Save Our Cures

Antibiotic Resistance
Now the Gravest Health Threat

It will kill more than 10 million people each year by 2050, overtaking cancer

Resistance makes antibiotics USELESS
Antibiotic Resistance CRISIS

MISUSE and overuse of antibiotics has led to many strains of bacteria that cause illnesses (like urinary tract infections, pneumonia, TB, gonorrhoea, blood and other bacterial infections) becoming resistant to antibiotics.

The failure of these antibiotics to cure bacterial infections without the availability of new and safe antibiotics means that we may be losing our cures in our battle against the resistant superbugs.

There is also the risk that infections which have for many years been easily managed may once again become untreatable and uncontrollable. The superbugs are killing millions of people around the globe.

What are Antibiotics

ANTIBIOTICS are powerful medicines used to treat or prevent a wide variety of infections or diseases caused by bacteria. They do this by killing or decreasing the growth of bacteria.

Since their introduction into mainstream medicine after World War II, we’ve been relying on antibiotics to keep pathogenic bacteria at bay.

Doctors and society in general have become excessively reliant on them to treat everything from acne to tuberculosis to gonorrhoea. Antibiotics are also widely used for preterm babies and to support the immune system before and after surgeries, cancer treatments and organ transplants.

When used correctly antibiotics save lives. They have saved millions of lives since they were first introduced in the 1940s and 1950s.

Unfortunately, because they have been overused and misused, many antibiotics today are no longer effective against the bacteria they once killed. When bacteria become resistant, it is more difficult to treat the infection they cause. Stronger, more expensive antibiotics are needed to overcome the same bacteria.

But new antibiotics are expensive and take time to develop. In the meantime, “antibiotic resistance is growing and we are fast running out of treatment options,” Dr Marie-Paule Kieny, WHO’s assistant director-general for health systems and innovation warned in a recent report.

How Antibiotic Resistance Spreads

1. Animals may be treated with antibiotics and can therefore carry antibiotic-resistant bacteria.
2. Vegetables may be contaminated with antibiotic-resistant bacteria from animal manure used as fertilizer.
3. Antibiotic-resistant bacteria can spread to humans through food and direct contact with animals.
4. Antibiotics are needed to overcome infections or diseases caused by bacteria. They do this by killing or decreasing the growth of bacteria.
5. Antibiotics are overused and misused, many antibiotics today are no longer effective against the bacteria they once killed. When bacteria become resistant, it is more difficult to treat the infection they cause. Stronger, more expensive antibiotics are needed to overcome the same bacteria.
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How SERIOUS is the Problem?

Globally, over 2 million people are infected by antibiotic-resistant bacteria.

In low and middle-income countries, resistance is already high: In Indonesia, Brazil and Russia up to 60% of bacterial infections are already resistant to at least one antibiotic.

The US Centers for Disease Control and Prevention calls it “one of the world’s most pressing public health problems.”

It warned that bacteria that cause illnesses (like urinary tract infections, pneumonia, TB, gonorrhoea, blood and other bacterial infections) becoming resistant to antibiotics.

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What is Antibiotic RESISTANCE?

ANTIBIOTIC resistance happens when bacteria change (or mutate) to protect themselves from an antibiotic. At a molecular level these tiny organisms are finding ways to outsmart the drugs designed to kill them.

The more we use antibiotics, the more chance bacteria have to become resistant to them. Resistant bacteria (or “superbugs”) don’t just survive — they thrive.

Drug RESISTANCE – Bacteria’s NATURAL Defence System

Bacteria develop resistance to drugs quickly. Disease organisms have been developing defences against the antibiotics meant to kill them for as long as antibiotics have existed.

- Even before penicillin was introduced in 1943, Staphylococcus germs had genes that would have made them resistant to its effects. Resistance to penicillin swept the world in the 1950s.
- Methicillin-resistant Staphylococcus aureus (MRSA) evolved just 2 years after methicillin hit the market in 1960.
- After MRSA, there were the ESRLs (extended-spectrum beta-lactamases), which defeated not only penicillin and its relatives but also a large family of antibiotics called cephalosporins.
- And after cephalosporins were undermined, new antibiotics were achieved and lost in turn.

Who’s at RISK?

The Organisation for Economic Co-operation and Development (OECD), which advises the WHO on public health initiatives, warned in November 2018 that high resistance rates in healthcare systems “will create the conditions for an enormous death toll that will be mainly borne by newborns, very young children and the elderly.”

New Zealand’s Ministry of Health says: People most at risk of illness due to resistant bacteria are those with lowered immunity such as: hospital patients who are elderly or very sick; hospital patients who have an open wound (like a bedsore) or a tube going into their body (like a urinary catheter); and people undergoing treatment for cancer.

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EACH year about
700,000 people around
the world die due to
drug-resistant infec-
tions including tu-
berculosis, HIV and malaria.

The actual figure
could be much higher
because there is no
global system to
monitor deaths due to
drug-resistant in-
fecions.

And there has been trouble
tracking those deaths in
places where they are monitored,
like in the US, where tens of
thousands of deaths have not
been attributed to superbugs,
according to a Reuters inves-
tigation.

In Britain, currently there
are 44,000 deaths from sepsis
every year — many of which
are due to antibiotic-resistant
infections.

According to a 2018 report
published in the Lancet Infect-
ious Diseases, superbugs are
killing about 23,000 people
in Europe every year.

Data cited in 2017 indi-
cate that each year, resistant
cancer claims the lives of
23,000 people in the US and
more than 63,000 babies in
Indonesia. Beyond those deaths,
bacteria that are resistant to
antibiotics cause millions of
illnesses — 2 million annually
just in the US.

