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# Evaluating the National Action Plan (NAP) on antimicrobial resistance, and recommendations for the next 5-year NAP: a roundtable discussion

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## Abstract

The UK's current 5-year National Action Plan (NAP) on tackling antimicrobial resistance (AMR), which runs from 2019 to 2024, is coming to an end. As such, the next 5-year NAP is currently under development, and progress made towards the UK's commitments on AMR is being analysed. This analysis has involved the publication of an addendum to the current NAP, which includes some new and revised commitments. Applied Microbiology International (AMI) held a roundtable discussion in November 2022, inviting UK experts from across the human and animal sectors to discuss their thoughts on progress to date, as well as any recommendations and key considerations they thought should be taken forward. Overall, it was agreed that there is a major disparity between the increasing ambitions of the NAP, and the reducing financial support for achieving said ambitions. The gap between evidence generation and implementing recommendations into real-world settings also presents a key challenge to overcome, if the NAPs commitments are to be achieved. A lack of communication and funding appear to underpin many of the barriers that prevent the successful delivery of current NAP commitments and are therefore highlighted as key areas of concern for policymakers to consider when looking to tackle AMR. The focus should be on successfully implementing and delivering the current NAP commitments ahead of identifying future ambitions.

**Sustainability statement:** The impact of antimicrobial resistance affects all sectors across the One Health spectrum, including human and animal health, the environment, and food security. As such, the concerns and recommendations recorded here on the UK's progress towards the current UK's 5-year National Action Plan (NAP), voiced by the human and animal experts who participated in the roundtable, are vital for informing next steps, including the development of the next 5-year NAP. These concerns and recommendations are based on real-world experience and evidence, which can be used to inform decision-making and therefore make progress towards several of the UN sustainable development goals (SDGs). These include UN SDG two (zero hunger), three (good health and well-being), six (clean water and sanitation), fourteen (life below water), and fifteen (life on land).

**Keywords:** antimicrobial resistance, veterinary, public health microbiology, environmental microbiology, AMR

## Introduction

Antimicrobial resistance (AMR) refers to the evolution of microbial organisms in response to the use of antimicrobial therapeutics, whereby they no longer respond to therapeutics (also known as 'become resistant') and consequently make infections more difficult to treat [WHO, https://www.who.int/health-topics/antimicrobial-resistance (accessed 7 February 2023)]. This can ultimately lead to an increase in mortality when no effective therapeutics remain. Often AMR focuses on bacteria and their increasing resistance to antibiotics, but it does also apply to other organisms such as viruses and fungi. Although this evolution of microbes occurs naturally, it is vastly sped up by human actions, including the appropriate use, overuse, and inappropriate use of antimicrobial therapeutics. This issue is now recognized worldwide, and as such both a global action plan [WHO, https://www.who.int/publications/i/item/9789241509763 (accessed 7 February 2023)], as well as National Action Plans (NAPs) have been

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devised to try and preserve the efficacy of current antimicrobial treatments as well as to reduce the need for them.

The UK's current 5-year NAP covers the period of 2019–2024 and was developed to support the UK's 20-year vision for AMR, which sets out how the UK plans to work towards containing and controlling AMR by 2040 [Department of Health and Social Care, https://www.gov.uk/government/publications/uk-20-year-vision-for-antimicrobial-resistance (accessed 11 January 2023)]. An addendum to the current NAP was recently published, highlighting some changes that have been made to the commitments within the plan; these are based on lessons learnt during the NAP's progression, and from the COVID-19 pandemic [Department of Health and Social Care, https://www.gov.uk/government/publications/addendum-to-the-uk-5-year-action-plan-for-antimicrobial-resistance-2019-to-2024 (accessed 11 January 2023)]. Evidence is currently being gathered to inform the development of the next NAP, which will run from 2024 to 2029 [Department of Health and Social Care, https://www.gov.uk/government/consultations/antimicrobial-resistance-national-action-plan-call-for-evidence/antimicrobial-resistance-national-action-plan-call-for-evidence#:~:text=20%20January%202023.-,Next%20steps,in%2Ddepth%20engagement%20with%20stakeholders (accessed 11 January 2023)].

