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Why we need to join forces against resistant microbes

It will take a well-planned global effort if we are to prevail in our fight against antibiotic-resistant microorganisms.

For the world as a whole, a growing number of microbes causing pneumonia, urinary or intra-abdominal infections – to name just a few – are becoming harder to treat as the drugs to treat them become less effective. This problem also includes tuberculosis, malaria and HIV. For example, in 2016, 490,000 people developed multi-drug resistant tuberculosis globally, including in the UK, and drug resistance is starting to complicate the fight against HIV and malaria, as well. Also, the proportion of gram-negative bacteria showing resistance to carbapenems, the last resource for many infections, has dramatically increased in the last decade on a worldwide scale.

An infection epidemic

Antimicrobial resistance (AMR) happens when microorganisms (such as bacteria, fungi, viruses, and parasites) are not susceptible to the action of antimicrobial drugs (such as antibiotics, antifungals, antivirals, antimalarials, and anthelmintics). Resistant microorganisms are sometimes referred to as "superbugs" by the media. AMR occurs naturally over time, however, antibiotic resistance is accelerated by the misuse and overuse of antibiotics, as well as poor infection prevention and control. Resistant organisms can spread easily today between distant geographical areas as a result of globalisation.

Infections caused by antimicrobial-resistant organisms are usually associated with worse outcomes. Life without effective antibiotics can also mean that medical procedures such as cancer chemotherapy, organ transplantation and other types of surgery suddenly become very high risk in some patients.

Professor Jesús Rodríguez-Baño
President-Elect,
European Society of Clinical Microbiology and Infectious Diseases (ESCMID)

Global effort needed to tackle antibiotic resistance

It is now accepted that there needs to be a global action plan on AMR. The most urgent need is on greater investment in research and development of new antimicrobial medicines or non-antibiotic approaches, vaccines and diagnostic tools to help clinicians identify when antimicrobial drugs are required. But other actions are needed, including promotion of appropriate use of antimicrobials in human and non-human environments, implementing better systems for surveillance of antibiotic-resistant organisms, improvement of sanitary conditions in developing countries, and enhanced infection prevention and control activities.

In the development of new drugs to treat such organisms, the pharma industry, of course, has a leading role, but cost-effective product development is intrinsically difficult. To facilitate the implication of industry in this field, a different model of commercial return may be needed. Academia and politics have a role to play in this – to explore what needs to change to ensure that industry finds it attractive to invest in discovering and developing new drugs or new treatment approaches, and to collaborate in the process. Additionally, publicly funded academic research in some existing but neglected old antimicrobial agents may also provide some partial solutions to the problem.

Solving the problem is clearly complex; single, isolated interventions will have limited or no impact at all. It will take sustained education of professionals and society, appropriate investments in critical areas and enhanced scientific research to make the progress we need to tackle antimicrobial resistance. To achieve this, AMR must be a priority for politics, scientific organisations, educators, researchers and healthcare professionals. ■

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Project Manager: **Kate Clements** E-mail: **kate.clements@mediaplanet.com** Head of Business Development: **Rebecca Nicholson** Content and Production Manager: **Kate Jarvis**
Managing Director: **Alex Williams** Digital Manager: **Jenny Hyndman** Junior Designer: **Mushada Raquib** Mediaplanet contact information: Phone: **+44 (0) 203 642 0737** E-mail: **info.uk@mediaplanet.com**
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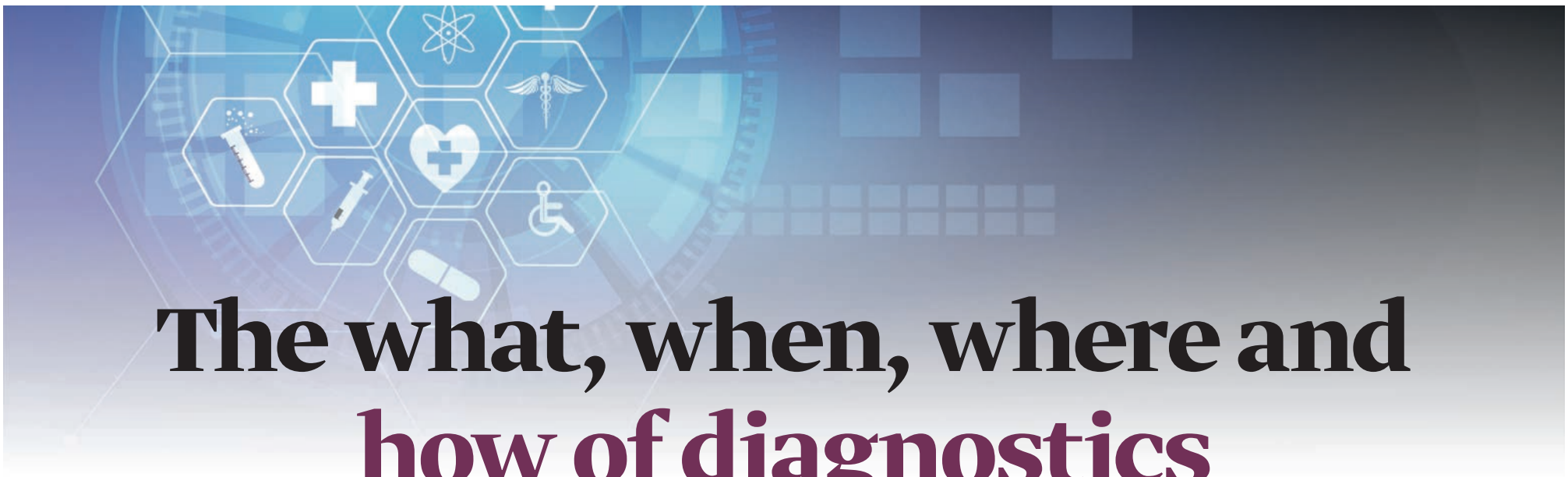


