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RESEARCH ARTICLE

# Bridging the gaps in the global governance of antimicrobial resistance: the UN sustainable development goals and global health security agenda [version 1; peer review: 1 approved]

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## Abstract

**Background:** This paper examines the suitability of extant governance frameworks at an international level for addressing antimicrobial resistance (AMR), which is a creeping crisis for global health security.

**Methods:** Our study begins by evaluating the place of antimicrobial resistance (AMR) within United Nations (UN) Sustainable Development Goals (SDG) targets and indicators. This is followed by a discussion of the global health security agenda (GHSA). We examine how AMR needs to be taken more seriously within global policy frameworks based on adopting a One Health approach. The research is supported by a systematic analysis of the national action plans for addressing AMR published by the World Health Organisation (WHO).

**Results:** We determine that political leaders need to do more to promote the problem of AMR and that global health institutions need to invest more energy in thinking about how AMR is governed as part of an already busy global health security agenda. This includes building capacities within health systems, embedding evaluation processes, and enhancing public service leadership within this area.

**Conclusions:** Our review of global policy frameworks and the national plans for AMR highlight the patchy coverage of AMR strategies globally and nationally. This article represents a springboard for future research including whether and to what extent a One Health approach to AMR in the environment has been implemented in practice within national health and environmental systems.

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**Keywords**

Global health security, Antimicrobial resistance, governance, One Health, Sustainable Development Goals (SDGs); United Nations (UN)

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## Introduction

The United Nations (UN) Sustainable Development Goals (SDGs) are recognised as the global blueprint for building a sustainable, fair, and equitable future for all. Guided by the five 'Ps' of People, Planet, Prosperity, Peace, and Partnership, the global agenda consists of 17 linked goals, 169 targets, and 244 indicators. The interconnectedness of goals provides opportunities for synergies to be made when trying to accommodate the numerous targets that underpin the SDGs (Teimory, 2020; UN General Assembly, 2015). Contrastingly, this interconnectedness provides avenues for the transfer of risks to other connected goals, potentially derailing their achievement. This is of concern if progress towards achieving goals is dependent on targets or indicators that have been neglected, omitted, or side-lined as part of the global agenda. One such conspicuous omission observed in the 2030 agenda for sustainable development adopted in 2015 is for specific targets and indicators to address antimicrobial resistance (AMR). AMR is a rapidly growing crisis that threatens the foundation of modern medicine. With AMR, pathogens increase resistance to antimicrobials, consequently, lifesaving antimicrobials lose their effectiveness, and necessary procedures can become fatal (Anthony, 2015).

The paper examines the suitability of the extant global health governance frameworks for tackling AMR as a global health threat initially through the evaluation of the place of AMR within UN SDG targets and indicators followed by a discussion of the global health security agenda (GHSA) about how AMR needs to be taken more seriously within global policy frameworks based on adopting a One Health approach. One Health is a perspective on health security that has become synonymous with the need to tackle health threats on a multi-disciplinary, inter-sectorial, and integrated basis to understand the 'causes of the causes' of health threats (Connolly, 2017). The disciplinary insights required to embed a One Health approach require the framing of societal problems that can go beyond environmental, public health, and veterinary health and include social scientists who can propose a set of solutions for dealing with health security threats. The paper concludes by arguing that political leaders need to do more to promote the global threats posed by AMR and that global health institutions need to invest more energy in thinking about how AMR is governed as part of an already busy global health security agenda.

## The UN SDGs and AMR

AMR threatens the achievement of up to twelve SDGs given that the availability of effective antimicrobials is crucial to the attainment of these goals (StopAMR, 2020). For example, AMR in animals will continue to threaten food security, in turn compromising the achievement of SDG 2 (i.e. zero hunger) and it will cause an estimated 300 million deaths by 2050 and significantly increase health care costs, both of which risk the achievement of SDG3 (Good Health and Well-being). AMR infections will also reduce economic output, in turn jeopardizing economic growth (SDG 6). If left unaddressed, Low and Low Middle-Income Countries (LMIC) will continue to be disproportionately

affected by AMR, thus widening the inequality gap (SDG 10) (StopAMR, 2020). It is therefore surprising that opportunities to specifically address AMR were missed in the 2015 global agenda.

