BMJ Global Health

Development of a cross-sectoral antimicrobial resistance capability assessment framework

Angeline S Ferdinand ,[1,2] Callum McEwan ,[1,2] Chantel Lin,[1,2] Kassandra Betham,[1,2] Karishma Kandan,[1,2] Gilam Tamolsaian,[3] Barry Pugeva,[3] Joanna McKenzie,[4] Glenn Browning,[5] James Gilkerson,[5] Mauricio Coppo,[5,6] Rodney James,[7,8] Trisha Peel,[9] Steph Levy,[3] Nicola Townell,[10] Adam Jenney,[11] Andrew Stewardson,[12] Donna Cameron,[1,2] Alison Macintyre,[13] Kirsty Buising,[1] Benjamin P Howden[1,2]

To cite: Ferdinand AS, McEwan C, Lin C, *et al*. Development of a cross-sectoral antimicrobial resistance capability assessment framework. *BMJ Glob Health* 2024;**9**:e013280. doi:10.1136/bmjgh-2023-013280

Handling editor Seema Biswas

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjgh-2023-013280).

Received 30 June 2023
Accepted 28 November 2023

For numbered affiliations see end of article.

Correspondence to
Dr Angeline S Ferdinand; a.ferdinand@unimelb.edu.au

ABSTRACT

Antimicrobial resistance (AMR) is an urgent and growing global health concern, and a clear understanding of existing capacities to address AMR, particularly in low-income and middle-income countries (LMICs), is needed to inform national priorities, investment targets and development activities. Across LMICs, there are limited data regarding existing mechanisms to address AMR, including national AMR policies, current infection prevention and antimicrobial prescribing practices, antimicrobial use in animals, and microbiological testing capacity for AMR. Despite the development of numerous individual tools designed to inform policy formulation and implementation or surveillance interventions to address AMR, there is an unmet need for easy-to-use instruments that together provide a detailed overview of AMR policy, practice and capacity. This paper describes the development of a framework comprising five assessment tools which provide a detailed assessment of country capacity to address AMR within both the human and animal health sectors. The framework is flexible to meet the needs of implementers, as tools can be used separately to assess the capacity of individual institutions or as a whole to align priority-setting and capacity-building with AMR National Action Plans (NAPs) or national policies. Development of the tools was conducted by a multidisciplinary team across three phases: (1) review of existing tools; (2) adaptation of existing tools; and (3) piloting, refinement and finalisation. The framework may be best used by projects which aim to build capacity and foster cross-sectoral collaborations towards the surveillance of AMR, and by LMICs wishing to conduct their own assessments to better understand capacity and capabilities to inform future investments or the implementation of NAPs for AMR.

SUMMARY BOX

⇒ Despite a proliferation of tools designed to inform policy formulation and implementation or surveillance interventions to address antimicrobial resistance (AMR), there is an unmet need for easy-to-use instruments that provide a detailed overview of AMR policy, practice and capacity.

⇒ The Combating the threat of antimicrobial resistance in Pacific Island Countries (COMBAT-AMR) Assessment Framework represents a unique model of a systematic, cross-sectoral approach to assess AMR capacity across human and animal health microbiological laboratories, and hospital antimicrobial stewardship and water, sanitation and hygiene and infection prevention and control programmes within acute healthcare facilities.

⇒ The framework is flexible to meet the needs of implementers, as tools can be used separately to assess the capacity of individual institutions or as a whole to align priority setting and capacity building with National AMR Action Plans or national policies.

⇒ The COMBAT-AMR Assessment Framework has been used in multiple countries to support priority-setting, programme design, monitoring and implementation across human and animal sectors, and at the national level.

⇒ Use of the COMBAT-AMR Assessment Framework may be undertaken individually or with support and training from the COMBAT-AMR technical team to complete the tools and collaboratively develop priorities and further strategies to increase capacity.

INTRODUCTION

Antimicrobial resistance (AMR) represents one of the greatest challenges to public health globally, reducing the ability to prevent and treat infectious diseases.[1] Infections due to resistant bacteria were associated with 4.95 million deaths and directly attributed to 1.27 million deaths in 2019.[2] Projections on the impact of AMR outline the potential of up to 10 million deaths annually by 2050, and costs up to an estimated US$100 trillion, if significant action is not taken.[3] However, the lack of high-quality data around the

incidence of infections, prevalence of resistance and attributable mortality in low-income and middle-income countries (LMICs) introduces uncertainty into estimates of the burden of AMR.[4] The overuse and misuse of antimicrobials including antibiotics, antivirals, antifungals and antiparasitics, in both humans and animals, have been the major factor to accelerate the emergence and spread of antimicrobial resistant organisms.[1] This has been compounded in LMICs where under-resourced health systems, inadequate sanitation and infection prevention and control (IPC) systems within health facilities and communities, and a higher overall burden of infectious disease continue to drive increased reliance on antimicrobial use, and consequently, increased AMR.[5 6] Contributing factors towards the spread of AMR globally occur across the human, animal and environmental health sectors and resultingly AMR requires a multidisciplinary and cross-sectoral One Health approach.[7]

Across Pacific Island Countries (PICs), there are limited data regarding existing mechanisms to address AMR, including national AMR policies, current infection prevention and antimicrobial prescribing practices, antimicrobial use in animals and microbiological testing capacity for AMR. The impact of the AMR in this region also remains poorly understood; however, there are some data to indicate that this is a major concern.[8 9] A 2015 review of AMR surveillance identified varied capabilities among PICs across diagnostic testing capacity, infrastructure and workforce to implement AMR surveillance and monitoring, and inadequate or unenforced regulations governing accessibility and use of antimicrobials.[10] Almost 10% of healthcare facilities in the western pacific region do not have a water supply, and almost two-thirds do not have basic supplies such as soap and water or alcohol-based hand rub to perform hand hygiene.[11] These findings highlight the need to continue to develop capacity among PICs to support the prevention, diagnosis, surveillance and management of AMR.

