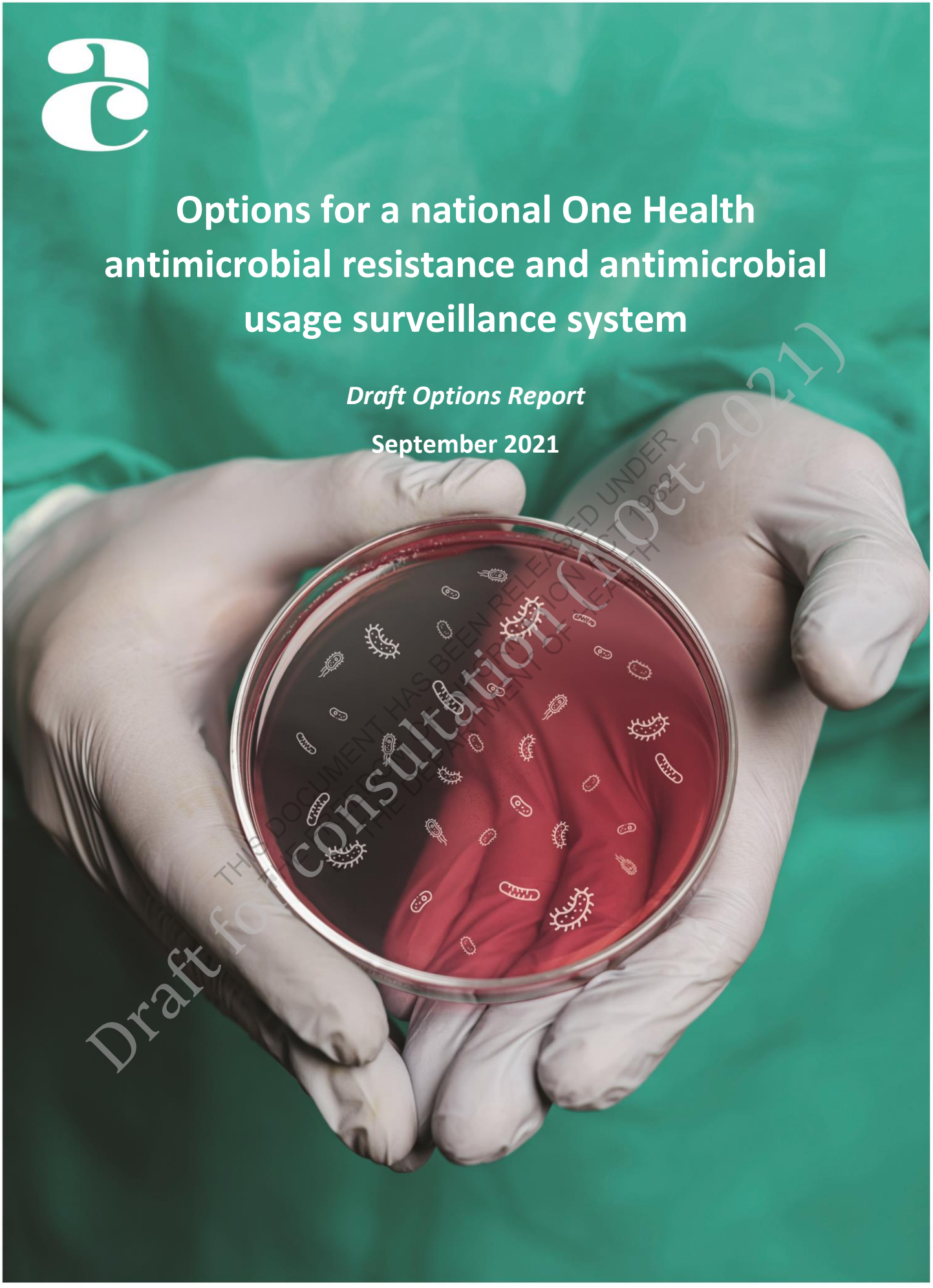
Options for a national One Health antimicrobial resistance and antimicrobial usage surveillance system

Draft Options Report

September 2021



ACKNOWLEDGEMENTS

The original artwork in our Acknowledgement of Country was produced by **Emma Walke**. Emma is a Bundjalung Aboriginal woman from northern NSW.

Allen + Clarke would like to acknowledge and thank all the stakeholders who contributed their views and insights during the engagement process undertaken to inform the development of options for a One Health surveillance system for antimicrobial resistance and antimicrobial usage in Australia. We appreciate the time commitment involved, the frankness and openness of the discussions, and the willingness to support us to understand the intricacies of this highly complex system.

CONTENTS

GLOSSARY

AMR	Antimicrobial Resistance
AU	Antimicrobial Use
ARGG	Antimicrobial Resistance Governance Group
ASTAG	Australian Strategic and Technical Advisory Group on AMR
AURA	Antimicrobial Use and Resistance in Australia
AVA	Australian Veterinary Association
CARAlert	Critical Antimicrobial Resistances
CARSS	Canadian Antimicrobial Resistance Surveillance System
CIPARS	Canadian Integrated Program for AMR Surveillance
CLSI	Clinical and Laboratory Standards Institute
CNISP	Canadian Nosocomial Infection Surveillance Program
DANMAP	Danish Integrated Antimicrobial Resistance Monitoring and Research Program
DAWE	Department of Agriculture, Water and the Environment
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
ESAG	Enhanced Surveillance of Antimicrobial-Resistant Gonorrhoea Program
EUCAST	European Committee on Antimicrobial Susceptibility Testing
FAO	Food and Agriculture Organization of the United Nations
FSANZ	Food Standards Australia New Zealand
GLASS	Global Antimicrobial Resistance Surveillance System
ISDS	The International Society for Disease Surveillance
NAPS	National Antimicrobial Prescribing Survey
NARMS - USA	National Antimicrobial Resistance Monitoring System
OECD	Organisation for Economic Co-operation and Development
OIE	World Organisation for Animal Health
PHAC	Public Health Agency of Canada
POPIT	Process, Organisation, People, Information, and Technology
STRAMA	Swedish Surveillance of Antimicrobial Resistance
SVARM	Swedish Veterinary Antimicrobial Resistance Monitoring
Svebar	Swedish Monitoring of Antibiotic Resistance
Swedres	Swedish Antibiotic Sales and Resistance in Human Medicine

FIGURES

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Australia launched the *National Antimicrobial Resistance Strategy – 2020 and Beyond* in 2020. A suite of associated activities are currently being implemented by the Australian Department of Health, Australian Department of Agriculture Water and the Environment, and Food Standards Australia New Zealand. These includes the development of options for a national One Health antimicrobial resistance (AMR) and antimicrobial use (AU) surveillance system model incorporating the human health, animal health, plant health, food production and environment sectors. Following decisions on what option to adopt, a Transition Plan will be developed to guide the implementation of the desired future surveillance system.

The purpose of this report is to provide potential options for the Model. These options will be refined following discussion and consideration by key stakeholders.

A conceptual design of the surveillance system has been developed to provide for key aspects of the system. These key aspects include:

- **Governance:** the way in which the system participants work together, including the specification of roles and responsibilities, to achieve the system objectives.
- **Surveillance and data management:** the core focus of the One Health surveillance system and the activities performed across the surveillance value chain.
- **Coverage and capacity:** the surveillance coverage factors the system needs to respond to and the subsequent capacity implications that this creates.
- **Capability:** the capability that needs to exist to conduct surveillance in the manner and with the coverage envisaged.
- **Authorising environment:** how the One Health surveillance system is enabled through funding, inter-government agreements, and legislation (where required).

Options for the critical components of a One Health surveillance system

Four options have been proposed for the critical components of a One Health surveillance system.

The core functionality requirements will determine shape and inform a future detailed design process. In keeping with the international examples and recommendations in establishing a One Health system, a greater focus and weighting is given to addressing the coordination and cohesion of the system (governance) as the first priority

In each of these options a governance structure is established with responsibilities for:

- the development, maintenance, implementation oversight, monitoring and evaluation of relevant components of the Strategy
- system communication and coordination
- system culture
- sectoral planning, approval, implementation and monitoring and evaluation, and
- resourcing and investment.

Additionally, for each of the options, a technical advisory group would provide advice to the governance structure.

Option 1: Centralised surveillance system – authority, leadership, coordination and direction of the surveillance system is centrally held

Authority is vested in a central body which would undertake the development of strategy, the setting of direction and the coordination of resources across the surveillance system. It operates on a traditional hierarchical structure that relies on a vertical chain to provide a continuum of accountability.

Option 2: Distributed surveillance system (also known as a hub and spoke model)

The reach and influence of the surveillance system is extended through a model which distributes governance functionality and capability away from the centre to other parts of the system to enable improved coverage and greater on-the-ground engagement.

There are two approaches for this Option:

- Option 2 (a) – a jurisdictional hub and spoke surveillance system, or
- Option 2 (b) – a sectoral hub and spoke surveillance system

Option 3: Fully devolved surveillance system

There are sectoral governance bodies with a key coordinating and decision-making role, in addition to the central governing body.

Key considerations for a One Health Surveillance System

Barriers	Enablers	Success Factors
Variable capability: the different levels of capability between and within sectors. **Differing drivers:** the different motivations between sectors to engage in AMR and AU surveillance. **Variable trust:** the different levels of trust in the system held by sectors or jurisdictions. **Variable methods:** the different methodologies used in surveillance activities between and within sectors and/or between and within jurisdictions. **Administrative complexity**: the complexity of decision-making processes within a structure, including multiple layers of administration.	**Collaboration:** the level of collaboration between stakeholders and governance bodies, and potentially collaboration within and across sectors or jurisdictions. **Coordination:** the level and degree of coordination across and between stakeholders and technology and infrastructure. **Integration:** the level and degree of integration of sectors, systems, and databases.	**Sustainability:** the long-term capacity for growth and the ability for Options to sustain a One Health system in the long term. **Cohesion:** to what extent the Options promote structures, strategy and surveillance activities that are cohesive across jurisdictions, sectors, and system actors.

Future decisions

Once the critical components of a One Health surveillance system have been established, decisions relating to other priority components will need to be made. Options for these priority future decisions are described below.

Data collection

- **Status quo:** leave data collection strategies as they are and aim to integrate data from existing systems
- **Develop existing AMR and AU approaches to work cross-sector:** build on or replicate existing data collection systems and databases to work across different sectors
- **Build new data collection approaches and systems for growth:** create a new or highly adapted data collection system

Data storage and access

- **Status quo:** data owners continue to store and access data in a way that meets their needs and requirements but limits data sharing
- **Work towards greater data sharing and accessibility:** establish data sharing, storage, and access agreements with the necessary stakeholders to enable data sharing at a mid-point aggregated level

Priority organisms and antimicrobial agents

- **Central list with priority organisms and antimicrobial agents for all sectors:** a single central list for priority organisms, informed by international and national lists, would be developed for all sectors – possibly providing guidance as to which sector the collection of data is relevant to
- **Central list with priority One Health organisms and antimicrobial agents, supplemented by sector-specific lists:** a central list would be developed focusing on priority organisms and antimicrobial agents to inform data collection, analysis, and reporting through a One Health lens. Sectors would still have (or would develop) sector-specific priority lists

Other key considerations for future decisions

- **Coverage**: does surveillance have adequate coverage (including geographic, sectoral, activity/practice, usage/prescription, and time)?
- **Equity:** does the scope of surveillance activities consider equity, including capturing data for rural and remote communities and Aboriginal and Torres Strait Islander Australians?
- **Capabilities:** how can we best enable the capabilities required for the Model to be successful (including process, organisation, people, information, and technology)?
- **Authorising environment:** What is required to successfully implement the surveillance system (including funding model, inter-government agreements, and enabling legislation)?

INTRODUCTION

1. INTRODUCTION

This section provides an overview of the report, including:

- Background to AMR
- Purpose of the report
- Structure of the report
- Details of the method

What is One Health?

The WHO describes One Health as an approach to designing and implementing programs, policies, legislation, and research in which multiple sectors communicate and work together (4). The One Health model promotes a collaborative, multi-sectoral, cross-jurisdictional, and transdisciplinary approach to promote health outcomes through the interconnectedness between humans, animals, and the environment.

1.1. Background

Antimicrobial resistance (AMR) occurs when bacteria, fungi, and parasites adapt over time to resist medication, making infections harder to treat (1). The rise of AMR is a significant threat to the health of humans, animals, plants, and the environment. Resistant pathogens threaten the continuing effectiveness of antimicrobials for human use; including for common infections such as pneumonia, urinary tract infections, sepsis, and sexually transmitted infections; and could undermine global efforts to end epidemics of tuberculosis, human immunodeficiency virus, and malaria. AMR also threatens the ability to effectively treat common infections in animals, such as Escherichia coli (E. coli), as well as fungi and parasites in plants.

The World Health Organization (WHO) *Global Action Plan on Antimicrobial Resistance* promotes a One Health approach to addressing AMR, including through national surveillance (2).

Australia's *National Antimicrobial Resistance Strategy – 2020 and Beyond* (the Strategy) was released in March 2020 (3). The Strategy sets a 20-year vision to protect the health of humans, animals, and the environment through minimising the development and spread of AMR while continuing to have effective antimicrobials available, through a holistic and multisectoral One Health approach. In Australia, this approach recognises the interconnectedness of the human, animal and plant health, food, and environment.

What sectors are we referring to?

The five sectors are:

- human health
- animal health
- plant health
- food
- environment

The Strategy sets out an intent to take "*longer term, coordinated action to ensure antimicrobials are managed as the valuable shared resource they are, and that a national effort is made to retain their usefulness to society*" (3, p.3).

The development of a One Health AMR and Antimicrobial Usage (AU) surveillance system is part of a $22.5 million commitment by the Australian Government to support the development and delivery of key national AMR initiatives as part of the implementation of the Strategy. Specifically, Objective 5 of the Strategy relates to the development of a nationally coordinated One Health surveillance system on AMR and AU that monitors and reports on AMR and AU across the five sectors.

1.2. Purpose of this options report

The Department of Health has commissioned *Allen + Clarke* to engage with stakeholders across the five sectors to develop options for a national One Health AMR and AU surveillance system model (the Model). This will be followed by the development of a Transition Plan to guide the implementation of the desired future surveillance system.

The purpose of this report is to provide potential options for the Model. These options will be refined following discussion and consideration by the Department of Health, Department of Agriculture, Water and the Environment (DAWE), Food Standards Australia New Zealand (FSANZ), key committees and other stakeholders.

Implementation details, including transition considerations relating to the incremental implementation of the Model, are largely outside of the scope of this report and will be included in a transition plan once a preferred model has been identified.

1.3. Structure of this options report

This report includes the following sections:

Section 1: Introduction Background to AMR, AU and One Health plus details on the methodology and engagement undertaken to date.

Section 2: Considerations for framing and designing the future One Health surveillance system Why One Health is an appropriate approach, the dimensions that are present in a surveillance system and a conceptual design for that system.

Section 3: One Health surveillance system Model Options Key lessons from the international analysis, an introduction to the four potential One Health models and considerations relating to sequential decision-making.

Section 4: Governance An assessment of the potential models against governance considerations.

Section 5: Surveillance and Data Management Considerations relating to the surveillance and data management design components of a One Health surveillance system.

System 6: Coverage and Capacity Considerations relating to the coverage and capacity design components of a One Health surveillance system, including priority organisms and antimicrobial agents and equity.

Section 7: Capabilities Considerations relating to five core capabilities central to enabling a One Health surveillance system and an assessment of those against the Process, Organisation, People, Information, and Technology (POPIT) capability model

Section 8: Assessment of Model Options An initial assessment of each model option against barriers, enablers, and success factor criteria.

Appendices: Key reference material.

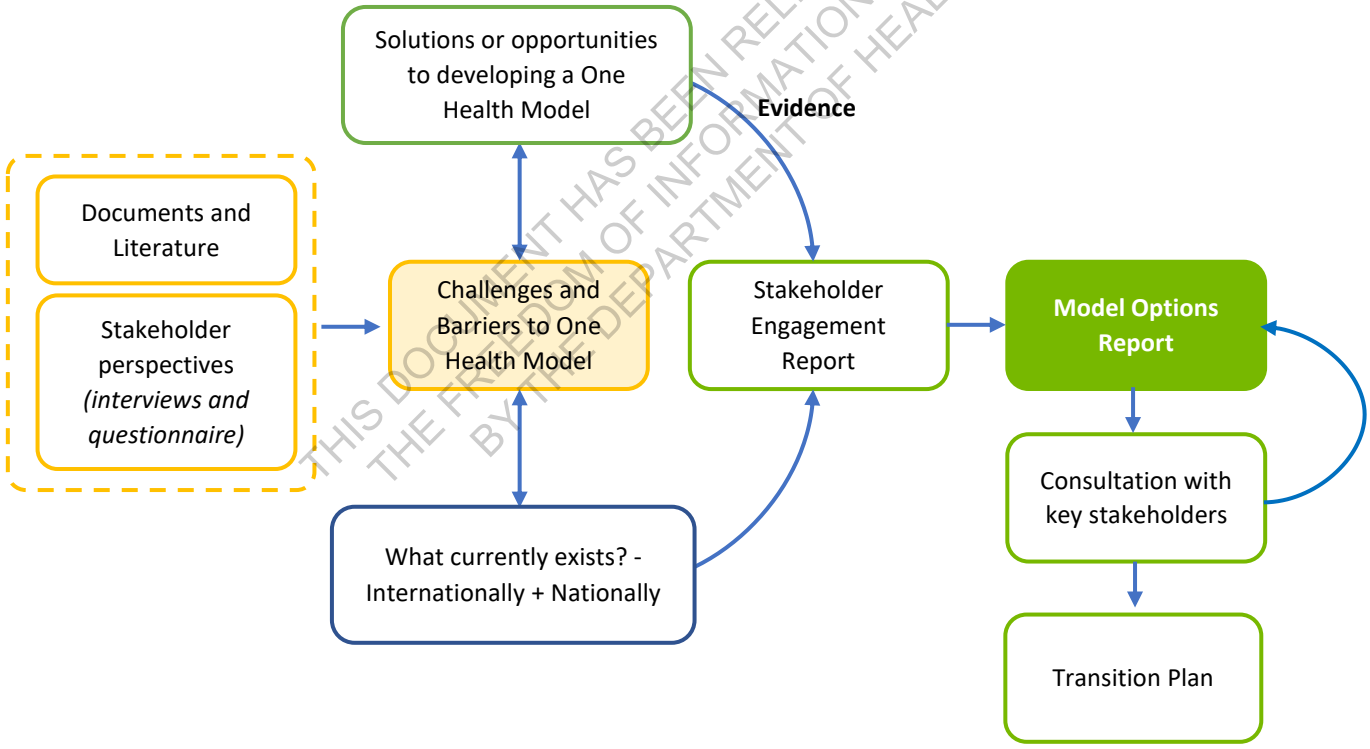
1.4. Method

In developing the options for the Model, information has been collected through a combination of desktop research, stakeholder interviews and an online questionnaire to build an understanding of the:

- current AMR and AU surveillance capacity, sources, and storage of data in Australia
- current approach to AMR and AU surveillance and monitoring undertaken in comparable international jurisdictions
- views of the different sectors and experts in terms of requirements for a One Health surveillance system
- critical sensitives for a successful One Health surveillance system
- future objectives, capabilities, and delivery method of a One Health AMR and AU surveillance information system, and
- potential feasible options for structuring and operating an effective, workable, and achievable One Health AMR and AU surveillance system.

Figure 1 illustrates the outputs, the overall process and the evidence used to inform this report.

Figure 1: Summary of overall methodology, data collection and outputs



1.4.1. Document review

A document review was undertaken to develop an evidence base for the current state of AMR and AU surveillance in Australia. Documents were provided by the Department of Health, DAWE, FSANZ, stakeholders, and were identified through online research. Documents included strategy and planning documents, published peer-reviewed literature, documents from international systems (including WHO, Codex Alimentarius [Codex], and World Organisation for Animal Health [OIE]), conference presentations, and information on existing surveillance activities.

1.4.2. International scan

A targeted international jurisdiction scan was undertaken to identify AMR and AU monitoring and surveillance systems in comparable countries that are progressing towards a coordinated One Health model. The purpose of this activity was to identify and describe the characteristics of the international models, how these models operate, their benefits and challenges, and how information is disseminated.