Applied Microbiology International (AMI) is working to solve some of the world's greatest challenges by bringing the applied microbiology community together, across borders and disciplines, to enable meaningful collaboration that delivers scientific impact. With a strong focus on influencing international policy, AMI is organized around seven core UN Sustainable Development Goals and encourages partnership between academia and industry to increase impact.

In November 2022, AMI organized an independent roundtable discussion, inviting UK experts from across the human and animal health sectors to discuss the recently published addendum to the NAP and the new and revised commitments it contains. AMI selected specific commitments for the roundtable discussion, based on three broad themes from the NAP: human health, animal health, and environmental health. Discussion points were formulated in response to the published amendments (see boxes) to steer the conversation. This summary highlights the key outcomes that emerged from the roundtable, including recommendations to take forward.

Theme 1: Human health (HH)
**NAP published amendments (HH)**:

- **New commitment**: conduct research on barriers and enablers to embedding fundamental infection, prevention, and control (IPC) principles within healthcare practice.
- **Revised commitment**: work with educators and local authorities to provide tools and resources to all school leavers to support their understanding of how to prevent infections, including hand hygiene, and use antimicrobials appropriately and ensure that those messages are shared in all communities.
- **Revised commitment**: support research to understand how to change behaviours for improved hygiene. Identifying which health behaviours resulting from COVID-19 have had positive benefits, and understanding how these can sustainably be implemented into practice.

The roundtable was chaired by Dr Adam Roberts, Reader in antimicrobial chemotherapy and resistance, and AMR lead, at the Liverpool School of Tropical Medicine.

## Roundtable discussion point 1.1: What barriers have we observed to implementing IPC principles and how can we mitigate these?

The main barrier to implementing IPC principles identified was the general lack of awareness of IPC, resulting from a lack of relevant education and training. This barrier was not limited to one population, but noted across all sectors and communities, including the general public, scientists, clinicians, and senior policy makers.

Several other barriers identified related to IPC research and research outputs, for example the difficulty of undertaking large-scale IPC clinical trials. Ethically, IPC practices cannot be reduced or removed for comparison with increased IPC practices. This can lead to low-value research outputs, which are not taken seriously due to their small scale and lack of replicability. Additionally, for the evidence that is available, there is a strong lack of implementation, which likely derives from a lack of communication between those producing the outputs (researchers) and those who would implement them into practice (healthcare professionals). There appears to be no 'middle-ground' for facilitating the transmission of this information, highlighting the need for enhanced interdisciplinary communication. Access to these outputs is a further barrier to implementation; the lack of a simple, easy to access repository for research outputs reduces the ability to monitor recent developments in the area. A more efficient and productive science-policy interface would help reduce these issues. The negative perception towards publishing 'bad' IPC research results (due to a fear of negative regulatory consequences) has also resulted in a lack of useful real-world examples being shared, limiting the opportunity for 'lessons learned' outputs.

It was agreed that all of these barriers are compounded by the overarching barrier of funding, or lack thereof. The lack of available funding is an overarching theme emerging from the roundtable discussion, acting as the main barrier to progression for achieving the NAP's commitments.

Several recommendations were made on how to overcome these barriers:

- development of a single, easy-to-access repository for IPC and AMR related research outputs and developments, similar to that used during the pandemic for COVID-19-related developments;
- a stronger focus on campaign studies and how to engage positively with target audiences, to help increase awareness on the importance of IPC, in particular reducing the autocratic nature of public health campaigns and instead moving towards a more bidirectional, conversational approach;
- promoting and enabling interdisciplinary thinking across sectors, to facilitate communication and the flow of information from source to implementation.

## Roundtable discussion point 1.2: Are school-aged children being educated sufficiently on IPC principles and appropriate use of antibiotics?

There was consensus that there are some effective initiatives in place promoting IPC to school-age children. For example, the 'Antibiotic guardian school ambassadors project'—developed by the UK Health Security Agency (UKHSA) and Boots pharmacy as part of the 'Antibiotic Guardians' campaign [UK Health Security Agency, https://antibioticguardian.com/ (accessed February 15 2023)]—involves various healthcare professionals (including trainee pharmacists) visiting schools and community settings to educate young people on IPC and AMR principles (Miah et al. 2022). However, despite these positive initiatives, there was also consensus that IPC, AMR, and One Health concepts are generally lacking from school curriculums and should be better incorporated for all age groups.