Australia's Department of Foreign Affairs and Trade's Indo-Pacific Centre for Health Security funded the *Combating the threat of antimicrobial resistance in Pacific Island Countries (COMBAT-AMR)* programme to take a One Health approach to capacity-building and training activities to address AMR in four countries: Fiji, Papua New Guinea, Samoa and the Solomon Islands. COMBAT-AMR is implemented in partnership with government, National AMR Committees and key human and animal health stakeholders. COMBAT-AMR operates across five themes: IPC, antimicrobial stewardship (AMS), laboratory diagnosis and surveillance, animal health and One Health.

In planning COMBAT-AMR implementation, there was a need to assess current capacity and understand needs and priorities across the project themes. A number of tools and instruments exist to assess country and institutional capacity to detect and address AMR, and there have been previous evaluations of some of these tools against factors such as functionality, user experience and level of stakeholder engagement.[12 13] However, there is currently no systematic, cross-sectoral capacity assessment model. Such an approach is particularly useful to build capacity and foster collaboration across multiple sectors and institutions, and monitor progress in implementation. Through COMBAT-AMR, we have developed a cross-sectoral AMR capability assessment structure (hereafter referred to as the 'Framework'). The framework comprises five assessment tools, able to be implemented individually or in conjunction, to provide a detailed assessment of country capacity to address AMR. Four of the tools correspond to project themes of IPC, AMS, laboratory diagnosis and surveillance and animal health. The fifth is a national AMR situation assessment tool. The five tools are designed to be appropriate for countries at all levels of AMR capacity. The design of programme activities is responsive to local contexts and needs, and enables ongoing monitoring and benchmarking.

Here, we outline the process taken to develop and implement the framework and illustrate its application in the COMBAT-AMR target countries.

DEVELOPMENT OF THE COMBAT-AMR CAPABILITY ASSESSMENT FRAMEWORK

Development of the five tools that comprise the framework was undertaken between September 2020 and April 2021, across three phases: (1) review of existing tools; (2) adaptation of existing tools and piloting; and (3) refinement and finalisation. The national AMR situation assessment tool was designed to take a One Health approach to reviewing national-level policies, practices and stakeholders related to AMR, disease surveillance and antimicrobial consumption and regulation.

The four tools that correspond with project themes are aimed at the organisational or facility level. The AMS tools and the IPC-water, sanitation and hygiene (WASH) tool are relevant to acute healthcare facilities. The human laboratory tool may be applied to all clinical microbiological laboratories; however, there are additional items specific to referral laboratories/sending laboratories. The animal health tool may be applied to any animal health microbiological laboratory.

Phase 1: review of existing tools

An initial literature review was undertaken to identify existing tools or instruments to assess AMR capacity across the project themes or at the national level. The literature review was undertaken with both peer-reviewed and grey literature; while the tools themselves were likely to be found in the grey literature, use of the tools may be reported in peer-reviewed literature (table 1). The COMBAT-AMR technical team was also asked to identify any known assessment tools or instruments in their relevant field.

Tools and instruments were considered for inclusion if they:

Table 1 Literature review search strategy

Inclusion criteria	► Published in English ► Published from 2015 to present ► Relevant to assessment of capacity to address antimicrobial resistance ► Relevant to the four COMBAT-AMR themes (Animal health, AMS, IPC and WASH, Human health laboratory capacity and surveillance) or assessment at the national level
Exclusion criteria	► Document does not include an assessment component
Search terms	► Antimicrobial resistance ► Antimicrobial stewardship ► Infection prevention and control ► Animal health ► Laboratory ► Surveillance ► Capacity ► Assessment ► Evaluation ► WHO ► FAO ► OIE (Office International des Epizooties, renamed the World Organisation for Animal Health (WOAH) in May 2022)
Databases	► Google ► Google Scholar ► SCOPUS ► Medline (Web of Science) ► CABI Global Health

AMS, antimicrobial stewardship; COMBAT-AMR, Combating the threat of antimicrobial resistance in Pacific Island Countries; IPC, infection prevention and control; WASH, water, sanitation and hygiene.

- had an explicit focus on assessment (eg, action plans, guidelines and recommendations, and implementation toolkits were excluded unless they had an assessment component) and
- were aligned with the COMBAT-AMR themes (Animal health, AMS, IPC and WASH, Human health laboratory capacity and surveillance) or focused on national policy, practice and context relating to AMR.

The review identified the following existing assessment tools (table 2):

Additional key guidelines and references which were not assessment tools but provided a more comprehensive overview of relevant items for inclusion are outlined in table 3:

Assessment tools were primarily considered on the basis of:

- Alignment with COMBAT-AMR themes of animal health, AMS, IPC and WASH, and human health laboratory capacity and surveillance or focused on assessment at the national level.
- Scope: the focus of tools aligned with the project themes should be located at the organisational, rather than system or national level.
- Complexity: simpler and easier-to-use tools were favoured over more complex ones.
- Primarily quantitative: as the purpose of the tools for the project themes were for benchmarking and assessment purposes, items should be quantitative and scoreable. The national assessment tool was primarily qualitative, rather than quantitative in nature.