According to the Organ-
isation for Economic Co-
operation and Development
(OECD) — which advises the
World Health Organisation
(WHO) on public health initia-
tives — millions of people in
Europe, North America and
Australia will die from super-
bug infections unless countries
prioritise fighting the
growing threat posed by bacteria
immune to most known drugs.

A report by the WHO in
2017 found that only 8 out
of 51 new antibiotics identi-
fied in clinical pipelines will
bolster today’s roster of treat-
ments. That shortfall means
doctors will be less effective at
combating antibiotic-resistant
infections as resistance rises —
an alarming trend given that
drug-resistant tuberculosis
alone kills around 250,000 people
per year, according to the report.

Developing new antibiotics
is scientifically challenging,
time-consuming and costly,
says Ed Whiting, OBE, Di-
rector of Policy and Chief of
Staff at the global biomedical
research charity Wellcome
Trust based in London.

“Insufficient numbers of anti-
biotics have been approved
since the early 1980s. Between
1940 and 1962 about 20 classes
were produced ... The pipeline
of new treatments is all but
dry, the void fast exploited by
resistant bacteria. A concern-
ing number are left resistant
to drugs reserved as the last
line of defence, and the most
vulnerable are in greatest dan-
ger — the young, old and criti-
cally ill,” writes Whiting in

Dr Suzanne Chisholm, director
of the Department of Essential
Medicines at the WHO, warns
patients could be left with “no
line of defence” without new
treatments for certain types
of “extremely serious infections
that can kill patients in a mat-
ter of days”.

A century’s worth of medi-
cal advancement is now under
threat as antibiotics stop work-
ing. And this has gravity impact
on public health — people who
develop antibiotic-resistant
infections are more likely to
need hospitalisation and are at
increased risk for death.

Health experts have cau-
tioned that resistance to anti-
microbial drugs could cause a
bigger threat to mankind than
cancer.

“Without effective antibi-
otics, we could see an end to
life-saving transplants, chemo-
therapy and routine operations
such as Caesareans and hip
replacements; and continued
misse and overuse of antibi-
otics could, within a genera-
tion, see the global death toll
from drug-resistant infections
rise from 700,000 today to 10
million — more than currently
die of cancer,” says Whiting.

A BBC News report puts it
succinctly: “A terrible future
could be on the horizon, a
future where some of the
greatest tools of medicine out
of the hands of doctors.”

Antibiotic-resistant strains,
if allowed to fester, has disturb-
ng repercussions on mankind,
scientists have warned. Here
are some experts’ take on
what can happen if superbugs
continue to reign.

Antibiotic Resistance KILLS

In low and
middle-income
countries, resistance is
already high: In
Indonesia, Brazil
and Russia up to
60% of bacterial
infections are
already resistant
to at least one
antibiotic.

Millions of people in Europe, North
America and Australia will die from superbug
infections unless countries prioritise the
fighting the growing threat posed by bacteria immune to most
known drugs.

“’If we don’t act now, any one of us could go into hospital
in 20 years for minor surgery and die because of
an ordinary infection that can’t be treated by
antibiotics’”

— Organisation for Economic Co-operation and Development (OECD) — which
advises the WHO on public health initiatives

“’We’re heading towards a post-antibiotic era, in which
many common infections will no longer have a cure and
[will] once again kill unabated’”

— England’s Chief Medical Officer Dame Sally Davies

END of Modern Medicine

In a drug-resistant world,
many aspects of modern medi-
cine would simply become
impossible. Without action
on antibiotics, medicine will
return to the dark ages. Eng-
land’s Chief Medical officer
Prof Dame Sally Davies has
repeatedly warned that if an-
tibiotics lose their effective-
ness it would spell “the end of
modern medicine”.

“The world is facing an antibiotic apocalypse. Unless
action is taken to halt the practices that have allowed
antimicrobial resistance to spread around the world,
we will find ourselves having to develop new types of antibi-
ocids, we could return to the
days when routine operations, sim-
ple wounds or straightforward
infections, could pose real
treatments to life, she says.

Simple Infections Can KILL

“’You could be gardening and
pick your finger on a rose
bush, get a bacterial infection
and go into hospital and do-
crs can’t do anything to save
your life. You live or die based
on chance,’ says Prof Neil
Woodford, from the Britain’s
Health Protection Agency’s
antimicrobial resistance unit.

“My lab is seeing an in-
creasing number of resistant
strains year on year,” he re-
vealed in a BRC News report
(19 November 2015). Most
cases, he said, were resistant
to some drugs, known as multi-
drug resistant strains, but
there were a few cases of pan-
drug resistant strains which no
antibiotic can touch.”

CANCER
Treatments Will be Affected

Cancer treatments such as
chemotherapy and radiother-
apy can damage the immune
system. A course of antibiot-
ics is prescribed to provide a
much-needed boost alongside
your body’s own defences.

Bacterial infection is one of
the most common complica-
tions among cancer patients.
A weakened immune system
and infections can prove life-
threatening for patients with
serious diseases. After surgery,
many patients require antibiot-
ics to treat infected wounds.

Radiation therapy and
chemotherapy kill cancer cells,
but also cells that are part of
our defence mechanism
against infections. This means
that patients who receive ra-
diation or chemotherapy often
develop infections that require
treatment with antibiotics.

