MONITORING AND EVALUATION OF THE GLOBAL ACTION PLAN ON ANTIMICROBIAL RESISTANCE

Framework and recommended indicators

Food and Agriculture Organization of the United Nations

WORLD ORGANISATION FOR ANIMAL HEALTH

World Health Organization

MONITORING AND EVALUATION OF THE GLOBAL ACTION PLAN ON ANTIMICROBIAL RESISTANCE

Framework and recommended indicators

Food and Agriculture Organization of the United Nations

WORLD ORGANISATION FOR ANIMAL HEALTH

World Health Organization

Monitoring and evaluation of the global action plan on antimicrobial resistance: framework and recommended indicators

ISBN 978-92-4-151566-5 (WHO)
ISBN 978-92-5-131466-1 (FAO)
ISBN 978-92-95115-12-5 (OIE)

© World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO) and World Organisation for Animal Health (OIE), 2019

All rights reserved. WHO, FAO and OIE encourage the reproduction and dissemination of material in this information product. Any proposed reproduction or dissemination for non-commercial purposes will be authorized free of charge upon request, provided the source is fully acknowledged. Any proposed reproduction or dissemination for resale or other commercial purposes, including educational purposes, is prohibited without the prior written permission of the copyright holders, and may incur fees.

Requests for permission to reproduce or translate WHO publications – whether for sale or for non-commercial distribution – should be addressed to WHO Press through the WHO web site http://www.who.int/about/licensing/copyright_form/en/index.html.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) or of the World Organisation for Animal Health (OIE) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these are or have been endorsed or recommended by WHO, FAO and OIE in preference to others of a similar nature that are not mentioned. The published material is being distributed without warranty of any kind either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall WHO, FAO and OIE be liable for damages arising from its use. The views expressed herein are those of the authors and do not necessarily represent those of WHO, FAO, OIE.

Publications of the World Health Organization are available on the WHO web site www.who.int or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland. Tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: bookorders@who.int.

FAO information products are available on the FAO website www.fao.org/publications and can be purchased through Publications-sales@fao.org

Publications of the World Organisation for Animal Health are available either on the OIE web site www.oie.int or can be purchased through the OIE online bookshop www.oie.int/boutique.

Contents

Acknowledgements iv

Abbreviations v

Terminology vi

A collaborative approach vi

Executive summary 1

Objectives of this framework 1

Tracking progress across the results chain 2

Core and additional indicators 2

Targets 2

Next steps 2

1. Introduction 3

2. Methodology for monitoring and evaluation 4

2.1 Global action plan on antimicrobial resistance results chain 4

2.2 Multiple dimensions of monitoring antimicrobial resistance 4

3. Implementing the M&E framework 9

3.1 Monitoring of the process and outputs 9

3.2 Monitoring and evaluation of the outcomes and goals 11

4. Indicators and data sources 14

Table 1. List of recommended core outcome indicators 16

Table 2. List of recommended core output indicators for each relevant outcome 19

5. The view ahead 23

5.1 Country-level next steps 24

5.2 Global-level next steps 24

Annex 1. Summary of the results chain for the global action plan and the response to antimicrobial resistance 27

Annex 2. Proposed additional standard antimicrobial resistance progress indicators 29

Annex 3. Reference sheets for the recommended core output and outcome indicators 32

Acknowledgements

Experts

Enis Baris, Neil Gupta, Eduardo Hage Carmo, Stephan Harbarth, Alison Holmes, Samuel Kariuki, Keith Klugman, Ramanan Laxminarayan, Rafael Lozano, Marc Mendelson, Gérard Moulin, Donald Prater, Celine Pulcini, Herbert Schneider, Mike Sharland, Anthony So, Visanu Thamlikitkul, Hnin Thidar Myint, Unesu Ushewokunze-Obatolu, Jaap A. Wagenaar, Xiao Yonghong

WHO Strategic and Technical Advisory Group members

Hanan Balkhy, Otto Cars, Dame Sally C Davies, Joseph Domenech, Rumina Hasan, Tabhish Hazir Rima Khabbaz, Shailendra Kumar, Helen Lambert, Masoud Mardani, Line Matthiessen, Mirfin Mpundu, Francis J. Ndowa, Iruka Okeke, Fernando Otaiza O'Ryan, Olga Perovic, Pascale Salameh, Hiiti B. Sillo, Jae-Hoon Song, Visanu Thamlikitkul, Haruo Watanabe, Yongning Wu

The Tripartite is especially grateful to Veronica Walford for developing the initial drafts of this framework.

FAO contributors

Executive team: Sarah Cahill, Irina Curca, Suzanne Eckford, Juan Lubroth

Technical leads: Carmen Bullon, Christine Czerniak, Alejandro Dorado Garcia, Gunilla Eklund, Anna Maria Grobicki, Baogen Gu, Kimberley Kane, Eva Kohlschmid, Francesca Latronica, Jeff Lejeune, Yingjing Li, Beatrice Mouille, Natalia Rodriguez Eugenio

OIE contributors

Executive team: Ben Davies, Elisabeth Erlacher-Vindel, Matthew Stone

Technical leads: Lina Awada, Catherine Bertrand-Ferrandis, Maud Carron, Taylor Gabourie, Glen Gifford, Delfy Gochez, Neo Mapitse, Stefano Messori, Jorge Pinto Ferreira, John Stratton, Maria Szabo

WHO contributors

Executive team: Anand Balachandran, Pravarsha Prakash, Marc Sprenger, Elizabeth Tayler

Technical and regional leads: Tjandra Yoga Aditama, Awa Aidara-Kane, Benedetta Allegranzi, Silvia Bertagnolio, Peter Beyer, Meg Doherty, Sergey Eremin, Socorro Escalante, Walter Fuller, Marta Gacic-Dobo, Laetitia Gahimbare, Sue Hill, Richard Johnston, Nicola Magrini, Karen Mah, Jorge Matheu Alvarez, Kate Medlicott, Kazuaki Miyagishima, Arno Muller, Claudia Nannei, Sarah Paulin, Carmem Pessoa da Silva, Pilar Ramon-Pardo, Pascale Ringwald, Maha Talaat Ismail, Astrid Wester, Karin Weyer, Danilo Lo Fo Wong

UNEP contributors

Jacqueline Alvarez, Gamini Manuweera

External contributors

Alex Beith, Luca Guardabassi, Sian Lewis, Rukhshona Rajabova

Public consultation contributors

We gratefully acknowledge and thank all those who provided feedback to the online global public consultation held in 2017. The consultation prompted 95 responses, including from government institutions, the private sector, academia and civil society respondents in 63 countries.