Following deliberation between COMBAT-AMR partners, the following tools were selected as the basis for the COMBAT-AMR assessment tools (table 4):

Phase 2: adaptation of existing tools

Phase 2 was an iterative process of refinement of the selected tools. For each of the themes, the relevant identified tools were reviewed for extensiveness and gaps. The identified instruments for the AMS and Human health laboratory surveillance tools were largely aligned with COMBAT-AMR project needs. In the case of the WHO Infection Prevention and Control Assessment Framework (IPCAF), the lack of items relating to WASH was seen to be a key gap. The IPCAF was adapted to include additional items from the WHO/UNICEF WASH FIT. National assessment for the animal health theme was included in the national assessment tool with a separate tool developed for assessment of animal health laboratories. The animal health laboratory capacity tool necessitated significant refinement in order to ensure that it was applicable to countries across differing levels of capacity. The Animal and Human health laboratory surveillance tools were adapted from the Fleming Fund AMR Surveillance Site and Laboratory Needs Assessment Tools for human and animal health, developed by Mott MacDonald with UKAid funding.

In order to allow for benchmarking and assessment of change over time, a scoring rubric was developed for each COMBAT-AMR theme assessment tool except the animal health laboratory capacity tool. Of the instruments selected to form the basis of the theme tools, only the IPCAF included an existing scoring rubric, and in this case the scoring needed to be adjusted to incorporate the additional WASH components. Key items with impact on potential AMR prevention or response capability and that were seen as representing best practice were selected to contribute to scoring, with non-scored items providing an overview of practice more broadly. For the national assessment tool, emphasis was placed on generating a snapshot of relevant policy and legislation, key stakeholders in AMR, regulation of antimicrobials and national priorities in AMR. For this reason, the national level tool was qualitative and did not use scoring.

The base tools each had different data capture methods. Some were Word or PDF-based, while others were Excel-based. In order to ensure consistency, each tool was entered onto the online application Research Electronic Data Capture (REDCap).[14] REDCap allows for

Table 2 Identified tools to assess antimicrobial resistance (AMR) capacity at organisational and national levels

National assessment	Animal health laboratory capacity	Antimicrobial stewardship	Infection prevention and control and Water, sanitation and hygiene	Human health laboratory surveillance
► The Joint External Evaluation Tool[16] ► Tripartite AMR Country Self-Assessment Survey (TrACSS)[17] ► Food and Agriculture Organization of the United Nations (FAO) Progressive Management Pathway for AMR[18] ► WHO rapid assessment tool for country situation analysis[19] ► SURVTOOLS[20]	► The Fleming Fund AMR Surveillance Site and Laboratory Needs Assessment Tool (Animal Health) ► FAO Laboratory Mapping Tool (LMT-Core)[21]	► National Centre for Antimicrobial Stewardship: Antimicrobial Stewardship in the Western Pacific Region Semi-Structured interview with Clinicians[22] ► National Centre for Antimicrobial Stewardship: Antimicrobial Stewardship in the Western Pacific Region Data gap analysis tool[23] ► National Centre for Antimicrobial Stewardship: Antimicrobial Stewardship in the Western Pacific Region Facility observation checklist[24] ► The Royal Melbourne Hospital Victorian Infectious Diseases Service Quality Assurance Project: HE12/067 Data Collection form: Hospital Executives ► The Royal Melbourne Hospital Victorian Infectious Diseases Service Quality Assurance Project: HE12/067 Data Collection form: Clinicians ► UK Royal College of General Practitioners Antimicrobial Stewardship Self-Assessment Checklist[25] ► CDC (United States Centers for Disease Control and Prevention) Antibiotic Stewardship Program Assessment Tool[26] ► SA Health AMS Self-Evaluation Toolkit v1.3[27] ► Antimicrobial Self-Assessment Toolkit[28] ► NICE (United Kingdom National Institute for Health and Care Excellence) Baseline Assessment Tool for Antimicrobial Stewardship[29] ► WHO policy guidance on integrated antimicrobial stewardship activities[30]	► WHO Infection Prevention and Control (IPC) Assessment Framework (IPCAF)[31] ► WHO/UNICEF Water and Sanitation for Health Facility Improvement Tool[32] ► WaterAid COVID 19_WASH in HCF Rapid Assessment[33] ► Hand Hygiene Self-Assessment Framework 2010[34] ► Infection Control Assessment and Response (ICAR) Tool for General IPC Across Settings[35] ► OGIPCP (University of São Paulo)[36] ► USAID Infection Control Assessment Tool[36]	► The Fleming Fund AMR Surveillance Site and Laboratory Needs Assessment Tool (Human Health) ► WHO Stepwise Laboratory Quality Improvement Process Towards Accreditation (SLIPTA) Checklist[37] ► WHO AMR Surveillance: Questionnaire for Assessment of National Networks[38] ► WHO Laboratory Assessment Tool: online supplemental annex 1: Laboratory Assessment Tool/ System Questionnaire[39] ► CDC Lab Assessment of Antibiotic Resistance Testing Capacity (LAARC)[40] ► FAO Laboratory Mapping Tool (LMT-Core)[21]

AMS, antimicrobial stewardship.

secure access and data collection, scoring and management and instruments can be accessed and used by individuals from multiple sites and institutions, making it appealing for projects where partners are geographically dispersed. Data can be entered into REDCap without an internet connection, then uploaded when a connection is available, facilitating data collection in areas of unreliable internet access. REDCap is used by nearly 6000 institutions and in 145 countries, representing strong potential for wider dissemination and uptake of the instruments. The scoring rubric for each tool was also incorporated into the REDCap versions. All tools except the AMS assessment tool incorporated significant branching to allow respondents to skip items that were not relevant to them while maintaining the integrity of the scoring system. This improved usability, reduced respondent burden and made the tools more responsive to contexts with a wide variety of capacities.

