**Appendix A**

**Summary of Inclusion and Exclusion Criteria**

|  |  |
| --- | --- |
| **Inclusion Criteria** | **Exclusion Criteria** |
| English language | Written in a language other than English |
| Published on or after January 1, 2012 | Published before 2012 |
| Peer reviewed articles | Non-peer reviewed and grey literature |
| Addressed the role of governance in AMR surveillance | Did not address the role of governance in AMR surveillance |

**Appendix B**

**Sample Search Strategy (PubMed)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Database: PubMed****Date: 25/07/2022** | **Search Words** | **Limits (filter, limits, refine)** | **Number of records** |
|  | governance OR (“intersectoral governance” OR “One Health governance”) AND (surveillance OR monitor\*) AND (“antimicrobial resistance” OR “antibiotic resistance” OR “antiviral resistance”) AND (evaluat\* OR “program evaluat\*” OR “evaluation tool”) | Publication date: 2012-2020;English language;Full text available | 94 |

**Appendix C**

**PRISMA-P Diagram**



**Appendix D**

**Scoping Review Protocol**

**Abstract**

**Background** Antimicrobial resistance (AMR) is a complex and pressing global health issue that affects human, animal, and environmental health. AMR surveillance involves the collection and analysis of data for the detection, monitoring, and prevention of AMR threats to public health. Adequate surveillance allows governments and other actors to understand the epidemiology of AMR through comparison with demographic and clinical data collected from the population. As this information is used to shape policy responses, including government initiatives and legislation aimed at curbing the threat of AMR, understanding the governance aspects that lead to strong AMR surveillance systems is central. The objective of the proposed study will be to identify and explore the existing evidence in published academic research that addresses the evaluation of governance of AMR surveillance systems from a One Health perspective.

**Methods** This scoping review will follow the framework outlined by Peters et al. (2020) in the Joanna Briggs Institute Reviewers’ Manual (Peters et al., 2020). English-language publications from January 2012 onwards retrieved from the Public Health (ProQuest), Medline (PubMed), and Web of Science electronic databases will be used. Publication types will be limited to peer-reviewed academic literature, including books and book chapters, original research articles, editorials, protocol papers reviews, and discussion papers. Inclusion will be based upon the article’s ability to answer the identified research questions which to aspects of One Health governance of AMR surveillance. Two reviewers will independently screen the titles and abstracts of search results and both reviewers will conduct full-text screening and populate a data extraction form with the relevant content. Thematic analysis will be performed in NVivoTM 12 and a summary of the themes and sub-themes reported narratively.

**Discussion** This scoping review protocol describes a method to identify, map, and synthesize the existing evidence on the design, governance, and evaluation of AMR surveillance systems. An additional goal is the identification and mapping of potential gaps in knowledge related to the governance of AMR surveillance. This will provide invaluable insight for future interdisciplinary and multisectoral studies and researchers. The findings and implications may be of interest to a diverse array of stakeholders and audiences, including policymakers, scientists, and global health actors that seek to collaboratively address the global social, economic, and health burden of AMR.

**Keywords:** antimicrobial resistance, AMR, antibiotic resistance, surveillance, monitoring, governance, One Health

**Background**

Antimicrobial resistance (AMR) is a complex and multifaceted global public health issue. Driven by human activities that promote the use of antibiotics and antimicrobials in healthcare systems, agricultural production, and the environment, AMR has the potential to cause severe negative consequences for international health, food security, and livelihoods (Holmes et al., 2016). If it is not addressed, AMR could cause millions of preventable deaths each year and cost the global economy billions of dollars in healthcare costs and lost trade and livestock production (Anderson et al., 2019). The issue transcends borders and can only be addressed through collective global action. However, AMR is not a new threat. Drug resistant bacterial infections are already estimated to cause 1.27 million deaths per year, most of which occur in low-resource settings (Murray et al., 2022). The Review on Antimicrobial Resistance estimated that 10 million people will die per year due to AMR by 2050 (O’Neill, 2016). An additional 5.7 million people die each year from a lack of access to antibiotics due to an inequitable distribution of resources that jeopardizes the world’s ability to achieve sustainable development (Jasovský et al., 2016). The resulting increase in healthcare, disease treatment, and infection prevention costs could shrink the annual global GDP by 3.8% by 2050 (World Health Organization, 2019).