Abbreviations

AM	Antimicrobial
AMR	Antimicrobial resistance
AMU	Antimicrobial use
ATLASS	Assessment Tool for Laboratories and Antimicrobial resistance Surveillance Systems (FAO)
AWaRe	Access, WAtch and REserve
BSI	Bloodstream infections
ESBL	Extended spectrum beta-lactamase
FAO	Food and Agriculture Organization of the United Nations
FAOLEX	Legislative and policy database (FAO)
FAOSTAT	Food and agriculture database (FAO)
GAP	Global action plan on antimicrobial resistance
GLASS	Global Antimicrobial Resistance Surveillance System
HTM	Cluster for HIV/AIDS, Tuberculosis, Malaria and Neglected Tropical Diseases (WHO)
IACG	Interagency Coordination Group on Antimicrobial Resistance
IPC	Infection prevention and control
JEE	Joint External Evaluation of International Health Regulations (2005)
LMIC	Low- and middle-income country
M&E	Monitoring and evaluation
NAP	National action plan
OIE	World Organisation for Animal Health
PVS	Performance of Veterinary Services
R&D	Research and development
SDG	Sustainable Development Goal
TB	Tuberculosis
TrACSS	Tripartite AMR country self-assessment survey
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
VPH	Veterinary Public Health
WASH	Water, sanitation and hygiene
WHO	World Health Organization

Terminology

This paper uses widely accepted definitions of the terms "evaluation" and "monitoring" as follows:

Evaluation

"An evaluation is an assessment, conducted as systematically and impartially as possible, of an activity, project, programme, strategy, policy, topic, theme, sector, operational area or institutional performance"

Source: Norms and standards for evaluation. New York: United Nations Evaluation Group; 2016 (www.unevaluation.org/document/detail/1914)

Monitoring

"A continuing function that uses systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing...intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds"

Source: Development Assistance Committee (DAC). Glossary of key terms in evaluation and results based management. Paris: Organisation for Economic Co-operation and Development; 2010 (www.oecd.org/dac/evaluation/2754804.pdf)

A collaborative approach

The monitoring and evaluation (M&E) framework of the global action plan on antimicrobial resistance (hereinafter referred to as "GAP") was developed in consultation and collaboration with diverse national and international partners and experts, including the WHO Strategic and Technical Advisory Group on antimicrobial resistance.

In June 2017, members of the Tripartite (Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, World Health Organization) convened a meeting of human and animal health experts from around the world to get advice on potential indicators. Participants at the meeting stressed the need to be realistic about developing practical indicators that can show progress for countries at different stages of their response to antimicrobial resistance (AMR).

Given the links to the Sustainable Development Goals (SDGs), and to minimize the need for additional monitoring, the global action plan M&E framework draws indicators from the SDG indicator set and from other established frameworks wherever possible. For example, the indicators for water, sanitation and hygiene come from the SDGs, and those for access to medicines and immunization come from core health data sets. However, in many cases, the AMR component of SDG indicators (such as the poverty indicators) are insufficiently AMR-specific to be informative for the global action plan M&E framework.

Following the June 2017 meeting, a draft M&E approach was published for public consultation with the wider international community. The consultation prompted 95 responses, including from government institutions, private-sector representatives, academia and civil society respondents from 63 countries. The Tripartite, taking into account the feedback from the consultation, then finalized the M&E framework document ensuring a balanced and coherent approach that predominantly draws on existing data sources.

Executive summary

The global action plan on antimicrobial resistance (hereinafter "GAP") is the world's blueprint for tackling the emergence and spread of antimicrobial resistance (AMR), which threatens many of the global Sustainable Development Goals (SDGs) on health, food security, environmental well-being and socioeconomic development. Adopted by the membership of WHO, the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE) in 2015, the GAP was further endorsed by political leaders in 2016, when Heads of State issued a high-level political declaration on AMR (resolution A/RES/71/3) during the seventy-first session of the United Nations General Assembly, committing them to implementing the GAP at the global, regional and national levels.

The GAP articulates five objectives for tackling AMR, and sets out the tasks required to achieve them, highlighting roles and responsibilities for country governments, the One Health Tripartite organizations (FAO, OIE and WHO) and other national and international partners. To ensure that all stakeholders assume their roles and responsibilities, and to assess whether they are collectively effecting the necessary change in AMR, the implementation of the GAP needs to be routinely monitored and evaluated. To that end, the Tripartite organizations co-developed a monitoring and evaluation (M&E) framework for the GAP, as outlined in this document.

Objectives of this framework

The framework aims to be robust and practical – to provide a manageable system that can facilitate the generation, collection and analysis of standardized data to assess the success of the GAP, and inform operational and strategic decision-making on AMR for the next 5–10 years at the national and global levels. Its other key objectives include enhancing the availability and quality of data, reducing or consolidating the multiple data collection and reporting requirements – especially in the human health sector – and increasing accountability at all levels. It will also underpin the forthcoming global development and stewardship framework for AMR. Rooted in experience and expertise across diverse sectors, the framework was developed in consultation and collaboration with many national and international partners and experts.

The framework provides a recommended list of indicators that:

- need to be compiled at the country level through primary AMR data collection systems, including the Global Antimicrobial Resistance Surveillance System (GLASS), the OIE global antimicrobial use (AMU) data collection initiative and the Tripartite AMR country self-assessment survey (TrACSS); and
- are available at the global level from secondary sources (for example, the availability of safe water as measured for SDG reporting, or global estimates of immunization coverage as prepared by WHO and UNICEF).

The proposed audience for this framework includes staff from multiple sectors implementing AMR national action plans, staff from international partner agencies working at the national, regional and global levels on AMR and related activities, policy-makers, researchers, consultants advising national officials on the M&E systems for AMR, and international development and funding institutions.

All components of the M&E framework were developed with a One Health perspective to reflect the intersectoral nature of AMR. That includes identifying approaches and proposed indicators across human and animal health, plant and food production and the environment. Some M&E activities and processes are intended to be performed jointly; others are sector-specific.

The framework will remain dynamic. The understanding of AMR is evolving rapidly, as are new techniques and technologies, such as molecular genetics, electronic patient records and big data analysis. As knowledge on AMR and related measures improve, and lessons emerge on what works in different countries and contexts, the indicators, and the framework itself, are likely to evolve substantially. Hence, this is the framework's first iteration; it will be revised

after a period to reflect the lessons learned from its implementation and to incorporate emerging evidence about AMR and any new tools or technology.

Tracking progress across the results chain

The M&E framework is designed to enable an understanding of both how the GAP is being implemented and with what effect. As such, it includes two sets of M&E activities:

- Monitoring of the process and outputs. This focuses on the GAP's inputs, activities and outputs and is designed to monitor the progress of the different stakeholders in its implementation and to evaluate how to improve the collective response.
- Monitoring and evaluation of the outcomes and goals. This focuses on the GAP's outcomes and impact objectives and is designed to assess the effectiveness of GAP implementation efforts – to monitor their results and evaluate their impact on, for example, AMR patterns, appropriate use and the burden of disease.

Across both sets, the framework works at the national, regional and global levels.

Core and additional indicators

The framework is underpinned by indicators that define what to measure, when and how. These indicators were developed to reflect the complexities of measuring AMR across multiple sectors and the realities of variable country contexts and surveillance capacities. In the first instance, the number of indicators collected for global monitoring is limited to a core set (countries or regions are free and encouraged to collect more for their own purposes). The core indicators (22 outcome indicators; 26 output indicators) were chosen because they:

- reflect an important aspect of the AMR response that will yield significant and meaningful information for managing AMR at the national or global level;
- are sensitive enough to pick up change;
- are measurable by most countries within five years (although in many cases measurement systems may need substantial investment and development, particularly in non-human sectors); and
- are not too difficult or expensive to measure.

The extensive consultation process also helped to identify 26 additional or supplementary indicators considered to be important and useful, but to minimize the data collection burden on countries, indicators that do not meet the selection criteria above were added onto the "additional" indicator list. Countries may choose to collect data on these additional indicators or adapt them based on their specific context, needs and capacity.

Targets

This framework does not set targets, as many countries have no baselines or knowledge of the current trajectory. Countries and contexts vary to such an extent that setting meaningful global targets at this stage would be extremely difficult. The Tripartite does, however, encourage countries, and regions, to set their own targets (that can be process or outcome measures).

Next steps

The view ahead for the GAP M&E framework includes activities at the country and global levels to finalize the framework, test it, use it and refine it. Implementing the framework, including designing country M&E plans and carrying out comprehensive M&E, relies on sufficient and sustainable funds and resources. That makes identifying resource needs and matching them to potential funding sources a basic first step in moving the M&E framework forward. In addition, building the technical capacity at the country level to develop and sustain a robust AMR M&E system will be essential.