It is estimated that 1 in
5 cancer patients need anti-
biotics during their cancer
treatment. Some cancer types,
such as acute leukaemia and
bone marrow cancer (multiple
myeloma) for example cannot
be treated without effective
antibiotics.

Antibiotic-resistant bacte-
ria will thus set cancer treat-
ment back for decades, while
the incidence of cancer cases
will continue to rise in the
years to come.

Cancer diagnosis will also
become more difficult. There
are already major concerns
that prostate biopsies will
produce higher risk biopsies
with antibiotic-resistant bacte-
ria in the bowels.

SURGERIES Won’t be Possible

Surgery that involves cutting
open the body poses massive
risks of infection. Courses of
antibiotics before and after
surgery have enabled doc-
tors to perform operations
that would have been deadly
before.

If antibiotics lose their
effectiveness, key medical
procedures — including organ
transplantation, Caesarean
sections, and hip and joint
replacements — could become
too dangerous to perform.

During transplant surgery
for example, patients’ immune
systems have to be suppressed
to stop rejecting a new organ,
leaving them prey to in-
fecions. Anyone with an organ
transplant faces a lifetime of
drugs to suppress the immune
system, otherwise it attacks
the transplant, so antibiotics
are used to protect the body. In
future, however, such drugs
may no longer be effective.

Take the example of more
standard operations, such as
abdominal surgery or the re-
moval of a patient’s appendix.
Without antibiotics to protect
them during these procedures,
people will die of peritonitis or
other infections.

A routine surgery, joint
replacements, Caesarean sec-
tions ... depend on antibiotics,
says Jonathan Pearce, head of
infections and immunity at the
UK Medical Research Council.

Prof Richard James from the
University of Nottingham
believes “It’s a pretty grim future... a lot of medical procedures
would be seriously threat-
ened.”

GRAVE Implications for HEALTHCARE

The rise of drug-resistant infec-
tions is outpacing the de-
velopment of new treatments,
leading to a global shortage of
effective antibiotics, according
to the WHO.

A report by the WHO in
2014 had found that if left
untreated, antibiotic resistance
could lead to 10 million deaths
a year worldwide by 2050 —
costing the world roughly $1.3
trillion.

In low and
middle-income
countries, resistance is
already high: In
Indonesia, Brazil
and Russia up to
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What Causes

Antibiotic Resistance

THROUGHOUT much of the world, antibiotics are used without proper oversight, resulting in their abuse. Examples include when humans take antibiotics to fight infections caused by viruses (like the flu), when humans start an antibiotic treatment but do not finish taking all the antibiotics, or when antibiotics are used as growth promoters in livestock. The cumulative results of these actions are ineffective medicines and persistent, untreatable infections.

HUMAN Misuse

Antibiotic overuse in humans—inauditorily or unnecessarily prescribed by doctors—can be significantly misused by consumers—contributes to antibiotic resistance.

DOCTORS’ Fault

Many doctors wrongly prescribe powerful antibiotics to patients. In 2016, 2 studies published in the Journal of the American Medical Association’s JAMA Internal Medicine, reported substantial overuse of non-first-line antibiotics for 3 of the most common conditions in ambulatory care. People with sore throats, ear infections and sinus infections get the wrong antibiotic at least half the time, it was found.

When an antibiotic is called for, it should be a basic one—at most amoxicillin, the research team said. But that’s not what people usually get.

“Overall, only 52% of patients treated with antibiotics received the first-line treatments recommended by prescribing guidelines,” researchers reported.

CONSUMERS’ Fault

Overusing antibiotics is a major cause of antibiotic resistance, as is incorrectly taking antibiotics you have been prescribed. As such, don’t take antibiotics unless you’re certain you need them.

In Australia, research suggests 1 in 5 people expect antibiotics when they feel unwell, and 57% of GPs will prescribe antibiotics for an upper respiratory tract infection—just to meet patient expectations, report the ABC News, Australia (28 April 2016).

The problem is, just 1 packet can have an impact on your body’s ability to fight disease the next time you get sick. It can also compound antibiotic resistance at a community level, contributing to the creation of antibiotic-resistant superbugs, which can be very hard—if not impossible—to treat.

Allen Cheng, professor of infectious diseases and epidemiology at Monash University, says when you take antibiotics, the risk of having antibiotic-resistant organisms increases by roughly 50%. Each time you take antibiotics, the level of resistant organisms in your system increases. This is when bacteria survive by outsmarting the antibiotic.

Professor Lyn Gilbert, an infectious disease expert from the University of Sydney, says that antibiotic-resistant organisms usually accumulate in the body over time. “It’s a quantitative thing—the more [antibiotics] you use, the more chance there is that a mutation will occur or a resistance gene will spread from one organism to another.... It’s a sort of slow instrumental thing,” she says. “It doesn’t happen dramatically but it happens over a long period of time.”

Once people become colonised with antibiotic-resistant organisms, they can then spread them to others, which deepens the issue for the general population.

Dr. Brad Spellberg, chief medical officer at the Los Angeles County and University of Southern California Medical Center, cautions: “When one person or group misuses antibiotics, they cause resistance to the antibiotics to spread, hurting everyone in society.”

Animal

Although overuse of antibiotics in human medicine is part of the superbug problem, increasing scientific evidence from a wide range of studies shows that the routine dosing of animals on intensive farms raised in disease-inducing conditions, is also an important contributor.

Antibiotics are often used in food for animals to control and treat disease but ALSO TO PROMOTE GROWTH.

MAGAFARMS, Overmedication & Antibiotic Resistance

Intensive farming of livestock—concentrated animal feeding operations (CAFOs)—accounts for 72% of pork, 42% of egg, and 53% of pork production globally.