The key features of select comparable jurisdictions (Denmark, Canada, and Sweden) are described further in Appendix 1.

1.4.3. Key stakeholder engagement

Between June and September 2021, key stakeholders were engaged with to provide a comprehensive overview of the current state of AMR and AU surveillance in Australia and the opportunities, enablers, and barriers for a future One Health surveillance system. Engagement processes included the completion of interviews and questionnaires with a range of representatives from across the five sectors.

Key personnel interviews

To inform the engagement approach and tools, five scoping interviews were undertaken with key personnel from the Department of Health, FSANZ, and DAWE - including separate interviews with relevant staff for animal health, plant health, and environmental health.

The purpose of these key personnel interviews was to provide insights and contextual information on the current state of AMR and AU surveillance in Australia. They included discussion of delivery, governance and management structures; enablers and barriers; and opportunities.

Stakeholder interviews and engagement

Following the key personnel interviews, 30 key stakeholder interviews and engagements were undertaken. Participants for these interviews spanned the five sectors and were identified in discussion with the Department of Health, DAWE, and FSANZ. As part of this process engagement was undertaken with the Public Health Laboratory Network and the Communicable Diseases Network Australia.

The greatest number of stakeholders interviewed were from the human health sector (n=14). Interviews were also undertaken with stakeholders from the animal health sector (n=9), environment sector (n=3), food sector (n=2), and plant sector (n=1). However, there is significant crossover between the animal health, plant, and food industries, with some stakeholders represented more than one perspective.

Questionnaire

A comprehensive questionnaire was sent to relevant committees and individuals from across the five sectors. Stakeholders were invited to complete the anonymous online questionnaire by email. The questionnaire was distributed, stored and analysed using Qualtrics (4).

A total of 71 questionnaire responses were received. Most respondents were from the human sector (62%) and are involved in a national based system (32%).

The information from document review, international scan, and stakeholder engagement have informed the development and analysis of options presented in this report.

CONSIDERATIONS FOR FRAMING AND DESIGNING THE FUTURE ONE HEALTH SURVEILLANCE SYSTEM

2. CONSIDERATIONS FOR FRAMING AND DESIGNING THE FUTURE ONE HEALTH SURVEILLANCE SYSTEM

This section outlines the key considerations for a One Health surveillance system, including:

- contemporary One Health systems
- a conceptual design for the One Health surveillance system
- the success factors to be considered in the design of a One Health surveillance system

2.1. What does a contemporary One Health surveillance system look like?

The WHO describes One Health as an approach to designing and implementing programs, policies, legislation, and research in which multiple sectors communicate and work together (5). The One Health model promotes a collaborative, multi-sectoral, cross-jurisdictional, and transdisciplinary approach to promote health outcomes through the interconnectedness between humans, animals, and the environment.

Figure 2: One Health model (3)

A One Health surveillance system has been defined by the International Society for Disease Surveillance (ISDS) as "*collaborative, on-going, systematic collection and analysis of data from multiple domains to detect health related events and produce information which leads to actions aimed at attaining optimal health for people, animals, and the environment*" (6, para. 1). A One Health Surveillance system is intended to better inform decision makers to create more effective, evidence-based health interventions (7).

Taking a One Health approach to the surveillance of AMR and AU will enable greater efficiency and efficacy in the fight against AMR in Australia. The effectiveness and efficiency of One Health surveillance systems is described below.

A One Health surveillance model is considered highly effective

The WHO suggests that a One Health approach is required to coordinate effective surveillance between the human, animal, and environmental sectors due to the transmissible nature of AMR, particularly between humans and animals. WHO notes that to effectively detect, respond to and prevent AMR, epidemiological data and laboratory information should be shared between sectors, and governments and sector stakeholders should work across sectors and jurisdictions to implement joint responses to AMR threats (5).

In addition to support from WHO, the Food and Agriculture Organisation of the United Nations (FAO) and the OIE, have joined WHO in a collaborative effort to develop and promote One Health as the most effective model to address health risks at human-animal-ecosystem interfaces worldwide (8).

Independent studies have also concluded that a One Health approach to surveillance is the most as the most comprehensive model for effectively capturing AMR data, and analysing the potential impacts of AMR on human, animal, and environmental health (9).

A One Health surveillance model is resource efficient

In addition to being an effective model for the promotion and protection of healthcare across the human, animal and plant health, food and environment sectors, a One Health model is also resource efficient. In addition to health burdens of AMR, there is a financial cost to the proliferation of AMR across human health, animal health, and environmental sectors. The Outbreak Project estimates the cost to treating urinary tract infections in Australia will increase from $909 million in 2020 to $1.1 billion in 2030 (10). From a broader AMR perspective, the Organisation for Economic Co-operation and Development (OECD) estimates that for eight bacterial resistances, by 2050 it is estimated that healthcare costs alone could reach $370 million (11).

As such, an investment in a One Health surveillance system could not only prevent additional financial burdens on direct and indirect healthcare services, but it is also deemed a financially and resource efficient solution to AMR and AU surveillance (12). Studies estimate cost savings of 10 to 35% from One Health surveillance systems compared to a non-integrated system (13).

2.2. One Health surveillance system design considerations

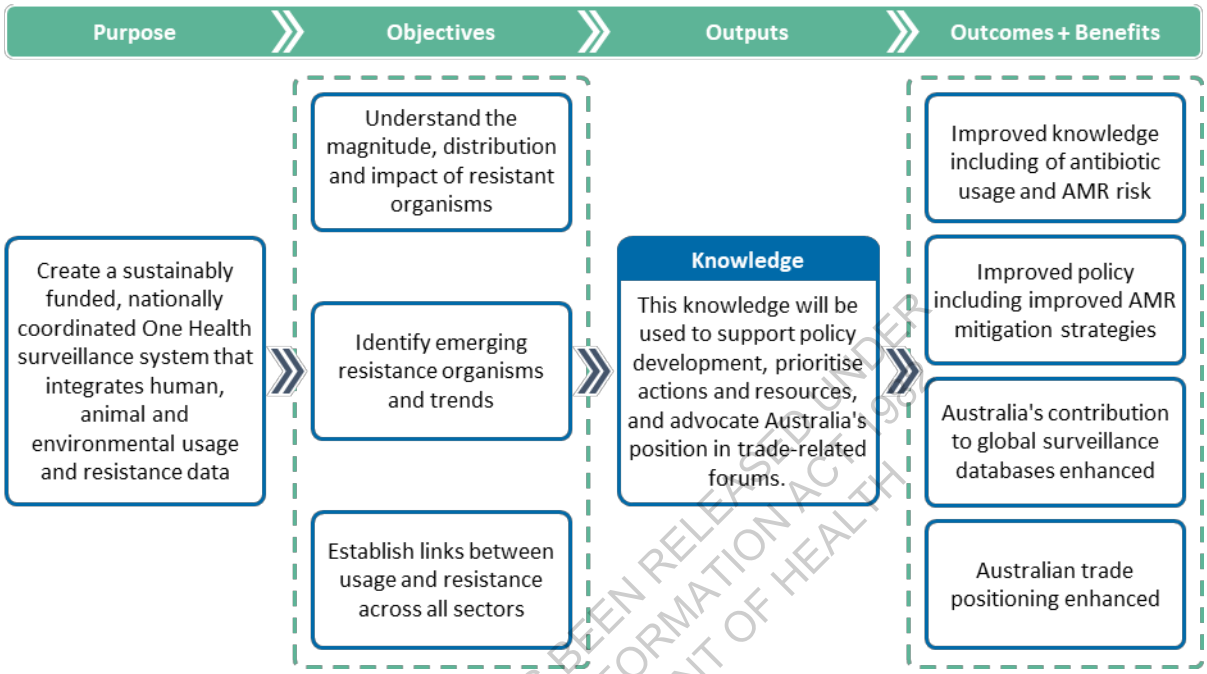
The design of the One Health surveillance system is shaped by the strategic context in which it will be developed and operated. The strategic context therefore needs to be part of the analysis of the Model options.

The Strategy includes seven objectives (3). These are:

- clear governance for antimicrobial resistance initiatives
- prevention and control of infections and the spread of resistance
- greater engagement in the combat against resistance
- appropriate usage and stewardship practises
- integrated surveillance and response to resistance and usage
- a strong collaborative research agenda across all sectors
- strengthen global collaboration and partnerships.

The options for the Model have been analysed with consideration of contextual factors set out in the Strategy. The options analysis considers the alignment of the options with the strategic intent in respect of the surveillance system. This intent is articulated explicitly in Chapter 5 of the Strategy (3). The strategic intent is distilled in Figure3.

Figure 3: Purpose of the Australian One Health surveillance system



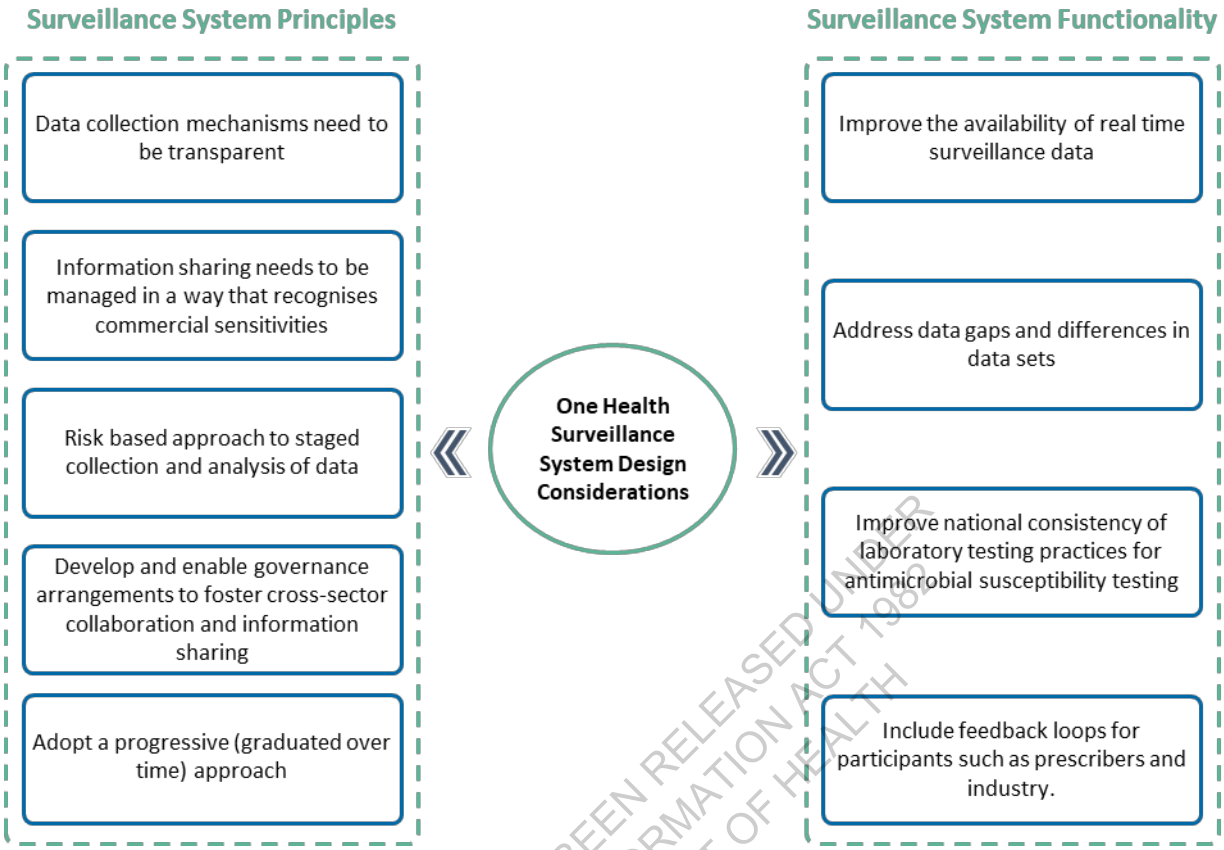
The surveillance system also contributes to the other objectives articulated in the Strategy and is in turn also influenced by the work undertaken in respect of the other objectives. The Model options developed are intended to recognise how the design of the surveillance system is intended to contribute to, enable, and leverage the other objectives in the Strategy.

In addition to the strategic purpose and objectives, the Strategy also provides other requirements and indicators that should be factored into options for the Model. These indicators highlight the intended ways of working and can be expanded upon so that they are expressed as guiding principles. Guiding principles are those that influence the design, development and/or operation of the One Health surveillance system.

The Strategy is not the only source of indicators of the guiding principles that are required. The detailed analysis and selection of the options themselves, also reveal principles pivotal to the success of the system. Accordingly, the principles identified in the analysis are not presented as an exhaustive list.

Other requirements specified in the Strategy include types of surveillance system functionality. These requirements, when read in conjunction with the purpose and objectives, provide further guidance as to suitable options for the Model The key requirements and principles have been illustrated in Figure 4.

Figure 4: One Health surveillance system design guidance



In addition to the widely acknowledged complexity of the strategic and operating environment for developing and operating the One Health surveillance system, there is also the scale of the undertaking to be considered. The combination of complexity and scale has implications for funding, resourcing, and time.

The timing implications are significant for the duration of the implementation process, and the maturation and optimisation processes. The approach to implementation influences the decisions around design and Model selection. An incremental implementation approach means that some decisions should be prioritised and made now, while others might be able to be deferred, enabling decision makers to take advantage of the future availability of better information regarding needs, options, and impacts.

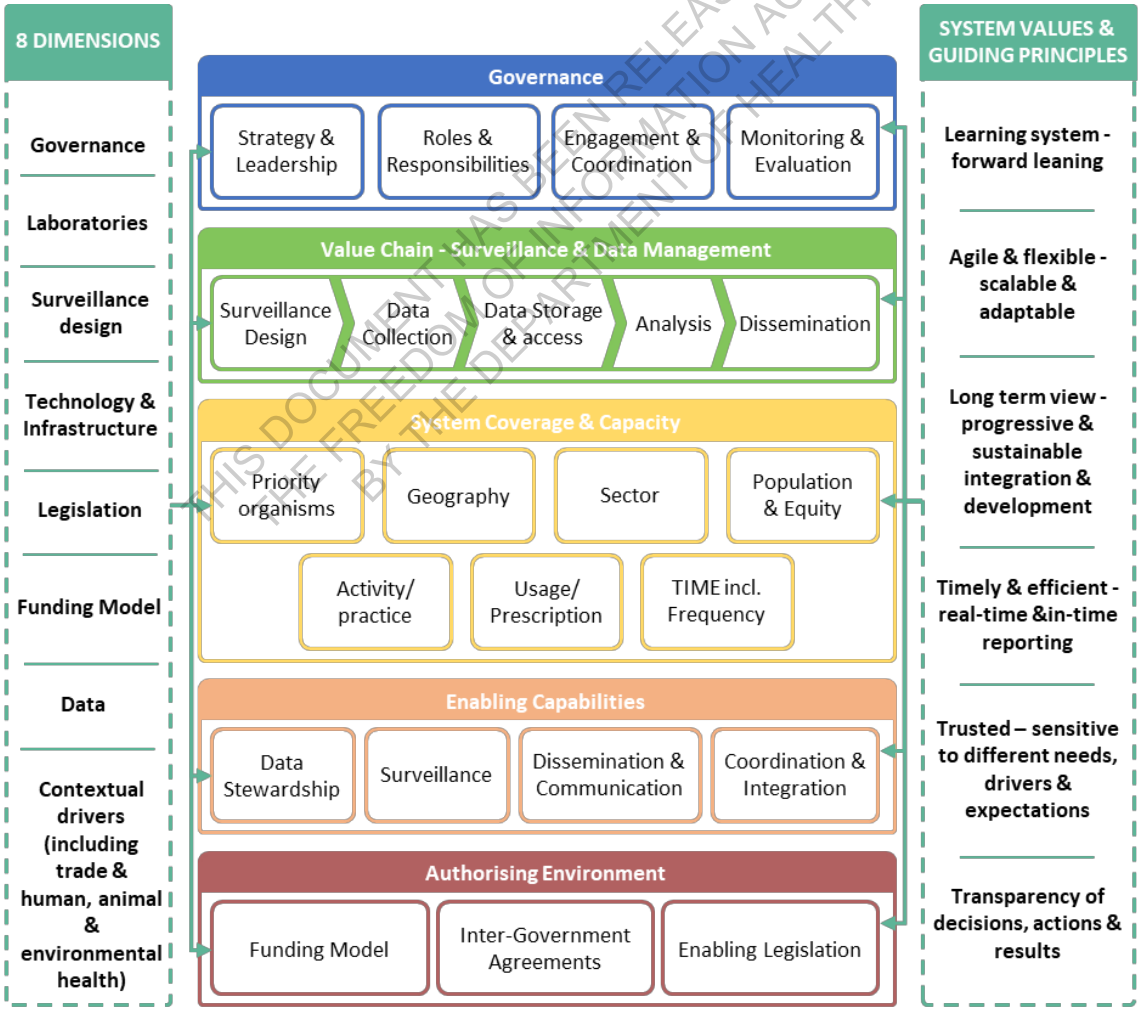
2.3. A conceptual design of the surveillance system

A conceptual design has been developed to frame the options for a One Health surveillance system. A conceptual design is used during the early phase of the design process, in which the broad outlines of function and form of the subject, in this case the surveillance system, are being developed. This approach has been used because a One Health surveillance system is highly complex. The system involves gathering, interpreting, and sharing data on the incidence of infection, prescription and use of antimicrobials, and monitoring for new or known resistance to antimicrobials (including antibiotics, antivirals, antiparasitic and antifungals).

The conceptual design of the One Health surveillance system is intended to provide a means of illustrating different elements and dynamics of the system, including, for example, the strategies, interactions, processes and influencing factors. The conceptual design is intended to help stakeholders envisage the One Health surveillance system holistically while also fostering an understanding of the component parts.

A preliminary set of guiding principles has been developed to help inform consideration of the One Health surveillance system needs, stakeholder expectations, design options and their fit. The principles have been reflected in the conceptual design depicted in Figure 5.

Figure 5: One Health surveillance system conceptual design



The conceptual design of the surveillance system provides a series of lenses to focus on key aspects of the system. The lenses include

- **Governance:** the way in which the system participants work together, including the specification of roles and responsibilities, to achieve the system goals and objectives. This is described further in Section 4.
- **Surveillance and data management:** the core focus of the One Health surveillance system and the activities performed across the surveillance (macro-level) value chain. This is described further in Section 5.
- **Coverage and capacity:** the surveillance coverage factors the system needs to respond to and the subsequent capacity implications that this creates. This is described further in Section 6.
- **Capability:** the capability that needs to exist to conduct surveillance in the manner and with the coverage envisaged. Capability in this context is a broad construct and includes process, organisation, people, information, technology, and infrastructure. This is described further in Section 7.
- **Authorising environment:** how the One Health surveillance system is enabled through funding, inter-government agreements, and legislation (where required).

The conceptual design allows the depiction and consideration of the different elements of the surveillance system through these lenses, at the component level, and holistically. This enables the consideration of the elements in conjunction with each other, how they fit together and how they are integrated to achieve the outcomes required. In doing so, the conceptual design will facilitate and enable consideration and discussion of design issues and options for the One Health surveillance system.

The concept design for the One Health surveillance system does this by:

- providing a backdrop against which the different roles and responsibilities across the system can be considered
- highlighting the relationality and inter-dependency of different component parts of the system
- providing a canvas for assessing the fit of the optional component parts.

Critically, it is intended that the conceptual design of the One Health surveillance system will also enable the development of key conceptual frameworks that can be used to inform more detailed designs, as well as the implementation and operation of the surveillance system. The most significant of these frameworks is a conceptual collaboration framework. Given the criticality of collaboration for One Health surveillance system success, it is important that the system is deliberately designed to achieve the levels and types of collaboration required.

In 2020, a review of One Health surveillance system characteristics identified that a conceptual collaboration framework provides a means of looking at the dynamic elements of collaboration, as well as the different approaches and mechanisms that could be developed and leveraged across the surveillance system to enable and promote it. The systematic literature review concluded that the lack of a conceptual framework to accurately define the notion of One Health surveillance undermines the operationalisation of collaborative efforts for efficient and sustainable surveillance systems (14). Consideration has been given to how the dimensions

of collaboration can be integrated into the conceptual design and are considered in the options analysis.