1. Introduction

Antimicrobial resistance (AMR) exists everywhere and can impact anyone of any age, in any country of the world. The impacts of unchecked AMR are wide-ranging and extremely costly, not only financially but also in terms of global health, food security, environmental well-being and socioeconomic development. Left alone, AMR poses a major threat to delivery of the 2030 Agenda for Sustainable Development.

No specific goal or target on AMR among the SDGs underpins the 2030 Agenda. But many complex and multidirectional links between AMR and the SDGs exist. For example, without effective antimicrobials, reducing maternal and child mortality due to infection cannot be achieved. Building sustainable food systems similarly relies on effective antimicrobials being available to tackle infections in animals. Rising levels of AMR will undermine progress towards the SDGs on health, poverty, food security and economic growth. At the same time, efforts towards other goals, including clean water and sanitation as well as responsible consumption and production, will help limit AMR's spread and impact.

In 2015, recognizing the urgent need to tackle AMR, the membership of FAO, OIE and WHO endorsed a global action plan on antimicrobial resistance (GAP),[1] which includes five strategic objectives aimed at ensuring the world's continued ability to treat and prevent infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way and accessible to all who need them. In 2016, the UN General Assembly reaffirmed the GAP as the blueprint for tackling AMR during its seventy-first session, where Heads of State issued a high-level political declaration on AMR (resolution A/RES/71/3),[2] committing them to supporting and implementing the GAP at the global, regional and national levels.

The GAP identifies roles for national governments, the Tripartite organizations (FAO, OIE and WHO) and other national and international partners. This includes a call for all countries to develop and implement collaborative, multisectoral national action plans (NAPs) in line with the GAP to address AMR in-country. Tailoring the response in this way is essential to ensure that action addresses individual country priorities and contexts, including, for example, disease burdens, human–animal interactions and environmental practices, such as sanitation and wastewater disposal.

To track whether stakeholders are taking action and to assess whether those actions are having the intended effect, an M&E framework is needed that includes process and output monitoring as well as a results assessment for outcomes and goals. This will also be important for the global development and stewardship framework for AMR that is currently under development.

The intention is to provide a framework that is both robust and practical – a manageable system that can generate useful data for operational and strategic decision-making for the next 5–10 years.

[1] Global action plan on antimicrobial resistance. Geneva: World Health Organization; 2015 (http://www.who.int/antimicrobial-resistance/global-action-plan/en/, accessed 28 February 2019).

[2] Seventy-first session of the United Nations General Assembly. Political declaration of the high-level meeting of the General Assembly on antimicrobial resistance (resolution A/RES/71/3). New York: United Nations; 2016 (http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/71/3, accessed 28 February 2019).

2. Methodology for monitoring and evaluation

2.1 Global action plan on antimicrobial resistance results chain

To design an effective M&E framework for the GAP, it is important to understand the intended "results chain": the causal pathways connecting the plan's inputs, activities and outputs with the desired outcomes and impact goals (see Fig. 1).

The five outcomes in the results chain relate to the GAP's five strategic objectives. These are expected to contribute directly or indirectly to preventing infection, more appropriate use of antimicrobials and new product development.

To clarify the full extent of the effects that the GAP objectives are expected to have, the impact goals in the results chain include:

1. reduced levels of AMR (including delaying the emergence of resistance, slowing the spread and, where possible, reversing trends to achieve a decline in resistance levels);
2. continued ability to treat and prevent infectious diseases with effective and safe medicines; and
3. reduced impact of infectious diseases on human and animal health.

AMR is only one contributing factor to this last impact goal. But decreasing the burden and effects of infectious diseases is the ultimate objective that can greatly facilitate progress towards the SDGs, not only in human and animal health, but in poverty reduction and sustainable food production and consumption. It is a great example of the interconnectedness of issues and the need for global solidarity and sustained action. In the human sector, an established methodology and robust estimates of the burden of infectious disease exist for all countries. An approach is being developed for the animal sector. The burden of infectious disease is also a useful contextual factor when reviewing antimicrobial consumption data.

The results chain provides the basis for defining indicators and monitoring levels for the GAP. It is not exhaustive; other components whose monitoring may be helpful include, for example, unintended consequences, specific transmission mechanisms and changes in legislative processes. Details of the specific M&E activities included in the results chain and their intended implementation are outlined in the following sections.

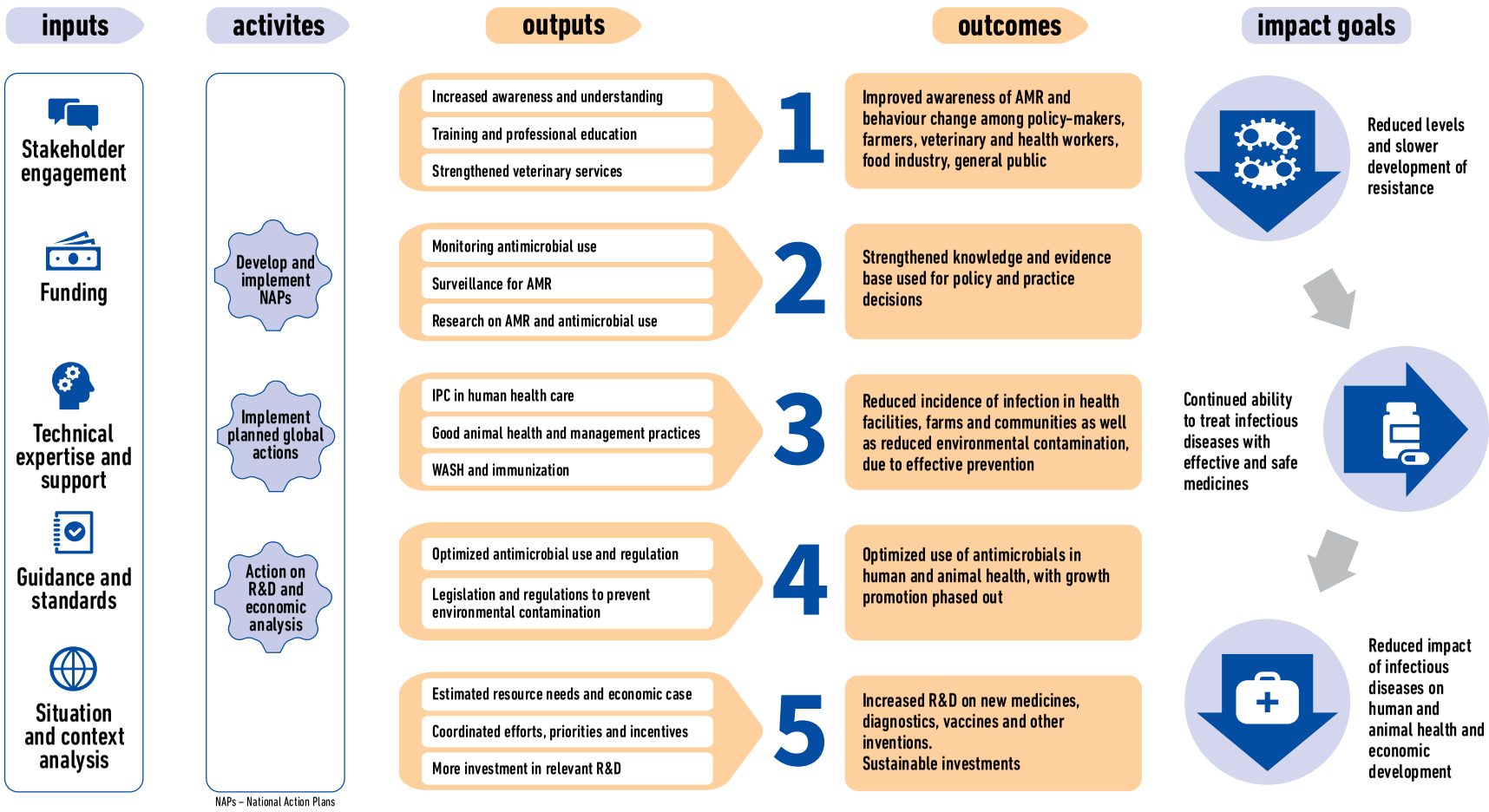
Annex 1 provides full result statements for the goals, outcomes and outputs.

