

*Antimicrobial use and resistance in livestock production in a One Health context – Edinburgh 2023 Symposium*

# One Health and AMR – Science into Policy and Practice

Professor Julie Fitzpatrick

Chief Scientific Adviser for Scotland

Scientific Director of the Moredun Research Institute

Chair in Food Security, University of Glasgow

 @ScotSciChief

## Chief Scientific Adviser's Role

- **Science Advice for Policy**

- science evidence and advice across all policy areas, especially on cross-cutting or strategic issues
  - UK Chief Scientists Network
  - Scottish Government (SG) Network

- **Policy for Science**

- input on issues affecting science policy and the science and engineering profession within SG
- science and innovation champion

- **Science for Society**

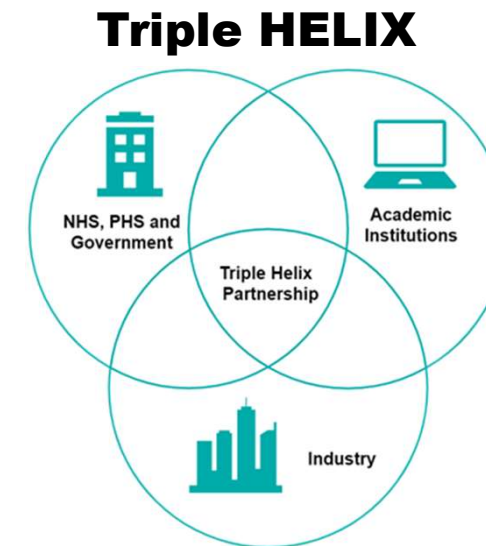
- speaking at events, promoting Scotland's science excellence with key stakeholders, and working with the science public engagement sector

### **My objectives:**

- Responding to COVID-19
- Pandemic preparedness
- Science and technology roadmap for Scotland's Climate Change Plan
- Sustainable food systems for Scotland as a Good Food Nation
- Enhancing the Science and Innovation platform in Scotland - **ScotSCIENCE**

## The Importance of the Innovation System in Scotland

- Vision: become one of the most innovative small nations in the world
- Ambition: boost innovation, productivity and green economic growth
- Research excellence is vital in driving innovation
- Industry investment linked to universities and institutes strengths
- Research and development is the third largest focus of foreign direct investment
- Sustained investment into research, development and innovation is critical



Scottish Innovation Ecosystem – talent, jobs, culture, society, economy

# Innovations for SARS-CoV-2

- Vaccines

- New technology
  - Viral vectored, mRNA, recombinant antigens
- Virus/variant sequencing
- **NOVEL PRODUCTS**

- Diagnostic tests

- New applications of existing technologies
- Virus/variant sequencing
- PCR
- Lateral flow tests
- **NEW TOOLS AND APPLICATIONS**

- Disease prevention/reduction interventions

- Data collection, analysis and sharing
- Modelling
  - Multiple organisations, different models
- Engineering
- Communications
- **PROCESSES**
- **BEHAVIOURS**
- **ACTIONS**

- Drivers

- **CRISIS**
- **FINANCIAL INVESTMENT**
- **SINGLE PURPOSE**
- **TRIPLE HELIX**



## AMR-Global Crisis

**“Anti-microbial resistance could kill us before the climate crisis does.”**

*Prof Dame Sally Davies, 2022*

“In the UK we believe that the major driver of resistance is prescribing for humans... nevertheless, we appreciate that good farm management, biosecurity and animal husbandry systems are vital to minimise the occurrence of disease and therefore reduce the need for antibiotic use”

*Prof Dame Sally Davies, Chief Medical Officer for England 2010-2019*



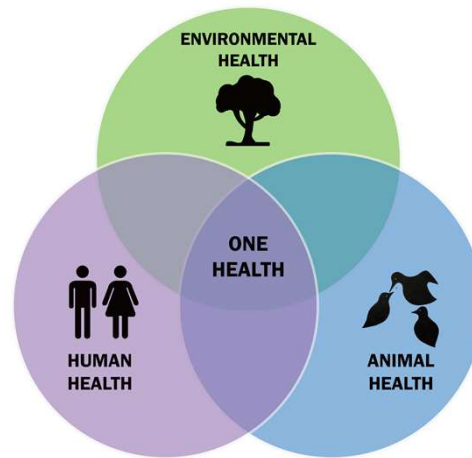
“If we fail to act,” he warned, “we are looking at an almost unthinkable scenario where antibiotics no longer work and we are cast back into the dark ages of medicine.”