2.3.1. Dimensions of the surveillance system

In conjunction with the conceptual design, eight dimensions have been used to facilitate a deeper analysis of the current state and future state of the One Health surveillance system. The dimensions have been used to examine the requirements of the One Health surveillance system, along with key drivers, challenges, barriers, and enablers. The dimensions utilised are:

- **Governance:** this covers the responsibilities at the local, state and territory and Commonwealth level that ensure leadership, engagement, and accountability for actions to combat antimicrobial resistance. Responsibility is shared between health, agriculture, and environment portfolios across all jurisdictions. Governance includes the framework in which the AMR and AU One Health model is directed, controlled, and held to account.
- **Contextual drivers (including trade and human, animal, and environmental health):** the factors that are increasing the prevalence of AMR. There is a consensus that these factors are interlinked and occur across the human, animal, and environmental health sectors. Drivers are described further in Section 2.4.1.
- **Surveillance design***:* the design and planning of surveillance initiatives and activities, developed as part of sectoral surveillance planning, and cognisant of the One Health surveillance system objectives and priorities. These activities result in the capture and production of information to inform strategies for preventing and containing AMR.
- **Data:** information collected through the ongoing monitoring of AMR and AU. This dimension includes the data management activities conducted throughout the end-to-end surveillance process (from collection to dissemination).
- **Laboratories***:* the role of laboratories in the surveillance system as facilities capable of susceptibility testing to fulfil the core data requirements, using standardized tests for identification of resistant microorganisms, storage, and operating to agreed quality standards.
- **Technology and infrastructure:** the necessary components parts of an antimicrobial surveillance system across human health, animal health, and the environmental sectors. For example, electronic health records and the devices needed to access, support, and maintain them.
- **Funding model:** the mechanism for providing financial support and resources to the cross-sectoral AMR and AU One Health surveillance system.
- **Legislation:** the preparation and enactment of legislation to create the regulatory settings to support and enable the One Health surveillance system.

These dimensions have been used to supplement the conceptual design analysis, providing a means of cross testing assumptions, and assessing the impacts of different Models.

2.4. Success factors for a future One Health surveillance system

2.4.1. Consideration of current state

While there are many AMR and AU surveillance activities currently occurring across Australia, there is not an overall national One Health surveillance system. Further, outside of the human health sector, there are limited to no sectoral surveillance systems currently in operation.

There are a range of key enablers, challenges, and considerations that will need to be factored into decisions about different options and the eventual implementation of the Model. These include:

- different stakeholder interests and sectoral drivers
- varying levels of sector maturity across a complex system
- disconnected systems and fragmented ways of working
- varying levels of trust.

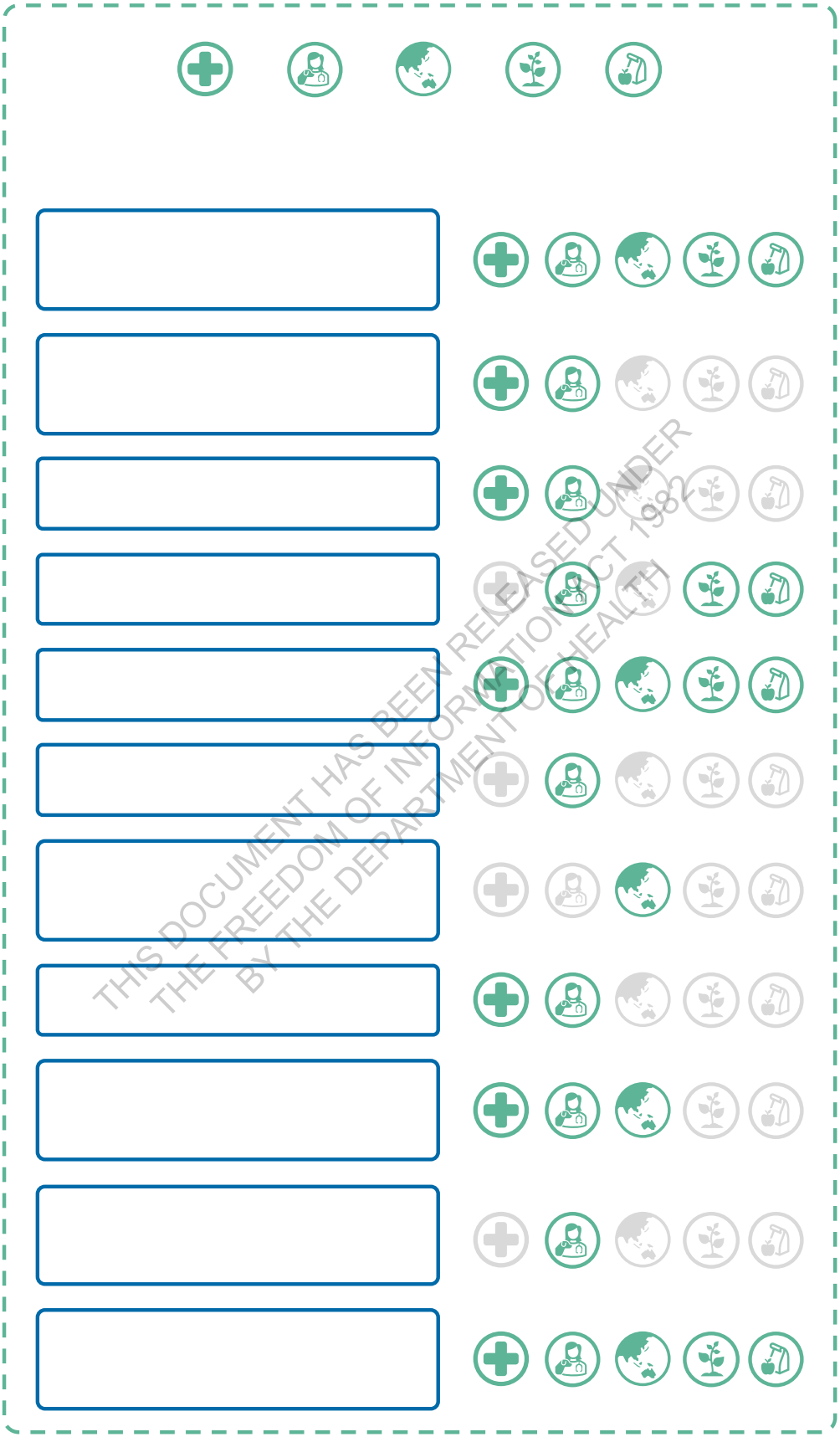
Different stakeholder interests and sectoral drivers

The One Health sectors have different interests and associated drivers for engaging or undertaking AMR and AU surveillance. Similarly, interests vary based on the roles and responsibilities of stakeholders. For example, policymakers, researchers, microbiologists, healthcare workers, veterinarians and farmers may all have different interests in relation to the collection, storage, analysis, and dissemination of AMR and AU data.

Drivers can be conceptualised as either an enabler or a barrier. If drivers are considered in the design and implementation of the One Health surveillance system, they can serve as opportunities to generate buy-in from stakeholders. For example, if the surveillance system uses data to identify and respond to outbreaks, or when this data can demonstrate compliance with trade requirements. Where an interest or driver is misaligned with the Model this becomes a potential barrier to stakeholders participating in the system. For example, concerns around data sharing due to commercial sensitivities will need to be factored into decision-making.

Some key drivers identified through stakeholder engagement are summarised in Figure 6.

Figure 6: Drivers for AMR and AU surveillance across the five sectors



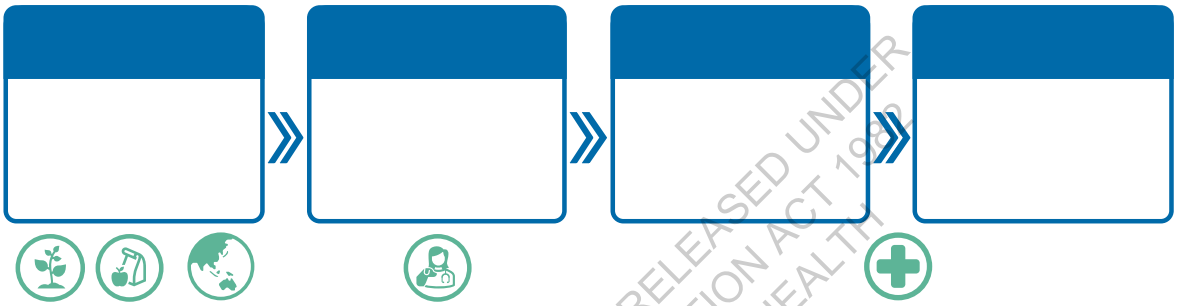
Varying sector maturity across multiple sectors and jurisdictions

The five sectors currently have varying levels of maturity in terms of existing AMR and AU surveillance. Maturity level is reflective of the level of perceived risk from AMR as well as level of previous investment in surveillance activities. The human health sector is the most mature, surveillance is expanding in the animal health sector and developing in the food sector, while there are very low levels of maturity in the plant and environment sectors.

As a result, some sectors will need significant resource, capacity building, and cultural change to transition to the new system.

Figure 7 illustrates the indicative position of the five sectors on a maturity scale. Figure was adapted from Agbo et al., (2019; 15).

Figure 7: Indicative Maturity scale



The development of a cohesive One Health system requires consideration of multiple existing sectors and sub-sectors and their associated governance arrangements, surveillance activities, roles and responsibilities, interests, and challenges. This is further complicated by the varying policy, funding, and structural arrangements across the Australian, state, and territory governments.

As an example, the animal health sector includes a multitude of production animal industries (including land-based and aquaculture), companion animals, wildlife, horses, and zoos. AU varies significantly between and within these groups – both in terms of which antimicrobials are used and how they are dispensed. For instance, antibiotics are used sparingly in poultry and are delivered to flocks through water or feed. In comparison, for companion animals, antibiotics are often prescribed off-label to an individual animal and level of prescribing depends on a range of factors including the preferences and financial means of the owner. Production animal industries have industry bodies, each with varying levels of data collection on AMR and AU and are subject to registration requirements which may be administered at different jurisdiction levels. In comparison, companion animals are attended to by private veterinary clinics with antimicrobial susceptibility testing undertaken on a case-by-case basis and very limited impetus for aggregated data collection.

The complexity of the One Health landscape means that a new surveillance system cannot be implemented overnight. This needs to be considered in the time frames, design, implementation, and optimisation of the Model.

Disconnected systems and fragmented ways of working

To date there has been minimal collaboration between sectors on AMR and AU surveillance. Surveillance activities are not aligned between, and often within, sectors. Similarly, approaches

to prescribing, recording, data collection, laboratory testing, analysis, and reporting are highly fragmented. Examples of disconnection and fragmentation that were raised by stakeholders include:

- **Laboratory testing:** standards that are used by laboratories and the tests that are undertaken on isolates vary significantly and there are challenges collecting laboratory data that is comparable between sectors. Laboratory practices and the sharing of information varies between public and private laboratories, and between jurisdictions.
- **IT infrastructure:** there is limited interoperability between systems used within sectors, and even less so between sectors. While there are some bespoke systems used for human health, most data across the five sectors is recorded in Excel or paper records.
- **Governance:** there are a range of structures at different jurisdictional levels responsible for different systems and sectors and there is currently very little interaction between these governance structures.

A recent study examined the challenges of implementing an integrated One Health surveillance system in Australia and identified the siloed nature of surveillance as a key barrier. In particular, the authors found that commercial interest, lack of inter-sectoral communication, lack of inter-sectoral trust, silos in education and funding were barriers to implementation of a One Health model (16).

Varying levels of trust

Some stakeholders described varying levels of trust towards government institutions and other sectors in the context of AMR and AU surveillance. Trust is an important factor for future governance arrangements, and for the custodianship and dissemination of data.

Mistrust stands in contrast to the critical success factor of collaboration. Therefore, varying levels of trust is a challenge which should be considered in the design and implementation of the Model.

2.4.2. Consideration of success factors for international systems

International examples of AMR and AU One Health surveillance systems provide important lessons for the Australian context (see Appendix 1). The international systems outlined in Appendix 1 highlight a range of differing approaches, but all have had sustained resourcing and time to build capacity and evolve. This has provided greater coordination and dissemination of AMR and AU information to Swedish, Danish, and Canadian governments and decision makers.

Key success factors for these international systems include long-term investment and outlook, trust in data collection and dissemination bodies, and coordination of relevant agencies, bodies, and organisations.

Financial investment in AMR and AU surveillance has been a key success factor in the international examples. Even in cases with mixed funding models, central government agencies have maintained investment, allowing for the success of a centralised One Health model. Long-term investment has also allowed systems to grow and mature holistically over time. This long-term approach to growth and investment has allowed stakeholders across

sectors, states, and territories, to engage with AMR and AU One Health systems at a pace and scale that fits their requirements and capabilities.

Another key success factor, particularly in the Swedish and Danish models is a high level of trust in the government and partner agencies collecting, analysing, and distributing AMR and AU data. Feedback from Australian stakeholders suggests that some sectors have concerns around data usage and privacy, which has resulted in hesitancy to participate in AMR and AU surveillance activities. Some stakeholders from the human health sector stress the importance of maintaining the high levels of privacy, should sectors work towards sharing data under a One Health model. Stakeholders from the animal agriculture sector were particularly concerned about data usage and were anxious about animal sectors being misrepresented in a One Health context.

Alongside trust, collaborative stakeholder relationships are critical to the success of a One Health surveillance system. As is displayed in the Danish model, stakeholders can successfully operate independently but collaboratively, which allows for varying levels of growth and capability between sectors (and states and territories). A centralised effort to coordinate, analyse, and disseminate data on an aggregated level allows for effective outputs from different arms of a surveillance system.

2.4.3. Collaboration and integration

Collaboration and integration are critical success factors for an effective AMR surveillance system. As highlighted by WHO, OIE and FAO, collaboration and integration are also core elements of a One Health model. The below discussion of what collaboration and integration look like in an AMR surveillance context demonstrates how these factors contribute to a successful One Health surveillance system.

Within an Australian One Health AMR surveillance context, collaboration can be achieved through the development of transdisciplinary, cross-sectoral, and cross-jurisdictional surveillance partnerships. In a 2020 review of One Health surveillance system characteristics (14), four main dimensions for collaboration were identified:

- **Institutional collaboration across sectors for the governance and operation of the surveillance system:** this includes collaboration between sectoral institutions with different jurisdictions and mandates within human health, animal health, plant health, environmental health, and food safety. Collaboration can take place at the governance-level for the coordination and supervision of the surveillance system and/or at the operational-level for the implementation of surveillance activities, at the different steps of the surveillance process.
- **Collaboration at the different scales of the decision-making process:** these scales include the different administrative jurisdictional scales within a same country (central, state, and local authorities) but also the supra-national scales such as the international-scale (e.g. international organisations) or the regional-scale (e.g. regional economic communities).
- **Collaboration across disciplines:** including among biosciences, social sciences, and engineering. These disciplines can be used for different occupational purposes such as risk assessment, research, data storage, analysis.

- **Collaboration through public-private partnerships:** through the development of public-private partnerships within, but also across, sectors. For instance, in Canada, veterinary pharmaceutical companies as well as private veterinarians collaborate within the surveillance system for antimicrobial resistance, which is coordinated by the national Ministry of Health (14).

Collaboration is a key feature of a successful surveillance system as it allows for greater information sharing and knowledge transfer between and within sectors, governance agencies and other stakeholders. Collaboration allows surveillance systems to detect and respond to AMR and inappropriate AU more effectively and more efficiently than systems that separate data and information between sectors and jurisdictions. Stakeholders who engaged with this process shared similar views, that collaboration would be key to ensuring the success of an AMR and AU One Health surveillance model.

Like collaboration, integration is a critical success factor for a successful AMR and AU One Health surveillance system. Stakeholders are concerned that the degree of variability of current systems and processes for data collection and analysis, within and between sectors, present persisting challenges to integration. This concern is also acknowledged as a barrier by the body of literature that exist on the subject (16,17).

In a study assessing integration mechanisms in human and animal surveillance systems worldwide, One Health surveillance systems were shown to mostly use *convergent integration* and *interoperability* models to meet the surveillance systems' integration requirements. Convergent integration involves the merging of technology with business processes, knowledge, and human performance. It is a highly sophisticated form of integration, and its key components include technology and data repository integrations, communication networks, embedding knowledge and human performance with the new processes and enabling technologies (17).

In the surveillance context, interoperability is the ability of the system or its component to work with another while exploring the capabilities of both, without special effort from the users. For instance, animal health surveillance systems may interoperate with hospital medical records. It allows the systems to communicate, exchange data based on the standards and use information that has been exchanged (17).

A level of integration is key to the success of a One Health AMR surveillance system, as effective integration will allow stakeholders to engage with each other and their collective knowledge to enhance surveillance outputs for all participating stakeholders. Integration of data, systems, information, and stakeholder relationships will ultimately build more sophisticated and effective health outcomes for humans, animals, plants, and the environment. Moreover, in this way collaboration and integration are intrinsically linked in the context of a surveillance system, with both factors being critical to interoperability and collective advancement across disciplines, sectors, and jurisdictions.

Intergovernmental Agreement on data sharing between Commonwealth and State and Territory Governments

In Australia there is a recent Intergovernmental Agreement on data sharing between Commonwealth and State and Territory Governments (the Intergovernmental Agreement) that outlines how sharing data relevant to AMR and AU surveillance could be managed (18).

The Intergovernmental Agreement commits all jurisdictions to share public sector data when it can be shared securely, safely, lawfully and ethically. The Intergovernmental Agreement aims to facilitate cross-jurisdictional data sharing with the goal of maximising the value of data to deliver outstanding policies and services for Australians.

Under the Intergovernmental Agreement the Commonwealth has the responsibility for the design and oversight of nationally consistent data sharing policy. States and territories have responsibility for the operation of the Intergovernmental Agreement within their jurisdictions, as well as a responsibility to work with other jurisdictions to identify and align common data requests.

The Intergovernmental Agreement outlines clear guiding principles and a governance structure to facilitate data sharing between the Commonwealth and state and territory governments. Data and Digital Ministers will have strategic oversight with regards to developing data sharing systems that improve outcomes for Australians. Portfolio Ministers have responsibility for data sharing activities within their portfolio responsibilities. Portfolio Ministers will collaborate with Data and Digital Ministers to identify and progress national priority data areas

AMR and AU surveillance data has the potential to fit within the data sharing arrangements facilitated by the Intergovernmental Agreement. The Intergovernmental Agreement outlines a framework for developing a National Data Sharing Work Program and specifying national priority data areas, under which AMR and AU surveillance data could sit.

ONE HEALTH SURVEILLANCE SYSTEM MODEL OPTIONS

3. ONE HEALTH SURVEILLANCE SYSTEM MODEL OPTIONS

This section outlines:

- key lessons from the international analysis
- the four model options
- why these options are the first priority for decision-making, and how subsequent decisions can be made after these have been determined.

Further details on the model options are included in sections 4 to 8, including analysis of the potential fit with the stated requirements of the system.

3.1. Key lessons from the international analysis

The analysis of the international One Health surveillance systems identified three key lessons regarding the possible approaches available to Australia.

1. There is no existing, all-encompassing surveillance system that meets Australia's needs that can simply be replicated and implemented in Australia.
2. The development and implementation of a One Health surveillance system is a long term, sustained undertaking. Building the necessary capability, relationships and ways of working will take time.
3. One Health surveillance systems are learning systems, that is they develop, grow, and evolve over time.

Why is it so complicated?

"I think AMR is an incredibly complex space. Even in human health, aside from One Health, it's complex. Huge numbers of players that sit across research, translational research, government, surveillance. So I think that's a really hard place to start in terms of doing this, but it's the right thing to do. I think there's a lot of experts and a lot of people interested in trying to do the right thing."

- Stakeholder interview

"*AMR presents a hugely complex and accelerating cross-sectoral public health and environmental challenge, to which Australia's multi-layered and complex, siloed health, agriculture and environmental government systems are currently not well-suited to respond. A singular federal AMR agency with the necessary reach and powers to cut across multiple areas and industries may be the only workable solution in the long-term."*

- - Questionnaire respondent

3.2. Four options for the Model

The four options identified for the One Health surveillance system are:

Model Option 1: Centralised surveillance system

In this option, authority, leadership, coordination, and direction of the surveillance system is centrally held. Authority is vested in a central body which would undertake the development of strategy, the setting of direction and the coordination of resources across the surveillance system. It operates on a traditional hierarchical structure that relies on a vertical chain to provide a continuum of accountability.