The what, when, where and how of diagnostics

Diagnostics are a crucial weapon in the battle against antimicrobial resistance, but they can only deliver their true potential if we get right the what, when, where and how of diagnostic use.

The power of a prompt, precise diagnosis in shaping the appropriate management of infection is widely recognised, but the key challenge is the appropriate integration into clinical care pathways and decision making, in both urgent and routine settings. This process of optimisation is known as diagnostic stewardship. This includes appropriate, timely diagnostic testing, including specimen collection, and pathogen identification and accurate, timely reporting of results to guide the treatment of suitable patients. Delivering effective diagnostic stewardship in healthcare settings will require a multiprofessional approach that brings together clinical staff, laboratory staff and epidemiological experts.

To ensure effective adoption and implementation of diagnostic stewardship, the UK is adopting a coordinated national approach through the formation of the UK Antimicrobial Resistance Diagnostic Collaborative (AMR DC). This brings together partners from across the NHS, academia, industry and other national bodies to develop coordinated professional guidance and evaluation of appropriate interventions to ensure proper integration of high-quality diagnostics service across the full range of care pathways. While early work to build this collaborative is taking place, the UK AMR DC will be formally launched on 5th July 2018.

Fiona Carragher
Deputy Chief Scientific Officer, NHS England and Chair, UK AMR Diagnostic Collaborative