 In this scoping review, governance is defined as the processes through which governmental actors, and non-governmental actors such as civil society, private sector actors, and non-governmental organizations, engage in policymaking and the implementation of those policies (Biswas, 2020). These processes occur simultaneously on the local, national, and global scale and involve a variety of actors that participate at each level. At each scale, there are entry points for analyzing the governance of AMR surveillance. Effective global governance for health requires fair, equitable global governance that allocates resources according to the greatest need (Ottersen et al., 2014).

AMR surveillance involves the analysis and collection of data that is used to detect, monitor, and prevent AMR threats to public health. This surveillance further informs the epidemiology of the threat to public health and its resulting burden on the population. It can include, for example, the compendium of antibiotic susceptibility test results conducted by microbiology laboratories using clinical samples sent for investigation and research (A. P. Johnson, 2015). This method allows governments to compare results with demographic and clinical data at the population level to gain insight into the underlying epidemiology. The information gained further facilitates the development of government initiatives to reduce the burden of AMR. These surveillance programmes and activities may be adequate and effective at the time of implementation; however, the local or national context may change over time. New findings from laboratory surveillance activities and data analysis, changes to disease demography, epidemiology, and clinical treatment practices, new opportunities, and/or a change in resource availability and government priorities can all lead initial surveillance programs to lose their fit for purpose over time. This means that evaluation of the governance of existing surveillance methods is crucial to ensure that AMR prevention legislation and practices remain effective and up to date.

 This paper outlines a protocol for a scoping review into the contribution of the relevant aspects (accountability, collaboration and coordination, equity, governance evaluation, management, participation, sustainability, and transparency) of an OH approach to the governance of the surveillance of AMR. The scoping review will use the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018). This approach will allow for the identification and mapping of available evidence on the governance of AMR surveillance in the existing academic literature, and for the clarification of conceptual understandings. It is an ideal tool to determine the depth of coverage on a given topic or research area in the existing body of literature as it gives a clear indication of the volume of evidence and a detailed overview of its focus.

 The scoping review, therefore, aims to identify, summarize, synthesize, and map the existing knowledge, literature, and evidence from published academic research addressing the governance of AMR surveillance systems. The review is part of a larger study that will attempt to answer the following research questions:

1. What are the relevant OH governance aspects for AMR surveillance?
2. How do these aspects impact surveillance outcomes?
3. What are the various facilitators and barriers to integrating OH governance principles into AMR surveillance?
4. What are the existing knowledge gaps in the literature pertaining to the OH governance of AMR surveillance?
5. How can OH governance support the alignment of surveillance systems and the use of evidence to inform policy and policy creation?

**Methods**

**Study Design**

 The procedural approach draws on a scoping review framework. Scoping reviews facilitate the investigation of broad research questions that require a systematic mapping of the volume and focus of available scientific literature on a particular topic (Munn et al., 2018). For emerging fields or issues such as AMR, AMR surveillance evaluation, and infectious disease governance, scoping reviews are a useful tool for analyzing the evidence in order to develop more specific research questions that may be addressed using more in-depth review methodologies. Finally, scoping reviews can be invaluable in uncovering and highlighting existing knowledge gaps within the literature.

 The present protocol is reported in accordance with the reporting guidelines provided in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) 2015 statement (Moher et al., 2015). The study will adhere to the methodological framework developed by Arksey and O’Malley (2005) and Levac et al. (2010) and expanded upon by Peters et al. in the most recent edition of the Joanna Briggs Institute Reviewers’ Manual (2020) (Arksey & O’Malley, 2005; Levac et al., 2010; Peters et al., 2020). It will be reported in accordance with Tricco et al.’s (2018) PRISMA Extension for Scoping Reviews (PRISMA-ScR), which includes:

1. Identification of the research questions and objectives
2. Identification of relevant published studies and documents
3. Selection of relevant studies and documents
4. Extraction and charting of the evidence and data
5. Collation, summarization, and reporting of the results, and identification of the implications of the study findings for policy, practice, and research (Tricco et al., 2018).

