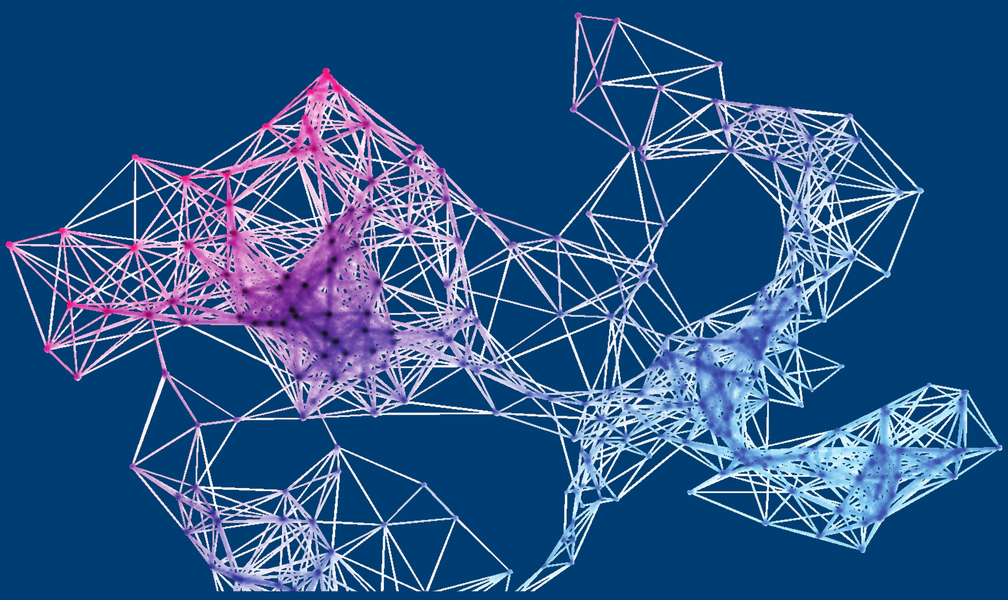
Interdisciplinary Antimicrobial Resistance Research

Local and Global Knowledge Gaps

21st – 25th November 2017



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Interdisciplinary AMR Research

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Introducing IDRRES

Aarhus University's Network for Interdisciplinary Drug-Resistance Research (**IDRRES**) brings together academics from multiple disciplines to interrogate the complex **biomedical**, **environmental** and **societal** interactions leading to **antimicrobial resistance (AMR)**.

Informed by the EU's AMR Action Plan and Horizon 2020, IDRRES seeks to develop an **international network of researchers** united under an inter-disciplinary research agenda.

Innovative Interdisciplinary Research

An interdisciplinary approach to AMR research maximises on cross-fertilisation between disciplines ranging from **microbiology, immunology, veterinary science, infection medicine, medical history and anthropology**, to develop a solid foundation on which holistic strategies against AMR can be developed.

This exhibition is divided into three sections:

- **UNDERSTAND** the Social Production of AMR
- **RETHINK** Antimicrobial Resistance
- **OVERCOME** AMR in Farm Animals

A 'One Health' Approach to AMR

The 'One Health' approach recognises that the health of **people** is connected to the health of **animals** and the **environment**, all of which are shaped by broader **societal structures** and forces.

The EU's 2017 **European One Health Action Plan against Antimicrobial Resistance** thus relies on progress in **interdisciplinary research**, pushing the boundaries of what we know not only about resistant pathogens, but also the complex environmental and social processes through which they emerge and spread.

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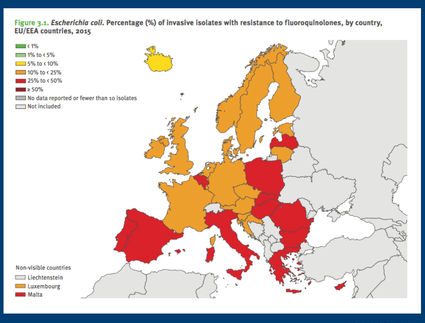
Antimicrobial Resistance in the European Union

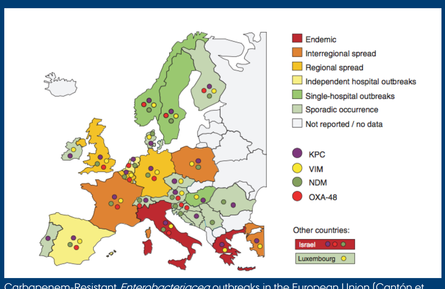
Antimicrobial Resistance (AMR) is a global health threat affecting all nations. Resistant pathogens increase treatment times and mortality rates, placing a heavy burden on health systems and affecting economic growth. Resistance to antimicrobial agents is growing throughout the EU, including to second- and third-line antimicrobial agents, threatening our ability to treat even the most common infections.

