

Institution: University of Bristol		
Unit of Assessment: 6) Agriculture, Food and Veterinary Sciences		
Title of case study: Improved policy and practice reduce antimicrobial use across the UK veterinary profession and livestock industries		
Period when the underpinning research was undertaken: 2015 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Kristen Reyher	Reader in Veterinary Epidemiology & Population Health	09/2012 - present
Prof David Barrett	Professor of Bovine Medicine, Production & Reproduction	04/2011 - present
Dr Gwen Rees	Senior Research Associate	01/2019 - present
Dr Hannah Schubert	Senior Research Associate	10/2016 - 03/2020
Period when the claimed impact occurred: 2015 – 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Reducing animal and human exposure to antibiotics is integral to reducing the worldwide challenge of antimicrobial resistance. The Antimicrobial Resistance Force (AMR Force) at the University of Bristol has led the UK veterinary and farming sectors to reduce and refine the use of antimicrobials in livestock. Providing the evidence and means to modify and accurately monitor AMU has shaped industry policy and changed professional practice. AMR Force has:

- influenced new Red Tractor certification guidance, contributing to 87% and 96% decreases in critically important antimicrobial (CIA) use in dairy and beef cattle, respectively;
- developed a responsible antimicrobial use (AMU) policy for Waitrose's milk producers, driving further reductions in AMU through changes in farmer behaviour;
- worked with a large veterinary business to change veterinarian behaviour and reduce sales of CIAs by 75% within one year across 100 dairy farms;
- developed software for the British dairy industry to accurately monitor and encourage responsible AMU in dairy cattle (accessible by 40% of GB's milk pool in 2020, and used by 15%).

2. Underpinning research

The rapid emergence and spread of AMR is a critical public health issue worldwide. It has profound implications not just for human health, but also for veterinary medicine, farming and global food security with pressures to reduce AMU in agriculture. The need to cut and monitor AMU was formally recognised by the UK Government in its 2016 response to a "Review on AMR" commissioned by the UK Prime Minister in 2014. The Review argued for a significant increase in regulatory oversight of veterinary antimicrobials worldwide. The Government's response set an AMU target for UK livestock and recognised the need to improve surveillance data on AMR and antimicrobial prescribing in farmed animals.

The University of Bristol (UoB) Veterinary School's AMR Force – led by Dr Kristen Reyher – are regarded as pioneers of research into AMU and AMR in the livestock sectors, publishing empirical evidence in preeminent international journals. This interdisciplinary team of epidemiologists, microbiologists, social scientists and veterinarians had already begun conceiving and pioneering initiatives to reduce AMU in livestock long before the 2016 AMR review. As an integral part of a cross-Faculty interdisciplinary approach to AMR spearheaded by UoB, the team work alongside human clinicians, physical scientists and others to share best practice, data and innovation across the AMR sphere, reflecting the WHO's 'One Health' approach to attaining optimal health outcomes for people, animals and the environment. Their evidence-based, participatory approach combines their own practical experience of antimicrobial monitoring and reductions across Bristol Veterinary School's client farms with wider investigations in the field. Their work has engaged multiple industry partners, clinicians, farmers and academics from various disciplines and institutions at all stages of the research process. While the specific effect of AMU in farmed animals on global AMR remains unclear, AMR

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Force's research, detailed below, has advanced understanding of: i) current AMU and AMR in UK agriculture, ii) effective interventions to improve responsible AMU in livestock veterinary practice and on farms and iii) accurate measurement of AMU to improve responsible reporting by the UK farming industries.

Defra AMU study. In 2015, the Department for Environment, Food & Rural Affairs (Defra) commissioned AMR Force, together with social scientists from Exeter University, to conduct a quantitative synthesis of evidence and generate empirical evidence to elucidate how and why antimicrobials were used in contemporary livestock systems [1]. This report demonstrated that AMU was prevalent across national and international livestock systems, yet little research and few interventions had addressed inappropriate use. Furthermore, although farmers and veterinarians were aware of AMR, this awareness did not lead to AMU behaviour change.

