

Designing and Evaluating Complex One Health Interventions An International Workshop



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1. Executive Summary

It is crucial to expand the scope of antimicrobial stewardship efforts beyond the hospital setting and large-scale commercial farms to encompass agricultural communities and small farms, that form the backbone of food production in many parts of the world. Agricultural communities are primary stakeholders in antimicrobial resistance (AMR) as they face a dual challenge of having weak health systems with limited access to medical and veterinary services, and experience high levels of antibiotic misuse and overuse in humans and animals. Innovative strategies must be developed to disrupt the cycle of antibiotic misuse and to improve healthcare accessibility in these settings, ultimately contributing to the global fight against AMR.

There are a comprehensive set of drivers of antibiotic use in community settings, including economic and infrastructural challenges, the absence of a supportive environment for frontline private sector providers responsible for first contact healthcare and antibiotic provision, the involvement of multiple stakeholders with vested commercial interests throughout the value chain, and the lack of effective regulations. These have been recognized as important contributing factors by a multi-country research consortium at LSHTM, known as 'AgriAMU', that seeks to enhance antimicrobial stewardship in community settings. The research group has emphasized the necessity for multi-level, multi-component One Health interventions to enhance stewardship in community settings. The present workshop was conceived of as a platform to explore the design, implementation, and evaluation of such complex and holistic interventions, facilitating knowledge exchange among experts from LSHTM's Antimicrobial Resistance (AMR) Centre, the Centre for Evaluation and researchers from the AgriAMU consortium.

The workshop brought together 46 participants from 26 disciplines and 8 countries. It was conducted over 2 days and included a series of presentations covering different types of intervention design approaches and evaluation techniques including implementation research. These were followed by AMR case studies and analyses, and presentations were interspersed with breakout discussions. The range of topics included frameworks to model and rank One Health interventions, comparison of different types of trial designs, the importance of systems approaches and process evaluations, and realist evaluations and evidence synthesis. AMR case studies included using participatory systems mapping to determine targets for AMR interventions, evaluation of mobile phone based clinical decision support tools, AMR policy analysis, investigating implementation through different frameworks, and the characteristics of a large-scale implementation research aimed at improving access and reducing inappropriate antibiotic use in children in five countries.

Key workshop recommendations for the design, implementation, and evaluation of a One Health intervention, or a collection of interventions, include:

- The importance of engaging stakeholders from various sectors and levels of the system. This involvement enhances ownership of the intervention and fosters a comprehensive understanding of AMR.
- To address the fragmented nature of data, modelling can aid in data integration and intervention prioritisation.
- Whether the intervention is focused on specific AMR issues such as antibiotic prescribing or takes a broader approach by addressing the burden of infections, adopting a systems approach to the evaluation is valuable.
- Evaluations could adopt a One Health perspective, considering the impacts of multiple interventions and adopting a complex systems approach to widen the evaluation design.

- Process evaluations and the consideration of implementation frameworks are essential for assessing the effectiveness of complex and holistic interventions.

By following these recommendations, interventions can be better tailored, implemented, and evaluated to effectively combat AMR while considering the interconnectedness of human and animal health.

This report provides the reader with a brief summary of each of the presentations. For more details, please contact:

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2. Background and Introduction

Agricultural communities, comprising approximately 50% of the population in many Asian and African countries, are among the most impoverished. These communities rely on small-scale farming, with a significant portion (70-80%) of farms being smaller than 2 hectares¹. Despite their size, these small farms contribute around 30% of food commodities, including cereals, vegetables, pulses, and livestock, particularly in South and Southeast Asia and Sub-Saharan Africa. In China, they contribute more than 50% of food commodities².