*David Cameron, Prime Minister of the United Kingdom, 2014*

“My Review not only makes it clear how big a threat AMR is to the world, with a potential 10 million people dying each year by 2050, but also now sets out a workable blueprint for bold, global action to tackle this challenge.”

*Lord O’Neill, 2016*

# Global Policies





## EU & UK Policies

- In 2017, the European Commission adopted the EU One Health Action Plan against AMR
- Twice a year, the Commission issues a progress report on the plan's implementation
- Almost all EU countries have a One Health national action plans in place
- In 2019, UKG published a 5-year National Action Plan for AMR and a UK 20-year vision
- The plan focusses on 3 key actions: reducing the need for, and unintentional exposure to, antimicrobials; optimising the use of antimicrobials; and investing in innovation, supply and access.
- VMD leads on cross-governmental activity on AMR in animal health



### Tackling antimicrobial resistance 2019–2024

The UK's five-year national action plan

Published 24 January 2019



Veterinary Medicines Directorate



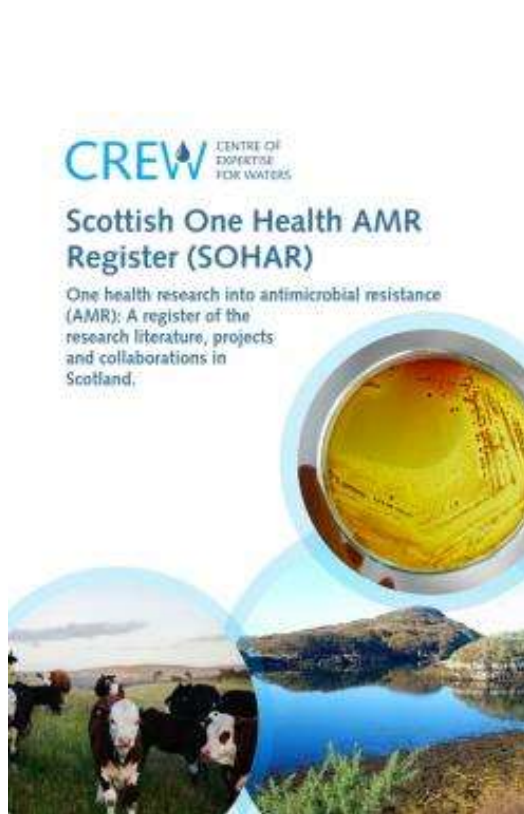
UK Veterinary Antibiotic Resistance and Sales Surveillance Report

UK-VARSS 2021

Published November 2022



# Scottish Policies



  
HM Government

## Tackling antimicrobial resistance 2019–2024

The UK's five-year national action plan

Published 24 January 2019



Scottish Government  
Riaghaltas na h-Alba

**ARHAI Scotland**  
Antimicrobial Resistance and Healthcare Associated Infection

**NHS**  
National  
Services  
Scotland

Scottish One Health  
Antimicrobial Use  
and Antimicrobial  
Resistance in 2021

Annual Report



Publication date:  
15 November 2022



## Livestock

- Species: Ruminants, Pigs, Poultry, Aquaculture, Game
- Diseases vary
  - Global, Regional, Local
  - Intensive, Extensive, Remote,
- Products and prescribing practice for anti-microbials differs