2.2 Multiple dimensions of monitoring antimicrobial resistance

Using the results chain as the foundation for understanding how the GAP will work and how it will make a difference, the Tripartite organizations developed a proposed framework for its M&E, as outlined in the sections that follow. The framework was designed with a One Health perspective to reflect the intersectoral nature of AMR. That includes identifying approaches and proposed indicators across human and animal health, plant and food production and the environment. Some M&E activities and processes will be performed jointly; others will be sector-specific.

For human health, monitoring and reporting related to AMR for HIV, tuberculosis (TB) and malaria (HTM) already exist within relevant country disease programmes. The results and narrative from these disease-specific systems will be incorporated into an overall AMR report, even though, at least in the short to medium term, they operate under a different results framework. For animal health, the M&E framework currently focuses mainly on antibiotics. For

Fig. 1. The GAP results chain: mapping the causal pathways connecting the inputs, activities and outputs with the outcomes and impact goals



Source: WHO, FAO and OIE

plants, the focus is on fungicides and antibiotics and, for the environment, all types of antimicrobials are included, but as the understanding of AMR in these sectors is still emerging, the indicators and monitoring mechanisms are not well developed.

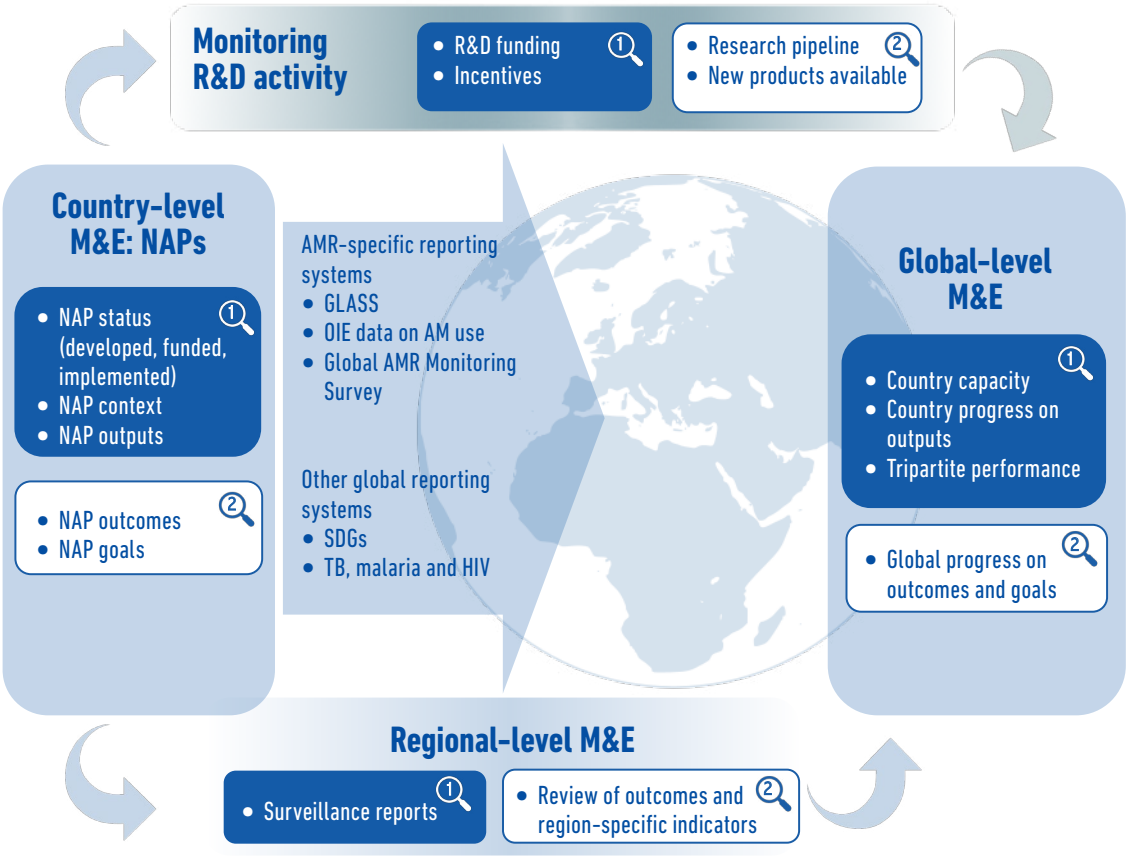
Across the results chain, the framework works at multiple levels – national, regional and global – and includes diverse components, such as country evaluations, national and international research and development (R&D) monitoring, global reporting systems and regional reviews. It should cover multiple sectors (see Fig. 2).

At the country level

Countries will need to both monitor their progress in developing and implementing their NAPs, and evaluate the extent to which this is making an impact at the national level.

Countries are expected to develop an M&E plan as part of their NAP, tailored to their context and priorities. This includes developing indicators appropriate to the country's own circumstances, considering the proposed core indicators of the Tripartite framework for monitoring and evaluation as far as possible (see section 4). Wherever possible, countries are encouraged to develop specific targets for outputs, outcomes and goals that can be measured by these indicators. Such a plan should be pragmatic and focus on the priority implementation areas where change is likely to happen.

Fig. 2. The proposed GAP M&E framework: assessing progress (① – in dark blue) and results (② – in white) through activities at the national, regional and global levels



Source: FAO, OIE, WHO

Given that national AMR M&E systems are at an early stage of development, with limited data available at the country level, it may be more realistic to focus on monitoring outputs in the short term, while the capacities and systems to measure outcomes and impact are developed. Some form of baseline data is important, which may come from special studies, modelling or extrapolation from similar contexts while seeking to obtain actual data.

Country M&E plans should outline how monitoring will take place, including responsibilities for collecting and analysing data in each sector, the frequency of monitoring, and the manner in which reports will be reviewed and evaluated. Country-level data collection may be stand-alone, extracted from existing systems or added into existing systems.[3]

The Tripartite will regularly review countries' demands for sharing experience and for guidance on M&E (including developing indicators) and will work with partners to respond to the needs.

At the global level

The global response incorporates process and outcome measures from country-level monitoring, as well as international action around R&D and by the Tripartite and other partners. Global M&E includes monitoring country progress in the implementation of NAPs and the overall impact of national activity. It uses existing and emerging information systems and reports wherever possible, including:

- the Tripartite AMR country self-assessment survey (TrACSS), which collects data on NAP implementation;[4]
- the Global Antimicrobial Resistance Surveillance System (GLASS), to which countries submit data on the antibiotic-resistant patterns of common bacteria and the consumption of antibiotics;
- the OIE annual data collection initiative for gathering country data on antimicrobial agents intended for use in animals;
- the FAO Assessment Tool for Laboratories and Antimicrobial resistance Surveillance Systems (ATLASS);
- SDG reporting, where appropriate; and
- other relevant data collection systems, including FAOSTAT (food and agriculture data), FAO FishStat Plus (software for fishery statistical time series), FAOLEX (electronic collection of national laws, regulations and policies on food, agriculture and natural resources management), OIE-WAHIS (World Animal Health Information System) and GLAAS (Global Analysis and Assessment of Sanitation and Drinking-Water).