Agricultural communities are primary stakeholders in AMR as they face a dual challenge of having weak health systems with limited access to medical and veterinary services, and experience high levels of antibiotic misuse and overuse in humans and animals. They rely on private healthcare providers such as drug sellers and paravets, who operate outside the formal system and are difficult to regulate. The prevalence of self-medication and over the counter sales of antibiotics further compounds the situation, posing a significant obstacle to global efforts in combating the misuse and overuse of antibiotics, which contribute to the rise and spread of AMR. Addressing the cycle of antibiotic misuse and poor healthcare that agricultural communities face requires innovative thinking and tailored stewardship approaches and intervention designs. There is also the additional complexity of the community setting compared to hospital settings due to the multitude of actors involved in this setting (see Table 1).

The current focus of stewardship research for human antibiotic use primarily centres on hospital settings, while research on animal production predominantly targets large-scale commercial farms. It is crucial to expand the scope of stewardship efforts beyond the hospital setting and large-scale commercial farms to encompass agricultural communities and small farms, that form the backbone of food production in many parts of the world. The community setting presents unique challenges due to its vast and market-driven healthcare environment, as well as the vested interests of multiple actors

¹ Lowder, S.K., J. Scoet, and T. Raney. The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide. *World Development*, 2016. 87: p. 16-29.

² Herrero M, Thornton PK, Power B, et al. Farming and the geography of nutrient production for human use: a transdisciplinary analysis. *Lancet Planet Health*. 2017 Apr;1(1):e33-e42. doi: 10.1016/S2542-5196(17)30007-4.

involved. Consequently, different stewardship approaches and purposeful intervention designs and evaluation techniques are necessary. By doing so, it will become possible to address the intertwined issues of antibiotic misuse and poor access to quality healthcare that these communities face. Innovative strategies must be developed to disrupt the cycle of antibiotic misuse and improve healthcare accessibility in these settings, ultimately contributing to the global fight against AMR.

Table 1: Differences between hospital and community settings which make interventions into and regulation of the antibiotic use (ABU) and consumption in community settings more challenging.

Hospital settings	Community settings
Governance	
Centralised governance	Decentralised governance
Guidelines, policies, and regulation on ABU	Guidelines, policies, and regulation either not established or not enforced/adhered to
Established documentation and monitoring processes	Little documentation and monitoring processes
Human resources	
Smaller number of stakeholders with common goals	Wider range of stakeholders with conflicting interests
Established structure of professionals	Wide variety of non-professional providers
Training structures	
Structured training programmes with documented knowledge distribution	Varying levels of providers knowledge and training
Diagnostic capabilities	
Greater access to diagnostic tools and facilities – depending on level of health facility	Limited access to diagnostic tools and facilities
Supply chains	
Simpler, established supply chains	More complicated supply chains – drug quality may be an issue
Organisation	
Easier to map the actors involved and their relationships	More difficult to map the actors involved and their relationships and networks
Referral systems clearly established	Lack of clearly established referral systems
More distinct spatial boundaries to work within	Sprawling and boundless pluralistic network of providers
Boundaries of responsibility	Sprawling, expanding responsibilities
Hierarchical medical system	Organic and adaptive market driven

Herrero, M.; Thornton, P.K.; Power, B.; Bogard, J.R.; Remans, R.; Fritz, S.; Gerber, J.S.; Nelson, G.; See, L.; Waha, K.; et al. Farming and the geography of nutrient production for human use: A transdisciplinary analysis. *Lancet Planet. Health* **2017**, *1*, e33–e42

Gautham, M.; Spicer, N.; Chatterjee, S.; Goodman, C. What are the challenges for antibiotic stewardship at the community level? An analysis of the drivers of antibiotic provision by informal healthcare providers in rural India. *Soc. Sci. Med.* **2021**, *275*, 113813.

This workshop was conceptualized and co-organized by a consortium of researchers seeking to investigate antimicrobial use and enhance antibiotic stewardship in health and food systems within agricultural communities across Asia, Africa, and Latin America. The consortium first came together as a Global Challenges Research Fund (GCRF) cluster known as 'Antibiotic stewardship in agricultural communities in Africa and Asia: A unified One Health strategy to optimize antibiotic use in animals and humans (AgriAMU)' (see Table 2).