This was remedied, to some extent, in the 2020 comprehensive SDG review via the inclusion of one AMR-specific indicator. SDG3.d.2. and SDG3.d.2 measure the percentage of infections in patients caused by methicillin-resistant *Staphylococcus aureus* (MRSA) and third generation cephalosporin-resistant *E.coli* (United Nations, 2021). However, critical AMR blind spots remain. The human-centric focus of this indicator underscores its disengagement with animal and environmental health, and its disregard for the anthropogenic activities that precede AMR. This is of critical importance as an estimated 75% of antibiotics used are in animal food production (Ritchie, 2017), while pharmaceutical wastewater and hospital effluents are considered to be "hot spots" for the transmission of resistant strains (Finley *et al.*, 2013). Consequently, this indicator has limited capacity to track the precursors of AMR in humans and has missed opportunities to apply a One Health approach in addressing what is clearly a One Health problem.

Furthermore, detection of bloodstream infections within SDG3.d.2 is limited to two AMR strains, i.e., MRSA and 3rd generation cephalosporin-resistant *E.coli* (United Nations, 2021). This brings into question the rationale behind the choice of these two AMR strains, and the decision to limit detection focus to only two strains. Ultimately, this narrow surveillance focus could limit early detection of other serious and urgent AMR strains e.g. multidrug-resistant (MDR) *Pseudomonas aeruginosa*, drug-resistant *Neisseria gonorrhoeae*, MDR *Mycobacterium tuberculosis*, Vancomycin-resistant Enterococci, Carbapenem-resistant Enterobacteriaceae, and *Clostridioides difficile* (CDC, 2019a). It is therefore critical that indicators that specifically track AMR are not limited in their coverage and that they include a wider spectrum of AMR strains of concern. Although SDG3.d.2 focuses on the detection of AMR-resistant strains, neither this indicator nor other indicators specifically track access to antibiotics (Anthony, 2015). This is another blind spot as more deaths from infectious diseases have been attributed to a lack of access to effective antibiotics than to resistant infections (Daulaire *et al.*, 2015). Furthermore, this access problem is recognised as a driver of AMR as it directly promotes ineffective treatment, insufficient treatment, and unwarranted use of watch and reserve group of antimicrobials (as classified by the WHO) (CDDEP, 2019). In light of these omissions and shortfalls, there are concerns about how the SDGs can holistically address AMR if on the one hand the excess problem is only partially monitored in humans, and on the other hand, the access problem is not tracked at all. Indeed, many of the SDGs (including 2, 3, 6, 9, 12, and 17) are relevant for AMR and can indirectly address many AMR concerns (WHO, 2018). However, sensitivity or relevance to AMR may not translate to specific or targeted AMR activities, as the lack of AMR specificity could result in the implementation of activities that navigate the peripheries of the AMR threat, but, in fact, inadvertently neglect AMR.

Calculated strategic measures that recognize and address these critical blind spots are, therefore, needed otherwise policymakers will remain ignorant to the data behind these AMR drivers, and progress towards achieving the SDGs will continue to be at risk. Strategies to address this oversight could include anchoring AMR within SDG indicators e.g. by including AMR-specific indicators during the next SDG comprehensive review, and/or by specifically mentioning AMR in existing indicators, thereby converting AMR-sensitive indicators to AMR specific indicators (WHO, 2018). Another practical approach is the adoption of a framework that exists outside of the SDGs and addresses the AMR deficits within the SDG framework. This is reminiscent of the approach used when tobacco control was omitted from the millennium development goals and was subsequently rectified by the introduction of the WHO Framework Convention on Tobacco Control (WHO FCTC) (Anthony, 2015). The adoption of a global framework that prioritizes AMR could provide opportunities to better anchor AMR on a global scale. The GHSA is one such framework that could deliver on some of the opportunities missed by the SDGs to address AMR.

It is useful to discuss the GHSA in more detail to consider how broader GHSA adoption can bridge the critical AMR gaps that remain in the revised SDGs and explore the synergies in their dual implementation.

### Global Health Security Agenda (GHSA)

The rise in the frequency of infectious disease outbreaks suggests that existing globally adopted frameworks, like the SDGs, may have implementation and capacity gaps pertaining to public health emergencies and global health security (Bali & Taaffe, 2017). The International Health Regulations (IHRs), which are legally binding instruments of international law, recognises the threat that infectious diseases pose to public health and transnational security. However, ambiguity as to how the IHRs can be applied (Bennett & Iredell, 2020), and the limited capacity of countries to fully implement them (CDC, 2019b), may, in part, contribute to the existing gaps in global preparedness for public health emergencies. There is, therefore, the need for countries to consider options that are founded on the principles of the IHRs that will enhance a countries' capacity to develop and maintain minimum capabilities to address public health threats.