Not just MRSA

While multi-drug resistant *S. aureaus* (MRSA) has garnered significant public attention, AMR threatens our ability to treat numerous common bacterial infections. In the last four years, resistance in *E. coli* and *K. pneumoniae* increased significantly throughout the EU/EEA. Carbapenem resistance of *Acinetobacter* has reached over 80% in some states, undermining our ability to treat one of the most commonly occurring hospital-acquired infections.



ECDC 2017: 10



Carbapenem-Resistant *Enterobacteriaceae* outbreaks in the European Union (Cantón et al 2012). *KPC, VIM, NDM & OCA-48 are different forms of Carbapenem resistance, occurring in bacteria such as *K. pneumonia* and *E. coli.*

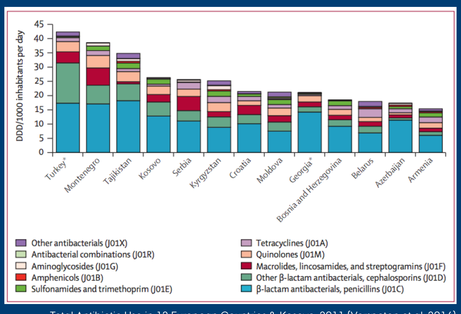
The Spread of AMR

With a growing number of countries struggling with endemic levels of resistance, the spread of AMR is almost inevitable as people and goods move throughout the EU and the world. Diseases such as tuberculosis, once consigned to history, are making a comeback throughout the European Union in drug-resistant forms that are far more difficult to treat.

A Dwindling Arsenal of Drugs

Research and development into new antibiotic agents remains at an all time low, leaving us with dwindling arsenal of drugs with which to treat increasingly resistant bacterial infections.

In 1995, John Burke wrote: "the more you use it, the faster you lose it" (*The Lancet, Volume 345).* Interdisciplinary research based on a One Health approach is necessary to retain the effectiveness of those antibiotic drugs that remain at our disposal.



Total Antibiotic Use in 12 European Countries & Kosovo, 2011 (Versporten et al, 2014)

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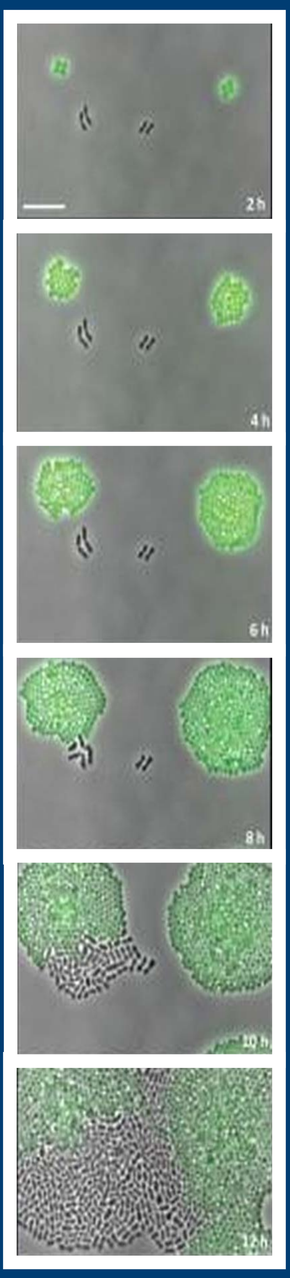
Mikala Wang[1], Jens Seeberg[2], Janika Hauser[2]
1) Aarhus University Hospital & 2) Aarhus University

The Biosocial Production of AMR

Antimicrobial resistance is best understood as a biosocial product - an outcome of complex processes that are both biological and social. Viewed as a biological process, the focus is on understanding microbiological mechanisms resulting in AMR. Viewed as a social process, the focus is on dynamic social and societal forces that result in or hinder the acceleration of the biological process of AMR development and transmission.