Guidance documents and instructions were developed for each tool. A data governance framework was established to support transparency and accountability in data ownership and usage.

Table 3 Key guidelines and references which informed tool development

Animal health laboratory capacity	Antimicrobial stewardship	Infection prevention and control and water, sanitation and hygiene	Human health laboratory surveillance
► FAO Regional antimicrobial resistance monitoring and surveillance guidelines Vol 1: Monitoring and surveillance of antimicrobial resistance in bacteria from healthy food animals intended for consumption[41] ► OIE Standards, Guidelines and Resolution on antimicrobial resistance and the use of antimicrobial agents[42] ► OIE list of antimicrobial agents of veterinary importance[43] ► OIE—Terrestrial Animal Health Code Chapter 6.8.- Harmonisation of national antimicrobial resistance surveillance and monitoring programs[44]	► Antimicrobial Stewardship in Australian Health Care Chapter 6: Measuring performance and evaluating antimicrobial stewardship programs[45] ► Core Elements of Hospital Antibiotic Stewardship Programs[46] ► Antimicrobial stewardship programmes in health-care facilities in low- and middle-income countries: A WHO practical toolkit[47]	► WHO Guidelines on core components of IPC programs at the national and acute health care facility level[48] ► Australian Commission on Safety and Quality in Health Care (ACSQHC) IPC resources[49] ► CDC IPC Guidelines & Guidance Library[50] ► Pacific Public Health Surveillance Network (PPHSN) infection prevention and control guidelines[51] ► Improving infection prevention and control at the health facility level. Interim practical manual supporting implementation of the WHO guidelines on core components of infection prevention and control programs[52] ► Core questions and indicators for monitoring WASH in health care facilities in the Sustainable Development Goals[53] ► Essential environmental health standards in health care[54]	► WHO Pathogen-antimicrobial combination under Global Antimicrobial Resistance Surveillance System (GLASS) surveillance[15]

AMR, antimicrobial resistance.

Phase 3: piloting, refinement and finalisation

Piloting was undertaken in Australian institutions to further refine the overall process, provide estimates of the time necessary to complete the tools, improve clarity and flow of the tools and individual items, and ensure the appropriateness of scoring categories and suggested personnel to be involved in the assessment process. While the tools are developed primarily for use in LMIC, it was decided to pilot in Australian institutions as these facilities would likely be more developed and extensive, ensuring that the full range of capacities would be able to be captured. Pilots were undertaken in human public health and animal laboratories and in acute care hospitals (ie, tools were not piloted in aged care facilities, or community-based or general practices). After each pilot, feedback was collated and discussion was held between the individual(s) completing the tool and the technical team to clarify any feedback or queries, and to refine the tool. Piloting was concluded once no substantiative feedback or suggestions were received. One to three rounds of piloting were undertaken for each theme assessment tool. Detailed outlines of the feedback received and modifications made to the tools throughout the piloting process are found in online supplemental annex 1.

The technical team completed extensive review and optimisation on the national assessment tool; however, this tool was not piloted. Once piloting had been completed, the theme assessment tools underwent a last round of refinement and review to ensure all comments and feedback were addressed. The tools and all accompanying documents were then finalised. Following implementation into the COMBAT-AMR countries, the tools underwent an additional round of revision incorporating feedback from their use in LMICs. Feedback was given on logistical issues in completing the tools, comments on the size of the tools and time needed to complete and comments of question wording. These were incorporated into updated final versions of the tools.

FORMAT AND STRUCTURE OF THE COMBAT-AMR SITUATION ASSESSMENT TOOLS

An overview of the COMBAT-AMR assessment tools is provided in table 5. Each of the assessment tools comprises

Table 4 Rationale for existing tools selected to form the basis for COMBAT-AMR assessment tools

Tools	Reliability of source (produced by appropriate and experienced organisations)	User-friendliness (simple to understand, interpret and implement)	Scorability (produces quantifiable metrics)	Flexibility (suitable for use in a range of different contexts, organisations and facilities)	Comprehensiveness (contains necessary level of detail and specific information)	Relevance (applicable to pathogenic bacterial AMR)	Integration (contains cross-sectoral assessment)
National assessment							
Tripartite AMR Country Self-Assessment Survey (TrACSS)	✓	✓	✓	✓	✓	✓	✓
FAO Progressive Management Pathway for AMR	✓	✓	✓	✓	✓	✓	✓
Animal health laboratory surveillance							
The Fleming Fund AMR Surveillance Site and Laboratory Needs Assessment Tool (Animal Health)	✓	✓	✓	✓	✓	✓	×
Antimicrobial stewardship							
National Centre for Antimicrobial Stewardship: Antimicrobial Stewardship in the Western Pacific Region Data gap analysis tool	✓	✓	×	✓	✓	✓	×
National Centre for Antimicrobial Stewardship: Antimicrobial Stewardship in the Western Pacific Region Facility observation checklist	✓	✓	×	✓	✓	✓	×
Infection prevention and control							
WHO Infection Prevention and Control Assessment Framework (IPCAF)	✓	✓	✓	✓	✓	✓	×
WHO/UNICEF Water and Sanitation for Health Facility Improvement Tool (WASH FIT)	✓	✓	✓	✓	✓	✓	×
Human health laboratory surveillance							
The Fleming Fund AMR Surveillance Site and Laboratory Needs Assessment Tool (Human Health)	✓	✓	✓	✓	✓	✓	×

AMR, antimicrobial resistance; COMBAT-AMR, Combating the threat of antimicrobial resistance in Pacific Island Countries.

