Fragmentation in One Health policy and practice responses to antimicrobial resistance and the salutary value of collaborative humility

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Abstract

This paper investigates One Health (OH) applied to antimicrobial resistance (AMR) to deepen and nuance its conceptual underpinnings and inform effective implementation. We consider how models of OH and AMR wedded to bioscience assumptions of life obscure biosocial complexity and reinforce the misleading assumption that scientific knowledge of AMR is generated outside social systems. With reference to in-depth interviews with medical practitioners, scientists and policy-makers working on AMR in Australia and the UK, we explore accounts of OH action on AMR. We show that the implementation of OH is subject to some fragmentation due to workforce organisation, funding arrangements and the absence of detailed guidance for translating OH into practice. Despite OH aspirations for transdisciplinary cooperation and innovation, human-centrism and somewhat incommensurable professional and scientific views on OH constrain trust in the policy approach and limit effective action. We discuss how, in some settings, OH action on AMR does resemble policy aspirations when emphasis is placed on collaborative humility, a finding that underlines OH's biosocial character. We argue for the development of more robust biosocial models of OH to guide its application to AMR in real world settings.

Keywords Antimicrobial resistance · One Health · Epistemic humility · Australia

Introduction

Antimicrobial resistance (AMR) is a leading threat to life that is commonly addressed through the public policy concept of One Health (OH) (The FAO-OIE-WHO Collaboration 2010; World Health Organization 2022). AMR is produced by the use of antibiotics and other antimicrobial pharmaceuticals in human and animal healthcare and agriculture (World Health Organization 2015). Because AMR is found in humans, animals and the environment, international and

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national agencies have adopted the view that reducing the threat will require OH approaches (Collignon and McEwen 2019; Hernando-Amado et al. 2019; McEwen and Collignon 2018). OH is based on the zoonotic origins of some infectious diseases, the related assumption that human, animal and environmental health are interdependent and, therefore, that intersectoral collaboration is vital for good health outcomes for all species (Velazquez-Meza et al. 2022). The Global Action Plan on Antimicrobial Resistance (World Health Organization 2015) sets priorities for human and animal health and food production, including effective health sector and public education, enhanced scientific understanding, improved infection control, rational use of antimicrobial pharmaceuticals, and discovery of new pharmaceuticals and vaccines. In the Asia–Pacific region (Wang, 2021), OH activities include, public awareness, surveillance, good governance and capacity building.

Though increasingly accepted, OH policies in general and for AMR are subject to challenges of translation and implementation (Anderson et al. 2019; Baekkeskov et al. 2020; Kirchhelle et al. 2020). Munkholm and Rubin (2020) found that national AMR policies do not always align with implementation, a situation that needs to be addressed with increased auditing and legal regulation. An evaluation review found variation in the interpretation and translation of OH and that no evaluations had directly addressed AMR (Delesalle et al. 2022). Though robust evidence of effectiveness was lacking, the review noted that without community participation and affordability, OH was unlikely to be successful.

It is also significant that OH arose out of zoonotic science regarding the animal origins of many infectious diseases (Craddock and Hinchliffe 2015; Hinchliffe 2014; Steffens and Finnis 2022), for example, the influenzas, HIV and Ebola. Its alignment with zoonotic disease somewhat obscures how AMR is associated with the human use of antimicrobial pharmaceuticals. In addition, the zoonotic legacy in OH is said to promote the anthropocentric view that policy and practice is conducted to protect human health, first and foremost (Kamenshchikova et al. 2021). OH also expresses Western cultural norms regarding biomedical phenomena and how to transform them, for example, by excluding non-biomedical ways of understanding health (Davis and Sharp 2020). The concept of 'one' health has also been challenged as too monolithic given observed biological variation and complexity (Hinchliffe 2014). Another issue is that OH discourse is itself multiple. In the OH journals, for example, zoonotic rationality is foregrounded, whereas, in the Berlin principles OH is a new paradigm for interspecies solidarity (Gruetzmacher et al. 2021).