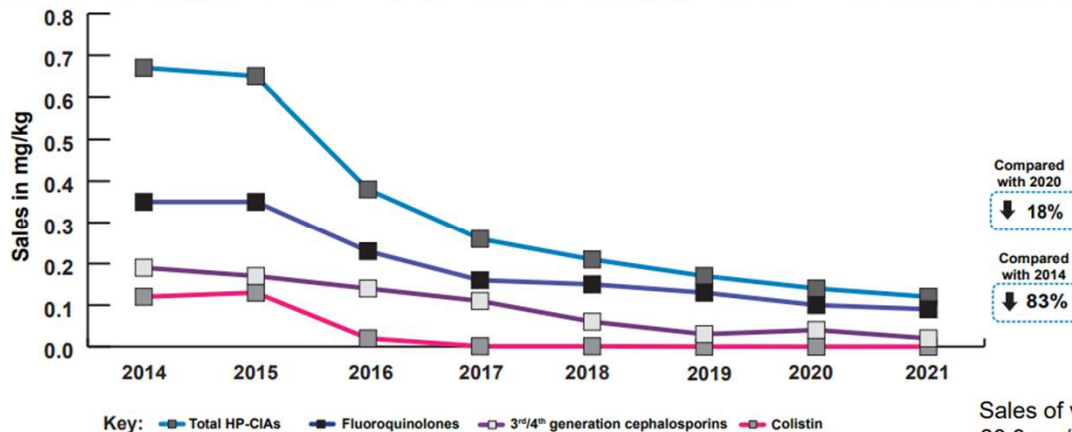


- Growth promotion products banned in 2006 in UK/EU; for imported foods in 2022 in EU
- Broad guidelines
- No unnecessary use
- Avoid overlong use
- No underdosing
- Adhere to product authorisation
- Adhere to meat, milk and egg withholding times
- Avoid prophylaxis
- Minimise metaphylaxis

# Antibiotic Sales – Veterinary Medicines Directorate

## Veterinary Antimicrobial Resistance and Sales Surveillance (VARSS) 2021 – reported Nov 2022

Sales of Highest Priority Critically Important Antibiotics (HP-CIAs) in food-producing animals account for 0.4% of total sales and have dropped from 0.14 mg/kg in 2020 to 0.12 mg/kg in 2021; an 18% decrease since 2020.

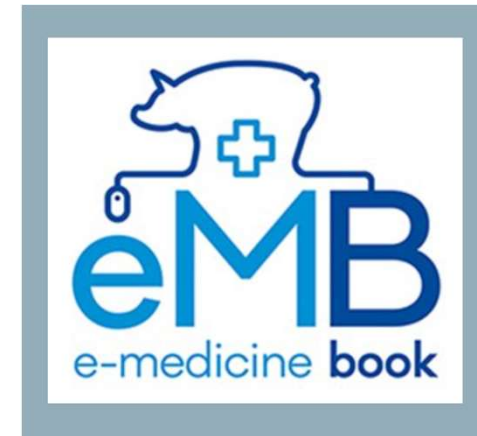


Sales of veterinary antibiotics for use in food-producing animals, adjusted for animal population, were 28.3 mg/kg; a 2.0 mg/kg (6%) decrease since 2020 and an overall 34 mg/kg (55%) decrease since 2014. This represents the lowest sales to date.



## Data on Antibiotic Use on Farms

- Agriculture and Horticulture Development Board (AHDB)
- Electronic medicine book for pigs (eMB-Pigs)
- The Medicine Hub for dairy, beef and sheep farmers



**MEDICINE + HUB**

## Responsible Use of Medicines in Agriculture Alliance (RUMA)

- 26 industry organisations
- “Farm to fork”
- Promote a co-ordinated and integrated approach to best practice of the use of medicines for farm animals
- Drug use: “As little as possible, as much as necessary”
- Balance between ensuring animal health and welfare and reducing risk of drug resistance of pathogens/bacteria
- Targets for antibiotic use for each livestock sector – Targets Task Force Initiative
- Biosecurity
- Disease prevention
- Farm management practices
- Farmer training
- Model for creation of the European Platform for the Responsible Use of Medicines in Animals (EPRUMA)