Finally, the scoping review will reflect the changes to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) that are relevant to the reporting of scoping reviews, as outlined in by Joanna Briggs Institute (Page et al., 2021; Silver, 2021).

A thematic analysis in NVivo™ 12, building upon deductively developed coding categories, will be conducted to answer the research questions. The initial coding categories and themes will be theoretically derived from the existing literature on a One Health approach to AMR governance evaluation, most notably the Anderson et al. (2019) literature review concerning the governance dimensions of national action plans for AMR (Anderson et al., 2019). The coding themes may be inductively enriched due to new information uncovered during the coding process.

**Eligibility Criteria**

The Problem, Interest, and Context (PIC) framework can be used to outline the eligibility criteria, frame the research questions, and contribute to the development of a search strategy. The PIC framework for this study can be found in Table 1.

**Table 1.** PIC framework for research questions

|  |  |
| --- | --- |
| Problem | Governance of Antimicrobial Resistance |
| Interest | Evaluation of AMR governance surveillance methods |
| Context | One Health governance |
| PIC question | How can One Health governance improve the functioning of AMR surveillance systems and the use of evidence to inform policy? |

To retrieve all of the peer-reviewed academic articles relevant for the scoping review, the study team will conduct a search of pertinent databases. The inclusion criteria will be studies that were: published in the last 10 years (from January 1st, 2012, and onwards), written and published in the English language, and that explicitly address the role of governance aspects (accountability, collaboration and coordination, equity, governance evaluation, management, participation, sustainability, and transparency) that inform AMR surveillance efforts or the evaluation of AMR surveillance methods. Publication types will be limited to academic literature – books, book chapters, commentaries, editorials, protocol papers, research articles, reviews, communications of findings, and discussion papers. Blogs, book reviews, corporate literature, leaflets and brochures, policy statements, reports of scientific meetings, and websites will be excluded. Academic literature published before 2010 in languages other than English, and that does not address the governance aspects of AMR surveillance and AMR surveillance evaluation will be excluded. Quantitative, qualitative, and mixed-methods study designs will be included. A justification for inclusion of all relevant evidence will be reported during the full-text review stage.

**Information Sources**

The Public Health Database (ProQuest), PubMed, and Web of Science electronic databases will be searched for potentially relevant studies published in English between January 1, 2012, and July, 2022. Citation searching may also be utilized to identify additional relevant materials that were not indexed in the above databases. Additional literature from a previous scoping review may be included. An example search strategy for PubMed is provided in Appendix A.

**Search Strategy**

The literature search strategies will consist of a two step process of searching Medline (Ovid) to identify all possible relevant keywords which will then be adapted to the particularities of each database. These search terms will be defined using the PIC question. Boolean logic and operators (i.e., ‘AND,’ ‘OR,’ and ‘NOT’, and the truncation operator ‘\*’) will be used to build and refine search terms and concepts. The search will include a broad range of terms and keywords related to the evaluation of surveillance methods in the context of the governance of AMR. After screening the abstracts, records received from the search will be managed through Zotero citation manager (George Mason University, Fairfax, VA) for collation of the bibliography and completion of references.

**Selection of Sources of Evidence**

The review process will consist of two levels of screening: a title and abstract screening and a full-text screening. For the title and abstract screening, two reviewers will conduct the search using the electronic databases listed above. The researchers will keep a record of their searches and exclude duplicate results. All titles and abstracts will be read once, evaluated, and authenticated independently by two researchers using the Covidence systematic review management platform (Cochrane, Veritas Health Innovation, Melbourne, Australia). Documents that do not meet the pre-defined eligibility criteria will be excluded and not subject to full-text evaluation. The researchers will hold scheduled discussions during the initial week of screening to address any questions related to the screening process that may arise and to further specify the inclusion criteria. If there is a debate as to whether to include an article, a third reviewer may be consulted. Any disagreement about how to conduct the screening will be discussed until a consensus is reached.