Table 5 Summary of the COMBAT-AMR assessment tools

	National assessment tool	Human health laboratory capacity assessment tool	IPC WASH assessment tool	AMS assessment tool	Animal health laboratory capacity assessment tool
Number of instruments	Three: ▶ National Antimicrobial Resistance Context Review Framework ▶ National Antimicrobial Resistance Policy and Practice Assessment Framework ▶ National Antimicrobial Resistance Key Informant Interviews	One	One	Two: ▶ Antimicrobial Stewardship Gap Analysis Tool ▶ Antimicrobial Stewardship Facility Observation Checklist	One
Themes covered	▶ Program planning ▶ National coordination of AMR ▶ The National AMR Coordinating Committee ▶ National action plan for AMR ▶ AMR policy ▶ Stakeholders in AMR ▶ Antimicrobial stewardship ▶ Antimicrobial surveillance in human health ▶ Antimicrobial surveillance in animal health/ agriculture settings ▶ Regulation of the supply of antimicrobials ▶ Antimicrobial resistance research ▶ Antimicrobial resistance surveillance ▶ Organisation of the animal health laboratory network ▶ Livestock industry and production ▶ Major AMR activities and issues ▶ Use of surveillance data ▶ Intersectoral coordination	▶ Antimicrobial Susceptibility Testing (AST) ▶ Pathogens versus antibiotic resistance combination ▶ Antimicrobial resistance diagnostic capabilities ▶ Reporting ▶ Referral pathways and sample transport ▶ Data collection and management ▶ Operations and infrastructure ▶ Biosafety and biosecurity ▶ Quality management system and quality assurance	▶ Infection prevention and control program ▶ Infection prevention and control guidelines ▶ Infection prevention and control education and training ▶ Health associated infection surveillance ▶ Multimodal strategies for implementation of infection prevention and control interventions ▶ Monitoring/audit of IPC practices and feedback ▶ Workload, staffing and bed occupancy ▶ Built environment, materials and equipment for IPC at the facility level	▶ Facility characteristics ▶ Governance and leadership ▶ AMS and antimicrobial prescribing processes ▶ Education and guidelines ▶ Clinical patient review ▶ Monitoring antimicrobial prescribing, use and resistance ▶ Reporting and feedback	▶ Bacteriology sample details ▶ Equipment ▶ Bacteria the laboratory is able to grow and identify ▶ Antimicrobial Susceptibility Testing (AST) ▶ Bacteria versus antibiotic combinations for AST ▶ Reporting ▶ Referral pathways and sample transport ▶ Data collection and management ▶ Operations and infrastructure ▶ Biosafety and biosecurity ▶ Quality management system and quality assurance
Recommended to be completed by	▶ National AMR Committee ▶ Ministry of Health AMR focal person ▶ Ministry of Agriculture AMR focal person ▶ Chief veterinary officer	▶ Laboratory managers ▶ Principal scientists ▶ Quality managers ▶ GLASS AMR focal point ▶ National Technical Working Group (TWG) on surveillance	▶ Managers for IPC, environment and maintenance ▶ Members of facility IPC Committee	▶ Infectious disease physicians and pharmacy directors ▶ Senior management involved with AMS ▶ Members of facility AMS Committee	▶ Laboratory managers ▶ Principal scientists ▶ Quality managers
Estimated time to complete	Variable depending on scope of assessment	8–12 hours	6–8 hours	4–6 hours	6–8 hours

AMS, antimicrobial stewardship; COMBAT-AMR, Combating the threat of antimicrobial resistance in Pacific Island Countries; IPC, infection prevention and control.

between one and three instruments. The tools can be used separately to assess particular aspects of an institution's AMR capacity, or as a whole to provide a detailed, cross-sectoral overview of a country's current AMR capacities, needs and priorities. Use of the National AMR Situation Assessment Tool in conjunction with the theme assessment tools allows

countries to align investment and capacity building with National AMR Action Plans or national and regional strategies, and provides the basis for a cohesive programme of work that addresses AMR using a cross-sectoral approach. Completion of the tools should be collaborative and involve a range of stakeholders and involved parties, rather than being a single individual's assessment.

The National AMR Situation Assessment Tool includes three data collection instruments: The National Antimicrobial Resistance Context Review, the National Antimicrobial Resistance Policy and Practice Assessment and the key informant interview schedule. These data collection tools have been designed to be flexible and minimise respondent burden, allowing for use with a variety of respondents and key informants and across countries. Topics covered by the national-level tools align with the COMBAT-AMR themes; the Strategic Objectives of the WHO Global Action Plan on AMR, the Tripartite AMR Country Self-assessment Survey; and the FAO Progressive Management Pathway for AMR.

The two components of the AMS assessment tool, the Antimicrobial Stewardship Gap Analysis Tool and AMS Facility Observation Checklist, work together to provide a robust assessment of a healthcare facility's AMS processes, policies and practices. The AMS Gap Analysis Tool provides a detailed overview of practices to support investment and planning, and to capture progress towards best practice over time. The AMS Faculty Observation Checklist provides observable confirmation of facility AMS activities and practices.

The other three tools are each comprising a single instrument. The animal health laboratory capacity assessment tool and human health laboratory capacity assessment tool have a number of elements in common, each examining capacity in antimicrobial susceptibility testing and elements of laboratory function including reporting, sample referral pathways and operations, quality assurance and infrastructure. The animal health laboratory capacity assessment tool incorporates queries regarding species that clinical and healthy samples are received from, as well as questions regarding food and environmental samples. Items in the human health laboratory capacity assessment tool regarding pathogens versus antibiotic resistance combination align with the GLASS guide.[15]

The IPC WASH assessment tool covers elements such as availability and use of IPC and WASH guidelines, WASH system and infection surveillance and practices regarding staffing and bed occupancy. WASH items are included in most sections of the tool and examine the built environment and all relevant WASH components for healthcare facilities: water, sanitation, hygiene for all healthcare users, healthcare waste management and environmental cleaning.