To comprehensively understand and address the multifaceted aspects of antibiotic prescription, dispensing, and usage at the community level in various global settings, the researchers conducted a series of internal international workshops to synthesize the ongoing work conducted by cluster partners. These workshops aimed to tackle the diverse factors related to health systems, policy environments, as well as social, cultural, and economic considerations that influence antibiotic practices in agricultural communities.

Table 2: Initial projects involved in the collaborative GCRF-funded AgriAMU cluster.

Active GCRF-funded Projects	Location
Understanding health system linkages: Formative research to develop strategies to support quality improvement in treatment in the private sector	Uganda
A multi-stakeholder approach to operationalising antibiotic stewardship in India's pluralistic rural health system	India
Supporting National Action Plan for Antimicrobial resistance (SNAP-AMR) in Tanzania	Tanzania
GCRF One Health Poultry Hub	Bangladesh, India, Sri Lanka, Vietnam
Previous GCRF-funded projects and other partners	Location
Social behavioural and economic drivers of inappropriate antibiotic use by informal private health care providers in rural India	India
How do policymaker perceptions of antimicrobial resistance drive behaviour and policies for appropriate antimicrobial use? A case study of Pakistan	Pakistan
Monitoring antibiotic stewardship in livestock and poultry production systems in Colombia	Colombia

The research group identified a comprehensive set of drivers that encompassed both immediate and broader factors, that exhibited both similarities and differences across the different settings. Economic and infrastructural challenges faced by rural and peri-urban populations, affecting the health of both humans and livestock, were identified as prominent challenges. Additionally, the absence of a supportive environment for frontline private sector providers responsible for first contact healthcare and antibiotic provision, the involvement of multiple stakeholders with vested commercial interests throughout the value chain, and the lack of effective regulations were recognized as contributing factors. To address these complex issues comprehensively, the GCRF antibiotic group emphasized the necessity for multi-level, multi-component One Health interventions to enhance stewardship in these community settings.

The present workshop was conceived of as a platform to explore the design, implementation, and evaluation of such complex and holistic interventions, facilitating

knowledge exchange among experts from LSHTM's AMR Centre and the Centre for Evaluation, and guiding future research endeavours in this area.

Workshop objectives

- To facilitate cross-disciplinary learning and exchange of knowledge amongst GCRF research partners and members of LSHTM's AMR and Evaluation Centres, across the different dimensions of One Health, AMR and complex intervention design and evaluation.
- Learn from case studies of complex intervention design and evaluation and apply these to an antibiotic stewardship framework for low resource community settings.

3. Participants



The workshop brought together multidisciplinary researchers from the GCRF cluster and from LSHTM's AMR Centre and Centre for Evaluation. There was a range of expertise across different types of impact and process evaluation designs, along with representation from different faculties and departments within LSHTM. The disciplinary expertise ranged from epidemiology to microbiology and modelling, public health policy to veterinary and social sciences, health economics to implementation science.

External participants represented Makerere University, Uganda; Public Health Foundation of India; Kilimanjaro Christian Medical Centre, Tanzania; Universidad Antonio Narenas, Colombia; the Royal Veterinary College, UK; Institute of Development Studies, UK; University College London, UK; and the World Organisation for Animal Health, France. (See Annexure 1: List of Participants)

4. Method

This was a hybrid workshop with primarily in-person attendance but with the provision of virtual participation in some sessions. It was conducted over 2 days and included a series of presentations covering different types of intervention design approaches and evaluation techniques (Day 1), along with investigating the implementation science of interventions (Day 2). These presentations were interspersed with breakout discussions to generate ideas for designing and evaluating holistic One Health interventions.

5. Presentations and Discussions

The workshop was inaugurated by Professor Sian Clarke and Dr. Meenakshi Gautham, Co-PIs of the GCRF cluster, and Dr. Mitzy Gafos, Co-Director of the Centre for Evaluation.