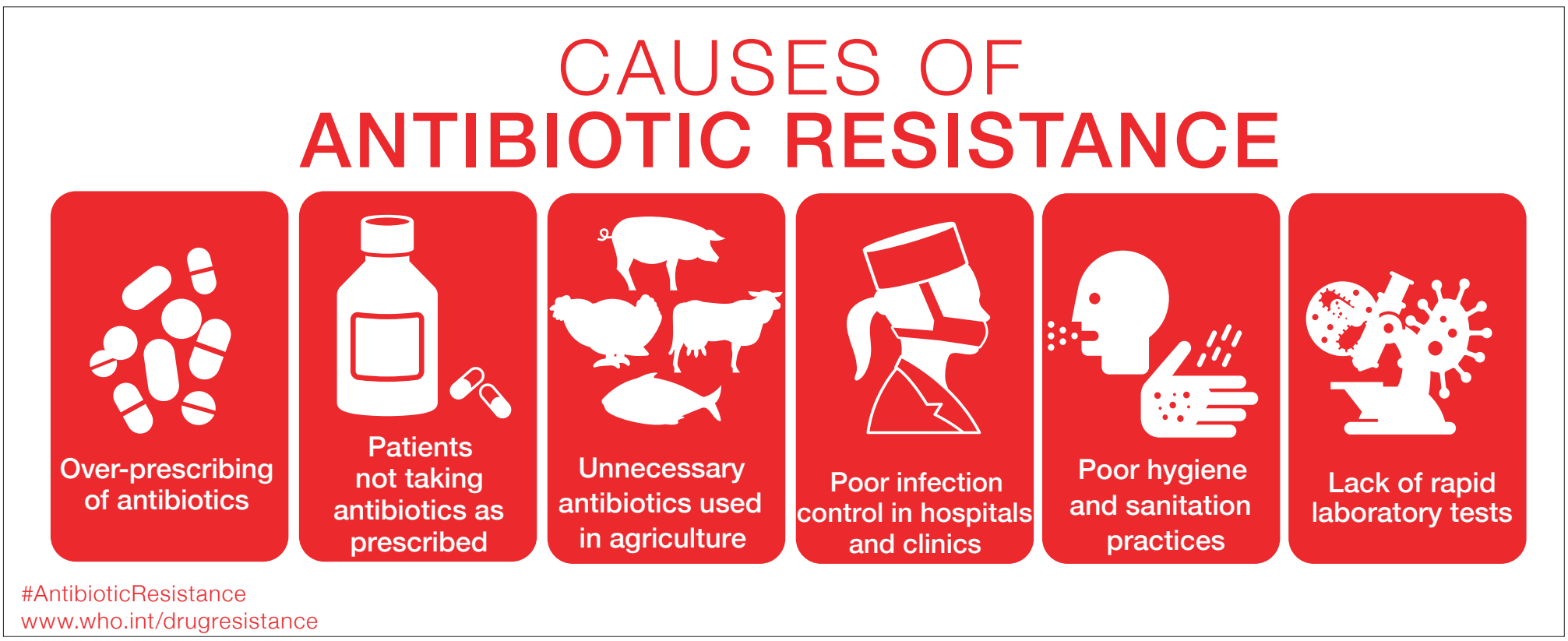
> "There will need to be a structured approach to educating, training and upskilling staff in clinical and diagnostic pathways."

The combined expertise of the UK AMR DC will play a central role in the evaluation of evolving technologies and approaches. Novel diagnostics are emerging, such as rapid point-of-care tests or genomic technologies that have the potential to transform appropriate treatment decisions. We need to ensure that the promise of these devices meets high expectations. Effective evaluation will require a co-ordinated approach across the innovation pipeline–from invention through evaluation and adoption–to gain the maximum impact on the AMR challenge.

Alongside this, there will need to be a structured approach to educating, training and upskilling the range of staff involved in the clinical and diagnostic pathways. Changing established approaches and care pathways is always one of the greatest challenges in healthcare settings and can often be the 'make or break' in whether a novel device or technology will deliver in the real world. Identifying and developing the appropriate education should be a key part of the evaluation of any new technology.

If, through diagnostic stewardship, we can move to a world where we are much more effective in targeting use of antibiotics, and so restricting inappropriate use, then we will have taken a great step forward in the ongoing battle against antimicrobial resistance. ■

Read more on globalcause.co.uk



TACKLING ANTIMICROBIAL RESISTANCE ON TEN FRONTS

SOURCE:REVIEW ANTIMICROBIAL RESISTANCE AMR-REVIEW.ORG

UK rising to the challenge of antimicrobial resistance

With deaths now exceeding 700,000 per year globally, and predicted to reach 10 million per year by 2050, the challenge posed by antimicrobial resistance is one of the biggest facing the world today, says Public Health Minister, Steve Brine.

As you read this article, bacteria are continuing to adapt and survive the effects of antibiotics—rendering our drugs less effective. It is a threat that will have a global impact if we fail to act. Over 700,000 people die each year across the world due to drug-resistant infections and that is predicted to increase to 10 million by 2050 if we take no action.

Life-changing treatments and procedures such as chemotherapy, caesareans and hip operations would all become too risky if antibiotics were no longer effective. But it is not just a health issue: projections from the World Bank place a global annual fall in GDP as a result of antimicrobial resistance (AMR) at between $1 trillion and $3.4 trillion by 2030. And for low-income countries, the potential impact is worse, leading to an additional 28.3 million people falling into extreme poverty by 2050.

How do we halt antimicrobial resistance?

Unfortunately, there isn't a silver bullet but there are a number of things we must do to address this problem.

It is imperative we prevent infections and where they do occur, that we manage them better. Better management of infections includes using our antibiotics appropriately and should help us use less of them.

We need to develop new and alternative treatments, vaccines and new diagnostic tests. We also need to do more to address AMR in the environment, including reducing pharmaceutical waste.

There is still so much that we do not understand about resistance and how it spreads, so we need more funding for research and surveillance to help improve our understanding, so we can better target our actions to address it.