At least the first four systems listed above will be linked in the future on a common platform called the Tripartite Integrated Surveillance System on antimicrobial resistance/antimicrobial use (TISSA).

At the global level, progress on R&D and ideally on the antibiotic market chain will be monitored.

At the regional level (supranational)

Regional organizations and economic groups also have a role in supporting countries and monitoring progress. Some regions have defined commitments or targets for tackling AMR; others have established regional monitoring systems, indicators and collaboration mechanisms. Consideration of transboundary spread may be particularly important at a regional level, and there may be economic, health or trade issues for which specific monitoring is required. The M&E framework is intended to coordinate with, and build on, existing regional efforts to avoid duplication or inconsistencies in data requests to countries.

[3] For example, data can be collected from existing general health service availability surveys to monitor the availability of antimicrobial medicines, water, sanitation and IPC measures in health facilities.

[4] The survey and responses are available at https://www.who.int/antimicrobial-resistance/global-action-plan/database/en/.

MONITORING AND EVALUATING R&D

Across all levels, efforts are required to monitor and evaluate the R&D elements of the GAP (the strategic objective related to outcome 5). While all countries may be doing some research, the bulk of R&D for new product development, which will be the focus for global monitoring, is conducted in a more limited set of countries.

WHO already monitors the research pipeline for antimicrobials, diagnostics and alternative treatments for human health, including the extent to which potential new products respond to need (as set out in the Priority Pathogens List[a]).

Given the existing market failure around new product development, the GAP M&E framework will track not only whether any new products are being developed, but also the funding instruments and levels of investment available for new product development.

The G20 has also established the Global Antimicrobial Resistance R&D Hub to, among other things, monitor AMR R&D funding and initiatives as well as R&D for animal health products.

The STAR-IDAZ International Research Consortium on Animal Health – an international consortium of public and private R&D programme owners and research funders – will also map R&D progress and existing initiatives to coordinate research and facilitate international collaboration on animal health.

[a] Prioritization of pathogens to guide discovery, research and development of new antibiotics for drug-resistant bacterial infections, including tuberculosis. Geneva: World Health Organization; 2017.

3. Implementing the M&E framework

As already stated, implementing the multilevel framework relies on establishing two types of M&E activities to track progress across the full results chain.

3.1 Monitoring of the process and outputs

The first set of M&E activities is designed to monitor the progress of the different stakeholders (countries, Tripartite organizations and partners) in implementing the GAP and to evaluate how to improve the collective response.

This set focuses on the inputs, activities and outputs of the results chain and comprises six components.

A. Country-led monitoring of NAP progress

Establishing and resourcing an M&E system in the country is important to track progress against the activities and outputs detailed in the NAP, which should be reviewed regularly (annually or biennially) to identify and address barriers to, and capacity for, NAP implementation. Country-led monitoring should include an assessment of NAP implementation at both the national and subnational levels. It should also include the monitoring of AMR funding from domestic and international sources to identify whether budgets were made available and were used for priority activities. A review of other inputs, such as the technical expertise available and policy context (legal and regulatory), should be conducted regularly.

Within specific sectors, some parts of country-led monitoring may be integrated with existing tools or processes, such as reviewing progress on the health aspects of the NAP during the routine monitoring of district health plans. Countries should develop their own results framework to track progress in the areas and sectors prioritized within their NAP. Given the potential complexity of AMR and limited resources in many countries, a pragmatic and proportionate approach is needed. At a minimum, an assessment of country progress against the TrACSS across the AMR spectrum should be collated and reviewed by the AMR coordinating group, ideally in consultation with civil society representatives and a wider group of stakeholders. This should be complemented by a more detailed (and ideally quantitative) monitoring of priority areas. The capacity and systems to do this in many countries are weak, thus the need for urgent action to address this.

B. Globally-led monitoring of country progress

The Tripartite organizations have already established a mechanism to monitor country progress in implementing key aspects of the AMR response: the TrACSS. Launched in 2016, this multisectoral, self-assessment questionnaire is sent to countries every year to capture information on their capacity, coverage and performance on major parts of the GAP;[5] the latest version has been amended to align more closely with the M&E framework and indicators. Future versions may include new questions to collect data on country context and on the proposed core indicators. Other systems supplement the survey results with information on other factors critical to understanding global trends. For example, FAOSTAT provides information on livestock and fish production, and FAOLEX provides data on countries' policies and regulation relating to the food and agricultural sectors.

External peer reviews of country systems allow further assessment of what is happening, how, where and with what impact. Currently, countries can obtain an external peer review by requesting a Joint External Evaluation (JEE) of

[5] The results of the TrACSS are available at https://www.who.int/antimicrobial-resistance/global-action-plan/database/en/.

International Health Regulations (2005) or an evaluation of Performance of Veterinary Services (PVS). AMR is one of the 19 action packages included in the JEE, and the OIE PVS has been strengthened with the addition of a Critical Competency on AMR to better reflect AMR issues. Both reviews only provide a partial picture, however, and more in-depth and focused assessments, and a standard methodology for internal and external programme review, will be developed.

C. Making the case for investment

Although most investment in AMR will probably come through domestic financing channels, ensuring adequate global investment in AMR will be particularly important, especially in low- and middle-income countries (LMICs) that will require external investment to fully fund their plans. Surveillance data are a global public good and will require long-term public investment from domestic or, in the case of low-income countries, international sources.

At the international level, a standard approach to identifying resource requirements for national plans, expenditures and funding sources is needed.

D. Monitoring the Tripartite's progress

FAO, OIE and WHO will individually monitor activities and outputs against each organization's AMR plan and budget, and will collectively track progress and report on activities in the joint workplan. They will report to their own governing bodies and in 2019 will contribute to the United Nations Secretary General's report to the United Nations General Assembly. The Interagency Coordination Group on Antimicrobial Resistance (IACG) may recommend other issues and indicators for the monitoring of the Tripartite organizations.

E. Monitoring progress in R&D

The focus is on monitoring progress on various elements of R&D that support the AMR response, including:

- mechanisms and incentives for R&D in new products targeted at AMR priority pathogens;
- the levels of funding available; and
- mechanisms that enable appropriate access to, and the uptake of, new products.

The Global Antimicrobial Resistance R&D Hub established by the G20 in 2017, focused on human health, is expected to monitor the mechanisms and incentives for R&D, as well as the spending on R&D into medicines, diagnostics and vaccines to address priority pathogens.

F. Evaluation to improve the AMR response

This part of the M&E framework is envisaged as a formative process evaluation. It includes reviewing experience in a sample of countries and performance across global organizations. Together, these reviews will be designed to:

- assess progress in implementing the GAP, taking account of different country contexts and including the role of multisectoral work at the country level;
- learn from country experiences, identifying barriers to progress and workable solutions; and
- identify ways to strengthen implementation, including how to improve the allocation of resources to maximize cost efficiency and build sustainable capacity.

3.2 Monitoring and evaluation of the outcomes and goals

The second set of M&E activities is designed to assess the effectiveness of GAP implementation efforts – to monitor the outcome of activities and evaluate their impact on, for example, AMR patterns, appropriate use and the burden of disease. It focuses on the outcomes and impact goals in the results chain and also comprises six components.

A. Monitoring GAP outcomes

Monitoring progress towards GAP outcomes at both the country and global levels occurs through a number of core indicators. A list of these indicators was developed as part of this GAP M&E framework and is detailed in section 4. The list is intended to enable comparison across countries, and includes a mix of indicators that:

- need to be compiled at the country level through primary AMR data collection systems, including GLASS, the OIE data collection initiative and the TrACSS; and
- are available at a global level from secondary sources (for example, the availability of safe water as measured for SDG reporting, or global estimates of immunization coverage as prepared by WHO and UNICEF).