Recommendations made are as follows:

- The potential for further IPC and AMR related initiatives involving pharmacists should be explored, since pharmacists are well trained on IPC and AMR and well placed across all communities, with a wide audience reach.
- IPC, AMR, and One Health principles should be included in school curriculums at all ages to increase general awareness.

**NAP published amendments (HH):**

- **New commitment:** conduct research on the potential impact of non-pharmaceutical methods (interventions and behaviours) to prevent common syndromes of infection, including hydration, increased mobility, and hygiene practices.
- **Revised commitment:** research potential interventions for control measures and behaviour change initiatives (including their economic impacts) and test impact, acceptability, and feasibility within real-world settings.

## Roundtable discussion point 1.3: How has COVID-19 altered the way we think about IPC, what related behaviour changes have been helpful and harmful, and how can the former be sustainably implemented into practice?

Although the COVID-19 pandemic has brought IPC to the forefront of people's minds, the usefulness of this was debated. It was agreed that this newfound awareness presents an opportunity to further push the importance of IPC education and training, in particular to promote training for those directly working in clinical environments (e.g. hospital workers), since IPC and AMR training is often lacking. However, it was also noted that regardless of increased awareness, the general view towards IPC and IPC-related principles post-pandemic is now very negative, presenting a barrier to capitalizing on it.

Negativity towards IPC among the general public is likely due to strict enforcement of IPC behaviours, and in healthcare professionals through the confusion generated by constantly changing guidance during the pandemic. This has not only led to a loss of trust regarding IPC guidance and principles, but also inappropriate antibiotic use, which is a key contributor to the development of AMR.

Although not directly related to discussion points 1.1–1.3, several wider comments were raised regarding the specific HH commitments evaluated. Funding was again raised as a barrier to conducting any IPC-related research, with the attitudes and allocation of funds by funding institutions highlighted as a particular risk to meeting NAP commitments. Additionally, the impact of the 'built environment' was discussed, in particular the lack of awareness and consideration for IPC in 'built environment' policy and guidance. Built environment policy frameworks do not allow for the nuance needed when implementing IPC guidance into different healthcare settings and as such it was agreed that a more flexible approach is needed within healthcare policy-making.

Recommendations made are as follows:

- investigate capitalizing on the newfound awareness of IPC, to try and increase education and training opportunities, in particular for healthcare workers;
- re-build general population and clinician trust in IPC guidance through education and training, to reduce the negative connotations associated with IPC that have developed during the pandemic, which will help promote positive behaviour change;
- apply pressure to funding institutions to ensure sufficient funds are allocated to research on non-pharmaceutical preventative measures, emphasizing that this will enable continuation towards the commitments within the NAP;
- make policy-makers aware that more flexibility is needed when implementing guidance into different healthcare settings because there is no 'one size fits all' within healthcare.

**NAP published amendments (HH):**

- **New commitment:** enhance the prevention of urinary tract infections (UTIs), the early, accurate diagnosis of UTIs and the treatment of suspected and confirmed UTIs, including the prescribing and use of antibiotics and therapeutics in older people, both in their own homes and in care homes, by developing mechanisms to support implementation or adoption and spread of optimal practice and potentially beneficial interventions.

## Roundtable discussion point 1.4: UTIs are a common pathway to Gram-negative bloodstream infections but does the increased focus on this route to these bloodstream infections mean that focus on other routes to infection will be reduced or enhanced?

Although the importance of tackling UTIs was recognized, this commitment was considered as tackling 'low-hanging fruit', implying an ignorance towards more significant infection routes. This was attributed to the NAP potentially having too much of a UK-centric view towards AMR, which was acknowledged as a global issue. An example of a more significant threat was *Acinetobacter baumannii*, which in

China causes four times more bloodstream infections than *Escherichia coli* and *Klebsiella pneumoniae* combined but does not cause UTIs. It was agreed that having a global view is key to maintaining an awareness of future national risks, to enable preparedness and mitigation. The commitment was also said to ignore health inequalities within the UTI patient population.

Recommendations made are as follows:

- A more global perspective is needed when considering the current and future NAP, to ensure global risks are not ignored or missed.
- Although UTIs are an important infection to tackle, it is worth considering for the next NAP whether this specific commitment removes focus from other, potentially more significant infections.
- An important focus for future research should be on health inequalities within AMR.