The GHSA is one such agenda. Launched in 2014, the GHSA is a collaborative framework between countries, international organisations, and the private sector that aims to strengthen global capacities to prevent, detect, and respond to infectious disease threats worldwide. Public health capacity within the GHSA itself provides the foundation needed to provide non-disease-specific resolutions. With this in mind, the GHSA consists of eleven action packages that are split across three main categories (prevent, detect, and respond) and serve as roadmaps to help countries build capacity to address infectious disease threats (Health Security Agenda, 2018). In recognition

of the challenge AMR continues to pose to global security, one action package is dedicated to addressing AMR.

AMR remains a real public health threat that is directly responsible for 700,000 deaths yearly, with a projected increase to 10 million deaths by 2050 if collective action is not taken (O'Neill, 2016). In order to effectively address AMR, the GHSA AMR action package considers the contribution of AMR to increased morbidity, mortality, and health care costs; the ease of spread of resistant genes and resistant pathogens in our increasingly interconnected world; the importance of a One Health approach; and the need for collaborative, multi-sectoral action to address this AMR threat (GHSA, 2022b; Joshi *et al.*, 2021). This resulted in the recommendation of AMR-specific action items that would strengthen national surveillance capacity. This was to ensure continued access to effective antimicrobials and to promote rational antimicrobial use across human, animal, and environmental dimensions (GHSA, 2022a). Consequently, successful implementation of the GHSA AMR action package could address the siloed, human-centric limitations of SDG.3. d.2, and tackle the other critical blind spots highlighted within the SDGs. The question remains as to why only 67 of the 196 WHO member states have signed up to the GHSA, particularly in light of the ease of spread of antimicrobial-resistant genes and pathogens and the transcending of gains in AMR mitigation beyond national borders (Toner *et al.*, 2015).

The barriers to the adoption of the GHSA are multiple and impact, negatively, on the realisation of desired GHSA AMR national impact gains that lie therein. Firstly, the national security-centric approach of the GHSA may limit its appeal to countries that do not see the correlation between health and security (Bali & Taaffe, 2017; Kanji, 2016). However, the experience of the COVID-19 pandemic, and the ensuing economic destabilisation, increased inequality, and social unrest (Galea & Abdalla, 2020), demonstrates how health security impacts the foundation of national security. The pandemic experience also stresses the need to build core public health capacities that bridge the existing prevention, detection and response gaps to infectious diseases.

The second barrier to the global adoption of GHSA is its focus on physical health, and the omission of mental health. This is despite the intricate interlinkage between physical and mental health, and the precipitation of mental health conditions by health security triggering events (Bouskill & Smith, 2019; Ip & Cheung, 2020). However, it can be argued that the narrowed focus of the GHSA on physical health, specifically on infectious diseases, is its strength, particularly in light of the all-encompassing, non-prioritising nature of the SDGs. This narrowed GHSA focus will facilitate targeted efforts and, in turn, decelerate progress towards attaining global health security as it relates to infectious diseases. As the GHSA does not require or necessitate the adoption of all eleven action packages, countries can implement specific action packages towards achieving specific GHSA objectives and targets. Furthermore,

implementation costs are reduced, and the practicalities of implementation are more realisable. That said, limited financial incentives for GHSA implementation have been identified as another barrier to its implementation (Bali & Taaffe, 2017).

Funding to build national health security capacity is provided by several funders (e.g. member nations, international organisations, and the private sector), however, implementation costs required to address national health security needs are largely met by the implementing countries. However, there are incentives to boost national preparedness and response capacity. This could be exacerbated in situations where low gross national income (GNI) per capita coexist with struggling health care systems and competing developmental needs (Centre for Global Development, 2021). In light of the health, economic, and social costs associated with the COVID-19 pandemic, leaders at all levels of government must understand that prioritising health security is a necessity. The funding that underpins the GHS should not be an afterthought, driven only in response to ravaging epidemics or pandemics. That said, countries should be supported in their financial capacity to adopt agendas that focus on pandemic preparedness and response, specifically the GHSA. Funding to bridge capacity gaps as it pertains to national health security will provide the added incentive to adopt the GHSA. When funding is tied to the achievement of targets within the chosen action package(s), then completion of proposed deliverables, and closure in preparedness gaps, could conceivably be more attainable.