Such megafarms are “on the rise across the globe, and they have been linked with antibiotic resistance, as whole herds of many hundreds of animals are often treated at once.”

Emma Slawinski, director of campaigns at Compassion in World Farming, said the problems of megafarms across the world included overmedication, where animals are given antibiotics whether they are needed or not.

“Factory-farmed animals are regularly given antibiotics in their feed or water, because of the higher risk of disease when large numbers of animals are kept in these overcrowded conditions.”

There is strong evidence that this overuse of antibiotics in intensive farming is contributing to antibiotic-resistant organisms in human medicine. If animals cannot remain healthy within the conditions in which they are placed, then it is time to take a closer look at our farming systems.

Kazuki Miyagishima, director of food safety at the WHO, says the links between antibiotic use on farms and risks to human health are clear: “Scientific evidence demonstrates that overuse of antibiotics in animals can contribute to the emergence of antibiotic resistance.”

The volume of antibiotics used in animals is continuing to increase worldwide, driven by a growing demand for foods of animal origin, often produced through intensive animal husbandry.

In 2013, more than 131,000 tons of antibiotics were used in food animals worldwide; by 2030, it will be more than 200,000 tons.

Resistant Germs SPREAD from Animals to Humans

In an interview with Science magazine (28 September 2017), epidemiologist Thomas Van Boeckel of the Swiss Federal Institute of Veterinary Medicine in Zurich reveals: “Most antibiotics are used either to prevent disease or to promote growth, and this means exposing healthy animals to antibiotics over long periods of time.”

In the United Kingdom, trimethoprim is commonly used to mass-medicate groups of animals via their feed or water, and significantly more amoxicillin is used in animals than is used in human medicine. Gentamicin is an aminoglycoside antibiotic, and about 20 times more aminoglycosides are used for mass medication in farming than in human medicine.

Misuse of antibiotics in farm animals is said to be a greater cause of bacterial resistance than misuse of the drugs in humans.

Animal herd’s treated with antibiotics can develop bacterial resistance to the drugs, and pass this on to humans directly, through contact with farm workers, or through food. Though Dr. Gail Hansen, a public health consultant and veterinarian in the US, “Bacteria transfer their resistance genes to other bacteria they come in contact with in the environment, via the intestinal tract of people and animals, making it very difficult to effectively treat infections.”

Through much of the world, antibiotics are used without proper oversight, resulting in their abuse. Examples include when humans take antibiotics to fight infections caused by viruses (like the flu), when humans start an antibiotic treatment but do not finish taking all the antibiotics, or when antibiotics are used as growth promoters in livestock. The cumulative results of these actions are ineffective medicines and persistent, untreatable infections.

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“Overall, only 52% of patients treated with antibiotics received the first-line treatments recommended by prescribing guidelines,” researchers reported.

In Australia, antibiotics are used either not consistent with guidelines, unnecessary, or the incorrect drugs were prescribed. When people get the wrong antibiotic, not only are they often not cured, but it can help drug-resistant superbugs evolve.

But overuse is the primary issue. At a community level the primary issue was the overuse and inappropriate use, of antibiotics.

This includes people being prescribed antibiotics for mild bacterial infections that their bodies are capable of fighting without drugs—and also for viruses (like the flu), which cannot be fought with antibiotics.

A 2016 Centers for Disease Control and Prevention (CDC) report estimates that at least 30% of antibiotics prescribed in US outpatient settings are unnecessary.

The biggest problem with using antibiotics when they’re not needed is the development of antibiotic resistance, which is when bacteria survive by outsmarting the antibiotic. Common infections become difficult to treat, and when you really need an antibiotic, it may not work.

Although overuse of antibiotics in human medicine is part of the superbug problem, increasing scientific evidence from a wide range of studies shows that the routine dosing of animals on intensive farms raised in disease-inducing conditions, is also an important contributor.

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Antibiotics are often used in food for animals to control and treat disease but ALSO TO PROMOTE GROWTH.
If the bacteria that colonise these animals acquire antibiotic resistance genes, treatment becomes ineffective: that’s a threat for the livestock sector because you can’t keep your animals healthy.

But bacteria in the animals’ gut can also transfer the resistance genes to microbes harmful to humans. We don’t know the magnitude of this process, but given the large amount of antibiotics used in animals we have good reason to be concerned. In 2013, researchers showed that people living near pig farms or crop fields fertilised with pig manure are 30% more likely to become infected with methicillin-resistant Staphylococcus aureus (MRSA) bacteria.

Antibiotic RESIDUES Can Remain in MEAT

According to a recent study in April 2018 in the Journal of Food Protection, “Residues of antibiotics (used) in poultry meat have been determined in many studies globally and are considered one of the possible causes of antibacterial resistance in human pathogens. The presence of residues of antibiotics in poultry meat and meat products beyond maximum permissible limits is a matter of serious concern.”

Another study published in the journal, Food Control (October 2017) indicated a high level of antibiotic residues in meat, milk and aquatic products.

The study screened 20 common antibiotic (3 tetracyclines, 4 fluoroquinolones, 3 macrolides, 3 beta-lactams, 4 sulfonamides, and 3 phenicols) residues in 125 samples from common types of livestock and poultry meat, milk and aquatic products in Shanghai. The result: 15 of 20 antibiotics were found with an overall detection frequency of 39.2%. Antibiotics were found in 28.6% of livestock and poultry meat (35.3% for pork and 22.2% for chicken), 10.6% of milk, and 52.1% of aquatic products.