Model Option 2: Distributed surveillance system (also known as a hub and spoke model)

In this option, the reach and influence of the surveillance system is extended through a model which distributes governance functionality and capability away from the centre to other parts of the system to enable improved coverage and greater on-the-ground engagement.

There are two possible variations:

- Option 2 (a) a sectoral hub and spoke surveillance system
- Option 2 (b) a jurisdictional hub and spoke surveillance system.

Model Option 3: Devolved surveillance system

In this option, there are sectoral governance bodies with a key coordinating and decision-making role, in addition to the central governing body.

3.3. Sequential decision making

The key elements from the Strategy's purpose for the One Health surveillance system are:

- the system is affordable, and funding is enduring
- there is cohesion across all jurisdictions, sectors, and system actors
- data is complete, comparable, and integrated, enabling the timely, accurate and useful telling of the AMR and AU stories in Australia.

The options identified above address each of these three issues, however there is a sequence to making decisions about system design. In this case, the approach to achieving cohesion across the system is a precursor to identifying the options for achieving data integration. Sustainable funding of the system is a consideration, informing the option selection for both system coordination and data integration. However, the funding model will be determined once the key approaches to system coordination and data integration are decided.

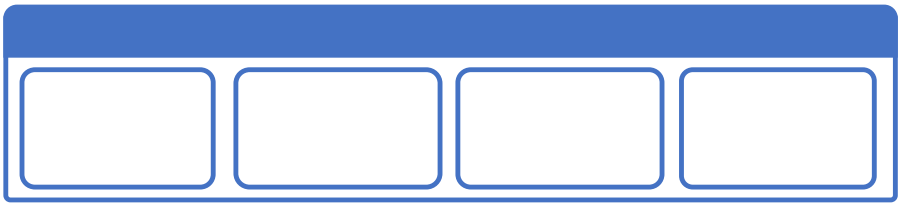
This report is not intended to provide a complete design of each of the surveillance system options. Rather the four options are based on the core functionality requirements of the Australian One Health surveillance system. The core functionality requirements will determine shape and inform a future detailed design process. In keeping with the international examples and recommendations in establishing a One Health system, a greater focus and weighting is given to addressing the coordination and cohesion of the system (governance) as the first priority

GOVERNANCE

4. GOVERNANCE

This section outlines the governance aspects of the One Health surveillance system conceptual design:

Figure 8: Governance elements from the conceptual design



This section includes:

- why governance is important, including why governance decisions need to be made before further decisions can be considered
- the Australian context
- elements of a contemporary One Health governance framework
- an assessment of each model option against governance considerations

4.1. Why is Governance important?

Governance describes the way in which the system participants work together, including the specification of roles and responsibilities, to achieve the system goals and objectives. The governance framework provides the basis for the collaboration requirements of the One Health system to be established and flourish. In other words, the governance framework is the mechanism through which the surveillance system requirement of national coordination and cohesion is achieved.

> *"Governance is about the rules of collective decision-making in settings where there are a plurality of actors or organisations and where no formal control system can dictate the terms of the relationship between these actors and organisations." (19, p.9)*

Governance incorporates the ways of working within and across the One Health surveillance system, including how strategy and direction are set, resources are allocated, infrastructure is designed, data is managed, investments are made (including how they are funded), strategy is implemented, and performance is monitored. It provides frameworks for planning, surveillance, engagement, communication, collaboration, ethics, risk management and coordination. It includes the setting and promotion of values, norms, and principles. Therefore, the governance framework is also the key determining factor shaping various options, including the data integration options and approach, as well as the funding model requirements and options.

4.2. Australian context

Governance in the Australian One Health surveillance system entails a particular set of requirements. In this context, governance is the set of relationships between the Australian,

state and territory and local governments, government departments and agencies, professional associations, non-government organisations, the private sector, industry, members of the research community, members of the public and other stakeholders.

The Strategy sets out the vision and goal for the One Health system and underpins these with objectives. The Strategy notes that effective action across the objectives *"will be driven by the overarching objective of transparent governance arrangements: clear responsibilities at the local, jurisdictional and national level to ensure leadership, engagement and accountability for actions to combat antimicrobial resistance."* (3, p.6) The successful design and operation of the One Health surveillance system is therefore heavily dependent on the One Health surveillance system governance arrangements.

The Strategy cascades objective one into four priority areas for action, which are also significant influencers and factors for consideration in the design and implementation of the One Health surveillance system. Those priority actions areas are:

1.1 Create sustainable funding for combatting antimicrobial resistance based on evidence of economic and societal costs and benefits of different approaches in all sectors

1.2 Develop, implement and/or maintain sector-specific action plans

1.3 Maintain and expand linkages and opportunities between stakeholders across all sectors to provide a nationally coordinated approach to combatting antimicrobial resistance; and

1.4 Monitor and review regulatory measures (legislated and other) relevant to antimicrobial usage and resistance (3).

These priority actions all shape considerations of the surveillance system requirements and the associated governance arrangements.

As a result of the criticality of the governance arrangements to the successful establishment and operation of the One Health surveillance system in Australia, they form a substantive component of the surveillance system design and are the top priority for decision making.

4.3. The current governance arrangements

The current governance arrangements reflect an evolving approach, with changes presently underway and recent arrangements still being formalised.

The current governance arrangements include the Antimicrobial Resistance Governance Group (ARGG) as the apex governance body. The ARGG has ultimate authority and responsibility for developing the strategic plans, setting direction, determining priorities, and directing resources. It is accountable for the delivery of the Strategy and also for the monitoring and evaluation of performance against the Strategy, including the effectiveness of the surveillance system and initiatives.

The Australian Strategic and Technical Advisory Group on AMR (ASTAG) is a multi-disciplinary advisory panel comprised of researchers and subject matter experts whose purpose is to support the ARGG through the provision of expert advice. ASTAG is not a decision-making body. While it is specifically convened to provide advice, it also forms part of the informal communication and influencing (networked) approach this governance model is dependent on.

The current national level surveillance system for human health is the Antimicrobial Use and Resistance in Australia (AURA) surveillance system. AURA is overseen by the Department of Health and reporting is managed by the Australian Commission on Safety and Quality in Health Care (ACSQHA). The AURA national Coordination Unit works with program partners to collect and report on AMR and AU data. AURA coordinates surveillance data from a range of sources and has included these in four reports, published between 2016 and 2021 (20–23).

The animal health, plant health, environmental health, and food sectors do not currently have established sectoral surveillance systems for AMR and AU.

4.4. Elements of a One Health governance framework

The One Health surveillance system conceptual design recognises the importance of the governance framework to enabling collaboration, coordination, and knowledge integration. Effectively the governance framework is the critical enabler of the One Health surveillance system. Given the complexity of One Health such as interests, legislation, sectors, jurisdictional boundaries, and professional silos, a systems-based and dedicated governance approach is proposed (24).

The conceptual design incorporates the core functions of the governance framework. These core governance functions are:

- roles and responsibilities
- strategy and leadership
- engagement and coordination
- monitoring and evaluation.

4.4.1. Roles and responsibilities

It is important to clearly define roles and responsibilities to enable alignment and avoid confusion and duplication. There are a broad range of actors and roles across the surveillance system. The analysis of the roles and responsibilities in this section is focused on those involved in governance activities and addresses the high-level governance requirements. The emphasis of the analysis is on the key governance roles that enable coordination and collaboration across the system.

The following governance activities are considered in this section and the proposed roles responsible for each activity are included in each option:

- the development, maintenance, implementation oversight, monitoring and evaluation of relevant components of the Strategy
- system communication and coordination
- system culture
- sectoral planning, approval, implementation and monitoring and evaluation
- resourcing and investment.

Notionally these roles and responsibilities can be conveyed upon individuals, governance bodies or organisations. There are certain structures and bodies required by the One Health surveillance system that remain relatively constant across each of the options.

Each option requires a One Health National Coordination Centre (Coordination Centre). The Coordination Centre has two core functional components:

1. to provide the overarching system governance by way of the National One Health Governance Group (Governance Group).
2. to provide operational support to the Governance Group and to the system stakeholders.

Research indicates that the establishment of a National Coordination Centre is recognised as a critical step in the successful establishment and operation of an effective One Health system. (25) This was supported by most key stakeholders.

4.4.2. Strategy and leadership

Strategy and leadership functions include the development of system level and sectoral level strategic plans. It also includes the development of the detailed surveillance system designs, capability roadmaps and transition/implementation plans.

These functions also include:

- communicating the strategic direction, setting priorities, and allocating resources
- defining, promoting, and modelling the system culture and associated values
- managing risk.

4.4.3. Engagement and coordination

Engagement and coordination relate to the relationships between the many and varied stakeholders across the system and how they will be communicated with and engaged to promote consistent and coordinated ways of working across the system. Engagement and coordination at a governance level directly influences how the stakeholders work together.

In practical terms this is about communication, relationship management, transdisciplinary approaches, and collaborative protocols.

4.4.4. Monitoring and evaluation

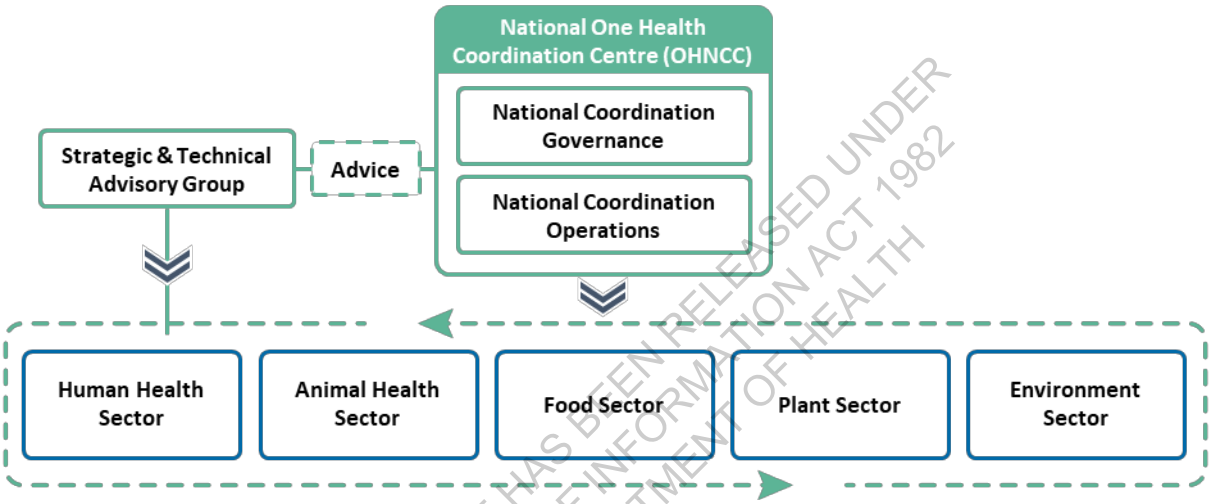
It is assumed that each of the options will require a similar approach to monitoring and evaluation. This function may be commissioned or undertaken by the Coordination Centre. It involves a system review and evaluation of performance against the Strategy, the effectiveness of the surveillance system, the degree of integration across the surveillance system, and individual surveillance activities. The outputs are intended to inform future planning activities (26).

4.5. Model Option 1 – Centralised governance framework

The centralised governance framework is based on a model where authority is vested in a central body, as presented in Figure 9. That central body would undertake the development of strategy, the setting of direction and the coordination of resources across the surveillance system. It operates on a traditional hierarchical structure that relies on a vertical chain to provide a continuum of accountability.

Traditionally these models work well where the issues that need to be addressed, and the actors involved in responding to those issues are within a single jurisdiction, and within the scope of responsibility of a single department or agency. These conditions are well suited to be addressed through a vertical governance model.

Figure 9: Model Option 1 - Centralised governance framework



4.5.1. Roles and responsibilities

National One Health Governance Group

In this scenario a Governance Group is the apex governance body and would have ultimate authority and responsibility for developing the strategic plans, setting direction, determining priorities, and directing resources. It would be accountable for the delivery of the Strategy and also for the monitoring and evaluation of performance against the Strategy, including the effectiveness of the surveillance system and surveillance initiatives.

The operational requirements will be beyond the capacity of the Governance Group. Accordingly, further capacity in the form of an operations and coordination function would be required. This could be established as a function within a Coordination Centre, that includes the Governance Group.

National One Health Strategic and Technical Advisory Group

In this scenario the National One Health Strategic and Technical Advisory Group (Advisory Group) is a multi-disciplinary advisory panel. It is comprised of researchers and subject matter experts whose purpose is to support the Governance Group by providing expert advice. The Advisory Group is not a decision-making body. While its remit is specifically to provide advice,

the relationships of its members could be leveraged for informal communication and influencing (networked).

4.5.2. Strategy and leadership

As mentioned above, responsibility for the development and oversight of the execution of strategy will rest with the Governance Group. Subsequently, the development of sectoral plans, as required by the Strategy, would be developed by the Coordination Centre operational staff in conjunction with sectors. Approval of the strategic plans would rest with Governance Group.

Delivery and execution of the plans will fall to Coordination Centre operational staff and also require input from other stakeholders across jurisdictions, across the different sectors, and across the private sector.

Successful implementation and executive of the plans will be dependent on system actors outside the centralised framework's chain of command. This will have significant implications for the surveillance system's enabling and authorising environment.

4.5.3. Engagement and coordination

The surveillance system will be heavily dependent on coordination and collaboration to realise the ambition contained in the Strategy. The ability of the Coordination Centre to achieve this within this governance framework, will be heavily dependent on either the voluntary commitment and contribution of the system actors, or regulation, or some combination of the two. Achieving the voluntary commitment and contribution of the system actors requires the Coordination Centre to be highly networked across the entire system. While this governance structure is light in terms of administrative overhead, the framework has limited capacity to facilitate collaboration, rather the mechanisms and processes within the framework traditionally support a command and control working style.

For example, there are no mechanisms in this framework designed to improve engagement and relationship development with the private sector or in this case with stakeholders across the sectors.

4.5.4. Enabling and authorising environment

If trust and cooperation are less likely to be achieved at the high levels required, the enabling and authorising environment will require regulatory settings to be calibrated to support the system. This also creates regulatory administration requirements for the Coordination Centre and regulatory burden for participants.

4.5.5. Conclusion - Model Option 1 Centralised governance framework

The centralised governance framework has limited application in distributed settings and therefore limited benefit in a One Health surveillance system context. The centralised model lacks reach for effective engagement and coordination. That limitation will not allow the variable trust barrier to be overcome, and data integration is therefore unlikely to occur. This has been acknowledged by the Australian Public Service Commission in its assessment of the new environment for public sector performance and accountability, where it identified that hierarchy and single points of accountability do not create an environment that fosters the collaboration required to be responsive to modern policy problems (24).

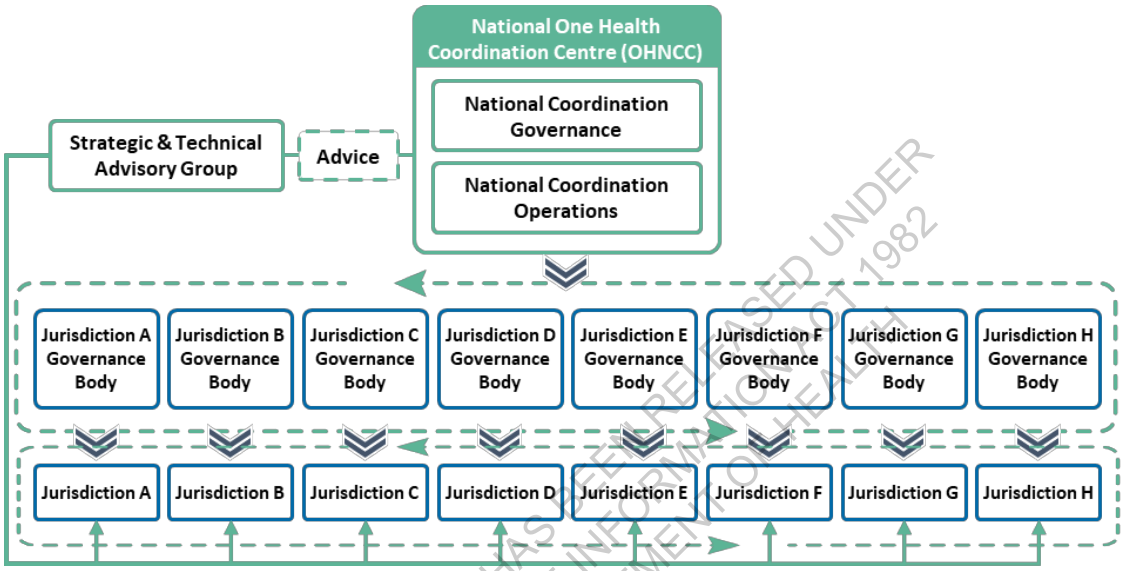
Pros and cons for Option 1

Pros	Cons
• Light touch governance model • Relatively low cost due to minimal new governance structures • A significant level of new resourcing may not be needed	• Limited formal structures for engaging with sectors or with other jurisdictions • Limited structures to engage with public or other stakeholders across the sectors • Not geared to enable horizontal governance Slightly restricted with regards to collaboration.

4.6. Model Option 2 (a) – Distributed jurisdictional governance framework

While Model Option 1 concentrates governance functionality and capability at the centre, a distributed governance framework is based on the premise that the reach and influence of a surveillance system can be extended through a model which distributes governance functionality and capability to the periphery, or other parts of the system to enable improved coverage and greater on-the-ground engagement. Coverage can be jurisdictional or geographic. The spokes are calibrated to achieve the targeted type and degree of coverage, Figure 10 presents a visual representation of this type of governance.

Figure 10: Model Option 2 (a) - Distributed jurisdictional governance framework



In light of the cross-sector nature of the One Health surveillance system, this "hub and spoke" framework would also be calibrated to enable a cross-agency approach. This approach would recognise that a One Health surveillance system does not fall within the sole domain or portfolio of a single agency, and that certain agencies will have roles in respect of certain sectors.

The distributed hub and spoke model contain and enable elements of both vertical and horizontal governance, although both tend to be highly structured and formalised forms.

4.6.1. Roles and responsibilities

As with the centralised model (Option One), a Coordination Centre is required. The basic construct of the Coordination Centre is also the same, being comprised of a governance body and an operations function.

National One Health Governance Group

In this scenario the Governance Group is the apex governance body and would have ultimate authority and responsibility for developing the strategic plans, setting direction, determining priorities, and directing resources. It would be accountable for the delivery of the Strategy (3) and also for the monitoring and evaluation of performance against the Strategy, including the effectiveness of the surveillance system and surveillance initiatives.

Under this option the composition of the Governance Group may accommodate the cross-jurisdictional nature of the framework by extending membership of this governance group to include Commonwealth, state and territory representation.

National One Health Strategic and Technical Advisory Group

In this scenario the National One Health Strategic and Technical Advisory Group (Advisory Group) is a multi-disciplinary advisory panel. It is comprised of researchers and subject matter experts whose purpose is to support the Governance Group by providing expert advice. The Advisory Group is not a decision-making body. While its remit is specifically to provide advice, the relationships of its members could be leveraged for informal communication and influencing.

One Health National Coordination Centre Operations

The operational requirements will be beyond the capacity of the Governance Group. Accordingly, further capacity in the form of an operations and coordination function would be required. This coordination need would be established as a function within the Coordination Centre. Coordination Centre operations are effectively the coordination and supporting functions of the "hub". Coordination Centre operations are also responsible for organising and coordinating a One Health systems monitoring and evaluation.

Jurisdictional based One Health Operations Centres

Each participating jurisdiction (state or territory) effectively establishes a One Health Operation Centre. The centres might be virtual or physical and are effectively the "spokes" of the framework. The focus of the centre is on the co-development of jurisdictional AMR and AU One Health surveillance plans and their implementation. The centres become the focal point for engagement, consultation, and coordination of One Health activities within that jurisdiction. Each operation centre reports back to the hub periodically, providing information about progress and proposed surveillance approaches.

4.6.2. Strategy and direction

The responsibility for the development and execution of strategy will rest with the Governance Group.