The application of OH concepts to AMR (herein AMR OH), therefore, is subject to considerable conceptual and implementation challenges. How AMR OH is defined, interpreted and put into action is an important step in the advancement of efforts to reduce the impact of AMR. As we will see, however, experts we interviewed reported that defining and enacting AMR OH was difficult despite their scientific and professional knowledge and skills. We argue that the implementation of AMR OH is not simply a matter of technocratic rationality and coordination because it is subject to a high degree of fragmentation due to the diverse and complex disciplines, social institutions and scientific paradigms implicated in AMR OH. We suggest, counterintuitively, that AMR OH is better understood as a form of

'collaborative humility' that enables scientific, healthcare and policy fragmentation to be more manageably abided.

Background

The conceptual and implementation challenges of AMR OH need to be acknowledged to advance action on AMR. As noted, OH's genealogy in zoonotic reason and related anthropocentrism, creates policy settings that give human interests higher status in policy, at the expense of other species and the environment (Craddock and Hinchliffe 2015). This tendency produces and legitimates scientific knowledge that privileges the health of humans over other species and limits generative, transdisciplinary collaboration. Content analysis of AMR OH documents (Kamenshchikova et al. 2021) found that they furthered anthropocentrism and the related assumption that animals and the environment were the sources of AMR threats to human health. This ordering of threat and blame is likely to create unhelpful blindspots. For instance, pet cats were for some time overlooked as a species at risk from BSE, despite evidence that cats had contracted the disease from commercial pet food (Blue and Rock 2011). This oversight was attributed to the prevailing conceptualisation of species thought to be at risk of BSE and therefore an elision of the health of pet cats.

In addition, anthropocentric emphases can prove to be ethically unacceptable and harmful. Rock and Degeling (2015) used the example of Hendra virus—a pathogen discovered in horses and humans in Queensland, Australia and thought to be spread by bats—to reflect on anthropocentrism. An anthropocentric approach to Hendra virus would remove bat colonies from urban areas since they are seen as the source of the virus. A less anthropocentric stance would recognise that the habitats of bats are dwindling (partly through human action), leading them to congregate where food and water is plentiful near humans and their horses. Pointing out how a truly OH approach to Hendra virus would seek to balance risks and benefits for all involved species, these authors have put forward the argument for interspecies solidarity—a fair reckoning of the interlaced nature of health for all species—to help temper counterproductive human centrism.

In a further example of blindspots, researchers have identified the narrowly conceptualised application of social science knowledge in AMR OH due to a pervading assumption that science is divided from society (Frid-Nielsen et al. 2019; Ahmad et al. 2019). For example, Australia's *National Antimicrobial Resistance Strategy: 2020 & Beyond*, mentions social science only once (page 9) and then only in relation to "champions" for the strategy (Australian Government 2019). This example makes apparent how social science is often construed as only the means by which knowledge about AMR OH is transmitted to the general public (Chandler 2019; Craddock and Hinchliffe 2015; Hinchliffe et al. 2018). This view splits in vitro science from the in vivo social world. Scientific knowledge is seen to be generated in the cloistered halls and laboratories separated from society; knowledge emanating from these sources has to then be transmitted by social science to the outside world for it to be taken up and applied (Steinberg 2015). This

in vitro/in vivo model of science and society fails to grapple with the social situatedness of bioscientific endeavour (Haraway 2007), which is a significant problem since AMR OH aims to address the interconnectedness of life. For example, the widespread production and use of antimicrobials dating from the 1940s transformed human and animal health and agriculture and thereby created new conditions of possibility for the life and death of species (Landecker 2016). In this light, it is vital for AMR OH to think biology and the social together, in other words, to understand AMR OH as a micro-biosocial knowledge and practice system (Whittaker, in press).

It is also the case that the diminution of the social imaginary is despite social research that offers new ways of conceptualising AMR OH. For example, Hinchliffe et al (2018) documented how Bangladeshi shrimp farmers managed the health of their farms in light of economic pressures on capacity to care for their ponds, antimicrobials contained in food for the prawns, and the likelihood of antimicrobial pollution in the organic fertilisers used to keep the ponds productive. Farmers managed these multiple drivers of farm health—not all of which were within their control—as a matter of their own survival. This research generated insight for new modes of AMR OH action and, therefore, demonstrated that social science can be much more than the conduit between science and society.

These conceptual troubles and blindspots indicate that social relations—sharing information and understanding, working across disciplines and professions, collaborative planning and action—are important for effective AMR OH. In the absence of these relations, it is difficult to see how AMR OH can be interpreted as a transdisciplinary field and for its troubling conceptual issues to be mitigated and hopefully arrested. The necessity of effective relations across scientific and professional boundaries implies that AMR OH is not simply a technical exercise of scientific inquiry, planning, implementation and regulation. AMR OH is equally the shared understandings and norms by which knowledge practices and related actions become possible.