During the second round of screening, each researcher will independently assess the full text of the remaining documents to determine if they meet the inclusion and exclusion criteria. Another round of discussions will occur during the final week of screening to examine concerns related to the screening process and to provide justification for the exclusion of articles that were deemed irrelevant to the study purposes. In the event of remaining uncertainty or disagreement, the relevant studies will be independently reread and re-evaluated by a third reviewer. A visual summary of the selection process will be captured in a flow diagram as per the PRISMA-P statement (consult Appendix B) (Page et al., 2021).

**Data Extraction and Charting Process**

A data charting methodology using NVivo™ 12 (QSR International, Cambridge, MA) qualitative data analysis software will be used to capture relevant details for studies examined during the screening process. One member of the research team will work independently to extract the publication details and other data, while recording the justification for exclusion via the tracking comments. Any disagreements will be resolved through discussion and, when necessary, independent validation by the third reviewer. As is common practice when conducting scoping reviews, two independent reviewers will pilot the charting table to adjust sensitivity using a sample of three studies (Granheim et al., 2020). The data extraction form will then be adjusted as required to align with feedback from the reviewers. The charted data will be compared and discussed at regular intervals to ensure consistency between reviewers and to enable iterative consideration of emerging themes and categories. To enable adequate abstraction of all data relevant to the research questions, the data chart will be continuously augmented and updated. A preliminary template of a charting table is provided in Table 2.

**Table 2**. Preliminary charting table template for a scoping review protocol

|  |  |
| --- | --- |
| Publication details | Description |
| Author(s) |  |
| Title |  |
| Year of publication |  |
| Journal |  |
| Type of publication  | (e.g., commentary, editorial, research) |
| Study setting | Geographic area of study (e.g., country, urban/rural, country income level) |
| Field of study/academic discipline | (e.g., sociology, epidemiology, medicine) |
| Study objectives/research questions |  |
| Study context (if applicable) | (e.g., pharmaceutical sector, healthcare sector, local/national/international policy sector) |
| Study population | (e.g., vulnerable populations) |
| Sample size (if applicable) |  |
| Study design and/or methodological approach | Observational, qualitative report, data collection tools (include data collection methods and analytical approaches) |
| Key results from study or document content | Related to antimicrobial resistance; AMR surveillance; governance of AMR; evaluation of AMR surveillance methods; research, program, and policy implications, etc.Key findings related to the research questions |
| Conceptual/theoretical framework or approach (if applicable) |  |
| Thematic content | Related to the themes/dimensions of AMR surveillance |
| Conclusions | Related to program and policy recommendations; research endeavors; remaining gaps of knowledge; biases, etc.  |

**Data Synthesis**

A flow diagram in obeyance with the PRISMA-ScR guidelines will be used to report the search strategy and the inclusion/exclusion pathway. NVivo™ 12 will be used to collate, store, and chart the data to provide a descriptive summary of the literature. To qualitatively describe study characteristics, a flexible approach will be employed to summarize and synthesize findings using domains that are addressed in the retrieved literature. Thematic content analysis methods will be used to identify themes and gaps in the existing literature and to evaluate, describe, and contextualize relevant information using thematic construction approaches. To quantitatively describe characteristics of the studies selected for inclusion, key data or categories will be obtained from each evidence source and illustrated using a variety of descriptive techniques (e.g., summary and frequency tables, figures). To comprehensively capture and describe emerging themes in the extracted data, a narrative approach will be employed, and topics will be organized by the reviewers into nodes or categories that correspond to the wider domains.

**Discussion**

 The purpose of this scoping review is to map the existing literature pertaining to the aspects of governance that are relevant to AMR surveillance from a One Health perspective. A secondary aim of the review is to identify knowledge gaps related to the governance of AMR surveillance and, in doing so, to provide useful insight for future interdisciplinary research on the global challenges of AMR and its local, national, and global surveillance mechanisms and evaluation processes.