The indicators focus on information that can both inform the global response and be collected without excessive cost. So, while improved public awareness and understanding are vital, the costs of tracking progress against this outcome in a meaningful way at the global level are considered disproportionately challenging at this stage. Measuring the appropriateness of prescribing is similarly difficult. Future revisions of the framework aim to capture these elements more effectively, as country and global activities progress. Countries will need to tailor their M&E plans and indicators to their own contexts and NAP priorities but should aim to reflect the set of core indicators as far as possible.

For more information on the list of core indicators and data sources, see section 4.

B. Monitoring patterns of antimicrobial consumption and resistance

A limited number of core indicators across human health, animal health, plant production and the environment can be used to measure trends in consumption and resistance.

Tracking consumption patterns is one of the most critical outcome measures of the M&E framework. All countries should develop systems that can track and report their total consumption of an antibiotic class and the species consuming it; it is important that a consistent approach be used to facilitate international comparisons and eventual benchmarking. This includes using the categories of the WHO Model List of Essential Medicines[6] (Access, Watch and Reserve groups) to track consumption in humans and the OIE List of Antimicrobial Agents of Veterinary Importance[7] to monitor use in animals.

Indicators for monitoring resistance were chosen based on their importance and the availability of data (see "Tracking levels of resistance across sectors").

Countries with limited data systems or capacity will need time and resources to report on the core resistance-level indicators with quality data that are both reliable and representative. In these cases, such tools as sample surveys, sentinel sites or point prevalence studies can help fill AMR data gaps.

In the short term, while systems are still developing, national M&E efforts will likely focus on monitoring their NAP implementation and outputs (for example, whether new policies have been approved and training has been conducted, or the extent to which infection prevention and control (IPC) measures have been put in place) rather

[6] March 2017 list, amended August 2017, available at https://www.who.int/medicines/publications/essentialmedicines/en/.
[7] May 2007 list, amended May 2018, available at http://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/A_OIE_List_antimicrobials_May2018.pdf

TRACKING LEVELS OF RESISTANCE ACROSS SECTORS

In human health, the choice of indicators to track resistance levels effectively translates to those that are included in GLASS. As countries develop their surveillance systems, the data on AMR in human health should become more representative of the community alongside hospital and other health care settings, and they should include a wider range of geographic and socioeconomic groups. In countries where surveillance systems are particularly weak, periodic point prevalence surveys of AMR may help assess trends in resistance levels in a more representative way.

In animal health, indicator choice is based on feasibility, given that national surveillance systems of resistance in this sector in many countries are considered to be less well developed. But as these systems develop, AMR data in animals (terrestrial and aquatic) are expected to become more comparable, detailed and species-specific, and indicators can be revised or added to in future framework revisions accordingly. For example, ATLASS will foster more standardized AMR surveillance systems, and the OIE standard on harmonization of national AMR surveillance and monitoring programmes (chapter 6.8 of the Terrestrial Animal Health Code) has been revised to include priority pathogens for major food producing animal species.

The critical One Health issue is transmission across the human, animal and environmental interfaces. This can be monitored by tracking the levels of resistance mechanisms, such as extended spectrum beta-lactamase (ESBL) in animals, the environment and human carriers, and those with ESBL-producing Escherichia coli infections (e.g. the Tricycle protocol).

than monitoring resistance levels themselves. The indicators listed are therefore sometimes proxy measures for true outcome measures.

C. Monitoring global investment to tackle AMR

Monitoring investment across countries is consistently challenging because so many of the activities to prevent and mitigate AMR are integrated with other programmes and do not have separate funds or budgets. Standard methodologies for costing plans and tracking investment should be developed.

At the national level, monitoring investment in AMR action and capacity should include asking whether funds are identified in the budget, available in a timely fashion and allocated to NAP priority activities. It should also include an assessment of how cost-effective the investment has been.

D. Assessing R&D outcomes and product availability and affordability

This assessment focuses on the extent to which new human, animal and plant health products (including diagnostics, vaccines and antimicrobials) are being, or have been, developed, and whether they are available and affordable to those that need them.

The evaluation component should assess how far the development and uptake of new products have been influenced by the GAP and related collaboration, market shaping and incentive mechanisms, and how well markets and the incentives are working.

E. Evaluating the impact on human and animal health and economic development

Measuring the GAP's impact on human and animal health (fewer infections and lower mortality) requires data for standard tracer conditions and modelling at the global level. The human burden of infectious diseases is modelled through the Global Burden of Disease estimates. Establishing the contribution of AMR to this burden and attributing change to the AMR response require further modelling. In countries where the WHO International Classification of Diseases (eleventh revision) is widely adopted, coders are encouraged to code AMR properly; estimates of the AMR burden in the human health sector may eventually be available through this route.

Further work is planned to build consensus on the standards for, and approaches to, modelling the burden of AMR alongside studies to improve the data available. More robust models are also required to assess the impact of AMR on health systems and economic development, particularly in LMICs. In addition, further analysis is needed to determine how feasible it would be to measure or model effects of changes in antimicrobial use (AMU) on animal health, welfare and productivity, and the economic impact of changing production practices in LMICs.

F. Evaluation to prioritize resources

This formative evaluation can identify best practices and highlight areas in which to prioritize resources for greater impact. Such an evaluation looks beyond the data to understand why change is or is not occurring, taking into consideration the country context, and to identify how to improve performance.

An independent assessment will take place within the first five years of the GAP implementation, concentrating on the lessons learned at the country, regional and global levels. It should inform revisions to the GAP. From the fifth year, an independent evaluation will assess the impact and value for money and identify opportunities to increase impact.

4. Indicators and data sources

Each component of the GAP M&E framework requires indicators that define what to measure, when and how. Choosing the right indicators for the framework's first iteration was challenging. Countries are at different stages of developing their systems to survey AMR and AMU and measure other results (such as access and quality of medicines and biosecurity in food production). Other challenges include:

- the broad range of infections, antimicrobials and types of resistance that exist across humans and different animal and plant species;
- the lack of knowledge on some aspects of AMR, making it difficult to know what to measure, for example to assess contributions of both the environment and the animal to human interface in the development and transmission of resistance;
- that outcome data for many indicators may not be representative, especially in the first few years; and
- the quality of data may be variable.

Given these constraints, the GAP M&E framework is designed, in the first instance, around a list of core indicators (both outputs and outcomes) for which data are more likely to be available and affordable (see Table 1). This proposed set of core indicators is based on extensive consultation. It considers the diverse levels of capacity and data availability across sectors and countries and seeks to minimize the burden on countries with few data available and weak systems for data collection. Countries are, however, encouraged to collect data over and above those outlined in these indicators, in accordance with national capacity and identified priorities.

The selection of core indicators was based on four key criteria:

1. **Relevance.** Core indicators measure an important component of the GAP response, globally or in many countries.
2. **Availability.** Most countries are expected to be able to report on the core indicators by the end of five years, if not before. In the meantime, while systems are under development, many countries will probably not be able to measure some outcome indicators, in which case they should aim to measure a recommended proxy indicator that can show progress towards the intended outcome. The proxy may be an output indicator or even a process indicator.
3. **Feasibility.** Collecting the information for core indicators should not be too difficult or expensive.
4. **Sensitivity.** Core indicators are sensitive to change over a two- to three-year reporting framework.

For each core indicator, countries will need to identify how to collect the relevant data, including any measurement methods and reporting arrangements they may need to create. Some data are already being collected through other initiatives, such as the SDGs. Others are not recorded anywhere and will need to be collected directly, mainly as part of the TrACSS. Some indicators may require new assessment methods (for example to establish how appropriately antibiotics are used compared to hospital guidelines). Others, such as health worker awareness, will rely on data collection tools that are still under development. There is no standard system for monitoring certain critical issues such as appropriate use, and more work is required to identify the tools or approaches that will be most useful in different contexts. However, where feasible, to encourage the consistency of data collection, methodologies for their collection together with detailed definitions of terminology are presented in the respective indicator reference sheet (see Annex 3).