But bacteria know no borders, political or regional divides—which is why we are showing global leadership, investing over £615 million to tackle this problem since we launched our national strategy at the end of 2013.

Steve Brine
Parliamentary Under Secretary of State for Public Health and Primary Care

"Over 700,000 people die each year across the world due to drug-resistant infections."

The UK has always been a leader in research and development

The UK's prevalence in tackling AMR is why our funding includes £162 million on interdisciplinary AMR research and infrastructure with a domestic, international, and developing-country focus. This is in addition to a ground-breaking project between the Wellcome Trust, Bill and Melinda Gates Foundation, the University of Oxford and Institute for Health Metrics and Evaluation on the world's largest dataset on drug resistance.

To raise awareness, we have embarked on a national public-awareness campaign, alerting the public to the issue of AMR and supporting healthcare professionals in the process of change. People do have an important role to play: by practicing good hygiene and reducing their risk of infection, by following the advice of their healthcare professionals, and by receiving the vaccinations recommended to them to stop the spread of disease.

But the UK cannot act alone in tackling this global issue. That is why we are strengthening our work with the World Health Organization, which has invested more than £6 million to support the development and implementation of national action plans on AMR in over 40 countries.

Reducing inappropriate use of antibiotics in agriculture can help

Industry in every country can contribute to tackling resistance, including by addressing run off from pharmaceutical factories or reducing inappropriate use of antibiotics in farming and veterinary medicine. With the development of an antibiotic from discovery to market taking up to 20 years, it's also vital that pharmaceutical companies, researchers and the public all work together.

As infection rates continue to increase and antibiotics lose their effectiveness, it is crucial we continue to lead the way and push this issue on the world stage post-Brexit. The UK's leadership was crucial in putting this issue firmly onto the priority list at the United Nations – and we will continue to champion action on drug-resistant infections into the future and push other countries to match this commitment. ■

Read more on **globalcause.co.uk**

Collaboration is key to tackling AMR research bottlenecks

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LifeArc

By James Alder

Embracing opportunities to work with different types of organisations can break down existing barriers and accelerate development, according to LifeArc's Catherine Kettleborough.

The AMR research jigsaw puzzle

Researchers face increasingly complex challenges in AMR drug development. Identifying areas of research likely to accelerate progress is a key component to success, according to Catherine Kettleborough, Head of Biology at LifeArc.

"We review pioneering science and look at how we can take that closer to the development of new medicines."

Focusing on the early stages of AMR research and seeking to prove whether interfering with specific molecular pathways will have an effect on disease is key. Equally, collaborating with partners in industry and academia to translate these findings into potential new drugs to treat bacterial infections is vital for efficiency.

Clearing research bottlenecks

Kettleborough believes that extensive and wide-ranging collaboration with academic groups, biotechs and pharmaceutical companies can only benefit the wider research community.

Drug discovery practice and primary goals have changed drastically since the 1990s.

"In the anti-bacterial space there is a big focus now on gram-negative bacteria which can cause infections like pneumonia. A particular challenge with these types of bacteria is that it is difficult to find compounds such as drugs that can get across the bacterial cell wall and then stay inside the cell so they can have an effect."

Catherine Kettleborough
Associate Director and Head of Biology, LifeArc

"Resistance to antibiotics makes them increasingly ineffective. The push to develop new antibiotics is therefore vital."

The end goal of this type of work involves developing an understanding of the characteristics that compounds aimed at tackling gram-negative bacteria should have, and putting together collections of these compounds that can be shared with groups interested in screening them.

"That could be biotechs, academic laboratories or pharmaceuticals companies. The sharing of information and learning is crucial to speed up drug discovery."

Standard antibiotics are increasingly ineffective

Resistance to antibiotics makes them increasingly ineffective. The push to develop new antibiotics is therefore vital.

Primary care inform researchers about types of infections and unmet need. It's then down to those involved at different stages in the drug discovery process to work with each other to share knowledge.

"The important thing is to talk to different groups that are working in this field to minimise overlaps and work together to identify where the gaps in research are. There are a number of big international schemes targeting particular stages of the drug discovery and development process," Kettleborough says. "While LifeArc can work with these schemes, as a charity we have a bit more fluidity and can be more interactive in terms of collaborating with organisations that will add value."

Barriers to physically forging a route to market for new antimicrobial drugs are plentiful. As Kettleborough notes, discussions within the research community as to how to overcome those challenges are key. "It's about asking what part we can play in filling gaps or overcoming bottlenecks and then building new models of working together to ensure we get new antibiotics into primary care." ■

Read more on **lifearc.org**

How do we enable more efficient patient management and antibiotic stewardship?