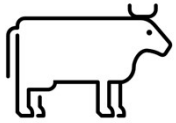
RESPONSIBLE USE OF MEDICINES IN AGRICULTURE ALLIANCE

**ruma**



European Platform for the Responsible Use of Medicines in Animals

## Ruminant Disease and Antibiotic Use



### Cattle

- Mastitis
  - Lactating cows - robotics
  - Dry period cows – selective antibiotic treatment of individual infected quarters
- Pneumonia
  - Common in housed animals
  - Complex infections with bacteria, mycoplasmas and viruses
  - Vaccines available for most viral infections
- Neonatal disease
  - Dairy and beef

### Sheep



- Lameness
  - Many are infections
  - 5-point plan
  - Judicious use of long-acting antibiotics along with vaccines and management
- Abortion
  - Multiple pathogens
  - Vaccines reduce use of metaphylactic therapy of flocks
- Neonatal disease
  - Still used widely to reduce *E. coli* infections

## AMR Stewardship

- Highest Priority Critically Important Antibiotics (HP-CIAs)
- Highest risk – antibiotics used for humans and animals
- Antibiotics used as last line of treatment for serious/critical human infections
- Classification varies WHO, EMA, VMD
  - Fluoroquinolones
  - 3<sup>rd</sup> and 4<sup>th</sup> generation Cephalosporins
  - Colistin
  - (Macrolides)
- Novel gene conferring resistance to colistin and capable of horizontal transmission (mcr-1)

**Ceasing the use of the highest priority critically important antimicrobials does not adversely affect production, health or welfare parameters in dairy cows**

Andrea Turner,<sup>1</sup> David Tisdall,<sup>2</sup> David C Barrett,<sup>1</sup> Sarah Wood,<sup>1</sup> Andrew Dowsey,<sup>1</sup> Kristen K Reyher<sup>1</sup>

- European Medicines Agency (EMA) – Anti-microbial Advice Ad Hoc Expert Group (AMEG)
- Prudent and responsible use of anti-biotics in animals
  - **A – Avoid**
  - **B – Restrict – most HP-CIAs**
  - **C – Caution**
  - **D – Prudence**
- Potential issues for livestock production
  - Dairy cows – ceftiofur – zero milk withholding period
  - Many livestock species – macrolides for pneumonia



# AMR Stewardship: British Veterinary Association and Royal College of Veterinary Surgeons



**BVA** British Veterinary Association

Responsible use of antimicrobials in veterinary practice:  
**THE 7-POINT PLAN**

- 1 Work with clients to avoid need for antimicrobials**
  - Inform owners about the benefits of regular pet health checks
  - Use symptomatic relief or topical preparations, where appropriate
  - Integrated disease control programmes
  - Animal Health and Welfare Planning
  - Isolate infected animals wherever possible
- 2 Avoid inappropriate use**
  - For example, for uncomplicated viral infections
  - Restrict use to ill or at-risk animals
  - Advise clinicians correct administration and storage of products and completion of course
  - Avoid underdosing
- 3 Choose the right drug for the right bug**
  - Identify likely target organisms and predict their susceptibility
  - Create practice-based protocols for common infections based on clinical judgement and up to date knowledge
  - Know how antimicrobials work and their pharmacodynamic properties
  - Use narrow spectrum antimicrobials where possible
- 4 Monitor antimicrobial sensitivity**
  - While clinical diagnosis is often the initial basis for treatment, bacterial culture and sensitivity must be determined whenever possible so that a change of treatment can be implemented if necessary
  - Monitor bacterial culture and sensitivity trends
- 5 Minimise use**
  - Use only when necessary and evidence that usage reduces morbidity and/or mortality
  - Regularly assess antimicrobial use and develop written protocols for appropriate use
  - Use long-acting injectable antibiotics and written practice guidelines
- 6 Record and justify deviations from protocols**
  - Be able to justify your choice of antimicrobial and dose
  - Keep accurate records of treatment and outcome to help evaluate therapeutic regimens
- 7 Report suspected treatment failure to the VMD**
  - This may be the first indication of resistance
  - Report through the Suspected Adverse Reaction Surveillance Scheme (SARSS)