A second list of additional standard indicators details further data that were too costly or complex to be included in the list of core indicators, but that countries may nevertheless find useful to collect, and that they will be asked to report on if the data are available (see Annex 3). This list also includes indicators that countries may wish to collect for their own management and monitoring, but that do not need to be tracked at the global level at this stage. Standard approaches are nevertheless encouraged as they are more likely to be valid and comparable.

Regional and subregional institutions can continue to support the monitoring of outcomes and collect results for regional analysis and review.

MONITORING APPROPRIATE USE AND ACCESS TO ANTIMICROBIALS

The list of core indicators identifies several measures related to the appropriate use of antimicrobials, as a means to monitor progress towards outcome 4. This is likely to require service quality studies in the private and public sectors, or reports on the supervision or audit of practices in health and food production. Some countries are mainly concerned with the overuse of antimicrobials, but it is also important to address access (the extent to which medicines are available and affordable to those who need them). WHO is developing standard surveys of availability and pricing and will continue to work with partners to share experience on how best to assess access and appropriate use.

Monitoring appropriate use of antimicrobials and access to medicines also poses a challenge to animal health and welfare. Assessing the role of antimicrobials in plant health and production and hence assessing appropriate use in plants still needs further research to inform indicator development. Environmental transmission is important, too, although more research is needed to identify what needs measuring before the right indicators can be identified. Across all areas of appropriate use and access, further work is needed to define what to measure and how, and to identify tools that are both robust and practical in LMICs. The Tripartite organizations are looking to partners to advance work in this area.

Table 1. List of recommended core outcome indicators

OVERARCHING GOAL: Reduced impact of infectious diseases on human and animal health			
	Measurement	**Indicator name**	**Source of data at the global level**
	I. Impact of infectious diseases	Burden of infectious disease in disability-adjusted life-years[a] per 100 000 population	Global burden of disease (key bacterial infections plus HIV, TB and malaria)
GOAL: Reduced levels and slower development of resistance			
	II. Patterns and trends in resistance in human health	Prevalence of bloodstream infections caused by the following: a: Methicillin-resistant *Staphylococcus aureus* b: ESBL in *E.coli* – third-generation cephalosporin resistance as a proxy	GLASS
	III. Patterns and trends in resistance for indicator *E.coli* from priority food producing species	Resistance in commensal *E.coli* from key food producing animals, as follows: a: Percentage of *E.coli* isolates showing resistance to third-generation cephalosporins (i.e. presumptive ESBL-producing *E.coli*) b: Patterns of resistance in *E.coli* to a defined panel of antimicrobials	FAO platform (to be confirmed)
	IV. Patterns and trends in resistance in HIV, TB and malaria	a: Percentage of new bacteriologically confirmed pulmonary TB cases associated with rifampicin-resistant or multidrug-resistant *Mycobacterium tuberculosis* b: Percentage of malaria patients displaying treatment failure after antimalarial treatment during surveillance in selected sentinel sites c: 1) Percentage of individuals tested positive for HIV starting antiretroviral therapy with detected HIV antiretroviral drug resistance (prevalence of pretreatment HIV drug resistance) 2) Percentage of individuals tested positive for HIV on antiretroviral therapy with virological failure and detected HIV antiretroviral drug resistance (prevalence of acquired HIV drug resistance)	Data collected through existing mechanisms

[a] Disability-adjusted life-years are a measure that combines deaths and disability due to a disease, giving an overall picture of the impact of each cause of disease/premature death. For further details and global and country estimates, see http://www.healthdata.org/gbd/about.

Outcome 1: Improved awareness of AMR and behaviour change among policy-makers, farmers, veterinary and health workers, food industry and the general public			
	1.1 Awareness of key groups	Percentage of stakeholders (e.g. human and animal health workers, prescribers, farmers, food processing workers) who have knowledge of AMR and the implications for AMU and infection prevention (metrics to be developed)	Methodology to be developed

Outcome 2: Strengthened knowledge and evidence base used for policy and practical decisions
See the "GOAL: Reduced levels and slower development of resistance" indicators at the beginning of this table.

Outcome 3: Reduced incidence of infection in health facilities, farms and communities as well as reduced environmental contamination, due to effective prevention			
	3.1 Quality of care	Incidence of surgical site infections – inpatient surgical procedures	National and hospital surveillance systems WHO Global Survey on Infection Prevention and Control and Hand Hygiene
	3.2 Immunization coverage	Percentage of the target population that has received the last recommended dose of the basic series for each of the following vaccines: i) pneumococcal conjugate vaccine ii) rotavirus vaccine iii) measles-containing vaccine, either alone, or in a measles–rubella or measles–mumps–rubella combination iv) *Haemophilus influenzae* type b containing vaccine (Hib)	Already being collected by WHO/UNICEF through established systems
	3.3 Access to safe water	Proportion of population using safely managed drinking-water services	SDG 6 indicator
	3.4 Access to sanitation	Proportion of population using safely managed sanitation services	SDG 6 indicator
	3.5 Environmental standards	a: Number of state parties to international multilateral environmental agreements on hazardous waste and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement b: Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment	SDG 12.4 indicator

Outcome 4: Optimized use of antimicrobials in human and animal health; phased out animal use for growth promotion			
	4.1 Use of antimicrobials in humans	a: Total human consumption of antibiotics for systemic use (Anatomical Therapeutic Chemical classification code J01) in Defined Daily Doses per 1000 population (or inhabitants) per day b: Proportion of Access antibiotics for systemic use, relative to total antibiotic consumption in Defined Daily Doses c: Relative proportion of AWaRe (Access, WAtch and REserve) antibiotics for paediatric formulations d: Percentage of adult and paediatric hospital patients receiving an antibiotic according to AWaRe categories	GLASS Cross-sectional point prevalence survey
	4.2 Access to antibiotics	Percentage of health facilities that have a core set of relevant antibiotics available and affordable on a sustainable basis	SDG indicator 3.b.3, with Access antibiotics disaggregated
	4.3 Appropriate use of antimicrobials	Percentage of inpatient surgical procedures with appropriate timing and duration of surgical antibiotic prophylaxis	Point prevalence surveys
	4.4 Use in growth promotion	Percentage of veterinary AMs authorized /used for non-veterinary medical use (e.g. for growth promotion).	TrACSS OIE AMU database
	4.5 Levels and trends in sales/imports/use of antimicrobials in food producing animals	a: Total volume of sales/imports (or use), in mg/kg biomass, in food producing animals b: Percentage of total sales/imports (or use) classified as WHO Highest Priority Critically Important Antimicrobial agents	OIE AMU database
	4.6 Levels and trends in sales/use of pesticides for the purpose of controlling bacterial or fungal disease in plant production	a: Total amount of pesticide (active substance) intended to repel, destroy or control bacterial or fungal disease (tonnes) b: Percentage of the above total composed of each of the following antimicrobial classes: aminoglycosides tetracyclines triazoles oxolinic acid	FAOSTAT (to be confirmed)
	4.7 Optimized AMU and regulation	Legislation or regulation that requires antimicrobials for human use to be dispensed only with a prescription from an authorized health worker	TrACSS