Governmental commitment to the adoption of the GHSA is another key determinant in the realisation of this agenda, however, governance challenges, as it relates to the adoption of the GHSA, remain. For example, Bell *et al.* (2017) consider a fundamental issue with GHSA adoption, which is linked to the capacities for implementation. This is that evaluation capacities need to be there for countries to demonstrate their contributions towards GHSA. Capacity development is partly about having skilled personnel in place whereby evaluation is part of policy design processes at national, regional, and local levels. It is also about having the skills in place to undertake community engagement, on the basis that communities themselves are also important sources of data/information on the effectiveness of health systems and interventions (Armstrong-Mensah & Ndiaye, 2018). Indeed, Armstrong-Mensah & Ndiaye (2018) argue that to mitigate future health threats there is a need build capacity to prevent, detect, and respond to infectious diseases, and thereby contain threats at their source. They note that ‘a country’s ability to prevent a local disease outbreak from becoming an epidemic often rests with the level of knowledge about the situation and the actions taken at the community level’. Moreover, capacity development is also important in terms of workforce development within healthcare settings. Purva *et al.* (2019) investigated the ‘core capacities’ for antimicrobial stewardship within Indian hospitals. The authors conclude that, in order to be better placed to accommodate the global health security on AMR, developing prescription policies, restricting the usage of high antibiotics, implementing

education and training and leadership support would be a positive step forward (Purva *et al.*, 2019).

At a systems level, Paranjape & Franz (2015) discuss lessons around the implementation of global health security programmes, and they emphasise the need for systems to be adequately agile to allow for interagency working given that global health imperatives require the ability to work across boundaries and cross-sectoral agencies (Paranjape & Franz David, 2015). This being the case, there is a need for multi-level leadership within systems, but the challenge is to avoid confusing lines of accountability and overly complex arrangements, otherwise these risks blame games and a reduced likelihood that actors will take responsibility for their performance (Connolly, 2020). In many senses, these issues point to structural barriers within systems and the requirement for national legislation to accommodate the GHSA. For example, Meier *et al.* (2017) suggest that ‘international efforts to address global health security have long focused on public health science rather than on the enabling legislation and authorizing regulations that empower, mandate, and authorize governments to prevent, detect, and respond to public health emergencies’ (Meier *et al.*, 2017). The authors argue, with a specific focus on Sub-Saharan Africa, that to achieve GHSA objectives and targets, new or supplemental legal authorities and powers are needed to strengthen existing legal obligations and implement the IHR frameworks. Indeed, Anderson *et al.* (2019) note that the ‘good governance of AMR policies is a key determinant for success and should be at the forefront of any efforts to address the AMR challenge’ (Anderson *et al.*, 2019).

The Tripartite Collaboration on AMR is the current UN-focused governance arrangement, comprising of the WHO, the Food and Agriculture Organization of the United Nations (FAO), and the World Organisation for Animal Health (OIE). However, Rochford *et al.* (2018) argue that there are limitations with this. It is worth quoting them in full:

Global public goods such as antimicrobials can only be preserved if all countries cooperate. A multi-stakeholder, multi-sectoral, and truly global response to AMR is required. This response needs to be reinforced by stronger global governance that has a mandate across health, agriculture, and the environment and is supported by a well-resourced secretariat. This approach would include four elements. First, an effective mandate to encourage countries to make binding national commitments with support provided to strengthen capacity, capability, and funding for alternatives to antimicrobials and innovations in LMICs. Second, a process for reporting on these commitments. Third, the capacity, ability, and authority to advocate for AMR. Fourth, is the ability to mobilise all stakeholders, including the private sector, civil society, and philanthropic actors.

Rochford *et al.*, call for a high-level AMR Commission and this is a response to the need to accelerate action to address

AMR globally and that AMR needs a greater presence within the global policy environment. Rochford *et al.* (2018) also call for a clear top-down and intergovernmental approach, in a similar way to that of the Intergovernmental Panel on Climate Change but to have a similar arrangement for AMR. The leadership, according to Rochford *et al.* (2018), needs to be drawn from a Global Steering Board which should be delivery-focused, monitor and report progress, and be a mechanism for joining up stakeholders and professional groups. Yet they also acknowledge that effective action is only possible if national authorities and agencies organise themselves to meet the challenges posed by the global threats of AMR. Anderson *et al.* (2019) also discuss the need to focus on national action plans (NAPs) for addressing AMR and this is essentially a response to the Global Action Plan on Antimicrobial Resistance in 2015, which asked for all countries to develop national action plans (NAPs) by 2017 but progress has been varied across the globe (Anderson *et al.*, 2019). The lack of progress was also the concern of Rochford *et al.* (2018). Part of the issue is capacity challenges, as discussed earlier in this paper, yet another is the complexity of the global health security landscape, which can hamper the clarity of health security messaging: They call for the following in NAPs:

- Increasing awareness of AMR
- Strengthening surveillance and monitoring, and moving towards national 'One Health' surveillance systems
- Strengthening antimicrobial stewardship in human health
- Strengthening infection prevention and control (IPC) in human health
- Strengthening IPC and reducing inappropriate antibiotic use in animals
- Limiting the exposure of antimicrobial-resistant pathogens to the environment.
- Fostering R&D of new antimicrobial therapies, diagnostics, and vaccines

For the details the results of a review of 92 national AMR plans across the globe, see Table 1 below.