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MOMENTUM BIOSCIENCE

Antimicrobial stewardship is an essential part of clinical care to reduce selection pressure on bacteria and lower antibiotic-associated complications. As such, it has become an important quality standard in healthcare.

Providing universal detection of viable organisms with accurate and reliable results is vital to improving diagnostic testing in this area. This can quickly enable clinicians to confidently rule out infection, allowing for more effective therapy, resulting in patients getting home sooner and freeing up beds, which can provide a positive economic impact. It can help stop the unnecessary use of antibiotics, which will reduce the pressure on antimicrobial resistance.

Momentum Bioscience is developing a range of innovative technologies to improve management in the area of bloodstream infections. We are particularly focused on early detection of the presence – or absence – of bloodstream infection (BSI) using our patented, universal detection technology. This is achieved by exploiting the organism's own DNA polymerase, which acts on our modified DNA substrate, thus creating the specific target that is then detected by real-time Polymerase Chain Reaction (PCR). This allows early rule-out of BSI within 24 hours with a negative predictive value (NPV) of 99.5 per cent. In addition to this important early result, a further benefit is how this type of diagnostic could help improve the use of antibiotics as well as support improved stewardship.

Our proprietary technology for early rule-out of BSI has been tested in over 1,800 patients over three locations in the UK.

Dr Helen V Bennett
Market Development Manager, Momentum Bioscience

"The outcome of these early negative results had the potential to reduce antimicrobial use and extra bed nights."

A clinical study (performed at Sheffield Teaching Hospitals NHS Trust) using Momentum's technology in 124 neonates showed reliable negative results from samples of blood culture within 15 hours after receipt of the sample within the laboratory, demonstrating an NPV of 100 per cent. The outcome of these early negative results had the potential to reduce antimicrobial use and extra bed nights by providing a result, on average, 10 hours earlier than the current 'gold standard' blood culture.

We followed this up with an economic analysis on neonates suspected of early onset sepsis using birth data from NHS England. Assuming 607,295 term babies are born in England each year, and our test turnaround time of 19 hours, with a sample transportation time of four hours and preliminary negative blood culture results at 36 hours, results can be summarised as follows when adding our test result to the current diagnostic pathway:

Total cost saved	£6.3 million
Total length of stay saved	19,501 days
Total antibiotics reduced	39,002 doses
Staff time saved by reducing antibiotics	135 days

SOURCE: AQUARIUS POPULATION HEALTH, 2017

This unique technology, in addition to providing universal detection of bacteria and fungi, detects many of the commonly found BSI causing organisms, at very low levels ensuring a more reliable and accurate result. ■

Read more on **momentumbio.co.uk**

Philip Howard
President, British Society for Antimicrobial Chemotherapy (BSAC)

What's your antibiotic footprint? – we all have one

By James Alder

We already know about the carbon footprint and combatting climate change. Now it's time to look at our 'antibiotic footprint,' argues Philip Howard, BSAC President.

The 'One Health' approach and reducing AMR's impact

The most recent AMR impact review predicts that antimicrobial resistance could result in over ten million deaths per year by 2050. 'One Health' is a global approach to tackling an issue that is "with us now," says BSAC's President, Philip Howard.

The One Health approach covers areas that are pivotal in reducing the impact of drug-resistant infections. These include the use of antibiotics and their development, vaccines, innovative diagnostics, in both human and animal medicine, as well as collaborative data collection that guides research and establishes vital guidelines for drug use.

Zoonoses – infections transmitted from animals to humans

"The link between reducing antibiotic use in animals and decreasing resistance in humans, especially farmers and those working directly with food-producing animals is 'strongest,' but the benefit for the general population is less clear," Howard says.

Research suggests that those working with food-producing animals carry the highest risk of being infected with resistant bacteria found in those animals as infections can cross between species.

As with human medicine, there has been widespread historic misuse of antibiotics in agriculture, with drugs often prescribed to healthy animals to enhance growth or prevent infection, rather than treating infected animals.

This is improving, and the World Health Organization now produces guidelines on the use of 'medically-important antimicrobials' in food-producing animals and humans respectively.

How to reduce our 'antibiotic footprint'

Just as people watch their carbon footprint, Howard, like others, would like to see the public take a similar level of personal ownership over their antibiotic footprint.