In this regard, the ethics of epistemic humility are helpful because they draw attention to the conditions of trust and trustworthiness that condition productive social relations (Nyquist Potter 2022). Humility captures the self-reflective requirement of authentic collaboration (McMillan 2023). Epistemic humility extends the ethics of self-reflection to one's scientific and professional commitments and their inherent limitations, combined with an ability to appreciate the stances of others (Dormandy 2021; McMillan 2023). Epistemic humility was important, for example, for political leaders governing their polities through the COVID-19 crisis in real time and therefore when knowledge of the virus and its effects was only emerging and being debated (Parviainen et al. 2021). Openness about the limitations of one's capacity to know is said to be a more sound and ethical basis for good governance in time of crisis. Epistemic humility is also salient for establishing the interconnectedness of human and other in light of COVID and therefore helping to overcome human-centrism (Braidotti 2020). Moreover, critical epistemologies have relevance for the other challenges of the Anthropocene (Robin and Steffen 2007), in which human action is changing the conditions of life and because human-centrism is unlikely to generate the necessary insight, knowledge and action.

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Our research, then, aims to generate insight into the implementation of AMR OH in the working lives of experts, that is, scientists, clinicians and policy-makers who contribute to action on AMR. In particular, we focus on how experts understand AMR OH and how they address its barriers and enablers to help advance the public policy address to AMR. On this basis and with reference to anthropocentrism, epistemic humility and related critiques, we seek to theorise the complex scientific and technocratic rationality of AMR OH to supply novel means of conceptualising policy and practice. In what follows we explain how we used qualitative methods to interview healthcare professionals, policy-makers, scientists and other experts with focus on how they translated the OH concept into action on AMR, the problems they encountered and how these might be addressed. The analysis is relevant for the Australian context given the importance of OH for national strategy, but the themes we discuss are also salient for other contexts and have resonance beyond the AMR challenge.

Methods

Our research approach is situated in science and technology studies applied to health and medicine. It depends on critical realism (Flyvbjerg 2001) and uses qualitative interview materials to generate insight into the lived experiences, knowledge and beliefs of experts regarding AMR OH. We assume that interview narratives generated in this way document how experts attempt to make sense of the application of AMR OH in real world settings, how they problematise AMR OH as a form of knowledge and practice, and how they individually and collectively imagine how AMR OH could be strengthened.

We recruited interviewees according to the following purposive criteria: individuals working in AMR leadership roles or crafting AMR policy in government, AMR researchers in university, government and industry settings, and those with AMR roles in human and animal healthcare and in agriculture. We also aimed to speak to people in all the states and territories of Australia, balance the number of men and women and establish a spread of years working in AMR. We also interviewed a small number of AMR experts ($n=6$) working in the UK to provide some contrast with the Australian perspectives.

To recruit interviewees, we firstly made a list of agencies and individuals based on our knowledge of the field, review of internet sources and recommendations made by interviewees. We approached 174 individuals (from governments, universities, hospitals, royal colleges, professional associations, peak health agencies, charities) by email and 51 (25 women and 26 men) consented to an interview. These interviewees mapped onto our purposive criteria as so:

- 17/51 = human health
- 15/51 = animal health
- 13/51 = researchers
- 11/51 = policy-makers
- 6/51 = international

Note that the numerators do not sum to 51 as some individuals had blended roles and often represented more than one organisation.

The in-depth interviews were conducted by MD and AS and addressed topics including: narrative on professional and disciplinary role(s), views on drivers of AMR and its prevention, views and experiences with AMR OH, sources of evidence for implementing AMR OH policy and practice, views and experiences of collaboration, and views on the key next steps for the prevention of AMR. Because our fieldwork coincided with the SARS-Cov-2 pandemic, we conducted the interviews via zoom or telephone. The interviews were commonly 55 min in duration (range 30–90 min) and audio recordings were professionally transcribed for entry into data analysis software (NVIVO).

