their admission to hospital, these infections could be defined as community-acquired infections. If the patient gets sick or the microorganisms are isolated 3 or more days after admission, it is likely that the infection is hospital-acquired.

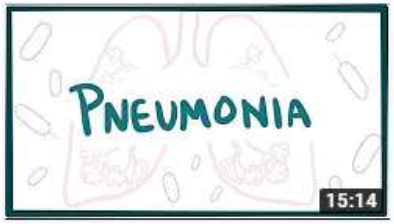
Recommended words for further reading: hospital-acquired infection, antibiotic, antibiotic-resistant, antibiotic misuse

Check out these videos about community acquired infection:

Assessing the Problem | Community-Acquired Pneumonia | MedscapeTV

https://youtu.be/K8X3d5SnYCQ

Pneumonia (community acquired, ventilator associated, aspiration) - pathology



https://youtu.be/_Gh_Z9nZt-M

Hospital-acquired infection

adjective. An infection acquired in a hospital.

"If you come to the hospital because of non-infectious diseases, such as heart attack, stroke, and cancer, and you develop an infection (such as pneumonia) after staying in the hospital for at least two days, doctors can assume that your infection is a hospital-acquired infection."

Related word

Nosocomial infection

adjective. Another term for hospital-acquired infection.

"Rates of antibiotic resistance in bacteria causing hospital-acquired infections are extremely high. As a result, patients with hospital-acquired infections have a high risk of complications and deaths."

Learning point

How can we avoid a hospital-acquired infection?

When we stay in hospitals – even for a routine procedure – we are at risk of hospital-acquired antimicrobial-resistant bacterial infections. Since antibiotics are frequently used within hospitals, the types of bacteria and their resistance to antibiotics are different from bacteria outside the hospital.

Based on the most recent data from the Centres for Disease Control and Prevention (CDC), USA, some 650,000 people developed hospital-acquired infections in 2011, and 75,000 died. Hospital-acquired infections are even more likely in developing countries where resources are limited and there are fewer controls on the use of antibiotics.[1]

To reduce the risk of a hospital-acquired infection, you should be aware of these recommendations for patients and the general public:[2] [3]

#1. Know that there is a risk of hospital-acquired infections.

Many people do not know that staying in hospitals puts them at risk of developing a hospital-acquired infection. In some countries, such as the USA, you can check a hospital's infection score from free websites to better understand the risks involved in staying there.

#2. Take a shower before admission or before surgery.
Ask your doctor about taking precautions before entering into a hospital for surgery, such as bathing with a special soap or using antiseptic wipes.

#3. Insist on clean hands, and practice telling people to wash their hands.
Insisting isn't easy! Asking someone to wash their hands can feel insulting, awkward, or even rude (particularly if you are a patient talking to healthcare workers). However, the best way to reduce the risk of hospital-acquired infection is excellent hand hygiene and handwashing. Many doctors and healthcare workers will be very open about handwashing, even asking you to remind them to wash their hands.

Everyone, including your relatives and all healthcare workers, must wash their hands: (1) before touching you; (2) before any health procedure; (3) after touching any body fluid; (4) after touching you; and (5) after touching your surroundings.[4]

Don't hesitate to say: "I'm sorry, but I didn't see you wash your hands. Would you mind doing it again?"

#4. Keep everything clean.
Routine cleaning of surfaces may reduce the spread of infectious microorganisms and prevent hospital-acquired infections.

#5. Inquire whether intravenous (IV) devices and catheters are still needed.
Ask every day whether central lines, urinary catheters or other tubes can be removed. The longer they're left in place, the higher the infection risk.

#6. Ask about antibiotics.
Ask if antibiotics were prescribed and whether you need them. Overuse and misuse of antibiotics can increase your risk of hospital-acquired infections.

#7. Watch out for diarrhoea.
If you have loose stools, please inform your doctors. That could be a sign of hospital-acquired infection.

#8. Stop smoking and drinking, even if only temporarily.
You won't be allowed to smoke or drink alcohol in the hospital anyway, and stopping as long as possible beforehand can cut the risk of infection.

While no medical outcome can be guaranteed, these tips may help reduce your chances of getting an infection while receiving treatment at a hospital or healthcare facility.