Session 1: Designing and evaluating complex interventions to address One Health and AMR.

Title: “One Health and Antibiotic Stewardship in Community Settings: Towards a Holistic Framework for Behaviour Change”

Presenter: **Meenakshi Gautham, Assistant Professor in Health Systems and Policy, and Head of the AMR Centre’s Economic, Social and Political Sciences Pillar.**

In this presentation, Meenakshi discussed the different antibiotic use practices in the community and touched on the challenges that should be addressed at the community, provider, health system, and policy levels. She described the five essential components of One Health community antibiotic stewardship programme. These include infection prevention, control and improved biosecurity; an enabling environment for providers, enabling environment and financial protection for communities; products and markets; and partnerships. She also highlighted six strong recommendations for interventions based on several consultations with multiple stakeholders in India. These include antibiotic guideline development for community-based para-professional health workers for humans and livestock (especially those in the private sector), strengthening mentorship and referral links between the informal and formal providers, education and prescription audits for primary care physicians, AMR surveillance at the community level, and a self-regulatory code of conduct for evidence-based marketing of antibiotics for pharmaceutical actors all along the antibiotic supply chain. The multi-faceted, multi-level nature of OH interventions make them inherently complex, requiring novel intervention design and evaluation techniques.

1.1 Intervention design and evaluation approaches

Title: “Modelling frameworks for One Health”

Presenter: **Gwen Knight, Associate Professor, and AMR centre Co-Director at LSHTM.**

Gwen discussed modelling frameworks for One Health interventions in AMR, highlighting the different contributions of the human, animal, and environment sectors to AMR. She presented the step-by-step modelling approach in her [SEFASI project](#) to model and rank farm level One Health AMR interventions in Denmark, England, and Senegal using the Agriculture Human health Micro-Economic (AHHME) tool. She emphasised the importance of considering different stakeholders within the system in intervention prioritisation and the importance of modelling to improve fragmented data availability for humans and animals.

Title: “Use and abuse of cluster randomised and stepped wedge trials in global public health”

Presenter: **Audrey Prost, Professor of Global Health at University College London.**

Audrey discussed the role of Randomised Controlled Trials (RCT) and Stepped Wedge Trials (SWT) in evaluating complex interventions. She described the main differences between RCTs and SWTs to compare and evaluate interventions. She highlighted that recent work suggests RCTs are not in and of themselves guarantors or internal validity

or say much about external validity; understanding external validity requires complementary work beyond an RCT. She suggested that SWTs can be used when governments and/or evaluators wish for the intervention to be offered to all study participants, but power and analytical requirements are different to RCTs. She also advised the use of SWTs in One Health interventions if the evaluator can actually control the phasing of the interventions in a systematic manner.

Title: “A complex systems approach to evaluation and its application to an alcohol intervention”

Presenter: **Elizabeth McGill, Assistant Professor in Public Health Evaluation at LSHTM.**

Elizabeth illustrated the use of complex systems approaches to the evaluation of public health interventions. In her presentation, Elizabeth introduced key concepts in complex systems thinking and described how using a systems-informed lens might produce better evidence for decision making. She then introduced four broad categories of complex systems methods and mapped them onto five stages of an evaluation (theorising; prediction; process evaluation; impact evaluation; further prediction). She then focussed on process evaluation from a complex systems perspective, introducing a two-phase framework to guide process evaluations with a complex systems perspective. In the first phase of an evaluation using this framework, the researchers develop an understanding of the system into which the intervention is introduced, generating an understanding of the system boundaries, the elements that constitute the system and how they relate to each other. The evaluation team then generates a series of hypotheses about how the intervention may generate change within the system, guided by views of stakeholders from across the system. In the second phase, the evaluators follow these hypotheses to analyse the system as it undergoes change. Elizabeth concluded by illustrating the use of the framework in the evaluation of a local alcohol intervention in the UK.