**NAP published amendments (HH)**:

- **New commitment**: derive, validate, and test implementation of clinical prediction rules to reduce diagnostic uncertainty, identify patients with self-limiting infections who are unlikely to benefit from antibiotics, and patients at risk of infections resistant to first-line treatments who are likely to benefit from broad-spectrum antibiotics.
- **Commitment merged**: work with global partners to develop evidence for and evaluate guideline-based antibiotic management of common infections and syndromes.

## Roundtable discussion point 1.5: How can we improve clinical confidence in diagnostic testing? Do we need to reduce the dependence we have on clinicians' judgement for treatment and instead rely on prediction models and data to inform decisions?

Improving clinician confidence in negative diagnostic results was highlighted as a potential focus point for helping improve the efficiency of discharging patients, which would alleviate the burden on clinical systems. To increase confidence in diagnostic results, it was widely suggested that there needs to be a shift in perspective, where diagnosis is recognized as a larger concept than just the result of a diagnostic test. It was acknowledged that diagnostic tests lack the essential contextual information, which high-quality, local epidemiological data would provide. Therefore, high-quality, local epidemiological data should be better incorporated into the process of diagnosis, to help inform the narrative of any diagnostic results, rather than relying on test results alone.

A key barrier identified to achieving this 'narrative-led' reporting was that high-quality, local epidemiological data is often not collected, and in instances where it is collected, is often low quality and/or not used effectively. As such, this would need addressing in order for clinician confidence in diagnostic testing to be improved.

Two recommendations were made:

- An electronic record standard and universal coding would greatly help improve the quality of local epidemiological data, which could then be used to provide context to diagnostic results.
- An ISO standard for microbiology laboratories that supply home testing kits to patients could help increase confidence in test results.

**NAP published amendments (HH)**:

- **Commitment merged**: work with global partners, including the Tripartite Plus, to promote, strengthen, and integrate AMR and antimicrobial usage surveillance on common or emerging threats through a One Health approach, including through the establishment of an AMR One Health UK Reference Centre, to better harmonize and integrate data on common or emerging threats across human, animal, food, and environment sectors internationally.
- **Commitment retained**: develop a single UK portal as a source of data and information on AMR.
- **Commitment retained**: continue to support improvement and surveillance programmes to reduce the risk of transmission of resistance by adopting a systematic approach to preventing infections.

## Roundtable discussion point 1.6: What would the portal and reference centres look like and how could they be used? What data should be included and maintained to ensure the centre has a One Health approach?

The usefulness of a One Health reference centre was debated. The argument for having a One Health centre was based on the benefit of bringing together expertise across sectors (human, animal, environment, and food) and the globe to have a more holistic, joined-up approach to tackling AMR. Not having a One Health reference centre risks an overly nationalistic focus within countries, reducing the regional responsibility involved in controlling and containing AMR on a global scale. It was also noted that there is currently a lack of opportunity for cross-sectoral collaboration; a problem that a One Health reference centre would circumvent. Differences in surveillance methodologies used across sectors represents a barrier to developing a joined-up approach. Comparative datasets would need developing to allow cross-sectoral comparison and therefore conversations around harmonizing methodologies would be necessary for facilitating a One Health reference centre.

The argument against a One Health reference centre was that a joint centre does not take into account the large differences in priority species and resistances between the human, animal, and environmental sectors. However, it was acknowledged that there is some significant overlap across sectors, for example, zoonotic organisms that can transmit between humans and animals.

Recommendations made are as follows:

- When developing a One Health reference centre, caution is needed to ensure that sectors can still make progress on combatting AMR that is specifically an issue within their sector, as well as ensuring join-up with other sectors to combat more cross-sectoral AMR issues.

- The feasibility of harmonizing methodologies across sectors should be explored, to facilitate data comparison and surveillance across the One Health spectrum.

Theme 2: Animal health (AH)
**NAP published amendments (AH)**:

- **Revised commitment**: improve the accuracy, availability, and coverage of antibiotic use data across the UK in the main livestock sectors. This will include working collaboratively across UK government administrations, the veterinary profession, and agriculture industry to implement sector targets by the end of 2024.
- **Revised commitment**: work with industry and the veterinary profession to improve our understanding of available disease data. Consider how to expand this and share at farm, regional and species level as well as nationally. Use in tandem each country's multispecies databases to improve disease surveillance and reduce antibiotic use.
- **Revised commitment**: work collaboratively across UK government administrations, the veterinary profession and professional bodies to encourage best practices for infection control and address infection risks in companion animals (pets) and horses.