Recommended words for further reading: community-acquired infection, antibiotic resistance, antibiotic misuse, antibiotic stewardship

Check out these videos about hospital acquired infection:

Hospital Acquired Infections & How to Prevent Them | Curos

https://youtu.be/izxdrkJIhQ4

Hospital Infections

https://youtu.be/V3oftSIE-kU

WHO: SAVE LIVES - Clean Your Hands - No action today; no cure tomorrow

https://youtu.be/kOKeFv5VvY4

References

[1] WHO. (2016). *Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level*. ISBN 978-92-4-154992-9

[2] Consumer Reports. (2016). 15 Tips for Preventing Infections in the Hospital. Retrieved from https://www.consumerreports.org/hospital-acquired-infections/15-tips-for-preventing-infections-in-the-hospital/

[3] Mitchell, E. (2015, May 13). 5 Things You Can Do To Avoid A Hospital-Acquired Infection. Retrieved from http://blog.eoscu.com/blog/5-things-you-can-do-to-avoid-a-hospital-acquired-infection

[4] WHO. (2013, May 03). About SAVE LIVES: Clean Your Hands. Retrieved from http://www.who.int/gpsc/5may/background/5moments/en/

Infection

noun. The result of microorganisms (bacteria, viruses, parasites or fungi) attaching or entering into a host (humans or animals) and producing illness.

"Common cold is an example of a viral infection. The patient will experience sore throat, cough, sneezing, and mild fever."

"Infection prevention is everyone's business. Patients and their families can stay healthy while receiving healthcare."

Related word

Infectious

adjective. Able to cause an infection; communicable infection.

Learning point

How can you protect yourself and your loved ones from infection?

Infections occur when disease-causing bacteria, viruses, parasites, or fungi enter your body and begin to multiply. Infections can be prevented by avoiding sources of infection or by vaccination before encountering the microbes. To avoid community-acquired infections, patients and the public should remember these recommendations [1]:

#1. Understand how infections are transmitted.

We know that most microorganisms enter our body through openings in the body, including our noses, mouths, ears, anuses, and genital passages. They can also be transmitted through our skin via insect or animal bites, and even from door handles. They can also be transmitted from the air. Therefore, the best way to prevent infection is to block those microorganisms from entering our bodies.

#2. Wash your hands often.

Handwashing is especially important before and after preparing food and before eating. It is also essential after you cough or sneeze, enter the home after being outside, touch your pets, and after using the toilet.

#3. Get vaccinated.

Immunization can drastically reduce your chances of contracting many diseases. Keep your recommended vaccinations up-to-date.

#4. Use antibiotics only when they are needed.

Take antibiotics only when prescribed. Do not pressure your doctors to prescribe antibiotics.[2] It would help if you asked, "Why am I taking antibiotics?" to verify the rationale.[3] Unless otherwise directed, or unless you are allergic to them, take all prescribed doses of your antibiotic, even if you begin to feel better before completing the dose.

#5. Stay at home if you have symptoms and signs of an infection.

Don't go to work or class if you're vomiting, coughing, have diarrhoea or are running a fever.

#6. Wear a mask when you are sick. If that's not possible, cover all coughs and sneezes.

When you are sick and coughing or sneezing, tiny droplets of saliva and mucus carrying viruses are expelled into the air. These viruses can spread to those around you and make them sick too. Wearing a mask is one of the best ways to prevent you from spreading germs to others when you do not feel well.

However, we still recommend that you wear a mask if you are sick, which is shown to be protective factors of infectious disease such as COVID-19. If that's not possible, cover your mouth and nose with a tissue paper when you sneeze or cough, then dispose of it in a sanitary manner. If no tissue paper is handy, cough or sneezes into your elbow rather than into your hands.

#7. Be smart about food preparation.

Keep counters, and other kitchen surfaces clean when preparing meals. In addition, promptly refrigerate leftovers. Don't let cooked foods remain at room temperature for an extended period.

#8. Eat cooked food and drink clean water.

Eating raw foods or unclean vegetables can increase the risk of infection and diarrhoea. In many countries, tap water is still contaminated with bacteria, and it is best to boil water before drinking.

#9. Avoid bugs

Both mosquitoes and ticks can carry several viruses, bacteria, and parasites. Use insect repellents during outdoor activity, drain any standing water near your home to prevent mosquitoes from breeding, and use animal-control to prevent mice, rats, and cockroaches that may carry harmful microbes.