The data in Table 1 shows that many national plans require to be updated and it is only India, Eswatin, Kenya, and, Afghanistan and Singapore that address AMR in the environment and acknowledge the actions needed to address AMR in pharmaceutical wastewater based on adopting a One Health approach. The vast majority of the plans are framed from a One Health perspective and, with cross-sectoral working in mind, highlight the importance of addressing AMR in the environment. Adopting a One Health approach to AMR within is dependent on strengthened and adequate global health security arrangements, that will serve to support the SDG agenda, and equally, have in place evidence-based national action plans where there are clear reporting and accountability structures.

## Dual implementation of GHSA and SDGs

The narrowed focus of the GHSA provides opportunities to build capacity to address infectious disease preparedness and response gaps. These gaps undermine the achievement of SDGs yet building capacity that targets these gaps is not specifically mentioned by the SDGs (Bali & Taaffe, 2017). The dual implementation of GHSA and SDGs, therefore, become necessary as the GHSA fills the gaps that facilitate the achievement of the SDGs, given that other SDG goals are affected by infectious diseases in general (including healthcare systems, economic development, social infrastructure, and partnerships for the achievement of the SDGs). Similarly, addressing the issues targeted by the SDGs (e.g. climate change, water and sanitation, poverty, responsible production, and health and well-being) reduces opportunities for the emergence and spread of infectious disease threats, which remain the primary focus of the GHSA (Bali & Taaffe, 2017). The dual implementation of GHSA and SDGs should be considered as an opportunity to deliver on a complementary and mutually beneficial set of goals that advance each other. This dual implementation of both agendas will involve fulfilling the goals of the GHSA within the context of the SDGs, which in turn also strengthens the foundations of the SDGs (Hotez, 2017). When synergistic activities that facilitate their dual implementation are identified, resources will be more effectively utilised, and the implementation of one agenda will not be at the detriment of the other.

The first strategic step in the dual implementation of both agendas is the identification of baseline factors that link both agendas and influence the realisation of the goals that these agendas target. Bearing in mind the threat AMR poses to the achievement of a number of SDGs, and AMR relevance within the GHSA, it would be desirable to understand and mitigate its identified drivers as a means to realise the mutual AMR (sensitive or specific) goals for these agendas. This could be achieved through the implementation of programmes that: a) facilitate antimicrobial stewardship programmes to promote optimal antimicrobial use (Rzewuska *et al.*, 2020); b) improve water, sanitation, and hygiene (WASH) to prevent the cycle of disease, antimicrobial misuse and AMR spread (FAO *et al.*, 2020); and c) provide access to effective medicines, vaccines and diagnostics to ease access problems (WHO, 2020).

Understanding the role of One Health approaches is also critical to the realisation of these agendas. With focus on AMR, One Health approaches should enhance understanding of the complex interactions that fuel antimicrobial resistance (McEwen & Collignon, 2018); facilitate comprehensive collaboration for increased AMR surveillance and monitoring of antimicrobial use (European Commission, 2017; McEwen & Collignon, 2018); and enable the creation of plans that support both agendas in AMR prevention, detection, response and control (Mackenzie & Jeggo, 2019). In terms of monitoring processes, Razavi *et al.* (2020) argue that *context* is important for performance measurement and suggest that capturing change

in preparedness overtime for each individual country may be a more useful way of using this information to track the progress and impact of national public health institutes, projects and partnerships.

The second strategic step in their dual implementation is adopting evaluation methodologies which, perhaps qualitatively, uncover the political and socio-economic conditions that shape individual health systems. That is not to say that quantitative measures are less than useful yet using mixed methodologies to understand context means getting to grips with the governance arrangements of the states being measured (including the quality of their public administration systems). This is needed to determine preparedness for disease outbreaks, and the level of prioritisation afforded to it. Moreover, understanding governance and capacities of global health security institutions

requires the examination of the quality of public leadership (Connolly & van der Zwet, 2021).