The sectoral plans required by the Strategy would be developed collaboratively at a national level. The process would be supported and facilitated by the Coordination Centre operations team. Each One Health Operations Centre would participate and contribute. Approval of these plans would rest with the Governance Group.

These sectoral plans would then need to be cascaded and each OHOC would need to develop a One Health plan with specific sections targeting commitments in each sector. Approval of these plans would also rest with the Governance Group.

An alternative would be that the system moves away from the sectoral based planning required in the Strategy and is replaced with a jurisdictional One Health plan. Irrespective of which planning approach, this activity would be guided and supported by Coordination Centre operational staff. To promote and enable collaborative relationships, the planning processes will require input from other stakeholders across the One Health sectors, including from the private sector.

Delivery and execution of the plans will fall to each OHOC, supported by Coordination Centre operations staff, and monitored and supported by the Governance Group. Successful implementation and executive of the plans will be dependent on system actors outside the centralised frameworks chain of command. This will have significant implications for the surveillance system's enabling and authorising environment.

4.6.3. Engagement and coordination

The hub and spoke model is able to support greater collaboration and coordination across the system than the centralised model. Notably it is intended to enable and improve cross-agency collaboration within each jurisdiction. In addition, it is intended to enable cross jurisdictional collaboration. Thus, it provides opportunities for enhanced coordination across the public sector.

It leverages a dispersed set of resources and personnel with a greater collective network of relationships across the system. As a result, it improves the reach of the hub in terms of communications and influence. The extended reach offers other benefits, including that in theory it enables the development of surveillance implementation plans more customised to local needs and expectations.

The hub and spoke approach will require the OHOC to incorporate stakeholder engagement planning into their approach. Consultation and collaboration will be critical to overcome the existing trust issues inherent in the model. The Coordination Centre has a critical role to play providing information to the OHOC and supporting consistency of messaging out across the sectors.

4.6.4. Enabling and authorising environment

Cross-jurisdictional, hub and spoke working arrangements are commonly established through inter-government agreements. In this scenario an inter-government agreement would be required. The agreement would shape the co-governance arrangements at the national and jurisdictional levels.

There are multiple examples of national partnerships where this has been done in the past. For example, the Remote Service Delivery National Partnership Agreement (RSD-NPA) provisioned for cooperative governance arrangements at the national, state, and regional levels, with Regional Operations Centre's (ROC) leveraging localised shared infrastructure and co-locating Commonwealth and state or territory staff.

While the distributed governance framework improves coordination between and across jurisdictions, its success will still depend on the participation and engagement of stakeholders outside of government. This still requires the stakeholders to trust government and want to work collaboratively with them. This is a significant challenge requiring trust and common aspirations.

If trust and cooperation are less likely to be achieved, the enabling and authorising environment will require regulatory settings to be calibrated to support the system. This also creates regulatory administration requirements for Coordination Centre and regulatory burden for participants.

4.6.5. Conclusion - Model Option 2 (a) Distributed jurisdictional governance framework

While the distributed jurisdictional framework offers an improved level of engagement with the private sector and other surveillance system actors compared with the centralised model (Option 1), it still has limitations in this regard. It will require extensive consultation and collaboration with stakeholders to get their buy-in to the approach and secure their support for any surveillance implementation plans and approaches. Overcoming the trust obstacles will likely take time.

Significantly, a model distributed according to jurisdictions does not naturally align with the sectors. Each jurisdiction is replicating effort to promote sector and system coherency but limiting that to the confines of the jurisdiction. Each jurisdictional approach must then in turn feed into nationally consistent approaches, both at the sector and the national system level. This has implications for timeliness of surveillance information and decision-making as well as resource implications such as administrative establishment costs and ongoing overheads, which is replicated for each participating jurisdiction. The lack of alignment is likely to inhibit intra-sectoral coordination as well as inter-sectoral coordination. The model is therefore not ideally suited to improving system collaboration, coordination, or data integration.

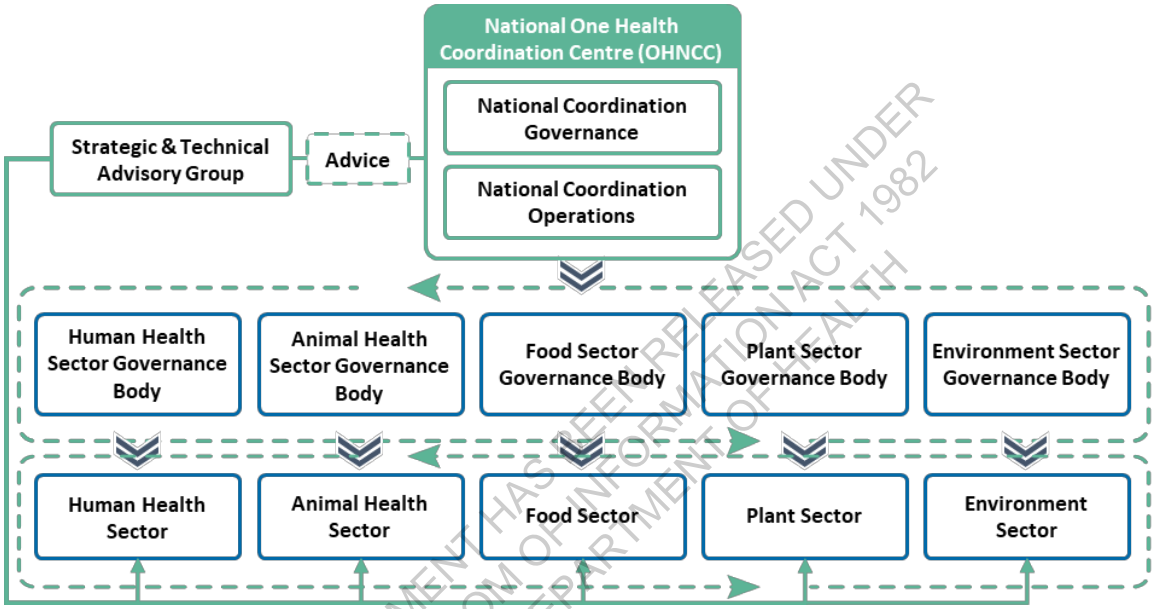
Pros and cons of Option 2 (a)

Pros	Cons
• Moving away from an national-centric model • Potentially increased stakeholder buy-in due to the increased role of each stakeholder group • Leverages relationships with the goal of fostering collaboration.	• Increased complexity due to the increased level of governance present across each jurisdiction • Each jurisdiction needs to have the ability to be One Health across the five sectors • Loss of efficiency due to replication at the jurisdictional level • Increased administrative burden and overhead costs • Does not foster collaboration at the sectoral level

4.7. Model Option 2 (b) – Distributed sectoral governance framework

This distributed sectoral governance framework has many of the same characteristics and traits of the Option 2 (a). It is also based on the premise that the reach and influence of surveillance system can be extended through a model which distributes governance functionality and capability away from the centre to the periphery, or other parts of the system to enable improved coverage and greater on-the-ground engagement. In this case, coverage is based on a sectoral construct. That is, rather than the "spoke" connecting to a jurisdiction or geographic area, the spoke is intended to extend the reach of the centre, providing a national level of coverage focussed on a specific sector of the One Health surveillance system. Figure 11 Figure 11provides a visual representation of the distributed sectoral governance framework.

Figure 11: Model Option 2 (b) - Distributed sectoral governance framework



Also consistent with the Option 2 (a), this approach would need to recognise that a One Health surveillance system does not fall within the sole domain or portfolio of a single agency, and that certain agencies will have roles in respect of certain sectors and facilitate the connections and collaboration between and across the sectors. Accordingly, this sectoral hub and spoke model requires both vertical and horizontal governance.

Cross jurisdictional support and involvement is also required in this distributed model. Cross jurisdictional representation and participation will likely be required at the hub and at the spoke parts of the framework. Accordingly, the vertical and horizontal governance requirements need to transcend jurisdictions.

4.7.1. Roles and responsibilities

National Coordination Centre

As with the centralised model and Option 2 (a), a National Coordination Centre is required. The basic construct of the Coordination Centre remains the same as that proposed for Option 2 (a).

National One Health Governance Group

The role of the Governance Group remains fundamentally unchanged from that described in Option 2 (a). Likewise, the composition of the Governance Group will also accommodate the cross-jurisdictional nature of the framework by extending membership of this governance group to include Commonwealth, state and territory representation.

National One Health Strategic and Technical Advisory Group

The role of the Advisory Group remains the same as described in each of the previous options. That is, it is a multi-disciplinary advisory panel, comprised of researchers and subject matter experts, supporting the Governance Group through the provision of expert advice.

One Health National Coordination Centre operations

The role of Coordination Centre Operations is also as described in Option 2 (a). That is, Coordination Centre operations are effectively the coordination and supporting functions of the "hub". Coordination Centre operations are also responsible for organising and coordinating the One Health monitoring and evaluation.

One Health Sector Working Groups

In this option a Working Group is established for each sector. Each Working Group is comprised of representatives from the relevant agency in each participating jurisdiction. The working coordinates responses and programs of work nationally. While five sector Working Groups are graphically represented in Figure 1111, these could be consolidated into three or four sectors.

4.7.2. Strategy and direction

As with Option 2 (a), responsibility for the Strategy development and execution rests with the Governance Group. The development of sectoral plans, as required by the Strategy, would be undertaken by each Working Group. This activity would be guided and supported by Coordination Centre operational staff. Responsibility for the approval of these plans would rest with the Governance Group.

Delivery and execution of the plans will fall to each Working Group supported by Coordination Centre operations staff and monitored and supported by the Governance Group.

4.7.3. Engagement and coordination

The sectoral based hub and spoke model improves the ability to foster collaboration and coordination across within each sector compared with the jurisdictional based framework. At the centre, the model provides an opportunity to establish cross jurisdictional and cross sector coordination and cohesion.

At the spoke or working group level, the framework is intended to enable and improve cross jurisdiction collaboration within each sector. While it has a different configuration, the sectoral hub and spoke model still leverages a dispersed set of resources and personnel with a greater collective network of personal and professional relationships. This effectively improves the reach and influence of the One Health governance framework.

The hub and spoke approach will require each Working Group to incorporate significant stakeholder engagement planning into their approach. The includes exploring the establishment and development of networked relationships with sector industry associations, research institutions and other stakeholders. Consultation and collaboration will be critical to overcome the existing trust issues that exist.

The Coordination Centre continues to have a critical role providing information to the Working Groups and supporting the consistency of messaging and approaches to each sector.

4.7.4. Enabling and authorising environment

Cross-jurisdictional hub and spoke working arrangements are commonly established through inter-government agreements. The sector-based approach is not a common version of the distributed governance framework.

Given the approach still requires cross jurisdictional cooperation, an inter-government agreement will still be required. The agreement would shape the co-governance arrangements at the national and sectoral levels.

4.7.5. Conclusion – Model Option 2 (b) Distributed sectoral governance framework

While the distributed sectoral framework offers an improved level of engagement with the private sector and other surveillance system actors compared with the jurisdictional hub and spoke model, it still has limitations in this regard. It will require extensive consultation and collaboration with stakeholders to get their buy-in to the approach and secure their support for any surveillance implementation plans and approaches. Overcoming the trust obstacles will likely take time.

The distributed sectoral governance framework is superior to the jurisdictional hub and spoke model in that it is more appropriately aligned with the structures of a One Health surveillance system. In addition, as a result of that improved alignment, there appear to be greater operational efficiencies, including the associated operating cost efficiencies.

The improved alignment of this governance framework with the natural topology of a One Health surveillance system, means that this framework is also more likely to enable intra-sectoral coordination as well as cross-sectoral coordination. It is therefore more suited for improving surveillance system collaboration, coordination, or data integration.

Pros and cons for Option 2 (b)

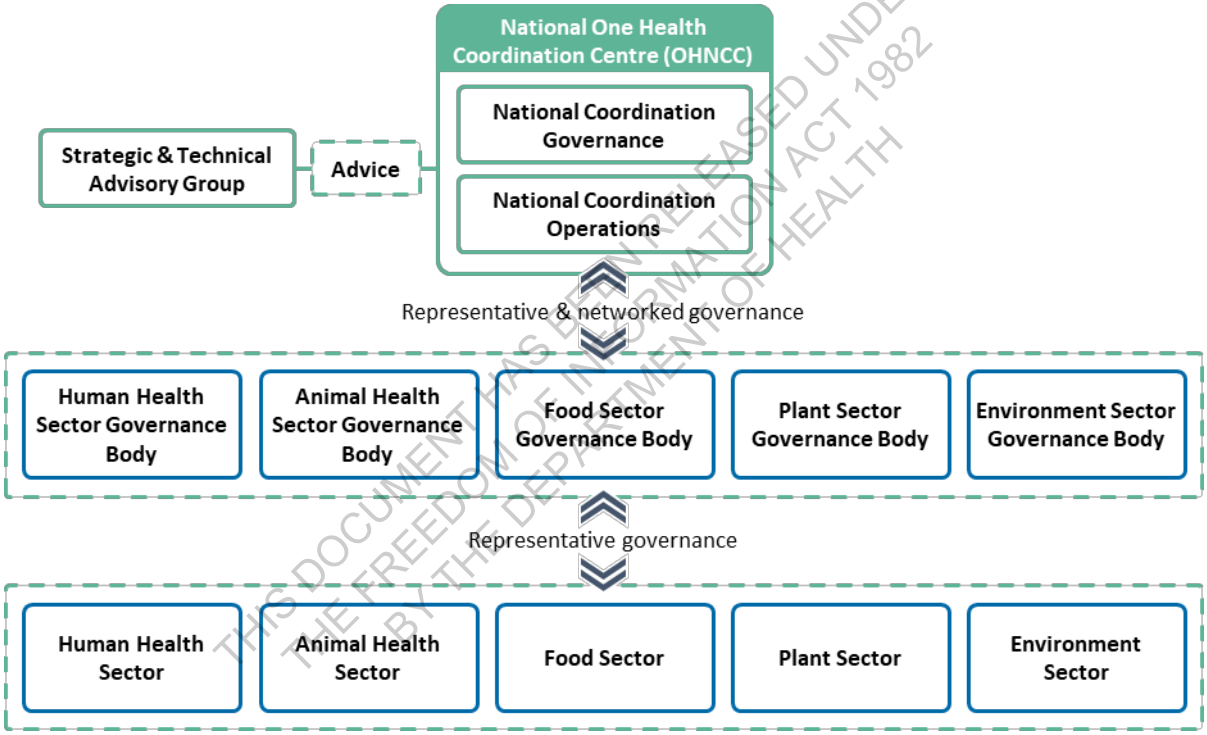
Pros	Cons
• Moving away from an national-centric model • Potentially increased stakeholder buy-in due to the increased role of each stakeholder group • Leverages relationships with the goal of fostering collaboration. • Structures are more closely aligned and connected to the sectors than the jurisdictional based option • More efficient than jurisdictional based option but still enables collaboration • Extends the reach and influence of the One Health approach out into each of the sectors	• The sector bodies operate across jurisdictions • Increased administrative complexity compared to Option 1

4.8. Model Option 3 – Devolved governance framework

The devolved governance framework has many of the same characteristics and traits of the distributed frameworks in that it is also based on the premise that the reach and influence of surveillance system can be extended through a model which distributes governance functionality and capability away from the centre to the periphery, or other parts of the system. In this devolved framework, the distribution of functionality is also on a sectoral basis.

Where the distributed governance frameworks highlighted previously, extend functionality from the centre, the focus of that distributed governance functionality tends to be operational. In other words, the distributed elements of the governance functionality do not include the distribution of decision-making authority. In the devolved framework, however, there is a sectoral governance body with a key coordinating role, that also is a decision-making body, as presented in Figure 12.

Figure 12: Model Option 3 - Devolved governance framework



Accordingly, the key distinction of this framework from the previous hub and spoke options, is that decision making authority is devolved from the centre.

Also consistent with the distributed governance framework options, this approach recognises that a One Health surveillance system does not fall within the sole domain or portfolio of a single agency, and that multiple agencies will have roles in the system and in respect of certain sectors. It seeks to engage different agencies, both at the centre and at the devolved points of the model. Accordingly, this sectoral hub and spoke model also requires both vertical and horizontal governance.

Cross jurisdictional support and involvement is also required in this devolved model. Cross jurisdictional representation and participation will likely be required at the hub and at the spoke

parts of the framework. Accordingly, the vertical and horizontal governance requirements need to transcend jurisdictions.

The other key characteristic of note proposed with this model is that it seeks to overcome the challenge of engaging effectively with non-government stakeholders through an inclusive and participatory governance approach. That is, by enabling representative participation in the formal governance structures, including the decision-making bodies.

4.8.1. Roles and responsibilities

National Coordination Centre

As with the centralised and the distributed models, a National Coordination Centre is required. The basic construct of the Coordination Centre remains the broadly same as that proposed for distributed models.

National One Health Governance Group

The Governance Group is responsible for the overarching system level strategy and decision making. It remains responsible for the overall implementation of the Strategy. The composition of the Governance Group will also accommodate the cross-jurisdictional nature of the framework by extending membership of this governance group to include Commonwealth, state, and territory representation. To enable an improved public-private partnership and the inclusive governance approach mentioned above, the membership of the Governance Group would be extended to include representation of sector stakeholders.

National One Health Strategic and Technical Advisory Group

The role of the Advisory Group remains the same as described in each of the previous options. That is, it serves as a multi-disciplinary advisory panel, supporting the Governance Group through the provision of expert advice. It is comprised of researchers and subject matter experts.

One Health National Coordination Centre operations

The role of Coordination Centre operations is also as described in the distributed governance framework options. That is, Coordination Centre operations are effectively the coordination and supporting functions of the “hub”. The coordination function includes is significant engagement and communications element. Coordination Centre operations are also responsible for organising and coordinating the One Health surveillance system monitoring and evaluation.

One Health Sector Governance Groups

In this option a governance group is established for each sector. The Sector Governance Group is comprised of representatives from the relevant sector agency from participating jurisdictions. In addition, the Sector Governance Group contains representatives of the sector (industry, professional associations, the research community, and NGOs). Each Sector Governance Group is responsible for leading sector-based planning, surveillance commissioning, sector capability development, communications, and coordination. The Sector Governance Group coordinates implementation of the sector surveillance plan and reports periodically to the Governance Group on progress and issues.

4.8.2. Strategy and direction

As with the other options, responsibility for the Strategy development and execution rests with the Governance Group. In addition, the Governance Group clearly signals the system requirements, direction of travel and expectations.

This includes by articulating and publishing the One Health surveillance system guiding principles of operation. Research indicates that sectors have different drivers, different levels of capability, different surveillance challenges and different priorities. The principles-based approach is intended to enable a nationally (system wide) consistent approach while still allowing approaches to be calibrated to meet the specific requirements of each sector.

The development of sectoral plans, as required by the Strategy, are the responsibility of each respective Sector Governance Group. This activity would be guided and supported by Coordination Centre operational staff. It is envisaged that the planning process is inclusive, reflecting sector stakeholder drivers, expectations and needs. The plans would be developed consistent with the One Health surveillance system guiding principles. Responsibility for the approval of these plans would rest with the respective Sector Governance Groups. However, they would be referred to the Governance Group for endorsement and to determine the government capability funding requirements.

Monitoring and evaluation of the Strategy, the sectoral plans, and surveillance initiatives are undertaken by the Coordination Centre. Results and information are provided to Sector Governance Groups and stakeholders to inform operational responses and future planning.

4.8.3. Engagement and coordination

The devolved governance framework is designed to enable cross agency and cross jurisdictional collaboration and coordination. As with the distributed governance frameworks, the sectoral based hub and spoke model also improves the ability to foster collaboration and coordination across and within the sectors.

At the centre the model provides an opportunity to establish system level coordination. That is, cross jurisdictional and cross sector coordination and cohesion.

At the spoke or sector governance group level, the framework is intended to enable and improve cross jurisdiction collaboration within each sector. While it has a different configuration, the sectoral hub and spoke model still leverages a dispersed set of resources and personnel with a greater collective network of personal and professional relationships. This effectively improves the reach and influence of the One Health governance framework. The relationships of the sector representatives extend this further and enables an enhanced form of networked governance.

The hub and spoke approach will still require each Sector Governance Group to incorporate significant stakeholder engagement planning into their approach. This includes exploring the establishment and development of networked relationships with sector industry associations, research institutions and other stakeholders. Consultation and collaboration will be critical to overcome the existing trust issues inherent in the model but will be aided by the representative governance structures.