Waitrose milk producers study. Due to their reputation and expertise, AMR Force were approached in 2016 by Waitrose's nationwide milk producers to conduct research to develop a responsible AMU policy [2]. The project actively engaged and opened a dialogue with multiple stakeholders (producers, veterinarians, industry and researchers) to develop practical recommendations for sustainable and responsible AMU. It was the first reported instance of participatory methodology in the livestock sectors to involve farmers from the outset. This work demonstrated that most of the 97 dairy farmers involved were aware of the AMR crisis and, while many were already stringent with AMU, they could envisage making further changes to improve responsible use on their farms, which they did following this work.

Successful interventions to reduce AMU. AMR Force identified interventions to reduce the use of CIAs, of special importance because bacteria that develop resistance to these antimicrobials present a particular problem for human health. Interventions included more targeted AMU and preventative measures (e.g. vaccination and improved hygiene, such as greater cleanliness and better ventilation). Their research found that interventions made it possible for veterinarians to discontinue the use of CIAs in livestock on participating farms without negative effects on animal health, productivity or welfare [3]. AMR Force research also demonstrated that participatory, farmer-led action groups showed great success in encouraging antimicrobial stewardship [5].

AMU monitoring. An accurate measurement of on-farm AMU improves understanding of how antimicrobials are administered and whether usage is truly increasing or decreasing. Due to differences in measurements used to calculate AMU by different groups, however, changes to AMU in livestock are difficult to compare across research outputs and official reports. AMR Force illustrated [4] that both over- and under-reporting of AMU result from the variety of AMU measurements in use, leading, in turn, to inconsistent interpretations of the same data. Further, they showed that farmers demonstrate preferences for certain metrics, taking ownership and using them to drive responsible use with benchmarking [5]. National approaches to responsible AMU measurement, however, do not accurately capture antimicrobials administered and stored locally on farms; standard approaches rely on farmers self-reporting usage and storage. An AMR Force study of a sample of dairy farms developed more accurate figures of usage and storage and found that over 85% of farms stored at least one CIA [6]. Furthermore, their research found that veterinary prescription records closely matched on-the-ground figures and could, therefore, be used as a proxy for AMU.

3. References to the research

1. Buller H, Hinchliffe S, Hockenhull J, **Barrett D, Reyher KK, Butterworth A, Heath C**, [Systematic review and social research to further understanding of current practice in the context of using antimicrobials in livestock farming and to inform appropriate interventions to reduce antimicrobial resistance within the livestock sector](#), DEFRA, 2015, Crown copyright.
2. **van Dijk L**, Hayton A, **Main DCJ**, Booth A, King A, **Barrett DC**, Buller HJ and **Reyher KK**, Participatory Policy Making by Dairy Producers to Reduce Anti-Microbial use on Farms, *Zoonoses and Public Health*, 2016, 64:476–484. DOI: 10.1111/zph.12329
3. **Turner A**, Tisdall D, **Barrett DC, Wood S, Dowsey A, Reyher KK**, Ceasing the use of the highest priority critically important antimicrobials does not adversely affect production, health or welfare parameters in dairy cows, *Veterinary Record*, 2018, 183:67. DOI: 10.1136/vr.104702

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4. **Mills HL, Turner A, Morgans L, Massey J, Schubert H, Rees G, Barrett D, Dowsey A, Reyher KK**, Evaluation of metrics for benchmarking antimicrobial use in the UK dairy industry, *Veterinary Record*, 2018, 182:379. DOI: 10.1136/vr.104701
5. **Morgans L**, Bolt S, Bruno-McClung E, van Dijk L, **Escobar MP**, Buller HJ, Main DCJ, **Reyher KK**, A participatory, farmer-led approach to changing practices around antimicrobial use on UK farms, *Journal of Dairy Science*, 2020, 104:2212-20. DOI: 10.3168/jds.2020-18874.
6. **Rees GM. Barrett DC**, Buller H, **Mills HL, Reyher KK**, Storage of prescription veterinary medicines on UK dairy farms: a cross-sectional study, *Veterinary Record*, 2019, 184:153. DOI: 10.1136/vr.105041