Our antibiotic footprint, according to Howard, consists of both antibiotic consumption directly through treatment, but also indirect consumption through eating meat, fish or crops, and the use of household products containing antibacterials, such as washing-up liquids.

Reducing our overall antibiotic consumption, by both direct and indirect means, is something each individual can work towards.

"For example, washing our hands more often and getting recommended vaccinations can reduce our infection risk, and therefore potential antibiotic use. Eating a healthy, balanced diet through informed choices can decrease indirect consumption of antibiotics."

Reducing antibiotic use in food production

Animal ingestion of antibiotics accounts for 44 per cent of the UK's total antibiotic consumption annually, having a direct effect on human antibiotic intake. The farming of fish, meat and crops will always include a level of necessary antibiotic use for good animal welfare or to prevent crop failure.

Some UK supermarkets are leading the change in terms of publishing both levels of antibiotics used in food production and promoting good animal husbandary standards, something Howard is keen to see spread to other areas of the food industry.

"It would be great to see the fast food industry follow suit," he says. "That way, people can make choices in terms of buying food based on those levels, and reducing their antibiotic footprint." ■

GPs and patients must drop antibiotics' 'wonder drug' tag

By James Alder

The overprescribing of antibiotics, often in cases where their use is unwarranted, is a hangover from before awareness of antimicrobial resistance, when antibiotics were used 'just in case', says BIVDA Chief Executive, Doris-Ann Williams.

"All too often, it's a case of people being prescribed antibiotics because there is a desire to take something home with them - an expectation to get better instantly," she says.

Doris-Ann Williams
Chief Executive, BIVDA

An alternative IVD could well see patients receive more appropriate treatment

IVDs, or in-vitro diagnostics, are tests commonly performed in hospitals on body fluids or tissues. Increasingly, simple IVD tests are being used effectively by GPs to improve diagnostic processes.

"The challenge is for GPs to educate patients on why taking a CRP test or an alternative IVD could well see them receive more appropriate treatment. Sending someone home with antibiotics who has a viral infection serves to have the opposite effect."

CRP (C-Reactive Protein) is a substance produced by the liver in response to inflammation. Testing for high levels of it is one way of ascertaining whether the cause of illness is bacterial, and whether antibiotics are a necessary next step or not. "Information provided by IVDs aids clinicians in piecing together the 'jigsaw puzzle' of a patient's illness."

GPs hold the key to wider adoption of IVDs

Williams argues that GPs hold the power in terms of taking a more proactive and informed approach to treatment. However, she says a change in attitude is necessary in order for a more widespread adoption of IVDs to take place.

"I think GPs are getting better at not giving out antibiotics unnecessarily, but they're still not doing the tests. Put simply, that means they're missing out on vital information that could be used to benefit the patient."

> "Sending someone home with antibiotics who has a viral infection serves to have the opposite effect."

Cost is undoubtedly an issue with regards to diagnostic stewardship techniques improving among GPs, with tests like the CRP often proving more expensive at face value than prescription drugs.

"With most diagnostics, by order of magnitude, tests are about 100 times cheaper than most drugs. But, suddenly, we've got to a situation where diagnostic tests are more expensive (for GPs) than most antibitotics." A CRP test would cost around £3.50 to perform, whereas antibiotics cost somewhere in the region of £1-£1.50 in comparison.

Patient and societal benefits of IVDs must trump costs

Within primary care, successful use of IVDs can go a long way towards reducing the need for unnecessary procedures, follow-up visits and antibiotic prescription.

Williams argues that these benefits far outweigh the cost element involved, and has seen first-hand the benefits of GPs adopting IVDs.

"In primary care, the typical approach is 'go away and come back if you don't feel better in a week'. But, if you can identify exactly what's wrong with someone right away, then there is often no need for that repeat visit." The benefits of this can be widespread, says Williams.

"People are often referred for chest X-rays, with GPs suspecting something more sinister. A simple test can help to discern what is or isn't going on, and avoid unnecessary exposure to radiation."

An X-ray tariff could be as much as £100 – far more expensive than many IVD tests that are currently available.

Education and communication is key to promoting the use of IVDs

Without the securing of central NHS funding for equipment and adoption of IVDs likened to 'guerrilla warfare', case studies and education are vital, says Williams.

Both Wales and Scotland, due to their population size and the difference in the way healthcare is funded, are ahead of England when it comes to making use of best practice on IVDs.

Shifts in both the mind-set of patients and the healthcare community in England are needed in order for more clinicians to spread the benefits of IVDs.