That being the case, the third strategic step could include refracting aspects of the public value-based approach to governance into the development of One Health-underpinned health security arrangements (which is rooted in public administration scholarship). Value-based approaches to governance promote the need for reinventing governance and being concerned about ‘how government works’ in order to achieve outcomes (such as increased health and wellbeing) (LSE British Policy and Politics, 2021). Public value-based approaches would see an approach to governance that promotes collaborative governance, resource sharing, and incorporates evaluation into policy design (Connolly & van der Zwet, 2021). This perspective brings into focus the outcomes accrued from the work of global institutions

**Table 1. National AMR plans (only includes countries that have their plan available via the WHO website).**

WHO Regional Office	*Country and date of report	One Health framing detailed	AMR in the environment <i>explicitly</i> considered	Includes activities that <i>explicitly</i> address pharmaceutical wastewater management
Africa	Burkina Faso 2017–2020	Y	Y	N
	Eritrea 2021–2025	Y	Y	N
	*Eswatini 2018–2022	Y	Y	Y
	Ethiopia 2015–2020	Y	Y	N
	Ghana 2017–2021	Y	Y	N
	*Kenya 2017–2022	Y	Y	Y
	Liberia 2018–2022	Y	Y	N
	Malawi 2017–2022	Y	Y	N
	Mauritius 2017–2021	Y	Y	N
	Nigeria 2017–2022	Y	Y	N
	Rwanda 2020–2024	Y	Y	N
	Sierra Leone 2018–2022	Y	Y	N
	South Africa 2018–2024	Y	Y	N
	Uganda 2018–2023	Y	Y	N
	Tanzania 2017–2022	Y	Y	N
	Zambia 2017–2027	Y	Y	N
	Zimbabwe 2017–2021	Y	Y	N
	Americas	Barbados 2017–2022	Y	Y
Canada 2017		Y	Y	N
United States		Y	Y	N



WHO Regional Office	*Country and date of report	One Health framing detailed	AMR in the environment <i>explicitly</i> considered	Includes activities that <i>explicitly</i> address pharmaceutical wastewater management
Eastern Mediterranean	*Afghanistan 2017–2021	Y	Y	Y
	Bahrain 2019	Y	Y	N
	Egypt 2018–2022	Y	Y	N
	Iran 2016–2021	N	Y	N
	Iran 2018–2022	Y	Y	N
	Jordan 2018–2022	Y	Y	N
	Saudi Arabia 2017	Y	Y	N
	Lebanon 2019	Y	Y	N
	Libya 2019–2023	Y	Y	N
	Oman 2020	Y	Y	N
	Pakistan 2017	Y	Y	N
	Palestine 2020–2024	Y	Y	N
	Sudan 2018–2020	Y	Y	N
	United Arab Emirates 2019–2023	Y	Y	N
	Belgium 2020–2024	Y	Y	N
	Czech Republic 2011–2013	N	N	N
	Denmark 2017	N	N	N
	Finland 2017–2021	Y	Y	N
	France 2021	Y	N	N
	Germany 2020	Y	Y	N
	Ireland 2021	Y	Y	N
	Italy 2017–2020	Y	Y	N
	Netherlands 2015–2019	Y	Y	N
	Norway 2015–2020	Y	Y	N
	Republic of Serbia 2019–2021	N	N	N
	Sweden 2020–2023	Y	Y	N
	Switzerland 2015	Y	Y	N
	Tajikistan 2018	Y	Y	N
	Republic of Macedonia 2012–2016	N	N	N
	Turkmenistan 2017–2025	N	N	N
	United Kingdom 2019–2024	Y	Y	N

WHO Regional Office	*Country and date of report	One Health framing detailed	AMR in the environment <i>explicitly</i> considered	Includes activities that <i>explicitly</i> address pharmaceutical wastewater management
South East Asia	Bangladesh 2017–2022	Y	N	N
	Bhutan 2018–2022	N	N	N
	Timor-Leste 2017–2020	Y	Y	N
	Korea 2018–2020	Y	N	N
	*India 2017–2022	Y	Y	Y
	Indonesia 2017–2019	Y	Y	N
	Maldives 2017–2022	Y	Y	N
	Myanmar 2017–2022	Y	Y	N
	Nepal 2016	Y	Y	N
	Sri Lanka 2017–2022	Y	Y	N
	Thailand 2017–2021	Y	Y	N
Western Pacific	Australia 2020	Y	Y	N
	Brunei Darussalam 2019–2023	Y	Y	N
	Cambodia 2019–2023	Y	Y	N
	China 2016–2020	Y	Y	N
	Cook Islands 2016–2020	N	Y	N
	Micronesia 2019–2023	N	N	N
	Fiji 2015	Y	Y	N
	Japan 2016–2020	Y	Y	N
	Lao PDR 2019–2023	Y	Y	N
	Malaysia 2017–2021	Y	Y	N
	Mongolia 2017–2020	N	N	N
	Nauru 2021–2025	N	Y	N
	New Zealand 2017	Y	N	N
	Papa New Guinea 2019–2023	Y	Y	N
	Philippines 2019–2023	Y	Y	N
	Marshall Island 2019–2023	N	N	N
	*Singapore 2017/2019	Y	Y	Y
	Tuvalu 2021–2025	Y	N	N
	Vietnam 2013–2020	N	N	N