## Roundtable discussion points 2.1: How can we ensure greater coherence in the governance of animal health to enable all stakeholders—e.g. government administrations, the veterinary profession, and agriculture industry, including farmers—to contribute more effectively towards reducing antibiotic use and promoting animal welfare? How can we promote the importance of farm management and husbandry practices as a means of IPC?

It was recognized that the animal health sector already has good coherence in the governance of animal health. Collaboration between the government administrations, veterinary profession, and agriculture industry is greatly facilitated by the Responsible Use of Medicines in Agriculture (RUMA) Alliance [Responsible Use of Medicines in Agriculture, https://www.ruma.org.uk/ (accessed 21 February 2023)]; a not-for-profit group of organizations, which provides leadership to the UK livestock industry, promoting responsible use of veterinary medicines, and optimum animal health and welfare.

Routine monitoring of antibiotic sales, usage, and AMR in UK livestock takes place annually and results are published in the UK Veterinary Antimicrobial Resistance Sales & Surveillance (UK-VARSS) reports [Veterinary Medicines Directorate, https://www.gov.uk/government/publications/veterinary-antimicrobial-resistance-and-sales-surveillance-2021 (accessed 23 February 2023)], where major reductions in antibiotic usage and corresponding effects on AMR have been noted. Similar monitoring in companion animals is just starting to be established; however, it is more complex, due to the different nature of the relationship between pets and owners compared to livestock.

It was raised that the animal sector can often be viewed as 'behind' the public health sector when it comes to AMR and appropriate antibiotic use, even though this is not true. This often arises from inaccurate comparisons of antibiotic consumption between the animal and human sectors, however these sectors use different metrics and methodologies. A more accurate comparison was made in the 2019 One Health report [Veterinary Medicines Directorate, Public Health England, Food Standards Agency, https://www.gov.uk/government/publications/uk-one-health-report-antibiotic-use-and-antibiotic-resistance-in-animals-and-humans (accessed February 23 2023)], which converted the human metric to the animal metric. This comparison clearly showed that antibiotic use in livestock is far lower than in humans, and it was noted that antibiotic use is very carefully monitored in livestock in order to preserve efficacy in humans. As such, a more careful narrative needs to be taken when comparing progress across sectors, as it can often cause misleading and inaccurate conclusions when not done properly, which can be reputationally damaging.

Recommendations made are as follows:

- Caution is needed when comparing efforts between sectors as they are not equivalent comparisons due to differences in metrics and methodologies. This is particularly needed in the media and press, where efforts within the animal sector can be unfairly reported in a negative light.

**NAP published amendments (AH):**

- **Revised commitment:** determine how to use new monitoring tools, such as whole genome sequencing and other molecular-based methods, to improve and add value to our surveillance data.
- **Commitment retained:** explore ways of using UK surveillance data to better understand AMR transmission pathways between animals, environment, and humans.
- **Commitment retained:** explore, in collaboration with industry, options to develop rapid and reliable diagnostic tools to inform veterinarians' prescribing decisions, and promote the uptake of these tools.

## Roundtable discussion points 2.2: How could knowledge sharing and collaboration within a One Health approach improve the development of monitoring and diagnostics methods? How can we increase the coherence between human and animal health data to aid with AMR surveillance?

There was a general enthusiasm for knowledge sharing and collaboration across sectors, in order to promote a One Health approach to surveillance. However, the lack of investment into national surveillance systems was noted as a major barrier to this, and was even recognized as a 'step back' on previous progress. It was agreed that there is an apparent disconnect between the growing ambitions and commitments set out within the national action plan, and the reduction in associated funds. Further barriers acknowledged were the lack of harmonized methodologies between sectors and also essential

data, which is not accessible in the public domain, e.g. data held by private laboratories and organizations.

Recommendations made are as follows:

- Better facilitation of interdepartmental working to enable different experts from across the One Health spectrum to engage with one is needed e.g. through formation of a One Health committee/regular meetings.
- Ways to reduce barriers to data-sharing across sectors need to be explored, e.g. harmonization of methodologies and metrics. Also, better communication of how data will be used to inform research could help promote data-sharing by private laboratories and organizations.
- Development of a single, easy to access repository for IPC- and AMR-related research outputs and developments, similar to that used during the pandemic for COVID-19-related developments would help collaboration and knowledge-sharing.