The transcripts were analysed using grounded theory methods (Bryant and Charmaz 2019) adapted for analysis of experiential narratives on AMR OH (Squire et al. 2014). This method offered the benefits of grounded theory (transparency, credibility, reproducibility) in combination with sensitivity to the value of narrative analysis (narrator style and positioning, narrative co-production, evaluation of events in time, ethical deliberation on practices). MD and AS coded the same 5 interviews using deductive codes based on the literature followed by inductive codes developed through constant comparison (Bryant and Charmaz 2019) and refutational logic (Silverman 2000). Narratively, we focused on the professional and disciplinary speaking positions of interviewees (policy-maker, researcher, physician, vet, microbiologist, environmental scientist, geneticist) including how these positions blurred and overlapped, their reflections on AMR OH knowledge and the small stories of lived practices. MD and AS conferred to discuss emerging codes and presented them at workshops with the research team. On this basis a code book was developed and used to recode the data to deepen and nuance the themes. Examples of emerging themes included, 'human exceptionalism', 'microbiological gaze', 'individual versus herd models of human and animal health', 'we are all connected', and 'virtue signaling'. Written memoranda were generated for key themes which became the basis for manuscripts. Interview excerpts in what follows are attributed to pseudonyms as per Monash Research Ethics Committee approval (Project ID: 26092).

Findings

In what follows we explore two themes: fragmentation and humility. We first establish that experts see that OH applied to AMR is fragmented due to disciplinary differences, anthropocentrism and widely held views that science is located outside society. We build on this foundation by suggesting that these problems are not simply a matter of improving AMR OH knowledge and clarifying practice guidance. They are attributable to disciplinary and professional divergence in the practical and epistemological stances of human medicine, veterinary medicine, microbiology, public health, to name a few stakeholders in the AMR field. We then reflect on the more hopeful, expert discourse on humility with implications for collaboration and the generation of responses to AMR. We suggest that, to help arrest practical and conceptual constraints, AMR OH calls for attention to the ethical basis of

intersubjective life, in particular, 'humility' with regard to the practices of different professions, the knowledge systems they employ to guide their work, and perhaps most importantly, with regard to the species relations implied in the OH concept.

Fragmentation

Interviewees from all professional and scientific disciplines endorsed the OH concept, in principle, but also noted that it was not easy to define or implement. Some could not easily see how OH applied to their professional practice and were somewhat cynical about the concept in a practical sense. Interviewees also noted how professional and science discipline boundaries interfered with AMR OH and how this fragmentation was tied to funding arrangements and the allocation of resources.

For example, a microbiologist, speaking from the position of environmental science, noted that there is no clear understanding of the AMR mechanisms that connect human, animal and environmental health:

> … in terms of the One Health stuff, I guess we have a really poor understanding of the connection between those key … I'm not sure what you'd call them … pillars. I don't know. Human, environmental and animal health. We don't have a mechanistic understanding of how they're connected but we also, to my knowledge at least, don't have a particularly good understanding in terms of what we can do to actually intervene and, or, alternatively, take measures to stop resistance… I think it's useful as a concept but then, as you say, it's often flung around as a sort of hazy, buzz word in terms of actually working in a One Health framework to actually produce any change. (Interview 35, environmental microbiology).

This account underlined how the interviewee was not able to outline how OH could be applied to reduce AMR. This point of view suggests the need for real world examples of AMR OH that can act to guide the action of those working in the field. It also implies that OH practice is difficult to imagine for other reasons, as considered below.

In this example from a veterinarian, the practical aspects of OH were seen as yet to be decided, implemented and evaluated:

> … even when you look at the AMR plan for Australia, there's all these great ideas of what to do but there's nowhere that's saying how it's going to be done or how it's going to be checked or assessed to see that people are competent, or where the funding is coming from, or support that people are going to get. (Interview 36, animal health).

This way of explaining AMR OH echoes the previous comment and suggests that the painstaking work is yet to be done to implement OH approaches and assess their effectiveness. It may be that dedicated resources could go some way to strengthening the implementation of AMR OH. But the comment also indicates that the real world working lives of individuals in the AMR field are shaped in

ways that block OH implementation. From this point of view, OH is a policy formulation that is imposed on organisational structures that are not amenable to the approach.