#10. Prevent sexually transmitted diseases (STD.

Do not have unprotected sexual intercourse. Use condoms if engaging in sexual contact. Get tested for HIV and other sexually transmitted diseases (STDs), and have your partner get tested – or abstain altogether.

Recommended words for further reading: bacteria, virus, fungus, microorganism

Check out these videos about infection:

The Immune system explained I- Bacterial infection

https://youtu.be/zQGOcOUBi6s

Germ Smart – Wash Your Hands!

https://youtu.be/NoxdS4eXy18

References

[1] Mayo Clinic. (2017, March 08). Germs: Protect against bacteria, viruses and infection. Retrieved from https://www.mayoclinic.org/diseases-conditions/infectious-diseases/in-depth/germs/art-20045289

[2] Knapton, S. (2015, August 18). 'Soft touch' doctors should be disciplined for over-prescribing antibiotics. Retrieved from https://www.telegraph.co.uk/news/science/science-news/11808015/Soft-touch-doctors-should-be-disciplined-for-over-prescribing-antibiotics.html

[3] Laliberte, M. (n.d.). 12 Essential Questions to Ask Your Doctor Before Taking Antibiotics. Retrieved from https://www.rd.com/health/conditions/antibiotics-side-effects-questions/#card-1/

Sepsis

noun. A serious condition resulting from the presence of harmful microorganisms in the blood or other tissues and the body's response to their presence, potentially leading to the malfunctioning of various organs, shock, and death.

"Sepsis happens as the body tries to fight off an infection. The body releases chemicals into the bloodstream to battle the invading germs — which can lead to a severe drop in blood pressure. That can damage vital organs and, in severe cases, cause them to shut down."

"The Centers for Disease Control and Prevention (CDC) report that at least 1.5 million people annually get sepsis in the U.S. Of these 1.5 million people, 250,000 will die."

"Sepsis accounts for at least 6 million deaths worldwide annually. In many parts of world, less than 50% of people know about sepsis, its diagnosis and prevention."

Learning point

Raising awareness of sepsis

Sepsis occurs when your body has a severe reaction in response to an infection from any microorganisms. It is a medical emergency and needs urgent treatment as it can cause tissue damage, organ failure, and eventually death.

Sepsis affects about 30 million people per year, and causes approximately between six and nine million deaths worldwide every year, most of which are preventable.[1]

Most infections can lead to sepsis. Among them includes common infections such as pneumonia, urinary infections, infections in the abdomen, skin or wound infections, or meningitis. Seasonal flu, malaria, dengue, Yellow fever and Ebola may all result in sepsis.[2]

More than 80% of infections leading to sepsis are contracted outside of the hospital. Anyone can get sepsis. As noted, sepsis is a medical emergency and must be treated quickly and correctly for survival.

Nonetheless, sepsis isn't talked about very often, and when it is, it's often incorrectly referred to as "blood poisoning."[3] We hear stories of people dying of infections, but this is often due to sepsis. The reason people don't hear about it is that the word is not often used.

Sepsis can be prevented by avoiding infection in the first place, which can be done through vaccination and basic hygiene. In order to prevent infection from leading to sepsis, it must be recognized quickly, and the source of the infection must be treated, including with antibiotics. Early treatment of infections and early recognition of sepsis can save lives.

Based on the CDC's "Get Ahead of Sepsis,"[4] signs and symptoms of sepsis can include any combination of:

- Confusion or disorientation
- Shortness of breath
- High heart rate
- High fever, or shivering, or feeling very cold
- Extreme pain or discomfort
- Clammy or sweaty skin

If left untreated, these symptoms can worsen and cause you to go into septic shock (a fall in blood pressure that stops blood getting to your vital organs). If you have an infection and experience any of these symptoms, visit your doctor immediately or go to an emergency room.