Title: “Introduction to Process Evaluations with Example from Zimbabwe”

Presenter: **Joanna Busza, Associate Professor in Sexual & Reproductive Health at LSHTM.**

Joanna presented on process evaluation with an example of a HIV project in Zimbabwe. She described the key domains measured in process evaluations including fidelity, acceptability, quality, feasibility, transferability, and scalability. Joanna described a process evaluation conducted within an RCT testing an intervention to reduce treatment failure among children with HIV in Zimbabwe. She highlighted that process evaluation study design should be defined before implementation and should include mixed methods comprising both qualitative and quantitative tools. Process evaluations help understand how and why an intervention did/did not work to produce intended outcomes, i.e. whether it was poorly implemented or whether its underlying logic had weaknesses. The findings can also help guide transfer of an intervention to new settings and inform adaptations for different contexts.

Title: “Mass drug administration of antibiotics to try and eliminate trachoma limitations of stepped wedge trials”

Presenter: **Jenny Thompson, Assistant Professor at LSHTM.**

Jenny's presentation highlighted the importance of selecting an evaluation design that aligned with the intervention objectives, research questions, and outcomes. Her

presentation focused on comparing a cluster randomized controlled trial with a stepped wedge design through a case study on trachoma prevention in children under nine years. The case study involved the administration of an additional dose of azithromycin one month after standard mass drug administration (MDA) for three years.

To ensure a trial's alignment with the intervention and its research questions, a parallel cluster randomized trial could be used to assess the intervention effect. In contrast, a stepped wedge trial may require switching clusters from the control to the intervention condition over time. In the trachoma case study, a cluster randomized trial was more appropriate because the trial intervention involved district geographical areas as clusters (MDA at cluster level), and both the control and intervention were cluster-level interventions. Additionally, the trial's intervention had an indirect effect on the whole community, which would benefit from a lower infection rate.

Data collection and analysis in the case study involved comparing the control and intervention conditions at yearly intervals before the next dose of MDA. The policymakers were primarily interested in the three-year effect of the intervention, and the trial design was developed to meet this objective. The study's outcomes were compared through a parallel cRCT, where some clusters received standard MDA for three years, while others received standard and child MDA for three years, followed by an end-line survey.

She explained that using an SW-CRT would be complex as collecting data on the intervention's effect within each cluster switching period was not feasible for determining the 3-year effect. They then considered an SW trial where clusters switch yearly, but this did not yield promising data. Thus, they concluded that a parallel cluster randomized trial was more suitable for determining the three-year effect of the child MDA intervention in the trachoma case study. It was also noted that the trial design should be based on the research question, and different intervention effects may require different trial designs. A SW trial design may have been more appropriate if a yearly effect was needed to be estimated.

Title: “Can Participation and Accountability Improve Outcomes? Findings from Realist-Informed Systematic Review”

Presenter: Hugh Sharma Waddington, Assistant Professor at LSHTM.

Hugh's presentation focused on the accountability of public services through a realist-informed systematic review. The review aimed to synthesize evidence on comparative effectiveness of different interventions that aimed to promote citizen engagement in public services governance. The study's main objective was to test different mechanisms within the broader framework of interventions designed with a bottom-up approach through citizen engagement.

The study focused on four citizen engagement mechanisms: participation, inclusion, transparency and accountability, collectively called PITA. The study evaluated various interventions to encourage citizen participation, including participatory planning and community-based natural resource management (CBNRM). It also evaluated citizen feedback and monitoring interventions, such as social audits. Finally, interventions providing information about rights or performance (e.g. scorecards) were included under transparency.

Hugh explained about realist synthesis, also known as context-mechanism-outcome configuration synthesis, which is the principal behind realist evaluation. The study combined meta-analysis of outcomes with realist synthesis in two ways: using causal pathways with individual meta-analysis and coding information from sibling studies (studies of an eligible intervention that did not otherwise meet the inclusion criteria to examine effects) to develop and test theories using meta-regression analysis.