Some interviewees attributed these problems to the separations between the professions and scientific disciplines, in part linked with funding arrangements:

> … my experience has been that funding and the perceived threat to certain silos has been a bit of an impediment to a One Health approach, even though the research tells us that a One Health approach is better in terms of cost effectiveness in so many cases anyway… … but I guess some people, particularly in remote settings where funding is hard to come by and they're under-resourced at any rate, they are protective of what little funding they get. So I can understand it from that perspective but it's still frustrating when there's basically no funding for that work. (Interview 23, animal health).

These perspectives indicate that a key factor for the effective application of AMR OH is the prevailing (dis)organisation of the health and scientific complex that generates knowledge and shapes how that knowledge is then translated into action. Our interviewees' comments concur with the literature suggesting that increased effectiveness requires that cost and knowledge translation be built into programme design (Delesalle et al. 2022).

There was general acknowledgement that AMR OH is typically depicted in human-centric terms (Kamenshchikova et al. 2021). There was a sense that animal and environment health were subservient to human health, for example:

> …what One Health looks at is the overlap and the interaction between human health, animal health and the environment, and seeks to provide an outcome that is beneficial for all three components of that interaction … … when we often talk about One Health, what we're really talking about is human health and what do we need to do to the environment or to the animal sides of the equation in order to improve human health without looking at, well, how does that benefit animal health or environmental health? (Interview 16, animal health policy).

AMR OH is in practice a means of protecting human health by recognising its dependence on animal and environmental health. Less important are bio-philosophical questions about the interdependence of life and the harms humans do to animals and the environment and therefore to themselves (Woods et al., 2018).

The dominance of anthropocentric rationalism in AMR OH may reflect its life-threatening immediacy for some of the experts we interviewed. This explanation from a physician researcher underlined how the day-to-day imperatives of work in the hospital shaped outlook on AMR:

> But beyond that, we sort of talk to our colleagues and so forth but, because in the hospitals we're so focused on just these patient-level problems, like sometimes we don't really get the [OH] perspectives. And I feel like so much of what happens to the patients that we look after, at least particularly like in transplant, it's much more related to interactions with the healthcare system

> rather than, for example, acquiring a drug-resistant infection because of some One Health reason. (Interview 15, physician researcher).

In this view, OH is recognised as important but for this sector of the AMR workforce has little obvious salience. The imperatives of protecting human life are at the forefront, not because OH is rejected in principle, but because physicians' work calls for it. In this view it is the organisation of healthcare that makes OH relevant or not.

This position on OH was echoed in a more cynical account of the concept. This physician/researcher working outside Australia commented that OH has a somewhat performative quality:

> I'll be honest with you: for me, it's a slightly esoteric subject because it doesn't affect my daily life. I know about it. I know what One Health means. I have a reasonable understanding of what the agenda is about, about acting together, animal health, human health, population health, so that AMR is not just about hospitals or about medicines. It's about societal wellbeing and societal response to it as well, so population behaviours … … I hear people talk about it and it's obviously sensible, laudable, the right way to look at things. It doesn't have a direct impact on what I do every day. I don't mention One Health from one month to the next to anybody. We don't talk about it in hospitals or anything like that. But it is a function of national conversations about policy. It gets talked about there. But, again, only peripherally and only occasionally. It's not at the centre of everything we're talking about yet. The very important people in very important positions in the powers that be talk about it occasionally. It's a bit like a name check to be honest. Kind of got to name-check it otherwise you're missing something in your presentation. The Power-Point has got to have One Health in there somewhere. (Interview 48, physician researcher, international).

This interviewee makes it plain that clinicians, in particular, cannot see why OH would apply to them and offers the view that OH is somewhat empty of meaning apart from virtue signalling. The comment and similar ones suggest that the OH policy construct has lost some its conceptual power through well-meaning repetition without clear actions and outcomes.

Importantly, as we have noted, individuals themselves rarely have a unified or singular gaze on AMR OH. In this example, the interviewee contrasts clinical and public health knowledges:

> I think that the evidence is kind of from the high end. We're looking at hospitals and acutely unwell people as opposed to a population-health approach that will look at poverty as a cause of antibiotic resistance. And I guess that's where there's the money and resources to do the research and I guess people just get interested in their own little area rather than looking at the big picture and how antibiotic resistance emerges in communities. (Interview 32, human health).