4. Details of the impact

Globally, AMR is estimated to cause over 700,000 human deaths and cost GBP66 trillion annually. Deaths from AMR are predicted to increase to 10 million by 2050, with use of antimicrobials in humans and animals also predicted to rise globally. Leading research from AMR Force has addressed this critical issue by advancing the understanding of AMU in livestock agriculture. Moreover, their research has inspired and initiated policy and behavioural change towards more responsible AMU. These achievements have been reached through high-quality research collaborations and commissions [1,2], serving on industry, charity and government committees and speaking at national and international meetings to provide evidence and influence decisions made at the highest levels.

The impact of AMR Force's research is highly regarded. Their paper [3] on AMR interventions was the "clear winner" in the *Veterinary Record's* 2019 Impact Awards. Explaining their decision, the publication commented that the paper "*gives a vision that these changes could be scaled up around the globe to greatly reduce the use of antimicrobials in farming*" [A]. AMR Force have twice received prestigious Antibiotic Guardian Awards (a Public Health England initiative, in collaboration with Defra): in 2018 for engaging agricultural stakeholders to reduce AMU, and in 2019 for their farmer-led, peer-to-peer learning approach to antimicrobial stewardship [A].

1. Impacts on UK public policy

New industry association and certification scheme guidance on CIAs. AMR Force's successful intervention to reduce CIAs in livestock – already well known within the industry before academic publication [3] – was a key reference in the not-for-profit British Cattle Veterinary Association's (BCVA) 2016 AMU statement recommending the reduction of CIAs in cattle practice. "*The robust research conducted by... AMR Force ... enabled us to formulate BCVA policy and make a case for our statement about highest-priority critically important (HPCIA) antimicrobials ... the research provided robust evidence to support the advice that the reduction and even cessation of HPCIA did not impact negatively on herd health.*" [B]. In turn, BCVA's 2016 CIA statement influenced Red Tractor – the UK's largest Farm Assurance and food standards certification body – to issue guidelines in 2018 to restrict the administration of CIAs among farm animals: "*As a result [BCVA's] statement was later reflected in the Red Tractor Assurance Scheme standards*" (BCVA) [B]. Red Tractor's updated guidance instructs certificate-holders to only use CIAs "*when all other treatment options have been exhausted*" and as "*a last resort, under veterinary direction, backed up by ... diagnostic testing*" [B]. This guidance is compulsory for farms to maintain accreditation and has been adopted by Red Tractor's 11,000 UK dairy members (responsible for ~93% of UK-produced milk) and around 24,000 beef and lamb members across England (80% of finished beef and 60% of finished lamb). This change is also reflected in government statistics: the *Veterinary Antimicrobial Resistance and Sales Surveillance report (VARSS, 2020)* relays an 87% and 96% drop in CIA use in dairy and beef cattle, respectively, since 2017 (p31) [B].

Industry and government groups commit to better monitoring and storage. Based on AMR Force's research, UK government and industry bodies have set standards for collection, measurement and recording of AMU. For example, the Cattle Health and Welfare Group (CHaWG) drew on AMR Force research [4] in a final consultation paper (2019) on AMU monitoring [C]. This paper publishes metrics that illustrate achievements in meeting AMU targets as set by the non-profit Responsible Use of Medicines in Agriculture Alliance (RUMA). RUMA's targets provide the foundation for the *Veterinary Medicines Directorate's* (an executive agency of Defra) approach to tackling antibiotic resistance (as acknowledged in *VARSS 2017*, p5) [C]. In

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VARSS 2017 CHaWG states *“the dairy and beef sectors are committed to increasing the amount, quality and representativeness of the data for both antibiotic usage monitoring and benchmarking”* (p38) [C]. In the VARSS 2020 report, CHaWG describe the benefits of the metrics, as set out their 2019 consultation paper as allowing: *“farms to understand their antibiotic use, and how this is changing over time and relative to the industry, as well as help guide the veterinarian-farmer discussions around disease prevention and responsible antibiotic use.”* (p46) [C]. Further, in 2019 the BCVA partnered with RUMA and the British Veterinary Association (BVA) to encourage veterinarians to work more closely with farmers on medicine usage, storage and collection of out-of-date medicines from farms, based on AMR Force’s work [6]. This is reflected in two key industry targets set by the RUMA Targets Task Force 2020 – on-farm benchmarking of AMU and the creation of a ‘Farm Vet Champions’ network (p30). Additionally, RUMA cite AMR Force work (a thesis which developed into [5]) to build their rationale for AMU targets (2021-24) for the UK livestock sector (p20, p29) [C].