4.8.4. Enabling and authorising environment

Cross-jurisdictional, hub and spoke working arrangements are commonly established through inter-government agreements. The sector-based approach is not a common version of the distributed governance framework. However, given the approach still requires cross jurisdictional cooperation, an inter-government agreement will still be required. The agreement would shape the co-governance arrangements at the national and sectoral levels.

In addition to the inter-government agreement, consideration will need to be given to formalising or enabling the appointment of sector representatives to decision making bodies.

4.8.5. Conclusion – Model Option 3 Devolved governance framework

The devolved governance framework offers improved levels of engagement with the private sector and other surveillance system actors compared with the centralised and distributed models. However, there is some complexity to navigate in establishing the private-public partnerships.

The devolved sectoral governance framework is aligned with the structures of the One Health surveillance system which should allow a more tailored approach to developing surveillance plans and capability for each sector balancing system and sector drivers and priorities.

The improved representation and inclusive governance arrangements of this devolved governance framework, means that it has greater potential for integration of the four dimensions of collaboration. It is therefore more suited for improving system collaboration, system coordination and ultimately, data integration.

Pros and cons for Option 3

Pros	Cons
• Moving away from an national-centric model • Potentially increased stakeholder buy-in due to the increased role of each stakeholder group • Leverages relationships with the goal of fostering collaboration. • Structures are more closely aligned and connected to the sectors than the jurisdictional based option • More efficient than jurisdictional based option but still enables collaboration • Extends the reach and influence of the One Health approach out into each of the sectors	• The sector bodies operate across jurisdictions • Increased administrative complexity compared to Option 1

SURVEILLANCE AND DATA MANAGEMENT

5. SURVEILLANCE AND DATA MANAGEMENT

This section assesses the necessary surveillance and data management design components of an Australian AMR and AU One Health surveillance system and the future decisions that will be made once the governance option is decided.

Figure 13: Surveillance and Data Management elements from the conceptual design

This section includes:

- why surveillance and data management is important
- surveillance design
- data collection future decisions
- data analysis, storage, access, dissemination and sharing future decisions.

5.1. Why is surveillance and data management important?

Carefully considered surveillance design; including data collection, data storage and access, analysis, and dissemination; is crucial for implementing a sustainable surveillance system which produces quality, meaningful, and useful AMR and AU data.

Effective surveillance and data management should consider:

- different sectoral drivers and generating sector buy-in
- different sectoral capability and maturity – and how this can be developed over time
- enabling data linkage and harmonisation
- ensuring data privacy and responding to privacy and usage concerns
- ensuring data is disseminated appropriately and the data is collected and shared with clear purpose.

5.2. Surveillance design

Effective surveillance design is key to operating a successful One Health AMR and AU surveillance system. Surveillance design will be an ongoing process throughout the transition and implementation of the surveillance system.

Surveillance design informs all aspects of surveillance activities, including:

- data collection
- laboratory systems
- data linkage and harmonisation
- data storage and access

- data analysis
- data dissemination.

These are discussed in detail in the following sections.

At a higher level, surveillance design also includes developing strategies and priorities for surveillance and taking a collaborative approach to surveillance activities.

One Health surveillance strategies and priorities

Key stakeholders highlighted the importance of clarifying the purpose of surveillance. At a high level, there was general stakeholder agreement with the 2020 Strategy's priority to protect the health of humans, animals and the environment through minimising the development and spread of AMR while continuing to have effective antimicrobials available (28), but emphasised the need to clarify what that would mean for their respective sectors and jurisdictions.

Stakeholders strongly suggested that data collection under a One Health surveillance system should be collected with a clear purpose and with clear pathways for data usage. Clearly articulated surveillance priorities and purposes which align with sector drivers would assist in generating buy-in to surveillance activities.

As such, a successful surveillance strategy should determine the surveillance objectives and goals, which will then inform which surveillance activities are most appropriate. The priorities and purpose for surveillance will differ between and within sectors, so collaboration with stakeholders at the sector level will inform what type and level of surveillance is appropriate. This might include passive or active surveillance or a combination of the two.

Strategies for an AMR and AU One Health Surveillance system will need to be informed by goal setting initiatives at the governance level. However, lessons can be learnt from the Swedish STRAMA program, with their bottom-up approach a key strategy for achieving SRAMA's AMR and AU surveillance goals (29).

Australian surveillance goals and priories might include:

- implementing and coordinating effective and integrated surveillance of AMR and AU
- identifying trends in antimicrobial resistance over time
- understanding the spread of resistant organisms within and across sectors, and the impacts of AU across the entire system
- providing systematic, coordinated, and central reporting on AMR and AU
- enabling the timely identification and response to critical instances of AMR
- informing sector-specific and multisectoral actions and responses to combat AMR, including through appropriate AU
- meeting international AMR and AU surveillance and data sharing obligations

Engagement and collaboration

Given the large and varying group of stakeholders affected by an AMR and AU One Health surveillance system, engagement, and collaboration with and between these groups will be a critical success factor for a One Health surveillance system. Collaboration was raised by stakeholders, and supported by the literature, as being one of the key components of a successful surveillance system (14). Moreover, clearly defining roles and responsibilities within the surveillance structure is necessary to ensure engagement and participation.

Engagement and collaboration is included in the options described in Section 4.

5.3. Data collection

5.3.1. Data sources

There are numerous sources currently providing AMR and AU data in Australia across the One Health sectors. Human health data collection is largely undertaken by AURA program partners and contributors across the spectrum of healthcare provision. This includes data on AMR susceptibility, prescribing data, and appropriateness of prescribing data. In addition to AURA contributors, there is significant data collection undertaken by universities, research centres, organisations, and state and territory governments.

In the animal sector, there are fewer formalised data sources. Available data includes veterinary pharmaceutical sales data, prescribing and dispensing data, and some antimicrobial residue and antimicrobial susceptibility data (including through industry-specific surveys). Across the animal health sector there is considerable variability in data sources and methodology.

Food, plant, and environmental data sources are limited and can overlap with other sectors. An increase in wastewater testing since the advent of COVID-19 provides an opportunity for growth in environmental AMR and AU data collection. Overlapping data sources arise when, for example, collection of animal samples occurs in production environments, capturing both environment and animal data.

Exemplar surveillance programs, such as NAPS or OzFoodNet could be leveraged, scaled-up, or developed for use within or across multiple sectors. For example, OzFoodNet collects data on foodborne diseases in Australia, including deidentified line data from NNDSS on gastrointestinal diseases, and aggregated outbreak data. These analyses enable the network to identify outbreaks linked to infections, and to help agencies to detect food or water safety. Programs such as OzFoodNet could be leveraged or replicated to include AMR data. Likewise, systems such as NAPS, which collects data on appropriateness of prescribing in hospitals, aged care facilities, and the community could be expanded to include veterinary prescribing. There are opportunities to adapt, develop and leverage existing data sources to progress towards a One Health model in Australia as well as gaps for the development of new or alternative data sources.

Another consideration is sustainability of data collection. Many stakeholders explained that the provision of data is currently voluntary for almost all AMR and AU surveillance and facilitated by relationships that have been fostered over time. Data collection options will need to be cognisant of the delicate nature of these relationships and the information they yield.

International examples of One Health systems highlight that even highly developed or evolved surveillance systems still have numerous data sources and systems for collection (see

Appendix 1: Overview of international examples). The goal is not to replace the existing data sources with a singular or even dual data source, but to massage exemplar data sources to work more cohesively with a One Health framework and fill gaps with new data sources when necessary.

Learnings from international examples will be particularly useful for surveillance activities that are not currently implemented in Australia. For example, the levels of AMR bacteria in the water, soil, and the air have been monitored for approximately 15 years in the Netherlands (3). The main sources of AMR identified during this monitoring include human wastewater, manure produced by farm animals, and the droppings of wild animals. These sources allow AMR bacteria to enter the environmental system through absorption into surface water, soil, and the air (3).

5.3.2. Laboratories

Laboratories are a key part of the data collection landscape. Stakeholder engagement confirmed that susceptibility and AMR testing was available across all sectors. However, both AMR and susceptibility testing wasn't always available in the organisation, laboratory, network or jurisdiction of some stakeholders. Stakeholders reported that EUCAST and CLSI are the most common standards used, sometimes independently but often simultaneously within laboratories.

Some stakeholders noted that inconsistency between laboratory standards can affect data harmonisation both within and across sectors. Data linkage and harmonisation are important success factors for a One Health surveillance system, so addressing inconsistencies across laboratory systems should be part of a One Heath strategy.

Another key laboratory consideration is regarding reference laboratories. Reference laboratories are distinguished centres of excellence which demonstrate key AMR and antimicrobial residue analysis capacities and engage in fields of expertise (30). They often pioneer research in specific areas and provide training opportunities for other laboratories. As such, reference laboratories could become key collaborators for developing or adapting laboratory standardisation across Australia with regards to AMR and AU. One policy implementation plan cites the importance of establishing a national AMR reference laboratory to provide technical support for participating surveillance sites and to confirm findings of unexpected resistance (25). Collaboration with sector and subject leaders such as reference laboratories would assist in creating standardisation, linkage, interoperability, and integration of services that is representative of users.

5.3.3. Data linkage and harmonisation

A lack of data linkage and harmonisation are significant barriers to implementing One Health systems in Australia and internationally (14). Linking AMR and AU data relating to the same priority organisms and associated agents across sectors and systems is necessary to optimise the usefulness of outputs from the surveillance system.

For data to be linked effectively from a range of sources, metrics should be comparable where possible. For example, this may include:

- standard definitions relating to what is considered an antimicrobial of importance for human use (for data collection on use in animals)
- collecting data on usage volume versus doses

- consistent definitions relating to what constitutes appropriate use
- selection of metrics for antimicrobial use in healthcare settings (such as defined daily doses versus days of therapy).

Key stakeholders highlighted that varied laboratory systems and practices, such as harmonisation, ethics, information systems and governance of data sharing, contributed to challenges with data linkages both within and across different sectors. It was also noted that there is a lack of consistency across states and territories, with differing reporting protocols and tools making national reporting difficult. Linkage between databases will be a complicated but important step in realising a One Health surveillance system.

Modelling could follow the Swedish example, where data is linked at the laboratory level, or harmonisation and linkage could occur at different points of collection and analysis, such as with registries.

Many stakeholders suggested that the increasing prominence of microbial genomics is a significant opportunity for increased data linkage and harmonisation. Some stakeholders suggested that AusTrakka (a platform for real-time analysis of integrated genomic data for public health) could be utilised to link data across sectors. Work undertaken by the *One Health Understanding Through Bacterial Resistance to Antibiotics Knowledge* (OUTBREAK) project could also be leveraged.

5.3.4. Data collection future decisions

The following future decisions would be applied to different types of data and collection activities within a surveillance system. For example, this might include AMR outbreak data, AMR data to inform prescribing decisions, AU data, appropriateness of AU data, and antimicrobial residue data. The choices may also be different for different sectors, based on current maturity of data collection, capacity for data collection, emerging data collection opportunities (i.e. where new technology or funding becomes available), and the need to address surveillance gaps.

Future decision – Status quo

Under a status quo arrangement, data collection strategies would remain as they are, with the aim to integrate data from existing systems.

The benefits of this are:

- this approach is simple and requires no intervention
- this approach will necessitate minimal additional resource.

The limitations of this are:

- this approach does not facilitate transition to a One Health model for data collection.

Future decision – Develop existing AMR and AU databases to work cross-sector

This approach would build on or replicate existing data collection systems and databases to work across different sectors. Systems that have been suggested for this purpose are AusTrakka and NAPS.

The benefits of this are:

- resource (time and money) is saved by using existing infrastructure
- existing systems have reputational weight and are known in at least some of the One Health sectors
- the body of knowledge around the strengths and weaknesses of existing systems can be utilised for development
- some of the existing systems already have endorsement from governing bodies
- future data could be compared to benchmark data with greater ease.

The limitation of this is:

- most of the existing systems have been built with singular focus which makes integration with cross-sectoral data collection methodologies difficult. This is further restricted by the number of data entry points, and lack of standardisation.

Future decision – Build new data collection databases and systems for growth

This approach would create a new or highly adapted data collection system. This might involve developing bespoke systems or repurposing existing systems outside of the AMR scope such as wastewater testing for COVID-19 or biosecurity surveillance systems.

The benefits of this are:

- tools will be purpose built within a One Health context.

The limitations of this are:

- building new data collection systems and databases require significant resource and require ongoing IT and infrastructural investment over and above what might be required for the approach outlined in future decision 2
- many stakeholders have recommended leveraging existing systems before considering the development of new systems or databases.

5.4. Data analysis, storage, access, dissemination and sharing

5.4.1. Data storage and access

Data usage and privacy are concerns for many stakeholders. In order to gain the trust of data owners, storage of and access to data will need to be carefully managed. Currently AURA data custodians are required to ensure that data management policies, guidelines and procedures are in place for data, including for:

- data governance
- data development
- data acquisition, storage and management
- data security
- data quality management
- data processing
- data disclosure and reporting
- metadata management (21).

In conjunction with these policies, guidelines and procedures, data sharing agreements can provide some level of assurance to data owners and could be a standardised element of data use.

Decisions relating to data storage and access will need to consider the point at which data is aggregated and shared, implications for identifiable data and ease of access for users within or across sectors. Responsibilities for coordinating data access and storage will need to be clearly delegated and agreed to and will likely depend on the eventual governance model. A cross-sectoral data stewardship group could control storage and access, as could groups at the sector or laboratory level. Registries could also offer an independent storage, access, and analysis service of data at the aggregated level.

Some stakeholders suggested the concept of a pyramid approach to data access. Under this framework there would be three tiers of data and data access:

- **granular (identifiable) data** is available to data owners, such as hospitals, farms, or aged care providers. Where data related to a notifiable disease, this data will also be made available to the relevant state or territory authority to inform outbreak investigation and management.
- **deidentified data** is provided to an intermediate level of data storage for the purposes of aggregation and analysis
- **aggregated data** is then provided to government and included in publicly available reporting.

5.4.2. Data analysis

Analysis of AMR and AU data, utilising a range of analytical tools and methodologies is key to deriving accurate evidence about AU and AMR.

A significant component of quality data analysis is consistent processes relating to data validation and cleaning. Effective IT infrastructure, data definitions and data dictionaries can minimise the burden of data validation and cleaning and limit inconsistency.

Analysis options need to consider ethics approvals and data accessibility. Analysis could be built into data sharing agreements, such as with registries, to allow for ease of data flow from access to analysis.

Capability, knowledge and expertise will be required for different levels of analysis and could be guided by a data steward or governing body. However, independent analysis could be an important factor in building trust with data owners.

IT infrastructure (including data collection tools and databases) and wider technological capability are significant enablers for effective and efficient analysis.

5.4.3. Data dissemination

Dissemination of AMR and AU surveillance data findings is currently occurring at several levels in Australia, including:

- CARAlerts and other alert triggers
- publication of Australian Pesticides and Veterinary Medicines Authority (APVMA) product sales data
- publication of National Residue Survey (NRS) data on antimicrobial residues in production animals and plants
- reporting at a national level through AURA, and
- publication of findings in journals when appropriate.

Decisions on dissemination need to account for current reporting, which is largely in the human health space, identifying methods of reporting that aligns with the spirit of data sharing agreements and commercial sensitivities.

Options will also need to align with international commitments, such as for trade purposes and with the WHO GLASS initiative.

Reporting frameworks could be developed in collaboration with sector representation, at the governance level, to mitigate data sharing concerns. Reporting bodies, including alert systems, will require a mandate or ongoing permission to collect aggregated data for analysis and dissemination - this could be built into data sharing agreements.

5.4.4. Data sharing, storage, and access considerations

As with data collection, these considerations for data sharing, storage, and access will need to be applied to multiple surveillance activities and data types during transition planning and implementation of the One Health surveillance system.

Future decision – Status quo

In this approach, data owners would continue to store and access data in a way that meets their needs and requirements but limits data sharing.

The benefits of this are:

- stakeholders retain control over their data
- stakeholders are only required to share data with whom they are currently regulated to.

The limitation of this is:

- it doesn't encourage cross-sectoral data sharing or mid-level aggregation analysis.

Future decision – Work towards greater data sharing and accessibility

In this approach, data sharing, storage and access agreements would be established with the necessary stakeholders to enable data sharing at a mid-point aggregated level. Data owners would provide data to databases or agree to data collection through a third party (such as a university), which is then aggregated and fed into a new mid-point level for comparison before then going onto governing bodies for analysis and dissemination.

Registries, such as those used for cancer research, could act as the independent mid-point for data comparison at either the sectoral or jurisdictional level.

The benefits of this are:

- it works towards a One Health model for comparison of cross-sectoral data, which is enabled by the use of registries
- registries tend to have strong ethics approvals and are established as trustworthy data repositories, providing stakeholders with confidence around data storage.

The limitation of this is:

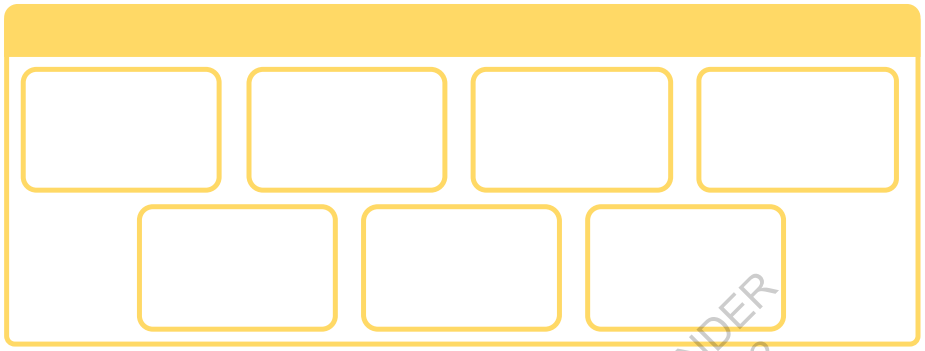
- potential hesitancy from stakeholders relating to data being made publicly available.

SYSTEM COVERAGE AND CAPACITY

6. SYSTEM COVERAGE AND CAPACITY

This section assesses the relevant considerations for system coverage and capacity from the conceptual design and the future decisions that will be made once the governance option is decided and alongside surveillance and data management decisions.

Figure 14: System Coverage and Capacity elements from the conceptual design



This section includes:

- why system coverage and capacity is important
- system coverage and capacity considerations
- priority organisms and antimicrobial agents future decisions
- equity considerations

6.1. Why is system coverage and capacity important?

As the One Health model intends to cover human health, animal health, plant health, the food system, and environmental surveillance, a One Health AMR and AU surveillance design should be cognisant of which areas (within sectors and geographically) require surveillance, and to what degree of urgency. For example, AMR and AU surveillance is already conducted within the human health sector in Australia. Coverage for the health sector might focus more on the One Health goal of expanding coverage to best utilise the data collection mechanisms already in place. Likewise, there is already some AMR and AU surveillance operating within the animal sectors, so priority might be given to increasing frequency or consistency of surveillance. Moreover, coverage should also consider prioritising organisms and antimicrobial resistances (existing or emerging), but coverage will vary across sectors.

Plant and environmental AMR and AU surveillance may receive less coverage, particularly in the early stages of establishing a One Health surveillance system as there is currently limited surveillance activities and resource capacity in these sectors. A One Health model could still prioritise these sectors, with an aim to building surveillance coverage in plant and environmental sectors over time. Several international cases, including Canada and Denmark have a stronger focus on human, animal, and food sectors. Environmental and plant coverage can be developed over time with system maturity as with the Swedish model (29).

6.2. System coverage and capacity considerations

System coverage and capability is an important consideration for the development of new surveillance activities under the future Model (31). In particular, the system will need to demonstrate sufficient coverage and representativeness of the following factors.