IMPLEMENTATION AND UTILISATION OF THE ASSESSMENT FRAMEWORK IN PROGRAMME DESIGN AND EVALUATION

Each assessment tool has been implemented in either one or two of the target COMBAT-AMR countries. Country 1 implemented all five assessment tools while country 2 implemented the national assessment tool and the animal health laboratory capacity assessment tool. Country 3 completed the AMS tools and partially completed the national assessment tool. Country 4 completed the IPC tool. Implementation of the theme assessment tools was undertaken within the target countries at the facility level. This was performed by key individuals at each of the different institutions whose professional roles corresponded to the project themes. Tools were completed online with significant support from the COMBAT-AMR country coordinator and the technical team.

Feedback regarding the tools from those institutions that completed the theme assessments was highly positive, and included comments that the scores for the different sections of the assessments corresponded with their own perceptions of their organisational capacity. However, feedback was also received that the human health laboratory capacity assessment tool was particularly burdensome to complete and required significant oversight and review from the COMBAT-AMR technical team.

Following tool completion, the information from the assessment is converted to quantitative scores to identify areas of strength and opportunities. This scoring is then discussed with relevant stakeholders to produce initial recommendations and identify key priorities for intervention or investment. Standardised summary reports are generated by COMBAT-AMR technical staff which includes an analysis of the strengths and opportunities for each participating institution. Following collaborative discussions of report findings, recommendations may be revised and workplans consisting of targeted activities are developed.

Reports were provided to and discussed with personnel within each institution who had completed data collection, and senior managers or government stakeholders. At this point, outstanding queries were able to be resolved and alignment or discrepancies in the institution's scores and staff perceptions were discussed.

The summary reports guided identification of key areas of opportunities, provided a foundation for prioritisation of key areas for support, and contributed to development of project workplans. The scoring system provided a transparent means of identifying potential priorities and areas that represented particularly important targets for capacity building while the reporting process supported collaboration and stakeholder engagement in identification of priorities and project workplan development. Further gaps were identified through completion of the national assessment and subsequent stakeholder interviews to refine the COMBAT-AMR programme and workplans. While project implementation is still ongoing, the theme assessment tools will be repeated at the end of the project to provide an objective measure of project progress against identified priorities and outcomes.

LIMITATIONS

The COMBAT-AMR Assessment Framework provides a systematic approach to assessing AMR capacity, but can also be time consuming and necessitate a high level of technical skills or resources. Countries may therefore struggle to complete the tools independently and need additional support.

Initial piloting of the tools occurred only in Australia, within highly developed facilities. This was to ensure that the tools would be able to capture the full range of complexity across diverse contexts within LMICs. Further revisions were made to the tools incorporating comments from end-users following implementation in each of the four target countries.

The COMBAT-AMR Assessment Framework can be undertaken with support from the COMBAT-AMR technical team. Given that the theme tools are focused on an organisational level, they do not capture variation in capacity across institutions, nor do they take into consideration differences between wards or units within a hospital. However, the tools can be used at multiple institutions to provide a more nuanced understanding of AMR capacity at the whole of country level. As with all cross-sectional instruments, the tools provide a single snapshot in time, although multiple rounds of completion can be used to assess progress periodically. The tools may be applied broadly however certain fields will only apply to specific health facilities with an acute care component and microbiological laboratories. The scope of the tools is on pathogenic bacterial AMR with a focus on drug-resistance in healthcare settings aligning with the key high priority areas for global health funding of governance, disease surveillance and laboratory capacity. This underpinned the selection of the four programme themes. However, other areas relevant to AMR such as antimicrobial-consumption surveillance, education and awareness, and immunisation are not directly addressed through the tools and may be addressed through future work and the development of additional assessment tools. The animal health tool focuses primarily on animal health laboratories. This focus is due to recognition of existing limitations in AMR capacity in the animal health sector across LMICs and the resulting need to build laboratory capacity to improve the availability and quality of AMR surveillance data in the animal health sector. While environmental health is included in One Health, in LMICs the sector was viewed as out of scope for the development of the tools. Prior literature reviews and the authors' own experience highlight that while One Health is a growing concept, the environmental sector is extremely limited in terms of infrastructure and resources. In the majority of LMICs, the environmental sector needs extensive investment in basic capacity building before focused planning in AMR is feasible.

CONCLUSIONS

AMR is an urgent and growing global health concern, and a clear understanding of existing capacities to address AMR, particularly in LMICs, is needed to inform national priorities, investment targets and development activities. Despite a proliferation of tools designed to inform policy formulation and implementation or surveillance interventions to address AMR, there is an unmet need for easy-to-use instruments that provide a detailed overview of AMR policy, practice and capacity.