In aquatic samples, some fish (7.7% of carps and 8.3% of snakeheads) tested had the antibiotics enrofloxacin and trimethoprim which exceeded their MRLs (Maximum Residue Limits) used in the study.

Do meats and aquatic products in Malaysia have antibiotic residues? In May 2016, the United States Food and Drug Administration banned shrimp and prawns from Malaysia because they contained 2 banned antibiotics, chloramphenicol and nitrofurans. Ironically these 2 antibiotics have been banned for use in Malaysia since 1985. Yet they continue to pop up in our farmed fisheries — as well as farmed meat products.

In the late-1980s CAP’s investigations found commercial pig and poultry farms using chloramphenicol. In 2002, the Health Ministry Parliamentary Secretary revealed that nitrofurans and chloramphenicol had been found in chickens tested.

In November 2012, the Sarawak State Veterinary Authority banned the import of certain Ayamas processed food products into the state due to the detection of chloramphenicol in a sample of a chicken frankfurter.

In the US, nearly 80% of meat sold in supermarkets contains antibiotic-resistant bacteria, according to the Environmental Working Group, a non-profit environmental research organisation.

The bacteria were resistant to at least 1 of 14 antibiotics tested for in 2015 by the US National Antimicrobial Resistance Monitoring System, a federal-public health partnership.

Antibiotic-resistant bacteria were found on 79% of ground turkey samples tested; 71% of pork chops; 62% of ground beef; and 36% of chicken breasts, wings and thighs, the findings showed. (Source: medicalxpress.com)

In the United Kingdom, past investigations have found the superbug MRSA in a significant sample of pork products on supermarket shelves, risking humans becoming infected with the strain.

In Malaysia, CAP’s tests on meats sold locally in the past have also indicated the presence of supergerms.

In 1988, CAP tests found penicillin-resistant bacteria in chicken, mutton and pork. Several strains of bacteria were also resistant to neomycin and chloramphenicol. This shows the rampant use of antibiotics in Malaysian farms.

Our tests in 1995 found a majority of bacteria in many types of meat — chicken, beef, mutton and pork — were resistant to 2 types of antibiotics, ampicillin and amoxicillin. This demonstrates the existence of food-poisoning supergerms that could not be treated with some medicines.

If an animal is carrying resistant bacteria, it can be passed on to humans through meat that is not handled or cooked properly.

You can also encounter these bacteria by consuming food crops that have been sprayed with fertilisers containing animal manure with resistant bacteria.

Once spread to humans, resistant bacteria can stay in the human gut and spread between individuals. The consequences of consuming resistant bacteria include: infections that would not have happened otherwise; increased severity of infections, often including vomiting and diarrhoea; difficulty in treating infections and higher chances that treatments will fail.

In the US, every year around 2 million people get infected with bacteria resistant to one or more of the antibiotics normally used to treat the infections. Of those people, at least 23,000 die each year. Many more die from other conditions made worse by the infection. (US Centers for Disease Control and Prevention report, 2013)
PLANT AGRICULTURE

In contaminated areas, water containing antibiotic residues and drug-resistant bacteria can be absorbed into food products through cropland irrigation. In addition, croplands are often treated with antibiotic-rich manure (from medicated animals) to improve plant growth. There is also evidence that untreated solid waste from the antibiotics manufacturing process is being used as fertilizer in China. This can result in antibiotics ending up directly in the food we eat, or being washed into rivers via run-off.

ANIMAL AGRICULTURE

Antibiotics are routinely used on animals, either to prevent disease or as growth promoters. Worldwide, significantly higher volumes of antibiotics are used in food animals than in human medicine. These antibiotic residues can be passed on to humans through consumption of meat or dairy products. Antibiotics can also enter the environment at this point through animal excretion (with most of the active ingredient unmetabolised) and run-off from farms. Superbugs can be passed on directly from livestock to the humans who tend them.

INTERNATIONAL TRAVEL

Antibiotic-resistant bacteria can be carried by travellers, who can then transport superbugs around the world.

PHARMACEUTICAL MANUFACTURING FACILITIES

Factories where antibiotics are produced are major point sources of antibiotic residues, notably in China and India, where most of the world's antibiotics are made. In an alarming number of cases, manufacturers simply dump untreated waste in the environment, or fail to treat it appropriately.

FISH FARMS

Farmed fish living in close confinement often need to be medicated to prevent the onset of disease. The antibiotics are often scattered into the water, thereby entering the environment directly.
Hospitals are a key point source for AMR as they contain large numbers of people using a cocktail of different antibiotics. High levels of different antibiotics in excreted matter pass directly into rivers or through wastewater plants that are often unable to filter antibiotic residues.

Towns & Houses

Human excretion of antibiotics, which leaves most of the active ingredient unmetabolised, is a key vector of drug resistance. In much of the developing world, large volumes of raw sewage enter rivers, lakes, and groundwater directly without any prior treatment.

Wastewater and Sewage Treatment Plants

Most wastewater treatment plants around the world are not equipped to filter antibiotic substances and other pharmaceutical micropollutants, which means that residues remain present even after the water has been treated. Sewage treatment plants, where human faeces containing a wide diversity of bacteria combine with antibiotic residues present an ideal breeding ground for drug resistance.

Antibiotics entering the environment kill off non-resistant bacteria, leaving only “resistant” bacteria behind. These remaining bacteria can then multiply and pass on their resistance to others.
How Resistance SPREADS in the Environment

Antibiotic Resistance Spreads Through the Environment

The environment is key to antibiotic resistance. Bacteria in soil, rivers and seawater can develop resistance through contact with resistant bacteria, antibiotics, and disinfectant agents released by human activity. People and livestock can be exposed to more resistant bacteria through food, water, and air.