- **Organisms and antimicrobial agents**: data should be captured across One Health sectors on an appropriate range of organisms and antimicrobial agents. The identification of priority organisms and agents is discussed in Section 6.3.
- **Geography:** data should be geographically representative, including from all relevant states and territories, and a mix of urban, regional, rural, and remote settings. This is particularly important for understanding prevalence of AMR in different locations and for identifying any geographic-specific AU trends.
- **Sector:** for the purpose of this paper, the sectors are human health, animal health, plant heath, food and the environment. A One Health surveillance system should include data sources across each of these sectors and be cognisant of existing and potential capacity for surveillance within each sector. Additionally, cross-sectoral capacity to link data would be important for overall One Health coverage.
- **Population:** data should include a range of populations, including:
    - a mix of age groups and ethnicities (including Aboriginal and Torres Strait Islander Australians) in human health (see Section 6.5).
    - different animal populations such as companion animals, wildlife, horses, pigs, and dairy cows
    - different plants, such as fruits, vegetables, and grains, and
    - different foods, such as eggs, dairy, and packaged meat.
- **Activity/practice:** the specific activity or practice in which data is collected. For example, this may include:
    - whether isolates are collected from aged care, the community, or hospital for human health and prescribing practices within these settings
    - industry-specific farming practices for production animals, such as cattle that are raised in feedlots versus dairy farms
    - environmental samples that are collected from wastewater or drinking water, or
    - linking data between activities or practices, for example linking data for an individual who has received care from multiple health services.
- **Usage/prescription:** The ways in which antimicrobials are used, prescribed, and dispensed. For example, this may include:
    - data on volume of antimicrobials versus doses
    - sales data for prescription and non-prescription antimicrobials
    - prescribing data versus dispensing data, and
    - appropriateness of prescribing data.

- **Time (including frequency):** the timeframes in which data is collected and reported, and the frequency with which this is undertaken. For example, some surveys may be undertaken on an annual or bi-annual basis, while data critical resistances should be collected and reported upon with urgency.

6.3. Priority organisms and antimicrobial agents

For the transition to a One Health surveillance system, consideration will need to be given to:

- principles and processes for identifying and updating a list of priority organisms, associated antimicrobial agents (including for known resistances and emerging threats) for surveillance
- the scope of priority organisms and antimicrobial agents to be included in such a list, including whether fungi and antifungals, viruses and antivirals, and parasites and antiparasitics should be included
- which priority organisms and antimicrobial agents should be included in the initial list.

6.3.1. Priority organisms for inclusion in a One Health surveillance system

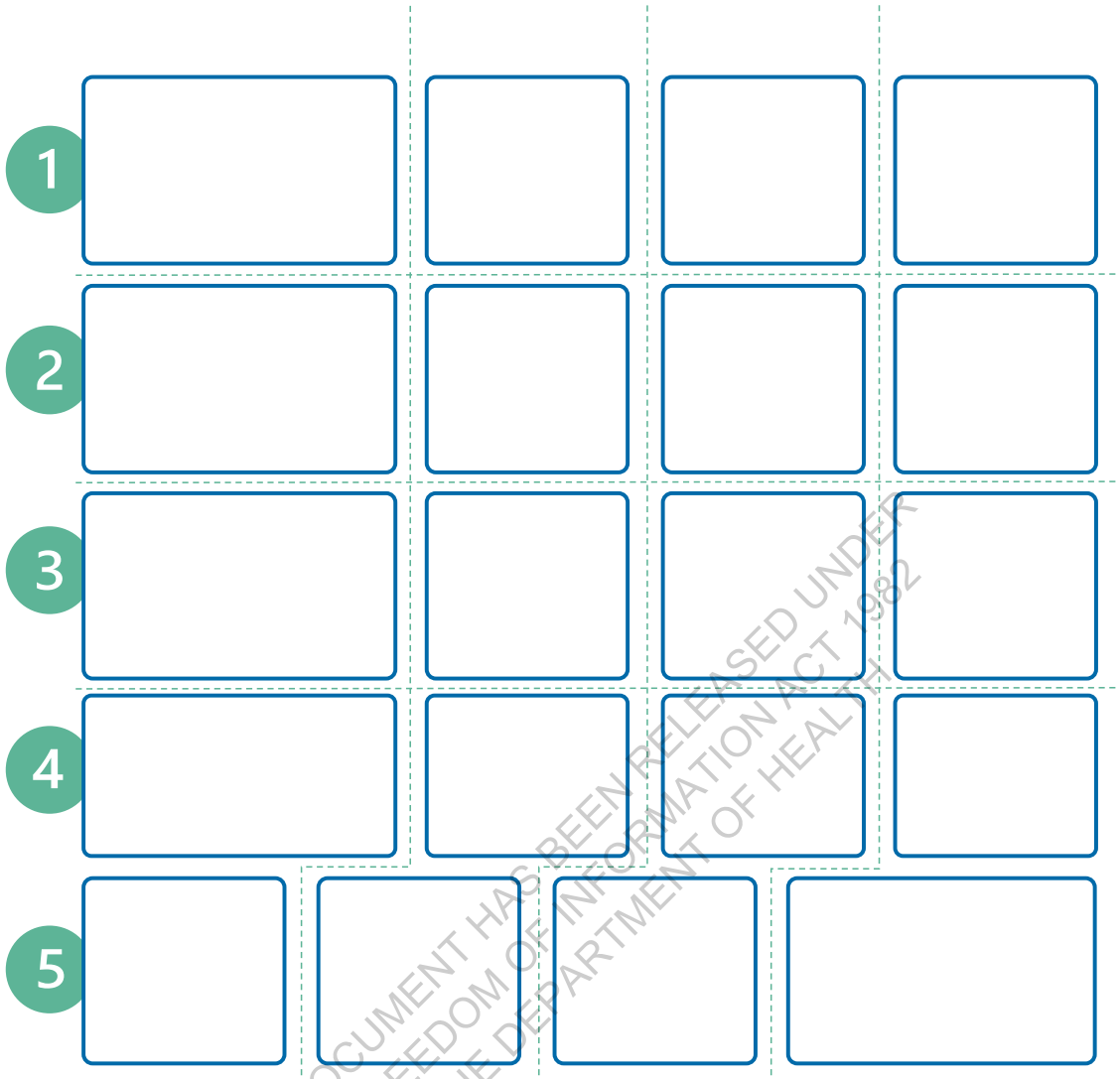
Of the five sectors, only human health currently has a list of priority organisms and antimicrobial agents for national surveillance reporting (20). The list was first created in 2015 and was reviewed and updated in 2019 (32). The list primarily includes bacteria categorised according to their importance for public health, impact on AMR in hospital and/or community settings and need for surveillance. This list was used as the basis for priority organisms and agents captured through CARAlert and was adapted in consultation with stakeholders. Unlike the AURA list which only includes bacteria, CARAlert also includes the fungi *Candida auris*.

ASTAG has published a list of *Importance Ratings and Summary of Antibacterial Uses in Human and Animal Health in Australia,* which includes a list of antibiotics used for human health, animal health, and both human and animal health (33).

The WHO has a list of priority pathogens for the research and development of new antibacterials due to their vulnerability to AMR (34). Given the growing resistance to antifungals, WHO are currently developing a list for priority fungal pathogens (35). Additionally, WHO and OIE have lists of critically important antimicrobials for human and animal medicine respectively (36,37).

Questionnaire respondents identified which specific organisms should be included in an Australian One Health AMR and AU surveillance system. Based on frequency of responses, the top 5 bacteria, fungi, viruses and parasites are identified in Figure 15. Given the diversity of respondents and the sectors in which their work is focused on, these results are a mixture of zoonotic parasites, primary human, and animal pathogens.

Figure 15: Top 5 bacteria, fungi, viruses and parasites by frequency of response in Questionnaire



Some stakeholders suggested that for the transition into a One Health surveillance system, an initial small group of priority organisms should be selected. These would be pathogens that cut across multiple One Health sectors and have a very high impact on human and/or animal health – for example Salmonella and E. coli.

6.3.2. Prioritising bacteria, fungi, viruses and parasites

An important consideration for the identification of priority pathogens and antimicrobial agents for inclusion in a One Health surveillance system is whether, when, and to what extent fungi, viruses, and parasites (and antivirals, antifungals, and antiparasitics) should be included in surveillance alongside bacteria and antibiotics.

Most international surveillance systems focus primarily on bacteria. Exceptions include Azole resistance in the fungi Aspergillus fumigatus in the Netherland's human health surveillance system.

Key stakeholders said that the use of antibiotics and the identification of antibiotic resistance was their foremost priority by a considerable margin. Many stakeholders from all sectors said that they thought a One Health surveillance system should be flexible enough to incorporate emergent threats, including from antifungals, antivirals, and antiparasitics.

Ranked in order of importance, bacteria, fungi, virus and then parasites were considered the priority for inclusion in a One Health AMR and AU surveillance system by questionnaire respondents.

6.3.3. Principles for prioritising organisms and agents

Key stakeholders were asked to use a principles-based approach to setting priorities for inclusion (e.g., organism, AMR or antimicrobial agents) in a One Health AMR and AU surveillance system.

From the 57 questionnaire responses to this question, the top five most important principles were: incidence, transmissibility, health resource impact, likely future incidence and economic impact (Figure 16). In addition to these principles, health impact (including for human, animals, plants, and the environment) should be a foremost consideration in the identification and prioritisation of organisms and antimicrobial agents for surveillance.

Figure 16: What principles should influence which microbe, AMR or antimicrobial agents are included in a One Health AMR and AU surveillance system?

Additionally, an evidenced-based cross-sector approach such as possible relationships between antimicrobial agents and AMR in humans and food-producing animals could be used to inform organisms and agents. Internationally, work has been progressed in this area (38).

6.4. Future decisions to determine priority organisms and antimicrobial agents

Future decision: Central list with priority organisms and antimicrobial agents for all sectors

Under this approach, a single central list for priority organisms, informed by international and national lists, would be developed for all sectors – possibly providing guidance as to which sector the collection of data is relevant to.

The benefits are:

- priority organisms and agents across all sectors would be easily identifiable and would contribute directly to One Health data collection
- it would support one collaborative process for reviewing and updating the list and for identifying new opportunities for overlap between sectors.

The limitations are:

- sectors would have less ownership over the list of organisms and antimicrobial agents that are collected within their sector, and this may contribute to the priorities being less flexible
- priority organisms and antimicrobial agents that data is collected against through a One Health lens (that is, with sources of data from multiple sectors) may not be easily differentiated from data on organisms and agents collected at a sectoral level
- there may be the expectation that One Health reporting spans all priority organisms and antimicrobial agents on the central list, rather than focusing on those which span multiple sectors. This could result in onerous reporting requirements as well as data ownership and privacy concerns.

Future decision: Central list with priority One Health organisms and antimicrobial agents, supplemented by sector-specific lists

Under this approach, a central list would be developed focusing on priority organisms and antimicrobial agents to inform data collection, analysis, and reporting through a One Health lens. This approach would be informed by international and national lists and would include AMR and/or AU across multiple One health sectors and would ensure that data is collected and reported consistently. Under this option, sectors would still have (or would develop) sector-specific priority lists.

The benefits are:

- there would be flexibility to begin with a shorter list or organisms and priority antimicrobial agents while the surveillance system is new, with expansion as capability and capacity allows
- updating the list would be a less onerous process, and the focus of these discussions would be collaboration, rather than sector-led

- sectors would retain ownership of sector-specific surveillance priorities, identify sector relevance and the processes for reviewing and updating these lists.

The limitations are:

- there would be less overall surveillance system oversight of priorities
- it could limit the system level reporting of data that is collected on priority organisms and antimicrobial agents at a sector level.

6.5. Equity considerations

When considering AMR and AU surveillance from an equity perspective it is important to consider remoteness. Australians living in remote locations have worse health outcomes, increased infection rates, and a greater burden of disease (39). Aboriginal or Torres Strait Islander peoples make up a proportionally larger portion of the remote populations of Australia; 3% of Australians identify as Aboriginal or Torres Strait Islander peoples, and approximately 31% of Northern Australia residents are Aboriginal and Torres Strait Islander peoples, and in 2020 18% of Aboriginal and Torres Strait Islander peoples live in remote areas (20).

There is limited information available on antibiotic use in Aboriginal and Torres Strait Islander populations (40), and specific prescription information in remote settings is difficult to obtain (41). The limited amount of available information is mainly due to antimicrobials supplied by Aboriginal and Torres Strait Islander health services not being measured through the Pharmaceutical Benefits Scheme or the Repatriation Pharmaceutical Benefits Scheme. Both schemes are used to monitor the use of antibiotics in Australia (20). However, there is an emerging body of research highlighted by the following key findings:

- Remote regions in Northern Australia have some of the highest rates of AMR in the world, for example, at least 40% of Staphylococcus aureus community-associated isolates are methicillin-resistant (MRSA), when MRSA rates are about 15 – 20% in other areas of Australia (21,41).
- Research conducted in remote central Australian remote primary healthcare settings found that 25% of antibiotic prescriptions were classed as inappropriate and almost half of the prescriptions did not follow endorsed guidelines (39), and 18% of prescriptions were inappropriate in remote Northern Territory (41) .

The impact of AMR and AU on Aboriginal and Torres Strait Islander populations sits within a broader context of significant barriers to accessing healthcare. These barriers to accessing healthcare for Aboriginal and Torres Strait Islander populations include lengthy wait times; lack of transportation and the distance required to access the healthcare service being too far; and a dislike, fear, or embarrassment of accessing the service (42). Some Aboriginal and Torres Strait Islander people are also concerned that accessing healthcare may require medical evacuation to a regional centre, in a foreign environment that is a great distance from their normal community support network (43).

Social determinants also have an influence on AMR and AU in Aboriginal and Torres Strait Islander peoples. The emergence of AMR in Australia may have been facilitated by conditions in socially disadvantaged populations, for example, domestic crowding, poor living conditions, a heightened burden of infectious diseases and corresponding increased AU in remote Australian Aboriginal communities (40,44).

These unique issues present in Australia's Aboriginal or Torres Strait Islander communities influence prescription guidelines. Prescription guidelines recommend decreased thresholds for AU in populations considered at higher risk of bacterial infections or their complications, such as Aboriginal or Torres Strait Islander communities (20).

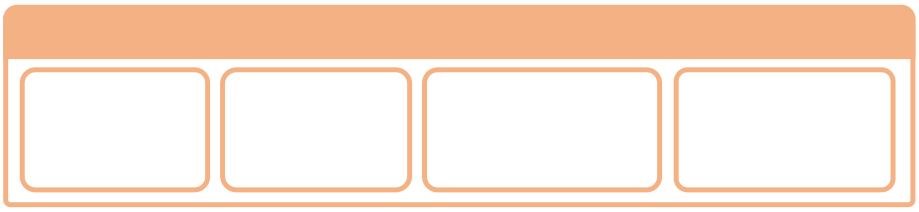
To examine AMR and AU surveillance from an equity perspective it is important to include a discussion of the unique context that Aboriginal or Torres Strait Islander Australians live in. Using the understanding of their unique environment to inform the AMR and AU surveillance process, and work towards capturing the necessary AMR and AU surveillance data to provide improved long-term health outcomes for Australia's Aboriginal or Torres Strait Islander peoples.

CAPABILITIES

7. CAPABILITIES

This section outlines the core capabilities required for a One Health surveillance system, as outlined in the conceptual design. and the future decisions that will be made once the governance option is decided, and alongside other elements of the surveillance system.

Figure 17: Capability elements from the conceptual design



This section includes:

- why capabilities are important
- the process, organisation, people, information, and technology (POPIT) capability model
- an assessment of the four key capabilities against the POPIT model.

7.1. Why are capabilities important?

The Oxford dictionary defines capability as the abilities or qualities to do something (45).

The core capabilities were identified though analysis of the activities and potential work streams envisaged in a One Health system. Considering the Oxford definition above, core capabilities represent the most essential components of a One Health surveillance system, in the context of the identified options.

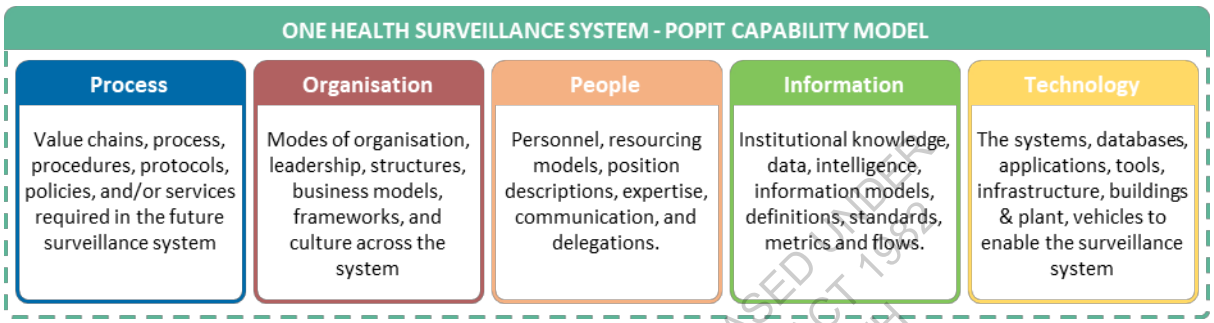
Analysing the capabilities provides some insight as to how these capabilities function, and what they need to be successful.

7.2. The POPIT capability model

The POPIT (process, organisation, people, information, and technology) capability model (Figure 18) provides guidance to the considerations for the capabilities.

The POPIT model is a holistic way of framing and analysing the capability needs of an organisation or a system, where a new future state or way of working is envisaged for that organisation or system. This model, in the context of the One Health surveillance system, provides a way of considering the necessary components to support the core capabilities.

Figure 18: One Health surveillance system – POPIT capability model



7.3. Surveillance activities

Surveillance activities are described in Section 5 and include:

- data collection
- data linkage and harmonisation
- data storage and access
- data analysis
- data dissemination.

Process

Methodology is a key process to supporting surveillance activities in a One Health surveillance system. A strong methodology creates consistency across the spectrum of surveillance activities and provides a guide for data collectors, managers, and stewards.

Organisation

Sustainability and cooperation are important elements of surveillance activities. Sustainable growth and funding enable investment in people and training, which stakeholders have noted is currently lacking at the operational level. Likewise, cooperation between stakeholders and governance bodies is necessary for adequate surveillance quality and coverage.

People

Personnel, such as a data collectors and laboratory technicians are essential to conducting surveillance activities. Investment in these people to engage with surveillance activities links to the cooperation process noted above.

Information

Information models, such as the list of priority organism and antimicrobial agents, and intelligence, including laboratory results and prescription data, provide important information for surveillance of AMR and AU. Priority organisms and antimicrobial agents, and any sectoral or jurisdictional amendments to the list, provide the basis for surveillance objectives. Advances in surveillance technology often connect with laboratory practices, so information exchange with laboratories is vital to surveillance outputs.

Technology

Data access and flexibility are key enablers of surveillance activities. Utilising digital database technology can safeguard data accessibility, promote consistent and accurate data collection, and enable greater dissemination of data though privacy controls. Safer and greater access to surveillance data supports a One Health approach to information sharing. Also, surveillance technology will need to be flexible enough to adapt to advances in technology or changes in surveillance goals, such as rapid testing field kits, genomic sequencing, or changes in priority organisms.

7.4. Data stewardship

Data stewardship is a collection of practices to ensure data is safe, useable, and trusted.

Process

Data sharing agreements, standards and strong methodologies and controls are important elements of data stewardship in the context of a surveillance system. Data sharing agreements provide parameters for data usage and data sharing, which can help foster trust in data stewards. Standards provide harmonisation to data use across sectors, disciplines and jurisdictions, and work as a guidance tool for data stewardship. Strong methodologies and controls guide data usage at each stage of its life cycle and provide clear roles and responsibilities for data stewards and others who interact with AMR and AU data. These processes provide support structures for data stewards and enable clear and appropriate use of data.

Organisation

Organisational components of data stewardship, such as ethics approval and independence, help to foster a trustworthy culture across the surveillance system. Data stewards that have ethics approval are then bound to highly ethical processes of data sharing and usage. Organisational structures such as registries align with the ethical requirements of AMR and AU data stewards.

People

People are at the centre of surveillance, as data owners, collectors, analysts, and decision makers. It is therefore important to foster good relationships with the people involved in all areas of surveillance. Relationship building can help data stewards build trust with stakeholders, encouraging higher levels of participation and data sharing with data stewards, and ultimately with the One Health surveillance system.

Information

Defining the purpose for surveillance and having clear data usage objectives are important drivers for data stewardship. Entrusting data stewards with creating clear data collection and usage parameters should optimise participation, collaboration, and engagement in surveillance, allowing functionality of a One Health surveillance system.