**NAP published amendments (AH):**

- **Revised commitment:** support coordinated AMR-related research on priority areas, including pathogens on the WHO-priority pathogen list as well as TB.

## Roundtable discussion points 2.3: What other support can be offered aside from funding to promote this research? How do we encourage new researchers to investigate AMR when they will likely have better career prospects in other fields?

There was consensus that funding is essential to promote the AMR-related research on priority areas, regardless of any other support that can be offered. However, disregarding funding, support could include better establishment and support of AMR-related clinical academic career pathways, and better AMR training within university curriculums. An issue raised was the current lack in specialist microbiology training courses in medicine, which is causing a loss of vital knowledge over time since microbiological clinical experts are leaving the field and not being replaced. An increase in, and promotion of, clinical positions with expertise in AMR would be very beneficial.

Additionally, although it was acknowledged that veterinarian training has a slightly higher focus on AMR, it was agreed that it could always be emphasized further. Training for farmers is also fairly comprehensive for those with premises under farm assurance schemes; however, their training is more IPC- rather than AMR-focussed. Increased education and training were identified as potential solutions.

Recommendations made are as follows:

- Better establish, promote, and support clinical academic career pathways that focus on AMR, including at earlier career stages (e.g. at PhD level) and in more senior roles. This includes creating more specialized microbiology-focussed training courses for clinicians.
- Increase AMR training within the curriculums for clinicians, vets, and other healthcare professionals, as well as for farmers/industry workers.

**NAP published amendments (AH):**

- Evaluate existing R&D capacity (including those available through COVID-19) and explore options for developing, improving, adapting vaccines, or other tools to prevent infections (and the need for antibiotics) in humans and animals.
- Building on learnings from the COVID-19 pandemic and the rapid roll-out of centralized and de-centralized diagnostics, identify and address R&D gaps for AMR diagnostics (including evaluation of impact) across humans and animals, including the identification of biomarkers and sample collection for validation, to reduce antibiotic prescribing by ensuring that the right antibiotic is prescribed at the right time. Research should consider the uptake and use of diagnostics and behavioural aspects of use alongside R&D.

## Roundtable discussion points 2.4: What are the major barriers preventing the uptake of new innovations in healthcare settings both practically and behaviourally? How might we use some of the tools developed for COVID-19 in tackling AMR for tackling AMR with regards to R&D?

The importance of vaccines was resoundingly recognized; however, consumer attitudes towards vaccines were raised as a barrier to implementation, particularly in the animal sector. Much of this anti-vaccine attitude was attributed to a lack of understanding surrounding vaccines and led to a discussion on how much the consumer should/would want to know about vaccines and impacts on the food. Opinions differed on whether the consumer just wants to know if the food they consume is safe for consumption, or whether an increased awareness of the effects of vaccines on animal welfare would affect purchasing habits (e.g. wanting to buy 'vaccinated' products).

Another barrier to implementing new innovations is accreditation. Two differing viewpoints were raised. First, that accreditation pathways lack the input of those who actually use the product; a step that could be added to the accreditation pathway as an improvement for real-world application. The second point identified that accreditation pathways could be made simpler, to get impactful products on the market sooner. An example given was the use of lateral flow tests throughout the pandemic; these were deployed without following the usual accreditation pathway due to the urgency of the situation, and were effective enough to have a positive impact.

Recommendations made are as follows:

- Efforts to re-frame vaccines to improve animal welfare and better education/awareness on how they work could be helpful in improving consumer attitudes towards vaccinating livestock.
- Increasing flexibility within accreditation pathways; deciding when a tool gives an accurate result enough times to have a positive impact could have major positive impacts of human health.
- Potential expansion of more lateral flow-type rapid diagnostics for other syndromes could be helpful.

Theme 3: Environmental health (EH)
**NAP published amendments (EH)**:

- **Commitment retained**: identify and address evidence and knowledge gaps on transmission pathways of AMR between animals and the environment within a systems approach.
- **Revised commitment**: gather evidence to understand the possible risks and hazards that AMR in the environment might pose to the public; and develop and appraise policy options guided by this knowledge to increase public awareness if necessary.