"One patient at a practice we're working with was adamant that he needed antibiotics, and was quite agitated, due to missing work. His GP did the CRP test, which came back negative, and was therefore able to make it clear to that patient that he simply had to rest up, with the necessary reasoning behind that call." ■

Read more on **globalcause.co.uk**

The impact of drug resistance will change healthcare at every level

SPONSORED

Mark Miller
Corporate VP and Chief Medical Officer, bioMérieux

By James Alder

AMR is a serious issue today in many countries, with a potentially dire future impact if it is not quantified, prevented, restricted and discussed globally, says bioMérieux's Mark Miller, Corporate VP and Chief Medical Officer.

In trying to better predict and reduce the impact of AMR, there are four key areas of focus.

1) Innovative diagnostics

"We're constantly developing faster and more accurate diagnostic tests as these provide high medical value information to clinicians. More efficient diagnostic stewardship is key to ensuring treatment is more focused and appropriate at an individual level."

2) Better education on AMR

"A really core principle is spreading the message about AMR, especially in low and middle income countries (LMIC). Discussions need to be had with the healthcare professionals on the ground in those countries, since they are the people who can effect change. We don't just aim at physicians, but we also aim at doctors, nurses, pharmacists and infection control professionals, who will inevitably be responsible for educating the public in the future."

3) Surveillance

"Surveillance of both antibiotic usage, and suceptibility to antimicrobials on a global scale, is key to understanding how best to go about tackling it on a country-by-country basis. You need that information before you can really do anything effective. bioMérieux is proud to be the supporter of a project, Global-PPS[1], that contributes to monitoring the worldwide prevalence of antibiotic consumption and resistance rates and to implementing antimicrobial stewardship programmes in hospitals."

4) Assisting in clinical trials

"Another important area is assisting pharmaceutical companies who are developing new antibiotics to join up the diagnostics with their antibiotic trials (so called supportive or facilitating diagnostic tests), making those trials more efficient. Essentially, this helps them ensure they are testing their drugs on the right patient with the targeted infection. Those companies can then validate their antibiotics in a better and more rapid way, and in a standardised improved patient population."

Challenges in education and advocacy of AMR

"The biggest obstacle is getting to the different groups who need that information, and you can't use the same tool or approach to educate all of those whom we need to reach. With AMR, you can't use the same approach with a hospital physician as you would with a general practitioner or a community pharmacist.

The additional problem is that there isn't enough understanding and appreciation of AMR, or the enormous threat it poses, within the general public. They don't understand the impact it'll have on them individually, their family or society.

If AMR gets out of hand, it will leave a mark on all elements of healthcare. We may not be able to perform elective surgeries or treat cancers without the risk of resistant infections, and common infections could become lethal to large portions of the global population again.

This is the kind of menace and appreciation of danger that we believe needs to be transmitted at all levels of society. It can't just be aimed at professionals."

How core is the surveillance of both drug usage and resistance in the fight against AMR?

"We're in a unique position in terms of providing surveillance, as we provide the diagnostic tests that can help collate that vital information.

It starts from the basic concept that knowledge is power. If you know what's going on, then you can implement actions to address those issues. If you don't, then you're acting blind. Surveillance gives us the knowledge. In many countries, there is no knowledge of what's going on. There are no records about antibiotic use or the amount of resistance. There are guesses about how bad AMR is, in both developed and non developed countries, but no concrete figures in many cases.

The key is to understand the extent of antibiotic usage, in both developed and lesser-developed countries, while also measuring the levels of resistance. We're pushing for inclusion of resource-limited nations in our Global-PPS.

The information we collate is invaluable. Both the global surveillance work, looking at antibiotic usage and the data regarding resistance generated by a web-based tool, help build a clearer picture of the whole issue.

It's then up to people to take that data and use it. Countries look to us to implement these initiatives and enable them to successfully monitor what the picture looks like in their region, which is vital. They can then harness that information and implement national action plans."

Rapid diagnostic tests are vital in reducing AMR

"In my eyes, there are five key reasons why diagnostics play a substantial role in tackling AMR.