The review included studies from several sectors of LMICs except education, which had already been reviewed. The study highlighted the outcomes, along with causal pathways, which include immediate outcomes, intermediate outcomes, and final outcomes.

The review's results showed that the bottom-up approach through citizen engagement had a positive impact on improving service access where citizens received services directly from frontline providers or were grouped (via a local CSO or citizen support group) to help redress the power balance between the service providers. But where services were not delivered by frontline providers, there were no effects on desired outcomes. The implications of this study are to utilize causal pathways for specific interventions and conduct evidence synthesis that includes a broader program and tests broader mechanisms.

1.2 AMR studies and frameworks

Title: “Using participatory systems mapping to identify hotspots for AMR interventions in aquaculture”

Presenter: **Dr Lucy Brunton, Lecturer in Molecular Biology at the Royal Veterinary College.**

Lucy presented participatory systems mapping as a tool for research in aquaculture settings. She described the AMFORA project, which applied multidisciplinary systems-based research to evaluate interventions to reduce antimicrobial use in aquaculture systems in Vietnam, Egypt, and Bangladesh. Her work, along with her colleagues, identified the many points that interventions can enter the aquaculture system, with legislative and regulatory frameworks (such as National Action Plans) being the most common intervention type. Most interventions were relevant to AMR but not necessarily specific to AMR as they instead focused on improving aquaculture health more broadly, and this is reflected by the multiple dynamics that contribute to rising antimicrobial use and AMR in agriculture. Finally, she concluded that systems-thinking and participatory approaches helped improve engagement with and ownership of interventions, proving to be important approaches to determine how and where an intervention should be implemented, as well as gain stakeholder acceptance.

Title: “Design and evaluation of a smart phone based clinical decision support tool to improve antibiotic guideline adherence, rehydration and surveillance of diarrhoeal diseases in Bangladesh”

Presenter: **Dr Farhana Haque, Assistant Professor at LSHTM.**

Farhana gave a presentation about her project that aimed to determine if smart phone apps could be used to automate clinical guidelines and syndromic reporting to improve antibiotic guideline adherence, rehydration, and surveillance of diarrhoeal diseases in Bangladesh. Her team developed the app over 2 years with hospitals and the national public health institute. The pilot showed that the tool was well received by

medical staff, with the surveillance data allowing real-time reporting and the rehydration calculator being accurate, resulting in improved guideline adherence. There were some operational challenges (such as lack of internet access at times) and further research is being conducted including a cluster RCT and rapid ethnography to identify barriers.

Title: “Rethinking AMR policy analysis to improve One Health intervention development and measurement.”

Presenter: **Lorna Benton, Research Fellow at LSHTM.**

Lorna discussed her analysis of AMR in the food system. She conducted elite stakeholder interviews, analysed UN member state National Pathways for Food Systems Transformation and conducted a content analysis of 70 National Action Plans on AMR to identify relevant environmental, economic, social and health food system policies, as well as the co-benefits and trade-offs of existing policy responses to the global challenge of AMR. She found that AMR is rarely mentioned in the UN Food System National Pathway submissions, and that AMR National Action Plans prioritise health policies but often overlooks policy connections with other dimensions of the food system, specifically environmental, social and trade domains. More could be done to leverage co-benefits and to mitigate policy trade-offs between domains, and within animal health.