2. Impacts on the UK dairy industry: new medicine monitoring software

Since 2018, AMR Force have been collaborating with National Milk Laboratories (NML), who receive samples from 98% of GB dairy farms, to develop ‘FarmAssist’. This database, managed and run by NML on behalf of milk buyers, provides a robust record of medicine use and antibiotic testing on dairy farms to support industry efforts to improve antimicrobial stewardship. AMR Force provided NML with advice on accurate data collection methods and metrics which provide meaningful measurements that are repeatable and consistent over time [4]. FarmAssist has influenced *“how [NML] relay potentially complex information in a way that supports vet-farmer discussion for positive behaviour change ... Already we can report usage figures that describe the range of use across GB herds, and notably a reduction in use of HPCIA [highest priority CIA] products. These benchmarking figures are important to both support active vet-farmer health planning discussion on-farm, and to show the dairy sector’s continued progress with antimicrobial stewardship.”* (Veterinary Advisor, National Milk Records (NMR)) [D]. At the end of 2020, two major milk buyers, representing 40% of the national milk pool, had contracts with NML to use FarmAssist. Over 1300 dairy farms (of around 8300 in GB) served by these buyers, and over 180 veterinary practices, have submitted data to the online platform. This equates to more than sixfold growth in fewer than two years, with the potential for this software to be scalable to 100% of GB’s dairy population [D].

3. Impacts on professional services: training & behaviour of veterinarians & farmers

AMR Force’s AMU interventions, which emphasise farmer-veterinarian collaborations for auditing antimicrobial prescribing and actively engaging farmers in education and herd health planning to reduce CIA use [3], were first piloted in UoB’s livestock veterinary practice and actively taught to veterinary students. This evidence base has been translated into practice by graduates of the Bristol Veterinary School and taken up across the profession. For instance, in 2016, these interventions were implemented by a large commercial livestock veterinary practice – Friars Moor Farm Vets (FMFV; including a UoB graduate who had studied under AMR Force researchers). As early adopters, FMFV developed a campaign that reduced CIA sales by 75% within a 12-month period from 2015-2016 across 100 dairy farms and approximately 30,000 dairy cows. This provided evidence that AMR Force interventions could be applied widely and successfully, giving confidence to the veterinary profession across the UK and beyond, as seen in the BCVA and Red Tractor guidelines. To develop this campaign, FMFV consulted AMR Force on their experience of eliminating CIAs from their own university farm practice, giving the practice *“confidence that we might achieve our aims”* (FMFV veterinarians) [E].

In AMR Force’s work with Waitrose’s milk producers [2], 70 of 72 dairy farms in the producer pool attended policy development workshops and designed an impressive and challenging policy for reducing reliance on antimicrobials [E]. Six months after the policy was launched, 70% of veterinarians and farmers (many of whom were already farming organically and therefore using very few antimicrobials) indicated they had reduced AMU even further [E]. In response to farmers’ appetite for more information about antimicrobials, these producer pools also designed an online training tool for their farmers which became the bedrock for [the National Office for Animal Health’s online course](#) supporting the livestock industries in training farmers in better antimicrobial stewardship. As of end-2020, 529 farmers have completed this course [E].

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4. Impacts on awareness and understanding of AMU

AMR Force have increased awareness of AMU issues among policymakers (both agricultural and health), the veterinary profession, the agricultural industries and the broader public.