## Roundtable discussion points 3.1: Is there enough being done to increase public awareness of AMR in the environment? What are some potential policy options and actions required to address the risks resulting from AMR in the environment?

Although work is starting within this area, environmental surveillance was acknowledged as lagging behind the other sectors. It was agreed that the general public are becoming aware of certain issues within the environment, such as sewage discharge into rivers and bathing waters; however, AMR is not the primary concern and most information is supplied by the media, which is often inaccurate or misinformed. Widespread knowledge of the risk of AMR within the environment is therefore lacking. The complicated nature of AMR transmission via the environment was also noted as a risk to certain professions, e.g. farmers and veterinarians. There are certain sensitivities and economic risks to agricultural professionals if and/or when resistances detected in livestock are associated with those detected in human cases, since a direction of transmission often cannot be ascertained.

The potential power of increased public awareness was discussed as an aid for applying pressure for policy change. An example of how this could be impactful was given; antibiotic use within fast food company supply chains. When it became more widely known that fast food chains were inappropriately using antibiotics and the associated risks with these practices were recognized, pressure was applied for certain fast food companies to set antibiotic use targets [The FAIRR Initiative, https://www.fairr.org/article/improving-antibiotics-stewardship-in-livestock-supply-chains/ (accessed 26 February 2023)]. Informing the public of the current AMR risks within the environment could potentially lead to a similar outcome. It was again acknowledged that more cross-cutting, interdepartmental working is needed within government to facilitate any policy changes, since all sectors are interlinked.

Recommendations made are as follows:

- Political misinformation through the media needs to be addressed to prevent harmful and inaccurate information being spread to the general public.
- Poor science communication can be harmful to the progress of the NAP. This can be addressed by acknowledging and actively working towards reducing the evidence gaps that currently exist in environmental surveillance.

## Concluding remarks

It was apparent from the roundtable discussion that the goal of containing and controlling AMR by 2040 is ambitious, complex, and will require much collaboration across all professions and sectors. Although progress has been made towards the commitments set out within the current UK NAP, further work is needed to overcome several remaining barriers. These barriers include, but are not limited to, a lack of awareness of the importance of AMR and IPC across all communities and sectors (including the general public, science community, and policymakers), lack of funding and ineffective communication across the science–policy–practice interface from evidence generation to implementation.

Although the expertise within the panel was extensive, it is worth acknowledging that views and opinions were personal to individuals, and did not always represent organizations. However, the common overlap in some individual's contributions demonstrates several widespread, cross-cutting themes that are impacting the One Health spectrum, which need to be addressed in order to move forward, including lack of funding and investment in surveillance activities, a lack of harmonization in surveillance methodologies, and the need for better join-up across all sectors.

A key overarching theme that emerged through the discussion was the lack of funding, and the crucial nature of having sufficient funds in order to achieve the NAP's commitments. The constantly increasing ambitions of the NAP are not being met with the associated increasing need for funds. This disparity in expectation and reality is clearly impacting those on the frontline of implementing the NAP's commitments. An interesting and related point raised was the observation that there could be a stronger focus on delivering and implementing the current NAP, rather than such a strong focus on formulating the next one, again highlighting the barrier posed by the lack of integration between policymakers, and those implementing the policies, e.g. practitioners. The recommendations set out within this roundtable summary represent an opportunity to reduce this gap.

## Acknowledgements

We would like to thank all who attended and participated in the roundtable discussion. This paper was reviewed by all who attended and participated in the roundtable, which included an Editor-in-Chief of AMI's journals and a member of AMI's One Health advisory group. Reviewers were given 2 weeks to provide any comments, and it was stated that 'no response' would be taken as approval of the draft. The draft paper was also reviewed by AMI's policy editor David Oliver for its journal *Sustainable Microbiology*.

## Author contributions

Daisy Neale (Writing – original draft [equal], Writing – review & editing [equal]), and Lucky Cullen (Conceptualization [lead], Visualization [lead], Writing – original draft [equal], Writing – review & editing [equal])

## Conflict of interest

The authors are employees of Applied Microbiology International. No other conflicts of interest apply.

## Data availability

No new data were generated or analysed in support of this policy-in-practice paper.

## Reference

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