Images from Org RA, L Lin, GS van Doorn, M Sorg, J Olson, V Nizet, et al. (2016) Collective Resistance in Microbial Communities by Intercellular Antibiotic Deviation. PLoS Bio14 (12): e2000631. [Image Edited for Formatting]

Gene, Bacterium, Drug

We are a long way away from understanding the exact way in which resistance works at the intra-cellular level. As a result, many questions relating to detection and treatment remain equally open. This demands huge amounts of primary research. We need to gain a better understanding of AMR, its emergence and spread. We must invest in research seeking to develop new antibiotics or novel alternatives to managing AMR, while also establishing protocols that secure patient, animal and environmental health sustainably in a rapidly changing context.

Life on Earth

When AMR emerges in the real world, we can see the interaction of the intra-cellular with its social context. Pharmaceutical manufacturing procedures and careless waste management practices have been linked to the contamination of local water supplies and the creation of so-called superbug breeding grounds. In the case of livestock production, the widespread use of antibiotics has been similarly linked to the AMR crisis. In both cases, drug resistance has emerged and spread through a bacterium's interaction with social structures, requiring both a biological and sociological approach to understanding and responding to the problem.

Doctors, Patients, Healthcare Systems

There are also primarily social questions that must be answered if we are to respond to AMR sustainably, in its real-world context. When and why do doctors prescribe antibiotics inappropriately? What forces drive patients to abandon treatment prior to completion? How do pharmaceutical marketing practices impact on prescribing and purchasing patterns in the developing world? How can we better control the use of antibiotic agents while not undermining access to lifesaving treatments? How can we ensure a globally cohesive response in spite of vast resource and health systems variation?

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Jens Seeberg, Janika Hauser
Department of Anthropology

Antimicrobial Resistance 1940-2000

Confidence, Awareness, Concern

The discovery of antimicrobial drugs (antibiotics) revolutionized the treatment of bacterial infections such as pneumonia, rheumatic fever and syphilis. Important groups of antimicrobial drugs were **sulphonamides**, **penicillins** and **cephalosporins**. During World War II, penicillin saved the lives of thousands of wounded soldiers. The use of the new drugs were, however, always accompanied by the development of **resistance** (AMR).

Photo: Chemical Heritage Foundation / Wikimedia commons

Three uses of antimicrobial drugs

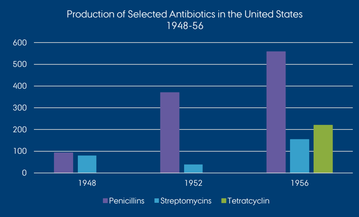
- High-dose therapeutics in humans
- High-dose therapeutics in animals
- Low-dose growth promotion in animals

Low-dose employment of antimicrobial drugs would challenge, but not destroy, bacteria.

- Stimulation of the growth of non-sensitive bacteria
- **Resistance**

1950s: Confidence

Penicillin and other antimicrobial drugs were seen as new 'wonder drugs' that would end the threat of infectious disease. There was an explosive increase in the use of the drugs in during the 1950s:



1960s: Awareness

From Methicillin to MRSA:

1960: The new antibiotic Methicillin enters the market

1962: The first human dies from methicillin-resistant *Staphylococcus aureus* (MRSA)

Robert Bud, *Penicillin. Triumph and Tragedy*, Oxford: Oxford University Press 2007, pp. 128-31

2013: The EU/EEA mean percentage of MRSA was 18%

European Centre for Disease Prevention and Control. Antimicrobial resistance surveillance in Europe 2013. Annual Report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). Stockholm: ECDC; 2014, p.59.

1990s: Concern

As more bacteria developed resistance to more antibiotics, warnings were raised more frequently:

"Can we say that ... the antibiotic age has come to an end? Not quite ... But we can see now that their usefulness will further diminish. We have squandered and immense resource ... by using it frivolously, inappropriately and ineptly."

Imre J. P. Loeffler, 'Microbes, chemotherapy, evolution, and folly', *Lancet*, 348, 1996, p. 1703

In **1994,** Newsweek ran a cover story entitled 'Antibiotics. The end of Miracle drugs?'

"Right now the microorganisms are winning ... They're so much older than we are ... and wiser."

Dr. Richard Wenzel, University of Iowa, quoted in *Newsweek*, 28. March 1994.

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