Waste

- **Waste Water.** Bacteria can spread via drinking water or water supplies that are used for irrigation, washing, and food preparation. Antibiotics may be present in raw source water and treated drinking water, and antibiotic resistance genes have been found in wastewater from antimicrobial manufacturing, hospitals, and wastewater from antibiotic-resistant bacteria in sewage.
- **Public Water Supply.** In 2011, a study led by a Cardiff University team found that disease-causing bacteria carrying the new genetic resistance to antibiotics, *metallo-β-lactamase-1* strain (NDM-1), were present in New Delhi’s drinking water supply. The researchers identified 11 new species of bacteria carrying the NDM-1 gene, including strains which cause cholera and dysentery. Antibiotics are used to reduce excretion of bacteria in cholera patients, and to reduce the duration and severity of dysentery. Worryingly, the identified Shigella isolate, which can carry dysentery, is resistant to all appropriate antibiotics. The study was published in *The Lancet Infectious Diseases* (6 April 2011).

Through SOIL

Although antibiotic resistance can occur naturally in soil bacteria, spreading manure on the ground as fertiliser can also spread antibiotic resistance to bacteria in the soil. In fact, manure fertiliser increases popularised areas where children play.

- **Waste from Large-scale Animal Farms and Industrial Wastewater.** A vast array of contaminants in municipal and industrial wastewater increases pressure on bacteria to become resistant.

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How Bacteria Acquire & Build Resistance to Antibiotics

H ow exactly do bac-
teria become resistant to antibiotics? Some bacteria are naturally resistant to certain types of antibiotics, but others may become resistant in 2 ways: 1) by genetic mutation or 2) by acquiring resistance from another bacterium.

MUTATIONS, rare spontaneous changes of the bacterial genetic material, are thought to occur in about 1 in 1 million to 1 in 10 million cells. Different genetic changes can lead to dif-
ferent types of resistance. Some mutations enable the bacteria to produce po-
tic enzymes that inactivate antibiot-
ics, while other mutations elimi-
nate the cell target that the antibiotic attacks.

In November 2015, Chi-
enese scientists identified a new mutation, dubbed the MCR-1 — a gene that can make bacteria more resistant to tetracycline, an old antibiotic that is the last-resort drug for some multidrug-resistant bacteria.

Although resistance to colistin had emerged be-
fore, the crucial difference this time is the mutation has arisen in a way that is very closely shared between bact-

China and Brisbane, Australia, had the highest levels of MRSA. Researchers believe that in-
haling the airborne antibiotic can transfer the spread of this resistance in our lungs and end up affecting our immune system.

Some bacteria are naturally resistant to many different antibiotics — can be passed around their resistance genes from parents but also from their children and descendents. Some bacteria are resistant to antibiotics even if they don’t take them. This is called intrinsic resistance.

Antibiotic resistance genes are spread through the air, in food, and in people, and this can lead to resistance in the environment. Some bacteria can carry genes that make them resistant to antibiotics.

In Australia for example, antibiotic-resistant bacteria previously reported in other countries are now being seen in the bacteria in the country. The New Delhi NDM-1 strain, which was found in healthcare settings in India has found its way to Australia, as well as some parts of Europe, the US, Canada and Japan.

Resistant strains of Es-
mcherichia coli, which often cause food poisoning, have been found in travellers re-
turning from the Indian sub-
continent, South East Asia and China. Australia has also seen a rise in urinary tract infections caused by multi-resistant Salmonella enterica subsp. (S. Typhi and S. Paratyphi). Increased travel to countries where this bacterial infection is endemic, particularly in India and In-
donesia, has been identified as a cause. Increased cases of typhoid fever have also been seen in the US, UK and Canada.

Bacterial infections com-
mon in the tropics, such as amo-
granous and MDR, have also been acquired by over-
seas travellers. Major cities in the world have seen a rise in multi-resistant strains of Neisseria gonorrhoeae, often in travellers returning from the Western Pacific and South East Asia, but from countries such as the US, Hong Kong, Ireland and South Africa.

In 2016, Professor Tim Walsh of the University of Queensland identified the MDR-1 gene in the bacteria N. gonorrhoeae. This gene enables the bacteria to resist antibiotics, which can lead to an increase in the risk of antibiotic resistance.

The transfer of antibiotic resistance genes is a global concern. Bacteria can exchange genes with other bacteria, and this can lead to the spread of resistance genes. This is called horizontal gene transfer.

Bacteria can also exchange genes through sexual reproduction, which is called vertical gene transmission.

Researchers are looking at ways to stop the spread of antibiotic resistance, such as developing new antibiotics, improving antibiotic use, and improving diagnostic tests.

In the future, we may see a decrease in the number of antibiotic-resistant bacteria, but this will require a global effort to reduce the use of antibiotics and improve antibiotic resistance monitoring.
Resistance in LAST RESORT Antibiotics

NEW Antibiotics URGENTLY NEEDED

The World Health Organisation (WHO) warned in 2017 that new antibiotics urgently need to be developed to combat 12 families of bacteria posing a threat to human health. The WHO says that if no new drugs are found to be in time to control the superbugs, as market forces do not respond fast enough to the threat.

Strains of E. coli and Salmonella, which live in the human gut, have also become resistant to first-line antibiotics. There are fears even 3rd-line emergency antibiotics, saved for the most resistant life-threatening infections, will no longer work.