**HIGHER RISK ANTIMICROBIALS**  
Fluoroquinolones, 3rd/4th generation cephalosporins and macrolides:

- Reserve these antimicrobials for clinical conditions that respond poorly to other classes of antimicrobials and where bacterial culture and sensitivity has been carried out.
- Do not administer systemically to groups or flocks of animals except in very specific situations and special attention should be given to the risk of antimicrobial resistance as part of the benefit/risk assessment.
- Avoid off label use whenever possible

For the latest detailed guidance visit [www.bva.co.uk](http://www.bva.co.uk)

**ANTIBIOTIC**

- Only Veterinary Surgeons can prescribe antibiotics for use in animals
- The animals must be “under the care of the Veterinary Surgeon”
- Veterinary practice is changing
  - Remote/rural practices
  - Large corporate practices
  - COVID-19
- Redefinition of “under care”
  - Physical examination
  - Farm visits
  - When and how to prescribe POM-Vs

## AMR and Wildlife Sentinel Species

### Anthropogenic activity:

- Spread of resistant bacteria
- Selection of resistant bacteria due to presence of antimicrobials / antimicrobial residues in the environment

### Focus on proximity to:

- Wastewater treatment plants
- Urban areas
- Livestock
- Agricultural run-off
- Aquaculture



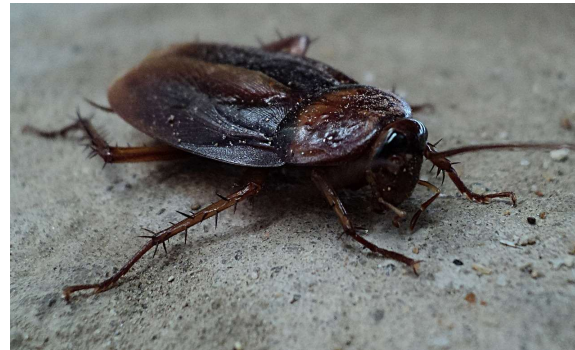
Top predators  
Generalist diet  
Defined  
geographical  
range



## Wildlife as Vectors for AMR

### Short range

- Examples include insects and rats
- Spread between farms
- May result in spread to humans



### Long range

- Examples include migratory birds and aquatic mammals
- Can be intercontinental

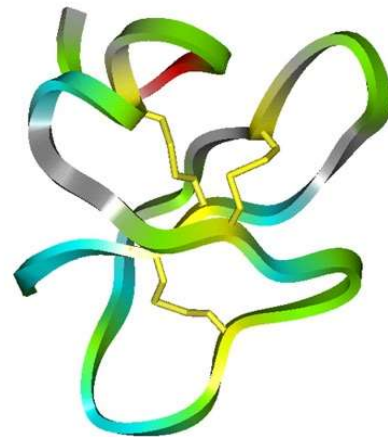


### Carriage of resistant bacteria by both sentinel and vector species may

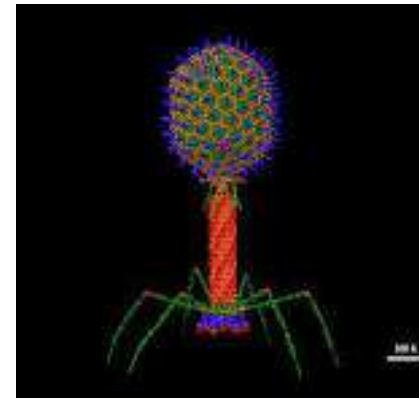
- Result in additional reservoirs with risks to human health
- Facilitate dissemination of genes across bacterial species within microbiota
- Compound risks from zoonoses

## Alternatives to Anti-Microbials - Biological Molecules as Therapeutics

- Moredun Scientific (animals)
  - Contract Research Organisation
- Fewer trials with anti-microbials
- Smaller biotech companies investing
- Bioactive peptides