Title: “A Health Policy Analysis on containment of Antimicrobial Resistance (AMR) in India: Antimicrobial Stewardship is a pivotal intervention in tackling AMR: A mixed methods study”

Presenter: **Chetan Singh, recent MSc student from LSHTM.**

Chetan presented an analysis of antimicrobial stewardship program implementation in India. His literature review and interviews with government officials identified that the main interventions in hospital settings include education & training, prospective audit & feedback, infection prevention and control (IPC), clinical guidelines, and microbiological testing. These interventions come with numerous challenges with implementation, including high competition among medical professionals, inadequate infrastructure, inadequate skills and knowledge of some tools, high workloads, lack of funding, absence of champions, lack of regulations and enforcement. However, there were many opportunities for improvement which could help stewardship programmes succeed, the main ones being to ensure audits are conducted, upgrading clinical microbiology labs, continuing education and training, and recruiting clinical pharmacy specialist personnel.

Session 2: Investigating Implementation

Title: “Investigating implementation”

Presenter: **Catherine Goodman, Professor in Health Economics and Policy at LSHTM.**

Catherine presented and discussed the importance of investigating implementation and the various tools and frameworks available to evaluate the process of implementation. She summarised four main steps in investigating implementation: these were describing the intervention planning, assessing the degree to which the intervention was implemented as planned, investigating why the intervention was implemented in that way, and investigating how and why this implementation has affected intermediate and final outcomes. Catherine also described several different tools and frameworks used to evaluate these steps. She highlighted the need to delineate tasks keeping in mind who should be doing what to whom, where, when, and how often.

Title: “Promoting access and rational use of antibiotics for children (PARAC) Implementation Research.”

Presenter: **Professor Debra Jackson, Takeda Chair in Global Child Health at LSHTM.**

Debra shared in-depth insights about implementation research from a programmatic perspective. Her presentation focused on a detailed case study of a multi-country research initiative led by UNICEF, and funded by the Wellcome Trust, that sought to increase access and optimise the use of antibiotics for children. Countries participating in this cross-country initiative included South Africa, Tanzania, China, Cambodia and Vietnam. The specific research areas were decided by in-country implementation teams and research participants included prescribers, dispensers and patients from diverse settings such as teaching hospitals in South Africa, district hospitals in Vietnam, primary care centres in China and accredited drug dispensing outlets (ADDOs) in Tanzania. The research questions varied by country context but were commonly driven by a focus on the acceptability and appropriateness of research, its feasibility, cost and sustainability, and adoption fidelity. By sharing the processes and lessons of this research in progress, Debra’s presentation highlighted the key characteristics of implementation research studies: it needs to be context specific, relevant and demand driven, it needs fit for purpose methods, and the participation of multiple stakeholders, it should happen in real time and in real world conditions and be embedded in programmes and preferably led by implementors.

6. Implications and recommendations for OH interventions

- Interventions for a One Health approach to AMR can take many forms. Historically, these have often targeted a particular sector (e.g. human health, animal health, or the environment), but there is increasing momentum to create genuine One Health approaches through multisectoral collaborations and through the implementation of AMR National Action Plans.
- In the design, implementation and evaluation of an intervention (or collection of interventions), it is important that stakeholders from different sectors and levels of the system are involved to increase ownership of the intervention and understanding of AMR. Involving the government can help improve the sustainability of interventions.
- The use of systems mapping tools can help identify stakeholders to bring to one table.
- Interventions can either be AMR specific or AMR sensitive, meaning they can aim to directly impact AMR (e.g. decision support tools for antibiotic prescribing) or they can target the health of humans, animals and the environment more broadly where AMR will be one of the co-beneficiaries (e.g. improved infection prevention control).
- Maintaining a systems framework for Universal Health Coverage can be useful to conceptualise and address the many factors that lead to AMR.
- The application of modelling can improve fragmented human and animal surveillance data and help with prioritisation of interventions.
- Intended as well as non-intended consequences need to be anticipated when designing some interventions, such as those targeting antibiotic use.
- Defining the research questions is critical before starting an intervention.
- For interventions such as reduction in antibiotic use, it would be ethically pertinent for the implementors to demonstrate holistically how reductions can improve people/farmers and animals’ health, not just reduce antibiotic use.