The COMBAT-AMR Assessment Framework represents a unique model of a systematic, cross-sectoral approach to assess AMR capacity. The COMBAT-AMR Assessment Framework is available for use outside of the COMBAT-AMR project, and tools have been used in additional countries to support other implementation projects. The Framework is flexible to meet the needs of implementers, as tools can be used separately to assess the capacity of individual institutions or as a whole to align priority-setting and capacity-building with National AMR Action Plans or national policies. We therefore provide access to this suite of instruments to assess AMR capacity across a range of contexts and invite interest from policymakers, practitioners and implementers that are in the process of assessing and building their capacity to manage AMR. Use of the COMBAT-AMR Assessment Framework may be undertaken individually or with support from the COMBAT-AMR technical team to complete the tools and collaboratively develop priorities and further strategies to increase capacity. Further information on how to access the COMBAT-AMR Assessment Framework may be found here: https://www.combatamr.org.au/project-activities/situation-and-needs-assessment-tool-development

Author affiliations
[1]WHO Collaborating Centre for Antimicrobial Resistance, Doherty Institute, Melbourne, Victoria, Australia
[2]Microbiological Diagnostic Unit Public Health Laboratory, The Peter Doherty Institute for Infection and Immunity at the University of Melbourne, Melbourne, Victoria, Australia
[3]Burnet Institute, Melbourne, Victoria, Australia
[4]Molecular Epidemiology Laboratory, School of Veterinary Science, Massey University, Palmerston North, New Zealand
[5]Asia-Pacific Centre for Animal Health, Melbourne Veterinary School, The University of Melbourne, Melbourne, Victoria, Australia
[6]Escuela de Medicina Veterinaria, Universidad Andrés Bello, Santiago, Chile
[7]Doherty Institute, Melbourne, Victoria, Australia
[8]Department of Microbiology and Immunology, University of Melbourne at the Doherty Institute, Melbourne, Victoria, Australia
[9]Department of Infectious Diseases, Monash University and Alfred Health, Melbourne, Victoria, Australia
[10]Infectious Disease Department, Sunshine Coast University Hospital, Sunshine Coast, Queensland, Australia
[11]Department of Infectious Diseases, Monash University, Clayton, Victoria, Australia
[12]Department of Infectious Diseases, Alfred Health, Melbourne, Victoria, Australia
[13]Nossal Institute for Global Health, Melbourne School of Population and Global Health, The University of Melbourne, Melbourne, Victoria, Australia

Twitter Angeline S Ferdinand @asferdinand

Contributors ASF led the development of the tools and conceptualised the article. ASF and CM wrote the manuscript. ASF, CL, JM, GB, JG, MC, TP, SL, NT, AJ, AS, DC, AM, BPH and KB contributed to the design and piloting of the tools. ASF, CL, KB, KK, GT and BP led the implementation of the tools in the pacific. BPH and KB led the COMBAT-AMR project. All authors provided feedback to help shape the manuscript.

Funding This study was funded by Department of Foreign Affairs and Trade, Australian Government.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

ORCID iDs
Angeline S Ferdinand http://orcid.org/0000-0002-4816-5539
Callum McEwan http://orcid.org/0000-0001-9415-2483