The OECD predicts that resistance to so-called 2nd- and 3rd-line antibiotics will balloon by 70% by 2030.

Can NEW Antibiotics be DEVELOPED?

The process of producing a new antibiotic is long and expensive, requiring approximately 10 years and $500 million to bring to market. Over the last several decades, only 2 new classes of antibiotics have been developed and brought to market.

A lot of development work on new medicines were to begin today, experience suggests that their availability for treating patients would be at least a decade away.

However resistance will eventually develop to these new antibiotics. Helping to speed the development of the latest antibiotic candidates and can lead to emergence of resistance in as little as 2 years.

Nonetheless, scientists are still searching for new antibiotics by looking in unusual places such as in bacteria living deep below the earth’s surface, in the skin of frogs and in certain insects.

ANTIBIOTICS & ANTIMICROBIALS

What’s the Difference?

ANTIMICROBIALS (the word antibiotic means “against life”) are actually a type of antimicrobial designed to target bacteria. They work by killing the bacteria or by preventing them from multiplying. All antibiotics are antimicrobials, but not all antimicrobials are antibiotics.

Most people use the term antibiotic when they’re talking about medicine that is meant to kill bacteria. Any drug that kills germs in your body is technically an antibiotic (this medicine terminology is where it stops the bacteria from copying themselves or reproducing, or kills it outright).

Antimicrobial is a broader term for anything that inhibits or stops the growth or multiplication of bacteria.

Antibiotics are thus subtly different from the other main kinds of antimicrobials. Because it is active against bacteria, antibiotic is the most important type of antibiotic agent for fighting bacterial infections.

Antibiotics Should be Used Sparingly. Use antibacterial products sparingly and only when appropriate. Regular soap is a natural antibiotic, and experts say proper hand washing is enough to keep people safe.

"(Plastic) soap and water works really well for almost everything. Using it constantly is a good thing," says Dr Michael Bell, deputy director of the US Centers for Disease Control and Prevention (CDC)’s Division of Healthcare Quality Promotion.

Bell recommends using alcohol-based hand sanitiser when travelling through the airport to prevent spreading disease.

How to USE Antibiotics

Use RESPONSIBLY

"ALL humans and animals have bacteria in their gut. When they are given antibiotics, many of these bacteria are killed, but the resistant ones may survive and multiply. This is why the responsible use of antibiotics is so important in both humans and animals."

When animals are slaughtered for food, the bacteria from the animal can contaminate meat or other products. Bacteria also can spread from animal faeces (poop) to the environment, which can then contaminate soil and water used to grow fruits and vegetables. Food from animals containing bacteria can contaminate with bacteria in these ways, including 5th bacteria resist to antibiotics resist to antibiotics.

People can get resistant infections by handling or eating raw or undercooked meat or produce contaminated with bacteria in these ways, including 5th bacteria resist to antibiotics resist to antibiotics.

Use Sparingly</s>
CONSUMERS, patients, healthcare providers (doctors, nurses, etc.) — and the farming industry — can all help stop the creation of super-powered germs and slowing antibiotic resistance.

CONSUMERS

TO help fight antibiotic resistance and protect yourself against infection:
- **DON’T** take antibiotics unless you really need them. For illnesses caused by viruses — common colds, bronchitis, and many ear and sinus infections — they won’t.
- **FINISH** your pills. Take your entire prescription exactly as directed. Do it even if you start feeling better. If you stop before the infection is completely wiped out, those bacteria are more likely to become drug-resistant.
- **GET** vaccinated. Immunisations can protect you against some diseases that are treated with antibiotics. They include tetanus and whooping cough.
- **STAY** safe in the hospital. Antibiotic-resistant bacteria are commonly found in hospitals. Make sure your caregivers wash their hands properly and ask how to keep surgical wounds free of infection. (webmd.com)

3 Important Measures

1. **KEEP YOUR Hands Clean**
   - 50% of men and 25% of women don’t wash their hands after using the restroom. Do you?
   - Bacteria can live on and spread 1,000 times longer on dry hands than on wet.

2. **TAKE Antibiotics as Directed**
   - When Not to Take Antibiotics
     - THERE are 2 major types of germs that can make people sick: bacteria and viruses. Bacteria are living organisms existing as single cells. Bacteria are everywhere and most don’t cause any harm, and in some cases may be beneficial. Lactobacillus, for example, lives in the intestine and helps digest food. But some bacteria are harmful and can cause illness by invading the human body, multiplying, and interfering with normal bodily processes. Antibiotics are effective against bacteria because they work to kill these living organisms by stopping their growth and reproduction.
   - Viruses grow and reproduce only after they’ve invaded other living cells.
   - The body’s immune system can fight off some viruses before they cause illness, but others (colds, for example) must simply run their course. Antibiotics do not work against viruses.

3. **EAT for Wellness**
   - **Yogurt** contains probiotics, one probiotic supplement a day reduces sick days by 50%.
   - **Oats and barley** contain beta-glucan, a fibre with antimicrobial and antioxidant effects — these help antibiotics work better.
   - **Watermelon** and broccoli contain glutathione, which stimulates your immune system.
   - Sweet potato contains beta-carotene (which convert to Vitamin A) and builds healthy skin (first defence against bacteria).
   - Green tea can help antibiotics to be 3 times more effective in fighting drug-resistant bacteria, even superbugs.

What Should Be DONE

**Protect patients from antibiotic-resistant infections.**

**Surgical sites and single-use catheters** help treat patients, but they can be pathways for bacteria to enter the body.