 There are several limitations to the study design. By restricting the results to English language publications only, important information in other languages and unpublished material may be missed. The review team is aware that valuable research that adds to our understanding of AMR surveillance mechanisms is not restricted to published papers that clearly state their intention to directly address the problems of evaluation and surveillance (i.e., the substantial body of epidemiological literature is clearly relevant and may implicitly, but not explicitly, address the research question). However, the team believes that by narrowing the eligibility criteria for this scoping review, the reliability and therefore, the quality of outcomes of this study will be greatly improved. Time constraints and the evolving nature of the subject area further necessitate the use of a narrow approach. Limiting the search strategy to electronic databases may introduce bias into the literature selection process, as qualitative evidence from other sources such as gray literature that may provide additional context about the factors that influence the way in which AMR surveillance is integrated would be excluded. Therefore, to assess the appropriateness of the data collection and data analysis steps, Dixon-Woods et al.’s (2004) checklist that was designed for the appraisal of qualitative research will be used. This will help to limit the magnitude of errors linked to the design and conduct of qualitative research (Dixon-Woods et al., 2004). Further limitations that may arise during the review process will be adequately reported once the results are finalized.

 The key findings, insights, and implications of this review may be of interest to a diverse set of stakeholders and other audiences, including academics and researchers, policymakers from multiple disciplines, and global heath actors working to address the intricate global challenge of AMR surveillance. No ethics approval is required for this scoping review as it draws on secondary analysis of previously published and publicly available documents. The findings of this review will be disseminated through peer-reviewed publications geared towards audiences involved in health research.