1. On an individual basis, diagnostics will tell a physician what infection is occuring and what the patient's pathogen is susceptible to. They can help determine if antibiotics are needed and then choose the right antibiotics and ensure more targeted use of those drugs against the infection.
2. Diagnostics are the only tool that can supply surveillance data. This is pivotal in following the status and progression of AMR.
3. Screening patients for carriage of drug-resistant pathogens so that they can be isolated in order to limit their spread.
4. Diagnostics can differentiate viral infections from bacterial infections. By quickly determining that someone has a viral infection and doesn't need antibiotics, you can reduce overall antibiotic use drastically.
5. Diagnostics are used within antibiotic clinical trials to ensure that the recruited patients have the infection and pathogen of interest, rendering those trials more efficient, less expensive, faster and easier to analyse."

Combined efforts are key to tackling AMR

"We think that AMR is the single biggest health threat that we face globally. A report in 2016 estimated that this is going to cost trillions of dollars in GDP loss, but it's also going to cost hundreds of millions of lives.

It's already at a frightening level in some countries where people are dying of untreatable infections. The reason people are not more alarmed is because many of those countries don't keep good figures. AMR is here today, it's not just a potential threat.

We believe that there is not enough awareness of this issue and its serious consequences at the political and public levels, and that's where we want to play a part in making sure that appreciation of this issue increases rapidly in order to improve the situation as fast as possible." ■

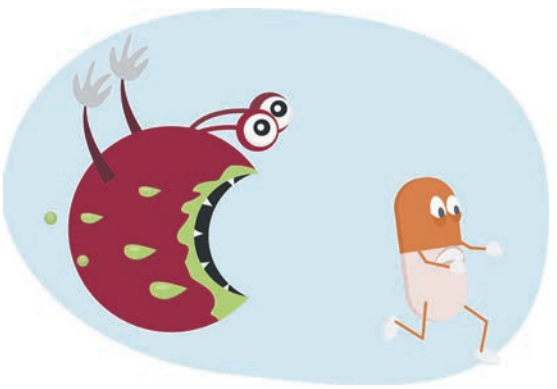
Read more on **www.antimicrobial-resistance.biomerieux.com**

[1]bioMérieux is the unique sponsor of the world's largest AMR surveillance initiative – the Global Point Prevalence Survey (Global-PPS), co-developed with the University of Antwerp (Belgium), which is aimed at measuring both antibiotic usage and resistance.

PHE's Antibiotic Guardian campaign www.antibioticguardian.com

ANTIBIOTIC GUARDIAN
Keep Antibiotics Working

ANTIBIOTIC GUARDIAN CHALLENGE CROSSWORD



Across

3 Veterinarians may prescribe antibiotics to these (7)
5 Antibiotics will most commonly be given to adults in these forms (7)
6 This type infectious agent will cause the common cold, coughs and the flu (5)
9 Medicine used to help treat fungal infections (10)
11 As an Antibiotic _11_, my actions help _19_ antibiotics for the children of tomorrow (8,7)
19
16 The main immune system cells for defending against bacterial infections (3 words: 5,5,5)
17 Antibiotics will most commonly be given to children in this form (5)
18 You require one of these for antibiotics (12)
20 These medicines should be used as prescribed and only when needed for bacterial infections (11)
22 Main professional group that administer and may prescribe antibiotics (5)
24 This infectious agent includes yeasts and moulds (6)
25 When the antimicrobials are no longer effective the microbes have developed this (10)
27 You often generate more of this when you have a cough, cold or flu and ranges in colour from yellow to green (6)
29 Professional who may prescribe antibiotics for humans (6)
30 Clean your hands to prevent the spread of these (5)
31 Medicine used to treat viral infections (9)

Down

1 You can get a vaccination jab against this viral seasonal illness (3)
2 When you have a viral illness you should consume lots of this (6)
4 Your body's natural defence system against infections (2 words: 6,6)
7 A common symptom of coughs, colds and flus (2 words: 4,5)
8 Runs from your nose, especially when sick with a viral infection (4)
10 This term covers antibiotics, antivirals and antifungals (13)
12 When you are ill and can make others ill with the same bug you are _____ (10)
13 A viral infection that causes sore throat and runny nose (4)
14 When you have a cough, cold or flu you should ask your pharmacist how to treat your _____(8)
15 Professional who may prescribe antibiotics for animals (12)
19 The first antibiotic discovered (10)
21 Taking antibiotics unnecessarily can lead to _____ such as diarrhoea (2 words: 4,7)
23 Ask this healthcare professional which over-the-counter medicines are best to treat your symptoms (10)
26 Misuse of antibiotics allows _____ to develop resistance (8)
28 Often a symptom of a respiratory tract infections caused by viruses (5)

Check your answers on **globalcause.co.uk**