Survivors of sepsis may suffer from life-long consequences. To read some stories of survivors of sepsis, click here or go to https://www.sepsis.org/faces/

For more information about sepsis, please visit these sites:

World Sepsis Day, or go to https://www.world-sepsis-day.org/sepsis
Global Sepsis Alliance, or go to https://www.global-sepsis-alliance.org/sepsis/
Sepsis Alliance, or go to https://www.sepsis.org/faq/

Recommended words for further reading: infection, drug-resistant infection, antibiotic, antibiotic-resistant

Check out these videos about sepsis:

What is sepsis (sepsis explained in 3 minutes) - in English

https://youtu.be/AEGUCpxwAlE

Infection Prevention is Everyone's Business

https://youtu.be/SeaIY7kP2uI

References

[1] World Sepsis Day. (n.d.). Sepsis. Retrieved from https://www.world-sepsis-day.org/sepsis
[2] Technology Networks. (n.d.). What is Sepsis? (Sepsis Explained in 3 Minutes). Retrieved from https://www.technologynetworks.com/diagnostics/videos/what-is-sepsis-sepsis-explained-in-3-minutes-308278
[3] Sepsis Alliance. (n.d.). Frequently Asked Questions About Sepsis and Sepsis Alliance. Retrieved from https://www.sepsis.org/faq/
[4] CDC. (2017, August 31). CDC urges early recognition, prompt treatment of sepsis. Retrieved from https://www.cdc.gov/media/releases/2017/p0831-sepsis-recognition-treatment.html .

Acknowledgements

The *AMR dictionary* is funded by The Wellcome Trust Provision for Public Engagement Award. Microbiology Society and Journal of Medical Microbiology are not providing any financial support for the AMR dictionary.

Contributors for English version

Anastasia Hernandez-Koutoucheva, BSc
Mahidol-Oxford Tropical Medicine Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

David Dance, MB, ChB, MSc, FRCPath
Honorary Visiting Research Fellow, Lao-Oxford-Mahosot Hospital Wellcome Trust Research Unit, Vientiane, Lao PDR and Centre for Tropical Medicine and Global Health, University of Oxford, UK; Honorary Professor, Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, UK

Direk Limmathurotsakul, MD, DLSHTM, PhD
Head of Microbiology, Mahidol Oxford Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand; Assoc. Prof., Department of Tropical Hygiene, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

Elizabeth Ashley, MB, BS, PhD
Clinician Scientist, Myanmar Oxford Clinical Research Unit, Yangon, Myanmar; Centre for Tropical Medicine and Global Health, University of Oxford, UK

John Bleho
Media & Communications Consultant, Mahidol Oxford Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

Kalai Mathee, BSc, MSc, PhD, MPH
Co-Editor-in-Chief, Journal of Medical Microbiology, Microbiology Society
Professor of Microbiology and Infectious Diseases, Herbert Wertheim College of Medicine, Florida International University, Miami, Florida, USA.

Marieke Bierhoff, MD
PhD candidate, ID specialist, Shoklo Malaria Research Unit, Faculty of Tropical Medicine, Mahidol University, Mae Sot Thailand; Department of Internal Medicine and Tropical Diseases, Academic Medical Center Amsterdam, the Netherlands

Pasathorn Sirithiranont, BPharm, M.IT
Clinical Data Manager Clinical Trials Support Group, Mahidol Oxford Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

Prasad Kuduvalli, Ph.D
Director of Scientific Programs; Health Security Partners (HSP); 1875 Connecticut Ave, NW, 10th Floor, Washington DC 20009, USA

Ravikanya Praphasavat, MPH
Social Scientist; Mahidol-Oxford Tropical Medicine Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

Vanaporn Wuthiekanun, BScs
Senior microbiologist, Mahidol-Oxford Tropical Medicine Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

Xin Hui S Chan, BMBCh MA MSc DPhil MRCP DTM&H
Clinical Research Fellow; Mahidol-Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand; Centre for Tropical Medicine and Global Health, University of Oxford, UK

Zoë Doran, RN
Head of Clinical Trials Support Group, Mahidol Oxford Research Unit (MORU), Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand

If you have any comments, suggestions, or questions about the *AMR dictionary*, kindly contact:
ravikanya@tropmedres.ac and direk@tropmedres.ac

AMR dictionary in other languages

AMR dictionary (www.amrdictionary.net) is currently available in Arabic, Chinese, English, French, Khmer, Lao, Malayalam, Myanmar, Tamil, Thai, and Vietnamese. Electronic file (PDF format) of each language can be downloaded by using the following QR codes.

Arabic/عربي

Chinese/简体中文

English

French/Française

Khmer/ភាសាខ្មែរ

Lao/ພາສາລາວ

Malayalam/മലയാളം

Myanmar/ မြန်မာ

Tamil/ தமிழ்

Thai/ ภาษาไทย

Vietnamese/ Tiếng Việt