This example shows how the clinical perspective is distinct from public health and that these disciplinary gazes give rise to professional/disciplinary differences and

therefore contribute to the fragmentation of AMR OH. Most importantly, it refers to different forms of knowledge about AMR that give rise to different ways of acting on it, that is, at the bedside as distinct from the population. OH is thus limited to the extent that clinical medicine and epidemiology pertaining to AMR can be effectively combined to bring about coordinated action. These science paradigm challenges sit at odds with how OH is said to comprise a new way of conceptualising health, as discussed previously. The epistemological bases of OH and its application to AMR need to be addressed if AMR OH is to be effective. However, it may be the case that OH meets its limits in the incommensurability of different science paradigms used in healthcare.

Our analysis provided further insights into the disciplinary divergences that constitute AMR OH. In this example, the interviewee contrasted human and animal health in terms of experience intermingled with epistemological outlook:

> I think there's a big disconnect in the human-health world that they forget that animals live with people and people will live with animals. That's sort of right up in your face when you work in Indigenous communities. But, in the human-health world, it's very, very separate. It's not even sort of on the radar often of the medical professionals … I think that the health-practitioner organisations, 'cause they're dealing with very immuno-compromised people, like I think they're so busy with treating individual people that are sick. I think sometimes that the human-health world doesn't have as, what's the word? Like they didn't have a herd mentality, obviously, for their practice, whereas, from our vet point of view and from an animal management point of view, we are treating animals on an individual level but I am also looking at it as a herd of dogs and cats in the community. (Interview 25, animal health).

This interviewee reiterates the tension between the medical and public health perspectives on AMR already discussed, that is, 'bedside' and 'herd' viewpoints. It shows how the anthropocentrism of policy discourse (Kamenshchikova et al. 2021) is tied to the ways in which the AMR workforce is deployed. The concept of Indigenous knowledges and practices of healthcare also helps to underline epistemic divergence, in the sense that there are multiple ways of addressing the AMR problem (Hinchliffe et al. 2018). The example also attests to the need for explanations of AMR OH that are able to capture its situatedness for practitioners.

In addition, some of our interviewees criticised OH from a scientific standpoint. In this quotation from a microbiologist, they disputed OH's status as scientific knowledge:

> To a microbiologist, it's a nonsense. The concept of One Health is a nonsense because the idea that there's a species tension between humans and the rest of the planet is, it's just a medical construct, really. If you look at it from a global point of view and you look at it as, if you pretend you're a tree for five minutes, you don't actually care about those kind of concepts. They're silly distinctions that are around policy settings. But, in terms of the spread of AMR dynamics, it's consequences, it's a nonsense. So, for a true microbiologist, One Health is a nonsense…True microbiologists are already there. So, for someone

to give that natural concept a special term, as though it's a new idea, it's a little short of embarrassing. To say to a microbiologist, "Were you aware that bacteria in animals and plants, and humans communicate?" It's healthy, really, but it's something that physicians have had to learn. So I think it's a useful term. But I think it reflects the fact that the policy-makers are extremely ignorant. (Interview 4, clinical microbiology).

From the standpoint of microbiology, then, portraying OH as a new form of knowledge is unhelpful. The comment also echoes the point that OH has a genealogy in zoonotic diseases and is at heart a human health-centred discourse. This way of talking about OH pushes it out of the world of science, which according to this researcher is unsullied by the political and social exigencies of action in the world. This is a provocative stance that may be as overstated as it is strident. It assumes that 'true microbiologists' understand OH in ways that others cannot and creates an inner sanctum of scientific truth, discursive action that may contribute to the fragmentations of the AMR OH field.

Collaborative humility

Partly in response to these tensions, interviewees also gave emphasis to the importance of collaboration and the related trust and humility that were needed to establish these relationships. These accounts moved away from professional and disciplinary differences towards a practical ethics of interaction between professions and disciplines. In this example, a policy-maker in animal health saw value in OH because it legitimated their practice and expertise:

One Health is a concept that's attractive to vets because it makes us feel that we are going to be recognised and have something to contribute. But it has very little traction with my medical-practitioner colleagues who tend to believe that they have the full complement of knowledge and anything outside of their complement of knowledge is less relevant or less valuable. (Interview 16, animal health policy).

OH has value because it strengthens the contribution of those working outside human healthcare. In this sense, it is a political construct designed to include animal health, the practitioners of which appear to have struggled to be taken into policy discourse. Interviewees also suggested that once 'around the table' personal reflexivity is vital:

So a bit of self-reflection and think, "How are this person's skills complementary to mine? And how can we work together for a better outcome?" And that's essentially what One Health's about, isn't it? (Interview 33, animal health policy).