Technology

Data linkage is a necessary information output from technology and infrastructure to support a surveillance system. Linkage of data enables the core objective of a One Health surveillance system to compare data across sectors.

7.5. Coordination and integration

Coordination and integration relate to the capacity for a system to ensure alignment between different parts of the surveillance system and surveillance activities. Integration is the act of bringing together component parts of the system (including sectors and jurisdictions) into one.

Process

The below processes are key components of coordination and integration in a One Health model. They support coordination and integration by establishing commitments and providing consistency and clarity around goals and priorities.

- Setting shared goals
- Creating a strategy, including priorities
- Establishing standard operating procedures
- Agreement of terms of reference
- Governance structures
- Partnership agreements

Organisation

Establishing roles and responsibilities and creating clear leadership structures are necessary organisational components of coordination and integration. Creating strong leadership structures supports governance, and establishing roles and responsibilities creates clarity, consistency and efficiency within governance and operational surveillance activities.

People

Trust is a recurring theme thought the options analysis, and is key to stakeholder buy-in. Establishing a cross-sectoral working group could help to mitigate barriers of trust amount sectoral stakeholders, particularly if there is strong stakeholder representation within the members of a working group.

Information

Mechanisms of communication, such as alerts, and notifications are ways to transparently communicate important information. Data stewards should be able to communicate or receive critical notifications and other important information for the surveillance system to succeed.

Technology

Utilising current and emerging technologies to manage database linkage and database capabilities is a key enabler for data stewards, and other stakeholders.

7.6. Dissemination

Dissemination is the act of distributing information. In this context, it is the dissemination of AMR and AU data, in an appropriate format to data owners, sectors, governments, and the public.

Process

The below components are important processes to enable dissemination of AMR and AU data.

- Meeting international commitments
- Quality control and sign out
- Contextualising information
- Establishing feedback loops to surveillance design

Organisation

Organisational structures involved in dissemination include reporting bodies, real time alert systems and education and awareness. Reporting bodies are responsible for disseminating aggregated comparison across One Health sectors and jurisdictions. They could highlight AMR and AU trends or any other relevant high-level information. Real time alerts notify the appropriate stakeholders of any unexpected or emerging AMR susceptibility, which enables escalation and reaction to susceptibility concerns.

People

People are needed to analyse and write reports before they can be disseminated and are thus important components to be accounted for. Likewise, identifying appropriate distribution lists is necessary to ensure the right people have access to the information being disseminated.

Information

To enable dissemination, information controls including data access, privacy and commercial sensitivities need to be addressed. Reporting bodies, or other information disseminators, will require access to aggregated data for analysis. It is important the data is aggregated to some degree, so it protects the privacy of data owners. Similarly, dissemination will need to consider commercial sensitivities of the data owners and stakeholders when analysing and reporting data outputs.

Technology

Technology required for dissemination will need to enable information to be digitally collated and distributed, and might also require printing and manual distribution, depending on the information type.

7.7. Summary of capability considerations

Capability requirements are defined as part of the detailed system design process, culminating in the eventual surveillance system blueprint. Capability requirements are determined once the governance model is selected, and key surveillance and data management activities are defined and the manner in which they will be undertaken is confirmed.

Trust and people are two of the most recurring capabilities and components for consideration across the One Health surveillance system.

Trust spans the breadth of surveillance capabilities and could be a barrier, or enabler, for each capability. Investing in measures that strengthen trust will mobilise components of a One Heath surveillance system across the identified capabilities.

Regardless of hierarchy or operational level, people are involved at all stages of a One Health surveillance system. Investing in people, particularly at the operational level, can help achieve a widely collaborative, and therefore integrated, system.

Capability provides a key lens for analysing the current and future state of the system. Through comparison of those states, it enables the identification of the capability deficits that require development and investment. This in turn enables the development of the capability roadmap, a key element of the Transition Plan, highlighting how capability will be matured over time.

The capability requirements are therefore part of the future decision-making requirements

ASSESSMENT OF OPTIONS

8. ASSESSMENT OF OPTIONS

This section provides an assessment of the model options, based on the identified considerations for a One Health surveillance system. This section includes:

- proposed assessment criteria
- assessment of Model Options 1, 2 (a), 2 (b) and 3 against the criteria
- risk considerations.

8.1. Proposed assessment criteria

The criteria below were identified through option analysis and stakeholder engagement as being important considerations for a One Health surveillance system.

8.1.1. Barriers

- **Variable capability:** the different levels of capability between and within sectors and/or between and within jurisdictions. Options that score highly on this criterion allow varying capabilities to coexist and move towards higher levels of capability as and when that is required.
- **Differing drivers:** the different motivations between sectors to engage in AMR and AU surveillance. Options that score highly on this criterion acknowledge these differing drivers and present options to mitigate negative impacts caused by differing drivers.
- **Variable trust:** the different levels of trust in the system held by sectors or jurisdictions. Options that score highly on this criterion acknowledge and account for varying levels of trust between sectors and/or between jurisdictions.
- **Variable methods:** the different methodologies used in surveillance activities between and within sectors and/or between and within jurisdictions. Options that score highly on this criterion account for this variation though surveillance design and database development.
- **Administrative complexity:** the complexity of decision-making processes within a structure, including multiple layers of administration. Options that score highly on this criterion have straightforward administrative processes.

8.1.2. Enablers

- **Collaboration:** the level of collaboration between stakeholders and governance bodies, and potentially collaboration within and across sectors or jurisdictions. Options that score highly on this criterion will promote collaboration as an early-stage enabler.
- **Coordination:** the level and degree of coordination across and between stakeholders and technology and infrastructure. Options that score highly on this criterion will promote coordination as a core enabler.
- **Integration:** the level and degree of integration of sectors, systems, and databases. Options that score highly on this criterion will frame integration as a critical enabler.

8.1.3. Success factors

- **Sustainability:** the long-term capacity for growth and the ability for Options to sustain a One Health system in the long term.
- **Cohesion:** the extent to which the Options promote structures, strategy and surveillance activities that are cohesive across jurisdictions, sectors and system actors. This is a culmination or collaboration, coordination, and integration. Options that score highly on this criterion enable collective response to emerging threats and conduct surveillance in an efficient and effective manner.

8.2. Initial assessment of the Model Options against proposed criteria

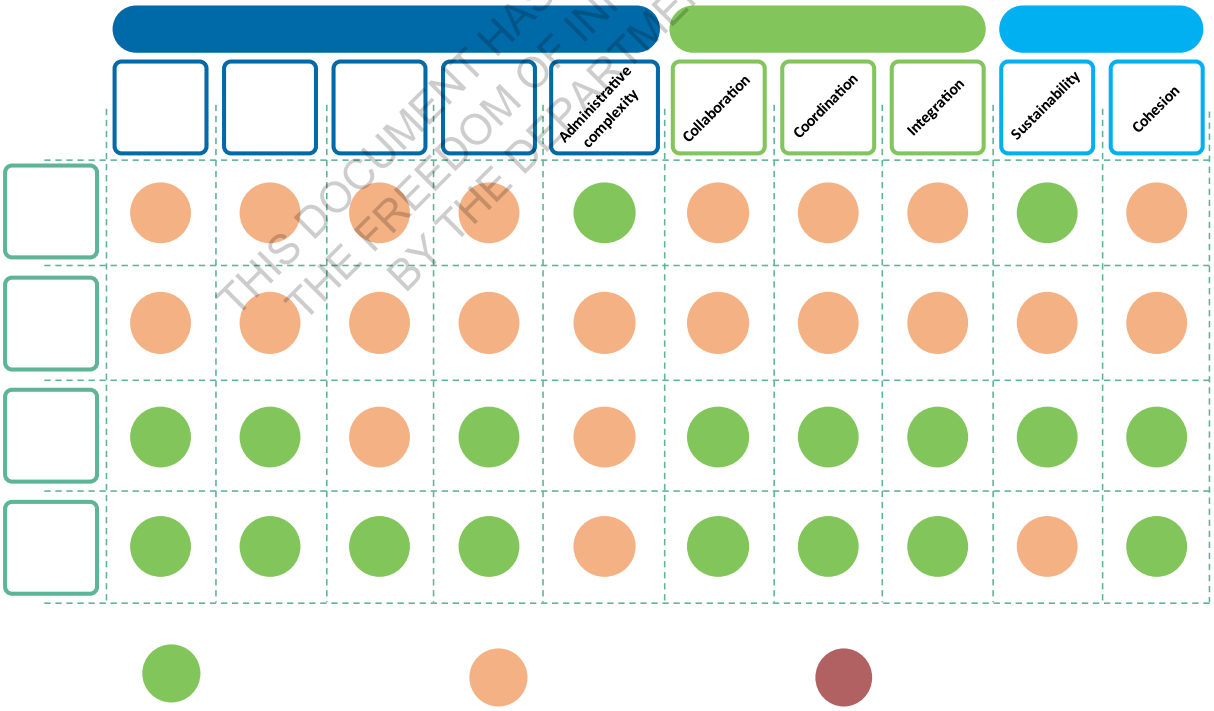
8.2.1. Assessing the options

The following initial assessment (Figure 19) is intended to provide an overview of how each option satisfies the identified assessment criteria. The initial assessment does not include stakeholder preference for a particular model and is likely to change subject to future trade-offs that alter the assessment against key criteria.

The initial assessment is provided using a traffic light scale:

- Green represents criteria that Model Options adequately satisfy
- Orange represents criteria that Model Options somewhat satisfy
- Red represents criteria that Model Options do not satisfy

Figure 19: Initial assessment of Model Options against proposed criteria



A further description of how each option has been assessed is provided below.

8.2.2. Model Option 1: Centralised governance framework

As a centralised model, Option 1 allows for control and cohesion within the system. However, the centralised nature lacks reach for effective collaboration, coordination and integration. The lack of support for these three key enablers does not position Option 1 to address variable capability, differing drivers, variable trust and variable methods across One Health sectors and jurisdictions.

Option 1 allows for the use of existing infrastructure but does not explicitly require existing infrastructure to be leveraged off.

8.2.3. Model Option 2 (a) - Distributed jurisdictional governance framework

The hub and spoke approach in Option 2 (a) allows for some collaboration, coordination, and integration, particularly at a jurisdictional level. However, there are still limitations with these enablers. The distributed jurisdictional framework will require extensive consultation and collaboration to ensure stakeholder buy-in. This process has potential to gradually reduce barriers to trust and variation in inter-jurisdictional capability.

Sectoral trust and capability variation is not addressed by this model and could continue to be barriers to the successful implementation of the Model. Similarly, differing sectoral drivers and variable methods of surveillance are not addressed by this model at the sectoral level. These could be considered more significant barriers than variable drivers and methods at the jurisdictional level.

8.2.4. Model Option 2 (b) - Distributed sectoral governance framework

Option 2 (b) offers an improved level of engagement with sector stakeholders, including from the private sector, compared with the jurisdictional hub and spoke model. This Option enables high levels of collaboration, coordination and thus integration between sectors. However, these enablers will require significant stakeholder consultation under this option. As such, overcoming the trust barrier will take time.

Taking a sectoral approach allows for barriers of varying capability, differing drivers, and varying methods to be more adequately addressed. Option 2 (b) is less cohesive than the centralised Option 1 but is potentially more sustainable as there appear to be greater operational efficiencies, including the associated operating cost efficiencies.

8.2.5. Model Option 3 - Devolved governance framework

The devolution of both coordination and decision making in Option 3 allows for greater collaboration, potentially leading to more effective coordination and integration. This level of devolution, more so than Options 2 (a) and 2 (b), has the capacity to address barriers or variable capability, differing drivers, variable trust and variable methodologies between sectors and jurisdictions.

The most significant barrier to this option is the complexity of establishing public and private partnerships and sustaining complex and devolved partnerships in the long term.

8.3. Preliminary risk considerations

There are several risks for the implementation of any option. These include:

- lack of stakeholder buy-in
- lack of representation
- unsustainable funding
- inadequate data security
- insufficient capacity and capability
- siloes becoming entrenched
- lack of data linkage and harmonisation.

These risks have the potential to restrict the effectiveness of a One Health surveillance system. Risk mitigation should be considered at the transition phase and may require consultation with appropriate stakeholders.

Lack of buy-in from sectors or jurisdictions

A significant risk with implementing a One Health surveillance system is that governance bodies do not gain adequate buy-in from jurisdictions or sectors.

Options 2 (a) and 2 (b) respectively rely on collaboration with jurisdictions or sectors to create a more effective surveillance model. This collaboration should foster greater investment and therefore buy-in from sectors and/or jurisdictions, but it is not guaranteed. Option 1 does little to encourage sectoral or jurisdictional buy-in, the consequences of which could significantly limit the effectiveness of a One Health surveillance system and result in little change from the current state of AMR and AU surveillance in Australia.

Option 3 should optimise collaboration, and therefore buy-in, between both sectors and jurisdictions, but comes with added complexity, relative to the other options presented. An unintended consequence of Option 3 is that with such devolved coordination and decision-making, it could be difficult for all governance stakeholders to reach a consensus, equating to limited or non-existent buy-in at the governance level as well as at the operational levels.

Lack of stakeholder representation in decision making

Across all options, there is a risk of stakeholders not being adequately represented by governance structures and in decision making. The risk of poor representation, real or perceived, is linked to a lack of investment, engagement and buy-in at either a sectoral or jurisdictional level. The consequences of this risk could involve asymmetrical buy-in between and within sectors, resulting in a lack of surveillance coverage.

Funding sustainability

Sustainable funding is another major risk to the success of a One Health surveillance system. Ongoing and adequate funding is required for any of the presented Options. Inconsistent or inadequate funding could result in poor coverage or quality of surveillance activities – undermining the success and credibility of the surveillance system. The funding model will need to consider the long-term resourcing requirements, goals and priorities for the system, and fund accordingly.

Inadequate data security

Several stakeholders raised concerns about the security of their data under a collaborative and integrated One Health model, which is a risk under any Option. Breaches in data security could occur at several stages in the surveillance and reporting process. Therefore, investing in adequate security measures is an important risk mitigation strategy across a One Health system. A breach in data security, or even the perception that data is insecure, could reduce trust in the surveillance system, resulting in limited participation. For a One Health surveillance system to operate effectively, with any governance or surveillance design structure, data needs to be handled, processed, and stored securely to uphold data sharing agreements and to foster trust with data owners who are critical to the coverage of data collection.

Insufficient capability and capacity

Insufficient capability and capacity are risks across the One Health Options and within the varying levels of surveillance activities. Inadequate resourcing, including financial, technical, and human resourcing, could impact on the capacity within and across sectors to meaningfully engage in AMR and AU surveillance activities, or engage at all. Similarly, capability to participate could be restricted by limited knowledge, access to training, technology, and infrastructure. Insufficient investment in capability and capacity can hinder the growth of One Health surveillance coverage, reducing data inputs and creating gaps in collective AMR and AU knowledge. This risks the efficacy of the surveillance system and ultimately the safety of human, animal, plant, and environmental health.

Siloes becoming entrenched

Stakeholders and the literature identified concerns of siloed workstreams, across sectors and jurisdictions. Should siloed workstreams become more, rather than less, entrenched, the surveillance system is at risk of limited integration and data sharing, leaving limited opportunities to create a harmonised One Health surveillance system.

Working towards a culture that reduces siloed workstreams will take time regardless of the Option, however the more integrated Options 2 (a), 2 (b) and 3 account for collaboration though the governance structures.

Lack of data linkage and harmonisation

A lack of data linkage and harmonisation risks creating a system that doesn't meet the basic objectives of a One Health system – it reduces the ability to compare data and extract a cross-sectoral and cross-jurisdictional picture of AU and AMR in Australia. Lack of data linkage and harmonisation could occur because of a lack of investment in technology and infrastructure, insufficient collaboration with data users and analysis, or lack of engagement with system designers and database architects. Data linkage forms the basis of One Health objectives, so it is key to mitigate these risks to ensure optimal surveillance outputs.

APPENDICES

APPENDIX 1: OVERVIEW OF INTERNATIONAL EXAMPLES

This section summarises three comparable international jurisdictions: Sweden, Denmark, and Canada.

Sweden

The Swedish surveillance model was established in 1995 and is considered a mature system, having undergone policy and governance development, evolving systems and processes. The Swedish model is comprised of two core elements:

- Swedish Surveillance of Antimicrobial Resistance (STRAMA)
- Swedish Veterinary Antimicrobial Resistance Monitoring (SVARM)

The maturity of the system has enabled a unique collaboration for rapid feedback and early warning of antibiotic resistance, a core objective of AMR surveillance systems. This model has also created a platform for gathering stakeholders, exchanging knowledge, identifying needs, and guiding implementation of treatment guidelines and other policies.

STRAMA is governed and co-ordinated by the Public Health Agency of Sweden and utilises a variety of information systems including Svebar (Swedish Monitoring of Antibiotic Resistance), SmiNet (web-based notification program), PRIS (Primary Care Record of Infections in Sweden) and ResNet. Annual Swedres-Svarm (Swedish Antibiotic Sales and Resistance in Human Medicine) reports detail antibiotic utilisation and resistance in humans and animals.

Some standout features of the Swedish model include the state funding model, strong policy framework, IT infrastructure and culture of continuous improvement:

- The Swedish system is funded by the government and funding has gradually increased and become more formalised over time (29). This provides a mandate for data collection and analysis which is supported by the high levels of trust stakeholders have in the Swedish government.
- Strong policy frameworks that are integrated into all relevant governmental systems, and are supported by adequate human, infrastructural, and operational resources in all sectors of the One Health model (46). This is a national mechanism which coordinates information exchange across the public health, animal health, food, and environment sectors.
- National web-based system for notifiable pathogens where results are communicated to laboratories, physicians, hospital management, decision-makers, authorities, key organisations, and the wider public.
- Continuous improvements and evolution of the system such as ongoing interaction between local laboratories and multi-professional groups to ensure that surveillance is useful for both healthcare professionals and decision-makers.

Denmark

The Danish Integrated Antimicrobial Resistance Monitoring and Research Program (DANMAP) was established in 1995 by the Ministry of Food, Agriculture and Fisheries and the Ministry of Health (47). DANMAP monitors AMR and AU in production animals and humans, studies associations between AU and AMR, and identifies routes of AMR transmission.

The Danish model includes:

- A broadly representative Danish National Antimicrobial Council, established in 2010 to support a One Health approach to AMR and AU.
- Antimicrobial consumption data is available through national databases MEDSTAT and VetSTAT. Antimicrobials for humans and animals are only available by prescription.
- Antimicrobial resistance data is collated and analysed by the Statens Serum Institute for human sectors, and by the Technical University of Denmark for food and animal sectors.

Standout features of the Danish system are a flexible approach to devolved sectoral integration, four core enabling capabilities and a strong devolution of risk assessment and risk management:

- Collection and interpretation of each sectors data is kept separate until the point of aggregation, simplifying the implementation of the One Health model. Each sector can take a flexible approach with how it collects data, allowing differing rates of growth and maturity between sectors (48).
- The Danish system relies on four equally important components: well-established and well-functioning diagnostic systems, well-designed and representative surveys, reliable registers as well as mutual trust and openness between all collaborators (48).
- The Danish system is supported by the separation of risk assessment and risk management. Scientists assess the risk while the authorities, are conducting the risk management (48).

Canada

The Canadian Antimicrobial Resistance Surveillance System (CARSS) was established in 2013 and reports on AMR and AU by integrating and synthesizing epidemiological and laboratory information from four Canadian surveillance systems (49). These four systems cover human, food and production animal sectors, and are run by the Public Health Agency of Canada (PHAC):

- Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)
- Canadian Nosocomial Infection Surveillance Program (CNISP)
- Enhanced Surveillance of Antimicrobial-Resistant Gonorrhoea Program (ESAG)
- Canadian Tuberculosis Laboratory Surveillance System

The Canadian system follows a methodologically unified approached, modelled after the Danish (DANMAP) and American National Antimicrobial Resistance Monitoring System (NARMS-USA) systems.

Standout features of the Canadian system include leveraging existing surveillance activities and sustainable growth:

- Emerging threats are being detected by integrating the results of existing surveillance programmes, innovative ad-hoc activities, collaboration with PHAC and leveraging existing systems for supplementary surveillance activities.
- The Canadian model is built on a long-term commitment to AMR with gradual improvements over time across sectors, states, and territories.

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