Policy events: The UK Chief Medical and Veterinary Officers invited Dr Reyher to present research evidence at a national policy meeting on Promoting One Health and Taking Effective Action to Combat AMR in May 2017. Reyher was one of only a few academic speakers at the event, attended by 50 delegates comprising veterinary association representatives and policymakers from both animal health and human health organisations such as Defra, NHS bodies and Public Health England [F]. AMR Force have also presented evidence to and engaged Welsh Government (2017) and the National Farmers Union (2017 and 2018) [F].

Media coverage and public events: Working alongside colleagues from the Bristol Medical School and Biomedical Sciences, AMR Force has also raised awareness of AMR among farmers and the general public by discussing their research through regular TV appearances, public talks and activity on social media [F]. These activities include:

- Appearances on national and regional TV and radio news programmes, including BBC Breakfast, BBC R4 Farming Today [reaching >1 million], BBC Points West.
- Wide coverage in written press, including in national, farming and veterinary press (The Guardian [reaching 35.2 million], Scotsman [reaching 5.8 million], Farmers Weekly [reaching >40,000 households], Farmers Guardian [reaching ~30,000 households], Farming UK [reaching >100,000]).
- A presentation on AMR Force's audit of a sample of dairy farms [6] was given to ~70 dairy farmers in at the Agricultural and Horticultural Development Board (the national agricultural levy board) roadshow in 2018.
- Two AMR Force projects are presented as shared learning resources on the Antibiotic Guardian website, "*show[ing] the public how agriculturalists work towards global [AMU/AMR] targets and are proactive*".
- Leading and participating in annual World Antimicrobial Awareness Week lectures and panel discussions (November 2015, 2016 and 2018 at Royal Society for Medicine).
- Acting as an expert panellist at Science Media Centre briefing to journalists (including from the BBC, Daily Mail and The Sun, 2017).

AMR Force interventions for reducing CIA use [3] have also been integral to video content produced by the Food and Agriculture Organisation of the United Nations and hosted on their YouTube channel (100,000 subscribers). Their 2018 video showcases UK farmers and vets working together under the AMR Force approach and has almost 3,000 views to date. Another video, launched in 2017, with 4,500 viewers to date, explains the One Health approach to AMR and highlights AMR Force as a successful example of how to work towards One Health goals.

5. Sources to corroborate the impact

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- A. **Awards:** Vet Record (2019) [Editorial](#) (Impact Award) | Antibiotic Guardian award
- B. **New guidance:** BCVA (2020) Supporting statement | Red Tractor (2019) Supporting statement | VARSS (2020) [UK VARSS 2019](#)
- C. **Monitoring and storage:** CHaWG consultation paper (2019) | VARSS report (2018) [UK-VARSS 2017](#) | RUMA (2020) [Targets Task Force Report](#) | VARSS (2020) [UK-VARSS 2019](#)
- D. **FarmAssist:** NML (2020 and 2019) Supporting statement – Veterinary advisor | FarmAssist (2020) September Newsletter | NML email (2021) FarmAssist 2020 figures
- E. **Veterinarian and farmer training and behaviour:** [In Practice article focusing on Friars Moor Farm Vets publication](#) (2017) | van Dijk et al. (2017), Zoonoses and Public Health, DOI: [10.1111/zph.12329](#) | NOAH (2021) Email correspondence - Senior Technical Policy Manager
- F. **Awareness and understanding:** BVA One Health event delegate pack | Welsh Government (2017) Email correspondence - Senior Veterinary Officer | NFU (2018) Email correspondence – Regional Policy Manager and Devon County Advisor | NFU (2017) Email correspondence – Chief Dairy Advisor | Antibiotic Guardian [learning resources](#) | 2018 [FAO video](#) | 2017 [FAO video](#) | TV/radio coverage – available upon request | Written press coverage - [Farmers' Weekly](#) (2017) | [Farmers' Guardian](#) (2020) | [Farming UK](#) (2016) | [The Guardian](#) (2019) | The Scotsman (2016) | Science Media Centre briefing (2017) | AHDB Roadshow presentation email correspondence (2018) | Antibiotic Awareness Week email correspondence and flyers (2015, 2016, 2018).