\* Countries that include all aspects to a degree, are highlighted in yellow background. Whilst there appears to be a recognition of the contribution of pharmaceutical wastewater to the development of AMR, the AMR NAPs hardly contain activities that specifically address this problem. The majority that include a One Health Framing do so based on including AMR in the environment as a component of their national plans.

at multiple levels of governance. For the global response to AMR, a values-based approach to health security would instil governance norms whereby meaningful co-production exists between leaders within health systems and their citizens on the basis of forming networks of deliberation and delivery. This means that when it comes to the development of global initiatives and associated measures, there is a better degree of realism about the governance context surrounding the health system being measured. Those researching AMR reach similar conclusions when examining the potential for One Health approaches within health systems. Mitchell *et al.*, (2020) ‘recommend an inclusive approach to multi-sectorial communication supported by government network activities to facilitate partnerships and create cross-disciplinary awareness and participation’ (Mitchell *et al.*, 2020). Moreover, Gongal *et al.*, (2020, emphasis added) encourage national governments to ‘develop a One Health strategic framework taking into account the country’s *context* and priorities’. Correspondingly, our argument about the need for mixed methods within global health security measures is not dissimilar to what is proposed by other AMR researchers who seek to take account of the factors which shape implementation processes. Wernli *et al.* (2020) note that ‘moving the agenda forwards requires an improved understanding of the diversity of interventions, their feasibility and cost–benefit, the implementation factors that shape and underpin their effectiveness, and the ways in which individual interventions might interact synergistically or antagonistically to influence actions against antimicrobial resistance in different contexts’.

## Conclusion

Existing agendas, such as the UN SDGs and GHSAs, already provide the framework needed to close pandemic preparedness and response gaps, whilst simultaneously promoting global development. Helping leaders understand the role of these agendas, equipping them with the resources to identify where the gaps lie, and implementing activities that close these gaps will make important differences. There is also a need for global health institutions to invest more in thinking about the word *governance* within the phrase *health security governance*. They should consider refracting public value-based ideas into health security governance as this will promote collaborative governance, resource sharing, and incorporate evaluation into policy design processes. Lastly, mixed methods are needed to

understand the context of national preparedness and capacities as standardization-based measures and league tables have clear limitations. In light of the COVID-19 experience, and the associated stress on health, economic and social systems, there are now calls for the introduction of new agendas focused on health security with AMR requiring greater prioritisation within global health security governance arrangements.

Moreover, the review of the national plans for AMR in Table 1 highlights the patchy coverage of AMR strategies and this presents challenges for the global governance of AMR. For example, only some countries have recognised the problems associated with AMR in the environment in detail, particularly by addressing the management of wastewater containing pharmaceuticals. In many senses, this article represents a springboard for future research to follow up on the national AMR plans in order to analyse specific case studies of how a One Health approach to AMR in the environment has been implemented in practice within different aspects of health and environmental systems.

Finally, there are ways in which interdisciplinary insights from the public policy and administration fields can enable new ways of conceptualising global health security for AMR and these include integrative public leadership (Morse, 2010), co-productive approaches to governance (Connolly & van der Zwet, 2021), outcomes-based evaluation based on mixed methods (Connolly, 2016), and network leadership within and across national health systems (Connolly, 2020). There are those who criticise the ambiguities of the discourse surrounding AMR and One Health (Kamenshchikova *et al.*, 2019) so it is important that global measures are piloted to demonstrate their relevance for health systems. More data should be collected to show how international and national policy strategies can be translated into local action. This would help to promote lesson learning and the sharing knowledge about the benefits of a One Health approach to AMR and, moreover, how AMR can be better represented within global health security approaches and measures (Powell *et al.*, 2017).

## Data availability

All data underlying the results are available as part of the article and no additional source data are required.