Here, OH emerges as an ethical stance on how collaboration can be possible. Understanding oneself and interlocutors is the foundation by which gains can be made in the reduction of AMR. In the next example, the interviewee referred to 'respect' as the necessary predicate of 'synergy':

> I think it's really respecting each other's discipline and what that brings to the table. And having that mutual respect and then synergising so that one plus one equals three. And that's what we need to work out. We need to work out some way that we bring that [about] so that then other people don't think that they're then the expert on that area because, actually, they're the expert on that area. And we need some way of bringing that dialogue together and then synergising. And that's where I guess we need you guys [social researchers] to help us do that: you know, bring those expertises together. And then you've got missing pieces of the puzzle that we don't know. But I think it is bringing that and having that mutual respect in the room. (Interview 31 animal health clinician and policy).

The interviewee noted that being an expert is a paradox for collaboration. For collaboration to work, experts need to recognise themselves as simultaneously 'the expert' and not 'the expert' so that dialogue can be possible. This paradox captures the epistemic quality of collaborative humility (Dormandy, 2021). These quotations move beyond the zoonotic or anthropocentric views of OH and foreground it as an ethical practice of productive social relations that build collaboration and create novel, practical solutions. In this collaborative humility, the focus is placed on building relationships by valuing trust, finding shared language, and problem solving:

> … actually going ahead with One Health or people seeing the need for it is built on relationships … … You need to trust the person. You need to understand what they do. You need to understand what they're doing professionally … … but the other thing that we also found in research that we did is part of it is that you need to have a bit of professional insight and humility. (Interview 33, animal health policy).

This person working in veterinary health implied that, for the effective development of AMR OH, trust and, especially, humility are needed. As the interviewee indicated, collaboration requires that professional and scientific chauvinism be suspended in the interests of respectful alliances and increased capacity to generate novel solutions to health challenges across species.

This is not to say that effective collaboration is always harmonious. In their interview, a UK-based biological scientist noted that dialogue is at times imbued with dissent:

> But you have, you know, you have to be prepared to get into arguments with people. You have to be prepared to actually have difficult conversations. (Interview 50, UK microbiology).

This statement implied that experts may not always agree but that, also, respectful disagreement may also be part of what makes collaboration effective. Moreover, collaboration requires effort and commitment:

> I do think it works well but I'd have to say that this takes a lot of effort. Anyone who's tried to work across disciplines I think knows that we all

tend to speak our own language and we have our own ways of approaching research and solving problems. And so I think it requires quite a bit of patience and understanding of other peoples' ways of doing business. (Interview 7, microbiology).

This explanation of OH situates it as an ethics of interprofessional humility, echoing calls for interspecies compassion as the foundation of OH (Gruetzmacher et al. 2021; Rock and Degeling 2015). This point of view helps individuals to gain understanding of professional divergences and disciplinary gazes. From this standpoint, OH is more than a technical exercise of interrupting the flows of AMR between species. It concerns the kinds of relationships that are made possible through OH collaborations and that make effective OH possible.

Discussion

Through close attention to AMR OH as biosocial phenomena, our analysis has provided important new insights into AMR OH and identified stumbling blocks and opportunities for strengthening AMR reduction. OH, in principle, was endorsed by our interviewees, but they were rarely able to speak of it as a practice, except possibly in rural Australia. They suggested too that the Australian response to AMR OH is fragmented by funding, geographic, and institutional arrangements intersected with divergent professional and disciplinary views. These are important considerations for the implementation of AMR OH, since a one size fits all approach is unlikely to be universally effective and sustainable.

The inherent dominance of anthropocentrism in AMR OH was understood and discussed by our interviewees, but some contradictions were apparent. Clinicians, for example, saw value in OH but also found it less salient for their work. Other kinds of professionals saw the stance of clinicians as counterproductive or even antagonistic. Scientists were somewhat critical of the scientific value of the OH approach. These clashing and contradictory points of view may contribute to a sense that OH is of weak practical use for AMR. Alternatively, these clashes suggest priorities for the development of AMR OH approaches. For example, more nuanced and expanded discourse on these concerns might go some way to restore shared commitment to the overall approach.