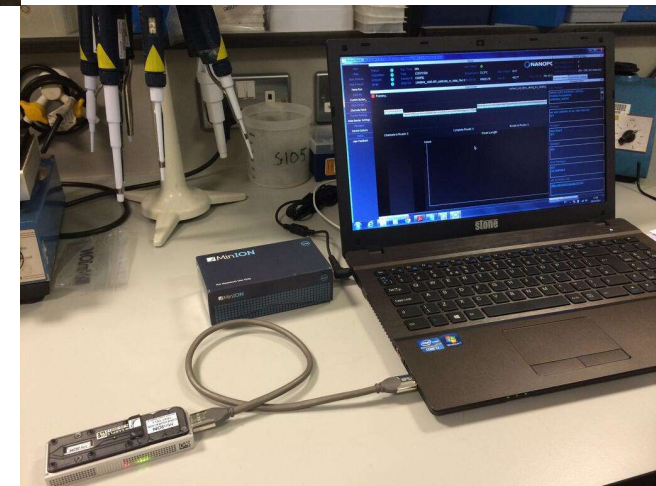
- Bacteriophage therapy (humans)
  - For patients with difficult to treat bacterial infections
  - Healthcare Improvement Scotland
  - SHTG (Scottish Health Technologies Group) - Advice on health technologies



Dr Victor Padilla-Sanchez

## Alternatives to Anti-Microbials - Diagnostics

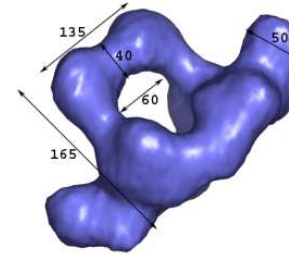
- Targeted treatment to pathogen present
- Reduces inappropriate treatment
- Rapid pen-side testing
- Herd and flock diagnosis as well as individuals
- Multiplex PCR – identifying multiple pathogens simultaneously
- MinION sequencing
- DIVA potential – differentiating infected from vaccinated animals



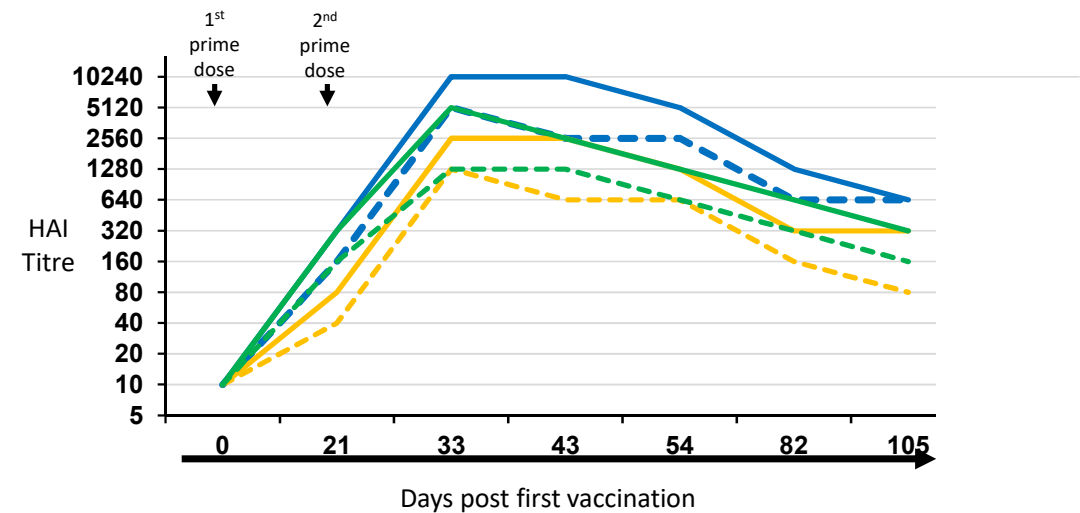


## Alternatives to Anti-Microbials - Vaccines

- Prevention better than cure!
- Immunity for adults and neonates
- No resistance issues
- Complementary to breeding programmes for disease reduction
- Reduces use of anti-microbials
- Integrated disease programmes required; vaccines are not a silver bullet