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**Appendix E**

**Table of Studies Used in the Scoping Review**

| **Author (Year)** | **Study Design** | **Description & Aim** | **Field of Study** | **Geography** | **Relevant Domains** |
| --- | --- | --- | --- | --- | --- |
| Ahmed et al. (2022) | Empirical | to explore the current situation of NAP on AMR implementation in Bangladesh and to improve policy and practice | public health | Bangladesh | participation, coordination / collaboration, management, sustainability, accountability / transparency, equity |
| Anderson et al. (2019) | Review | to develop the first governance framework to offer guidance for both the development and assessment of NAPs | health policy | global | participation, coordination / collaboration, management, sustainability, accountability / transparency, equity |
| Baum et al. (2017) | Review | to determine the status of OH frameworks and case studies and review possible outcome metrics suitable for future OH evaluation | evaluation science | global | participation, coordination / collaboration, management, sustainability, equity |
| Bennani et al. (2021) | Empirical | to characterize and map the surveillance system for AMR and AMU in the UK using a OH approach and to identify integration points in the system | epidemiology | United Kingdom | participation, coordination / collaboration, management |
| Birgand et al. (2018) | Review | to analyze governance approaches in healthcare systems for AMR prevention | public health | England, France, Germany | participation, coordination / collaboration, accountability / transparency |
| Bordier et al. (2018) | Review | to define the contextual, organizational, and functional characteristics of OH surveillance systems | veterinary public health | global | participation, coordination / collaboration, management, sustainability |
| Boudreau LeBlanc et al. (2022) | Methods | to synthesize an alternative governance model ease collaboration through public-private-academic partnerships | empirical bioethics | Quebec, Canada | participation, coordination / collaboration, management, accountability / transparency |
| Chua et al. (2021) | Empirical | to assess NAPs from SEA nations to identify policy priorities for addressing AMR and best practices in policy formation | public health | Southeast Asia | participation, coordination / collaboration, management, sustainability, accountability / transparency, equity |
| Donado-Godoy et al. (2015) | Empirical | to report on a pilot project to establish baseline data and adapt the working processes between national institutes and stakeholders of the COIPARS | agriculture | Colombia | participation, coordination / collaboration |
| dos. S. Ribero et al. (2019) | Review | to provide insight into the challenges of designing and implementing OH initiatives, their causes and solutions  | public health | global | participation, coordination / collaboration, management, sustainability |
| Essack et al. (2017) | Review | to ascertain whether countries in the WHO African region had implemented at least one aspect of the WHO Policy Package to Combat AMR | public health | WHO African region | management |
| Harant (2022) | Empirical | to assess the transparency of AMR NAPs in 15 African countries using a governance framework | public health | Africa | participation, management, sustainability, accountability / transparency, equity |
| Hawes et al. (2020) | Review | to determine the core components of frameworks that have been described in the literature and which stakeholders are responsible for AMR governance | medicine | global | accountability / transparency |
| Haworth-Brockman et al. (2021) | Empirical | to describe the development, application, and utility of their two-way matrix AMR/AMU surveillance system tool  | public health | Canada | participation, sustainability |
| Hein et al. (2022) | Empirical | to assess the progress and impact of implementation of the AMR NAP in Ghana | public health | Ghana | participation, management, sustainability, accountability / transparency, equity |
| Iskandar et al. (2021) | Review | to demonstrate the limitations and challenges to implement AMR surveillance systems in LMICs | public health | LMICs | coordination / collaboration, management, sustainability, equity |
| Johnson et al. (2017) | Empirical | to explore human, animal, and ecological health professionals’ perceptions of OH zoonotic disease surveillance and identify barriers to implementation | public health | Australia | participation, coordination / collaboration, management |
| Joshi et al. (2017) | Policy and practice | to describe their approach to building and strengthening coalitions to catalyze action against AMR | public health | Ethiopia, Namibia, Zambia | participation, coordination / collaboration, management, sustainability |
| Kirchhelle et al. (2020) | Perspective | to examine whether a universal approach to AMR policy is possible and, if yes, what hallmarks characterise 'good' antibiotic policy | multidisciplinary | global | equity |
| Mader et al. (2022) | Empirical | to describe and analyze national monitoring systems for AMR in bacterial pathogens of animals in 27 countries affiliated to the EU-JAMRAI  | veterinary public health | Europe | coordination / collaboration, management, sustainability |
| Mdegela et al. (2021) | Empirical | assess the use, regulatory roles, and governance of antimicrobials and extent and governance of AMR in agricultural products in Tanzania | veterinary public health | Tanzania | equity |
| Molstad et al. (2017) | Policy and practice | to describe the main strategies of STRAMA and the lessons it offers for the development of other NAPs | public health | Sweden | management, sustainability |
| Munkholm & Rubin (2020) | Empirical | to probe the extent to which NAPs are driven by the GAP (vertical alignment) vs regional and/or income dynamics (horizontal alignment) | social science | global | management, accountability / transparency, equity |
| Otto et al. (2022) | Empirical | to evaluate the progress towards achieving comprehensive, integrated AMR/AMU surveillance in Canada | public health | Canada | management, sustainability |
| Phelan & Gostin (2017) | Commentary | to propose that the process of law-making, implementation, and evaluation can strengthen law as a fixture between OH interfaces | law | global | participation |
| Queenan et al. (2016) | Review | to propose a framework to promote and build a business case for a OH surveillance system for AMR | veterinary public health | global | coordination / collaboration |
| Ruegg et al. (2018) | Empirical | to propose an evaluation framework (NEOH) anchored in systems theory to address the complexity of OH initiatives | human health | global | participation, coordination / collaboration, management |
| Sommanustweechai et al. (2018) | Review | to review Thailand's NSP-AMR and the mandates of implementing agencies and to recommend actions to mitigate implementation barriers | public health | Thailand | coordination / collaboration, management, sustainability, accountability / transparency |
| Sumpradit et al. (2021) | Policy and practice | to assess the implementation of Thailand's NSP-AMR, interim outcomes, and lessons learnt | public health | Thailand | coordination / collaboration, management, sustainability |
| Tangcharoensathien et al. (2017) | Policy and practice | to describe the relevant changes and lessons learnt from the creation of Thailand's NSP-AMR | public health | Thailand | participation, coordination / collaboration, management |
| Uchtmann et al. (2015) | Review | to identify issues caused by a lack of OH surveillance, and barriers and facilitators to the development of OH surveillance  | veterinary public health | global; USA | coordination / collaboration, sustainability, equity |
| Wakimoto et al. (2022) | Review | to assess COVID-19 and zoonoses preparedness and response in Brazil, with a focus on equity and the OH approach | public health | Brazil | management |
| Wernli et al. (2020) | Perspective | to advocate for the creation of an international OH platform to strengthen the global governance of AMR | public health | global | coordination / collaboration, management, equity |
| Wielinga et al. (2014) | Review | to describe the factors, stakeholders, and events that contributed to the emergence and mitigation of AMR in Denmark | agriculture | Denmark | participation, coordination / collaboration |

**Appendix F**

**Screenshot Showing the NVivo Node Structure**



**Appendix G**

**Inputs and Outputs of Governance Domains**