**Bacteria can be spread when appropriate infection control actions are not taken.**

**Antibiotics save lives, but poor prescribing practices puts patients at risk.**

**Antibiotics can be spread when appropriate infection control actions are not taken.**

**SOURCE: CDC Vital Signs, March 2016**

Combine infection control actions with every patient to prevent infections in health care.

**Source:** New Scientist

England said antibiotics are essential for treating serious bacterial infections. The drugs are frequently used to treat cows, sows and pigs.

- Epidemiologist Thomas Van Boeckel has proposed 3 different strategies to reduce antibiotic use worldwide. He told Science magazine (28 September 2017) the following:
  - The 1st strategy: Targeting the antibiotics used in agriculture when they come out of the factory or at the point of import. This — which is not new — is to make antibiotics more expensive so that farmers and veterinarians will only use them when necessary.
  - If the 3 measures were combined and fully implemented, we could reduce the antibiotic consumption up to 80%, he says.

**SEVERAL** fast food chains have also announced that they would be phasing out antibiotic use in their meats.

- McDonalds announced it will start globally rolling back the use of antibiotics in its chicken products from 2018 as part of efforts to curb microbial resistance to drugs and the rise of superbugs. It had undertaken this move in the US market in 2016.
- In December 2018, it announced a plan for a phased reduction of antibiotics in beef as well.
- In 2016, Papa John’s and Papa Murphy’s announced they had transitioned their poultry raised without antibiotics in their pizzas.

- In 2017 KFC said its suppliers had been given until the end of 2018 to stop raising chickens using antibiotics important to human medicines.

The latest to join the bandwagon is Pizza Hut which has pledged to serve chicken raised without antibiotics important to human medicines in the US by 2022.

Some Steps Taken Overseas

**HEALTH officials in England have launched a campaign to persuade people with minor ailments not to ask for the drugs. Public Health**
Developing countries face many challenges in addressing Antimicrobial Resistance (AMR). There is a lack of awareness, expertise, funds, technical equipment and personnel to take the range of multiple actions required to tackle the AMR problem. Unless these factors are resolved, they will remain obstacles to concrete implementation of AMR action plans.

The developing countries also have other problems that compete with AMR for attention. Although it is a major problem, AMR is more like a ticking time bomb that gradually builds up and is not such an obvious problem as compared to other issues in the health sector (such as malnutrition) as well as outside the health sector (such as violence and terrorism; floods, drought, water scarcity and climate change; unemployment, poverty, migration and refugees).

In the competition for scarce funds and personnel, it is difficult for AMR to obtain the resources and attention it deserves.

Boosting the capacity of developing countries to take required actions is therefore of key importance. The actions that need to be taken at national level include:

- Research in science, analysing bacteria mutation, gene transfer, rates and ways of spread of resistance, and AMR in the food chain
- Vastly improving surveillance and data collection on resistance in various pathogens and drugs, and resistance of bacteria in food-related animals, in food, and in the environment
- Upgrading equipment and technology, including diagnostic tools
- Infection control in hospitals, including hygiene, upgrading of rooms and theatres, equipment, air-flow systems etc.
- Formulating and implementing a national policy for rational and appropriate use of antibiotics and other anti-microbials
- Regulation and enforcement in the sale, prescription and dispensing of antibiotics
- Guidelines or regulations for medical personnel, hospitals and clinics on the appropriate use of antibiotics, and on relations with industry sales representatives
- Regulating drug companies in marketing practice to improve their role in appropriate drug use, and address incentives to sales personnel and to medical and veterinary personnel linked to volume of antibiotic sales
- Regulation of the agriculture and livestock sector to phase out the non-therapeutic use of antibiotics, as this inappropriate use is a major factor in the AMR crisis. As a first step, antibiotics that are used for treatment of life threatening diseases in humans should be prohibited for use in animals as growth promoters, and the list should be extended.
- Addressing the contamination of the environment by residues of antibiotics
- Educating the consumer and community on the appropriate use of antibiotics.
- Establishing a national action plan on AMR and the institutional framework for implementation, including coordination within the health sector and with other Ministries including Ministries of Agriculture, Education, Information.
- Boosting the capacity of health related NGOs, the media and educational institutions to take on AMR issues as a priority.

**Recommendations Regarding Meeting the Needs of Developing Countries**

Future programmes dealing with implementing actions on AMR should include the following points:

- Fully take into account the challenges and needs of developing countries
- Strong international cooperation for building capacity of developing countries to address AMR
- Mobilising of financial resources to support capacity building and implementation of AMR action plans in developing countries.
- Establish a fund for capacity building in developing countries on AMR issues, to be based in WHO, and linked to implementing the Global Action Plan on AMR.
- Technology transfer and the provision of technical equipment including diagnostics and knowhow to developing countries on grant or concessional terms.
- Ensuring affordable access to existing and new anti-microbials, especially to people in developing countries; also, affordable access to vaccines and diagnostics.
- Developing and encouraging R&D models which delink the price of anti-microbials and other products from the cost of R&D; including where the innovation costs are financed through public funds and charities, and the license to produce the new products is available cheaply or at low cost, at least to companies and institutions in developing countries.
- Support to developing countries for capacity building and financing of the comprehensive range of activities in addressing AMR at national level, including prevention of infections, appropriate use of antibiotics, new regulations including on marketing, prescription and dispensing of drugs and their enforcement, reform of antibiotic use in agriculture, improvement of practices in hospitals and clinics, educating the public, etc.