Our analysis indicated, however, that challenges for AMR OH run deeper than professional and disciplinary differences. Adopting the view that our analysis provided a window on AMR OH in real world settings, it is possible to argue that the experiences of healthcare professionals, policy-makers and scientists are shaped by their diverse work settings and the concepts and evidence they use to guide their practice. Human health clinicians, for example, appear to focus on the individual patient. Conversely, veterinarians working in agriculture are necessarily thinking of animal populations. Microbiologists, as noted, might see OH as only crudely reflective of what they do. These professional and disciplinary gazes on AMR might help to intensify the fragmentation that was apparent to our interviewees. Strengthening AMR OH will require efforts to understand the

diverse epistemological outlooks of healthcare professionals, policy-makers and scientists. New practices for generating epistemological consensus and/or valuing dissensus will be needed to advance AMR OH.

Interviewees were also focussed on collaboration for AMR OH. They spoke of it as a social practice that built trust, shared understanding and advanced the chances for imaginative, transdisciplinary solutions to the prevention of AMR. This theme was not technocratic or to do with anthropocentrism, silos and epistemology, though each of those could be addressed through more robust collaborative efforts. Collaboration was construed to be a practical ethics for action that foregrounded inter-expert humility. This way of explaining AMR OH, underlined how the challenges presently faced are tied to the structures that shape the work of health carers, policy-makers and scientists and therefore how they do and do not interact. At present, structures that would facilitate professional and disciplinary interaction and social connection do not appear to be in place, for our interviewees at least. Importantly, some interviewees recognised themselves to be working in OH-like modes of action in rural settings though not, it seems, by design.

Another element of this mix of challenges for AMR OH were assumptions about science and society that drive one way communication of discoveries and solutions from the laboratory into the world (Steinberg, 2015). As we noted, OH policy subscribes to a splitting of the practice of science and its discoveries from the worlds of non-scientists. This view was apparent in the comment by a scientist that "… policy-makers are extremely ignorant". It is also a model of science and society that constructs social science as mediator, that is, helping to inform and educate publics of scientific discoveries and solutions. Given that the challenges identified by our interviewees are largely social, the narrow, mediator view of the social sciences is a key problem for AMR OH. Improved models of OH need to be developed that account for its biosocial character (Kirchhelle et al. 2020; Hinchliffe 2014; Chandler 2019; Rock and Degeling 2015). Social science critiques of policy discourse and the evidence used to make decisions need to be considered. The pivotal role of collaboration as a value, in itself, also indicates an important arena for the deployment of social science perspectives on matters such as the political economy of scientific knowledge and the professions and the social qualities of effective collaborative relations and problem solving. From our point of view, the effective implementation of AMR OH will be built up from grassroots action shaped to fit local social, cultural and organisational circumstances. Fine-grained transdisciplinary evidence of what works on the ground will be vital for sustaining action to prevent AMR.

Our research focussed mostly on the views and experiences of Australian experts, and is therefore circumscribed by the social, institutional and economic conditions that pertain in Australia. It would, therefore, be important to reflect on the ways in which fragmentation and collaborative humility manifest in other contexts, for example, in those with fewer public health resources, or established histories of syncretic healthcare, or different epistemic traditions and cultures of collaboration. A key insight from our Australian case, however, is the importance of looking beyond technocratic rationality to address the conditions and effects of collaborative humility and how it can support efforts to reduce AMR.

Conclusion

AMR is a specific case of OH because it involves failing pharmaceutical solutions to life-threatening infections. Moreover, this failure is attributed to the overuse of antimicrobials to further human life prospects, be it in healthcare or for ensuring food production. It is, then, not surprising that AMR OH policy discourse has been found to be anthropocentric (Kamenshchikova et al. 2021). This doubling of human agency in the production of AMR underlines the social dimensions of the AMR problem and connects it with the other planetary challenges of our era (Robin and Steffen 2007). Our research supports the view that solutions to the complex biosocial challenge of AMR are unlikely to be solely technocratic (Gruetzmacher et al. 2021; Hinchliffe et al. 2018). As we have argued, it is also crucial to understand AMR OH approaches as profoundly social activities. Effective responses to the AMR threat will require attention to the material and symbolic social structures that can help to produce shared understanding and commitment and above all collaborative humility to ensure effective and sustainable action.

Data availability Not applicable

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