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# Open Peer Review

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## Version 1

Reviewer Report 10 June 2022

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**Lisa Avery** 

The James Hutton Institute, Aberdeen, UK

This paper addresses the role of the UN Sustainable Development Goals and Global Health Security Agenda in tackling the global threat of AMR. The authors highlight the omission of specific indicators and actions on AMR in the SDGs and explore how the GHSA approach could be used in conjunction with SDGs to better- govern approaches to AMR. Indeed, the omission of specific action on AMR within agenda 2030 is worrying considering AMR will have much more wide-reaching consequences to society than e.g. the recent pandemic. The paper is well written and timely. Some minor suggestions are highlighted below:

### Introduction

Paragraph 2 " include social scientists who can propose a set of solutions for dealing with health security threats." I feel this simplifies the role of social scientists in that their inclusion is much more far-reaching than proposing solutions (which actually needs to be done jointly across all of the disciplines). A social science input can be particularly useful in developing participatory approaches across sectors which tends to bring about much greater stakeholder buy-in and thus is more likely to have successful outcomes. On a similar note, there are other sectors who equally bring great value - e.g. economists, life cycle analysts etc. Essentially - the role of the interdisciplinary approach is simplified a little too much here and could probably be explained a little better.

### The UN SDGS and AMR

First paragraph - would have been interesting to see a table of the 12 SDSGs that AMR relates to - did you consider the animal welfare aspects of Agenda 2030?

Paragraph 2 - I wholeheartedly agree that only considering which human infections arose from two resistant species tells us nothing about the wider context of AMR. Indicators across animal health and environment are critical to a One-Health approach.

Paragraph 3 - worth including that the WHO produced a list of priority resistant pathogenic bacteria - could a recommendation be to consider bringing this into the SDGs

(<http://www.who.int/medicines/publications/global-priority-list-antibiotic-resistant-bacteria/en/>)- and considering the WHO Tricycle approach (<http://resistancecontrol.info/2017/the-esbl-tricycle-amr-surveillance-project-a-simple-one-health-approach-to-global-surveillance/>).

Points made at the end of paragraph 3 of this section are critical - is there a sense of which is most likely to be established soonest - inclusion of AMR indicators in SDGs or a global framework approach? Given time is of the essence with this threat.

#### GHSA Section:

Paragraph 6 - "leaders at all levels of government must understand that prioritising health security is a necessity." I would be inclined to add in here "in a fair and proportionate manner" after "health security" - this actually circles back to the lack of focus on mental health mentioned in the prior paragraph in that it does indeed seem to be one of the very apparent omissions of GHSA. There was little account of mental health in measures taken during the recent pandemic, which were apparent during the pandemic and on-going impacts are seen.

Paragraph 7 - Should this be rephrased? "restricting the usage of HIGH ANTIBIOTICS,"

Paragraph 8- "For example, Meier et al. (2017) suggest that 'international efforts to address global health security have long focused on public health science rather than on the enabling legislation and authorizing regulations that empower, mandate, and authorize governments to prevent, detect, and respond to public health emergencies' (Meier et al., 2017). The authors argue, with a specific focus on Sub-Saharan Africa, that to achieve GHSA objectives and targets, new or supplemental legal authorities and powers are needed to strengthen existing legal obligations and implement the IHR frameworks. Indeed, Anderson et al. (2019) note that the 'good governance of AMR policies is a key determinant for success and should be at the forefront of any efforts to address the AMR challenge' (Anderson et al., 2019)."

Authors could highlight that legislative powers need to be developed with communities rather than imposed, both to ensure potential side-effects of such legislation are taken into account and that buy-in leads to understanding and therefore compliance.

"Part of the issue is capacity challenges, as discussed earlier in this paper," If there are capacity issues, it seems that something beyond global top-down legislation is key to tackling this issue.

Table 1 & following paragraph. The finding that One-Health Framing is directly linked to the inclusion of AMR in the environment is an interesting observation. The first sentence in the paragraphs following the table needs some attention though as depending on how you read it, it can imply that those are the only countries that consider the environment, which isn't the case (UK one does, as an easy e.g.) - I think it means to consider both environment and pharmaceutical wastewater... although the UKNAP does seem to address pharmaceuticals i.e. antimicrobials in waters - section 2.4.2 - or are the authors using specific criteria to determine whether a NAP does or doesn't address these? Could the authors check this bit please?

Last paragraph brings the discussion together nicely

#### Conclusions:

I wonder if within the conclusions (paragraph 2) - a recommendation might be to work on getting

more NAPs held with the WHO?

**Is the work clearly and accurately presented and does it engage with the current literature?**

Yes

**Is the study design appropriate and does the work have academic merit?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

Yes

**Are all the source data and materials underlying the results available?**

Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**

Not applicable

**Are the conclusions drawn adequately supported by the results?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** I work on AMR in the environment in particular in water bodies and catchments, frequently work in an interdisciplinary manner and have a good understanding of One-Health approaches. I have undertaken research in the UK, Africa and India and therefore have a good understanding of the importance of the local context on implementing AMR mitigations.

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

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