REFERENCES

1 WHO. Antimicrobial resistance. 2020. Available: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
2 Murray CJL, Ikuta KS, Sharara F, *et al*. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet* 2022;399:629–55.
3 O'Neill J. Tackling drug-resistant infections globally: final report and recommendations: government of the United Kingdom; 2016.
4 de Kraker MEA, Stewardson AJ, Harbarth S. Will 10 million people die a year due to antimicrobial resistance by 2050? *PLOS Med* 2016;13:e1002184.
5 Pokharel S, Raut S, Adhikari B. Tackling antimicrobial resistance in low-income and middle-income countries. *BMJ Glob Health* 2019;4:e002104.
6 Boutayeb A. The burden of communicable and non-communicable diseases in developing countries. In: *Handbook of Disease Burdens and Quality of Life Measures*. 2010: 531–46.
7 McEwen SA, Collignon PJ. Antimicrobial resistance: a one health perspective. *Microbiol Spectr* 2018;6.
8 Loftus MJ, Curtis SJ, Naidu R, *et al*. Prevalence of healthcare-associated infections and antimicrobial use among inpatients in a tertiary hospital in Fiji: a point prevalence survey. *Antimicrob Resist Infect Control* 2020;9:146.
9 Loftus MJ, Everts RJ, Cheng AC, *et al*. Antimicrobial susceptibility of bacterial isolates from clinical specimens in four Pacific Island countries, 2017-2021. *Lancet Reg Health West Pac* 2023;32:100677.
10 WPRO. *Action agenda for antimicrobial resistance in the Western Pacific Region*. Manilla: WHO, 2015.
11 World Health Organization, UNICEF. WHO/UNICEF joint monitoring programme (JMP) Healthcare data: the WHO/UNICEF joint monitoring programme (JMP). 2023. Available: https://washdata.org/data/healthcare
12 Nielsen LR, Alban L, Ellis-Iversen J, *et al*. Evaluating integrated surveillance of antimicrobial resistance: experiences from use of three evaluation tools. *Clin Microbiol Infect* 2020;26:1606–11.
13 Sandberg M, Hesp A, Aenishaenslin C, *et al*. Assessment of evaluation tools for integrated surveillance of antimicrobial use and resistance based on selected case studies. *Front Vet Sci* 2021;8:620998.
14 REDCap. REDCap. 2023. Available: https://www.project-redcap.org
15 World Health Organization. Global antimicrobial resistance and use surveillance system (GLASS). 2022. Available: https://www.who.int/initiatives/glass
16 World Health Organization. Joint external evaluation tool: International health regulations, (2005) - third edition. 2005. Available: https://www.who.int/publications/i/item/9789240051980
17 World Health Organization. Tripartite AMR country self-assessment survey – Tracss (6.0) 2022. 2022. Available: https://www.who.int/publications/m/item/tripartite-amr-country-self-assessment-survey---tracss-(6.0)-2022
18 Food and Agriculture Organization. FAO progressive management pathway for antimicrobial resistance (FAO-PMP-AMR). 2022. Available: https://www.fao.org/antimicrobial-resistance/resources/tools/fao-pmp-amr/es
19 World Health Organization. Worldwide country situation analysis: response to antimicrobial resistance; 2015.
20 RISKSUR. RISKSUR tools for surveillance design and evaluation. 2015. Available: https://www.fp7-risksur.eu/results/tools
21 Food and Agriculture Organization. Strengthening veterinary diagnostic capacities: the FAO laboratory mapping tool; 2015.
22 National Centre for Antimicrobial Stewardship. *Antimicrobial stewardship in the Western Pacific Region semi-structured interview with clinicians*.
23 National Centre for Antimicrobial Stewardship. *Antimicrobial stewardship in the Western Pacific data gap analysis tool*.
24 National Centre for Antimicrobial Stewardship. *Antimicrobial stewardship in the Western Pacific Region facility observation checklist*.
25 RCGP Learning. Antibiotic stewardship tools, audits and other resources. 2021. Available: https://elearning.rcgp.org.uk/mod/book/view.php?id=12649&chapterid=455
26 Centers for Disease Control and Prevention. Antibiotic stewardship program assessment tool; 2019.
27 SA Health. SA health antimicrobial stewardship program: self evaluation Toolkit; 2015.
28 Cooke J, Alexander K, Charani E, *et al*. Antimicrobial stewardship: an evidence-based, antimicrobial self-assessment toolkit (ASAT) for acute hospitals. *J Antimicrob Chemother* 2010;65:2669–73.
29 National Institute for Health and Care Excellence. Baseline assessment tool for antimicrobial stewardship. 2015.
30 World Health Organisation. WHO policy guidance on integrated antimicrobial stewardship activities; 2021.
31 World Health Organization. Infection prevention and control assessment framework at the facility level. 2018. Available: https://www.who.int/publications/i/item/WHO-HIS-SDS-2018.9
32 United Nations Children's Fund, World Health Organization. WHO / UNICEF water and sanitation for health facility improvement tool (WASH FIT). 2022. Available: https://www.unicef.org/documents/who-unicef-water-and-sanitation-health-facility-improvement-tool-wash-fit
33 Global Handwashing Partnership. WASH in HCF response to COVID-19 assessment tool. 2020. Available: https://globalhandwashing.org/resources/wash-in-hcf-response-to-covid-19-assessment-tool
34 International Society of Antimicrobial Chemotherapy. WHO hand hygiene self-assessment framework. 2015. Available: https://www.isac.world/news-and-publications/who-hand-hygiene-self-assessment-framework
35 Centers for Disease Control and Prevention. Introduction to the ICAR tool for general IPC practices across settings; 2022.
36 Abraao LM, Nogueira-Junior C, Orlandi GM, *et al*. Infection prevention and control program assessment tools: a comparative study. *Am J Infect Control* 2022;50:1162–70.
37 World Health Organization. Stepwise laboratory quality improvement process towards accreditation (SLIPTA) checklist V2:2015; 2015.
38 World Health Organization. AMR surveillance: questionnaire for assessment of national network (2003); 2021.
39 WHO Lyon Office for National Epidemic Preparedness and Response. Laboratory assessment tool. WHO Lyon office for national epidemic preparedness and response; 2012.
40 Centers for Disease Control and Prevention. Lab assessment of antibiotic resistance testing capacity (LAARC). Atlanta, GA U.S. Department of Health and Human Services; 2017.
41 Food and Agriculture Organization. Monitoring and surveillance of antimicrobial resistance in bacteria from healthy food animals intended for consumption. In: *Regional Antimicrobial Resistance Monitoring and Surveillance Guidelines – Volume 1*. Bangkok, 2019.
42 World Organisation for Animal Health. OIE standards, guidelines and resolutions on antimicrobial resistance and the use of antimicrobial agents. Paris, France,
43 OIE. *OIE list of antimicrobial agents of veterinary importance Paris, France*. 2021.
44 World Organisation for Animal Health. Chapter 6.8.- Harmonisation of national antimicrobial resistance surveillance and monitoring programs. In: *Terrestrial Animal Health Code*. 2022.
45 Australian Commission on Safety and Quality in Health Care. Chapter 6 - measuring performance and evaluating antimicrobial

stewardship programs. In: *Antimicrobial stewardship in Australian health care*. Sydney: ACSQHC, 2022.
46 Centers for Disease Control and Prevention. *The core elements of hospital antibiotic stewardship programs*. Atlanta, GA: US Department of Health and Human Services, CDC, 2019.
47 World Health Organization. Antimicrobial stewardship programmes in health-care facilities in low- and middle-income countries: a WHO practical toolkit. Geneva World Health Organization; 2019.
48 World Health Organization. *Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level*. Geneva: World Health Organization, 2016.
49 Australian Commission on Safety and Quality in Health Care. Infection prevention and control [ACSQHC]. 2023. Available: https://www.safetyandquality.gov.au/our-work/infection-prevention-and-control
50 Centers for Disease Control and Prevention. Guidelines & guidance library. 2020. Available: https://www.cdc.gov/infectioncontrol/guidelines/index.html
51 Pacific Community. Infection prevention and control. 2021. Available: https://php.spc.int/programmes/surveillance-preparedness-and-response/infection-prevention-and-control
52 World Health Organization. Improving infection prevention and control at the health facility: interim practical manual supporting implementation of the WHO guidelines on core components of infection prevention and control programmes. Contract no.: WHO/HIS/SDS/2018.10. Geneva World Health Organization; 2018.
53 World Health Organization, UNICEF. Core questions and indicators for monitoring WASH in health care facilities in the sustainable development goals; 2018.
54 World Health Organization. Essential environmental health standards in health care; 2008.