Self-assembling sub-virus particle encoding two surface proteins of LIV





## Challenges for One Health and AMR

- Funding
  - “He who benefits should pay”
  - Food-borne pathogens often asymptomatic in carrier or source host
  - Farmer, food processor or retailer, human medicine?
- Zoonoses and wildlife
  - Few routes of funding
  - Surveillance difficult
- Developing countries
  - Close proximity of animals and people
  - Urbanisation and mega-cities
- Global shocks and migration
  - Movement of animals and people
  - Food chain disruption
  - Border controls

## Opportunities for One Health and AMR

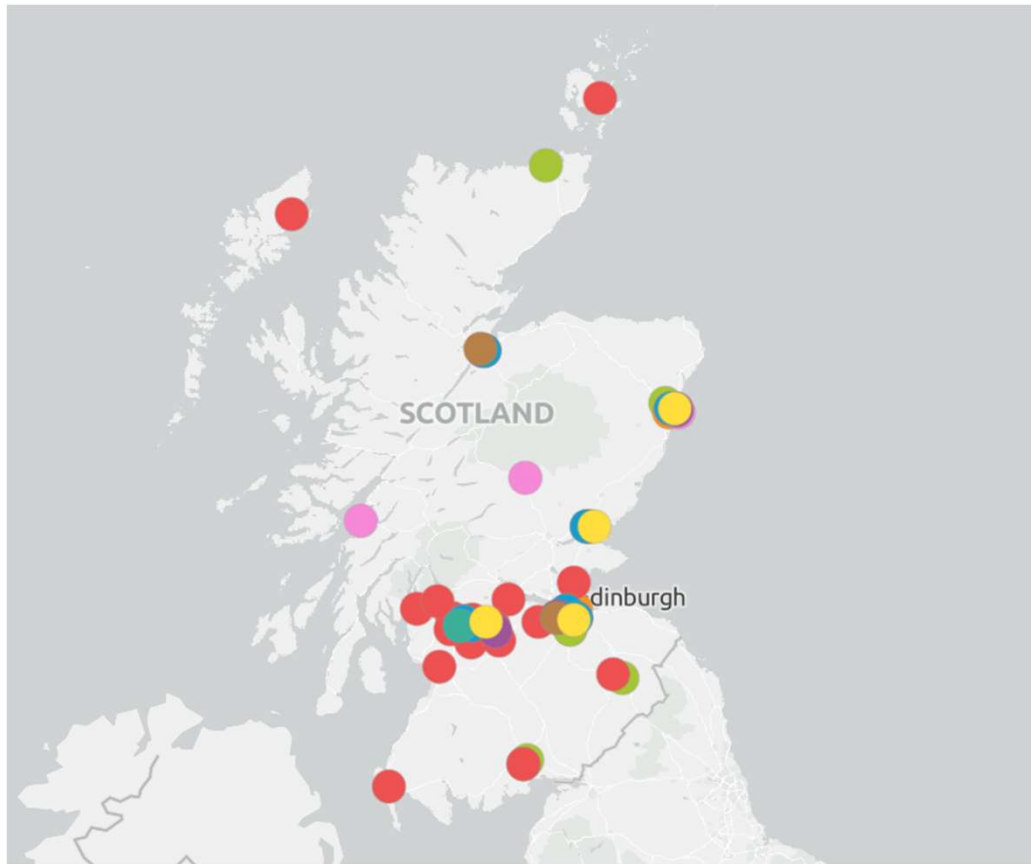


- EAVE II Project – COVID-19
- Professor Sir Aziz Sheikh
- 5.4M patients across GP practices in Scotland
- National linked dataset primary care, out of hours, hospitals, laboratories, mortality
- First, critical, unique information on vaccine responses



- Scotland and further...
- Integrated AMR initiative across One Health
- Interdisciplinary science
- Laboratory network and pathogen collections
- The TRIPLE HELIX for AMR CRISIS MANAGEMENT?
- A new priority

## Conclusion



### One Health

- Humans
- Animals
- Environment
- Scientists
- Policy makers
- Funding bodies



### Acknowledgments

- Sam Cox
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- Eleanor Watson