- Interventions that directly influence the point of prescribing should be tailored to that specific setting (e.g. hospital-based tools need to be context-specific depending on the needs and limitations of that geographic area).
- Other interventions that sit upstream of the point of prescribing are an opportunity to demonstrate a One Health approach, for example through multisectoral legislation, and through approaches to raise awareness or educating stakeholders.
- Evaluations can also take a One Health approach, extending beyond an assessment of the impacts of a single intervention and considering a complex systems approach to widen the evaluation design.
- A process evaluation requires the process being adaptive and flexible, and responsive to the evaluation results.
- SWTs can be useful in One Health interventions if the implementation includes controlling the phasing of the intervention in a systematic manner.
- Keeping in mind implementation investigation frameworks can be useful even while designing an intervention.

7. Annex 1: Participant list

Participant	Affiliation
Meenakshi Gautham	Global Health and Development, PHP, LSHTM
Sian Clarke	Disease Control, ITD, LSHTM
Mitzy Gafos	Global Health and Development, PHP, LSHTM
Jessica Myers	Global Health and Development, PHP, LSHTM
Freddy Kitutu	Pharmacy Department, School of Public Health, Makerere University, Uganda
Tiziana Lembo	School of Biodiversity, One Health and Veterinary Medicine, University of Glasgow
Fortunata Nasuwa	Kilimanjaro Christian Medical Centre, Tanzania
Nelson Arenas	Universidad Antonio Nariño, Colombia
Priya Balasubraminiam	Public Health Foundation of India
Chetan Singh	M.Sc. student, LSHTM
Rebecca Knowles	Health Services Research and Policy, PHP, LSHTM
Audrey Prost	Institute for Global Health, University College London
Dana Itani	Infection Biology, ITD, LSHTM
Matthew Hennessey	Pathobiology and Population Sciences, RVC, UK
Pablo Alarcon	Pathobiology and Population Sciences, RVC, UK
Gerald Bloom	Institute of Development Studies, Brighton, UK
Syed Abbas	Institute of Development Studies, Brighton, UK
Harparkash Kaur	Infectious and Tropical Diseases, LSHTM
Elizabeth McGill	Public Health and Policy, LSHTM
Farhana Haque	Infectious Disease Epidemiology, EPH, LSHTM
Gwen Knight	Infectious Disease Epidemiology, EPH, LSHTM

Jenny Thompson	Infectious Disease Epidemiology, EPH, LSHTM
Hugh Waddington	Disease Control, ITD, LSHTM
Joanna Busza	Public Health Environments and Society, PHP, LSHTM
Lucy Brunton	Pathobiology and Population Sciences, RVC
Lorna Benton	Global Health and Development, PHP, LSHTM
Debra Jackson	EPH, LSHTM
Catherine Goodman	Global Health and Development, PHP, LSHTM
Virginia Castellano	Public Health and Policy, LSHTM
Shunmay Yeung	Clinical Research, ITD, LSHTM
Kathrine Gallagher	Infectious Disease Epidemiology, EPH, LSHTM
Isatou Sarr	MRC Gambia
Holy Teneg Akwar	World Organisation for Animal Health, Paris, France
Robert Aunger	Disease Control, ITD, LSHTM
Giulia Scarpa	Infectious and Tropical Diseases, DCD, LSHTM
Saffie Darboe	MRC Gambia
Camille Maringe	Non-Communicable Disease Epidemiology, EPH, LSHTM
Aye Myat Thi	Innovations for Poverty Action, Myanmar
Jone Gracia Lurgain	Public Health Environments and Society, PHP, LSHTM
Miriam Abdulla	Global Health and Development, PHP, LSHTM
Ojonugwa Temitope Abubakar	Infectious and Tropical Diseases, DCD, LSHTM
Siddharuda Shivalli	Medical Statistics, EPH, LSHTM
Maria Bernardez Agrafojo	Disease Control, ITD, LSHTM
Emily Marshall	Professional Support Services, LSHTM