Outcome 5: Increased R&D on new medicines, diagnostics, vaccines and other interventions related to priority pathogens			
	5.1 Global R&D pipeline	a: Number of new medicines in the R&D pipeline targeting products on the WHO global priority pathogens list (antimicrobials and alternative treatments) b: Number of new diagnostic products in the R&D pipeline responding to the essential diagnostics list (forthcoming) c: Number of new Vaccines registered according to prioritisation (OIE reports on prioritisation of diseases for which vaccines could reduce antimicrobial use in pig, poultry and fish, 2015, and in cattle, sheep, and goats, 2018)	WHO Global Observatory on Health R&D WHO Global Observatory on Health R&D Health for Animals

Table 2. List of recommended core output indicators for each relevant outcome

Outputs for outcome 1: Improved awareness of AMR and behaviour change among policy-makers, farmers, veterinary and health workers, food industry and the general public			
	Measurement	**Indicator name**	**Source of data at the global level**
	1.a Targeted awareness raising	Nationwide, government-supported AMR awareness campaign targeting priority stakeholder groups in the following sectors: a: human health b: animal health c: plant health d: food production e: food safety f: environment	TrACSS
	1.b Strengthen veterinary services	a: Countries that in the last five years have had an OIE PVS Pathway activity (e.g. evaluation, gap analysis, follow-up legislation or laboratory mission) b: Number of PVS Pathway missions within the last year globally	OIE PVS Pathway

Outputs for outcome 2: Strengthened knowledge and evidence base used for policy and practical decisions			
	2.a Data on AMR and AMU in humans	Countries that report to GLASS on: a: AMR in humans b: AMU in humans	GLASS
	2.b Data on AMU in animals	Countries that report information on total quantities of antimicrobial agents sold for/ imported for/used in food producing animals	OIE AMU database
	2.c Data reporting on AMU in animals	Countries that regularly report data on AMU in animals to the OIE database, broken down by group of animal and administration route	OIE AMU database
	2.d Data on AMU in plants	Countries that have systems to collect and report information on the quantity of pesticides used to control bacteria or fungal diseases in plant production	TrACSS
	2.e Food and agriculture AMR laboratory network	a Percentage of laboratories included in the national AMR surveillance system in the food and agricultural sectors with capacity to perform antimicrobial susceptibility testing and/or bacterial isolation and identification according to international standards b: Robustness of the national AMR laboratory network included in the AMR surveillance system for the veterinary, food and agricultural sectors	ATLASS reports TrACSS
	2.f AMR surveillance data in animals and food	Countries that collect and report AMR surveillance data for: a: food producing animals (terrestrial and aquatic) b: food (of animal and plant origin)	TrACSS
	2.g Prevalence of ESBL-producing indicator *E.coli in animals*	Countries that measure the prevalence of ESBL-producing indicator commensal *E.coli* in key food producing species (terrestrial), in accordance with the OIE Terrestrial Animal Health Code and the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals (Terrestrial Manual)	TrACSS

	Measurement	Indicator name	Source of data at the global level
	2.h Use of AMR surveillance data	National bodies that review information from national AMR surveillance programmes, and make and implement recommendations accordingly	TrACSS
	2.i Authority and capability of veterinary services to manage AMU and AMR	Countries that achieve level III or more on PVS Critical Competency II-9 The authority and capability of the veterinary services to manage AMU and AMR, and to undertake surveillance and control of the development and spread of AMR pathogens in animal production and animal origin food products, via a One Health approach	OIE PVS Pathway

Outputs for outcome 3: Reduced incidence of infection in health facilities, farms and communities as well as reduced environmental contamination, due to effective prevention			
	3.a Regulation for antimicrobial waste	Countries that have a regulatory framework for the discharge of antimicrobials and waste potentially contaminated with antimicrobials into the environment	TrACSS
	3.b Access to strengthened veterinary services	Level of access to veterinary advice and care within a country (e.g. number of qualified veterinarians and/or veterinary paraprofessionals per animal population)	OIE PVS Pathway
	3.c Food safety standards	Countries that have adopted food safety standards consistent with the Codex Alimentarius	Survey on the use of Codex standards (to be confirmed)
	3.d Infection prevention at the national level	Countries that implement minimum requirements for infection prevention (e.g. husbandry and biosecurity) for food animal production, in accordance with OIE standards	OIE PVS Pathway
	3.e Hand hygiene in health care	Percentage of acute tertiary health care facilities monitoring the hand hygiene compliance of health workers according to the WHO direct observation method or similar	WHO Hand Hygiene Self-Assessment Framework, and the WHO Infection Prevention and Control Assessment Framework
	3.f Basic water services in health care facilities	Percentage of health care facilities where the main source of water is from an improved source, located on premises	WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene

	Measurement	Indicator name	Source of data at the global level
	3.g Basic sanitation services in health care facilities	Proportion of health care facilities with improved and usable sanitation facilities, with at least one toilet dedicated for staff, at least one sex-separated toilet with menstrual hygiene facilities and at least one toilet accessible for users with limited mobility	WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene
Outputs for outcome 4: Optimized use of antimicrobials in human and animal health; phased out animal use for growth promotion			
	4.a Regulatory framework for veterinary medicinal products	Countries that have a regulatory framework for veterinary medicinal products (including medicated feed) that covers all stages of the cycle (manufacture, supply, sale, use, disposal) and meets other requirements in the OIE and Codex standards	FAOLEX
	4.b Regulatory framework for non-medicinal AMs	Countries that have a regulatory framework for pesticides that considers all stages of the antimicrobial life cycle (production, supply, sale, use, disposal) and meets other requirements in the reference international standards	FAOLEX
	4.c Optimized use	Countries that have laws or regulations that prohibit the use of antibiotics for growth promotion in the absence of risk analysis.	TrACSS
Outputs for outcome 5: Increased R&D on new medicines, diagnostics, vaccines and other interventions related to priority pathogens			
	5.a Incentivizing R&D and increased access	Mechanisms and investments for R&D: list of mechanisms and funding for R&D to prevent, diagnose and treat priority pathogens (new medicines, diagnostics, vaccines, etc.)	Global AMR R&D Hub STAR-IDAZ International Research Consortium
	5.b Investment in R&D	Mechanisms and investments for R&D: list of mechanisms, commitments and expenditures for R&D targeting priority pathogens (new medicines, diagnostics, vaccines, etc.)	Global AMR R&D Hub STAR-IDAZ International Research Consortium

5. The view ahead

In practice, implementing the M&E framework, including designing country M&E plans and carrying out all the M&E activities across the results chain, relies on maintaining sufficient and sustainable interest and funds. In that regard, monitoring country progress is the top priority and all international support for in-country AMR responses should aim to align with the country M&E plan to avoid multiple, partial or overlapping assessments. That includes supporting the development of efficient approaches, such as building standard measurement tools, integrating monitoring into existing systems and surveys, and carrying out joint reviews.

Doing this will require investment; without resources it will not be possible to know the scale of the problem, where progress is being made and where course correction or an expansion in activity is required. Countries that can afford to invest in these systems must do so; low-income countries with very small health budgets will require external support.

Beyond investment requirements, the view ahead for the GAP M&E framework includes activities at the country and global levels to test the framework, implement it and refine it (see Fig. 3). Once countries start to routinely implement their M&E plans, they will need to analyse their data and performance to address gaps in the implementation of the

Fig. 3. Next steps for the GAP M&E framework: activities at the country and global levels to finalize, test, use and refine the framework

Source: FAO, OIE, WHO

NAPs, and refine their activities accordingly. At the global level, support will be provided to countries to strengthen their NAP's implementation based on the review and analysis of global data, and to help close gaps in data availability and quality. New indicators and measurement tools will also be developed based on the evidence gleaned from the country-level implementation of the M&E framework, analysis of the data and new knowledge.

5.1 Country-level next steps

Countries are encouraged to:

- **complete an implementation plan, including the monitoring framework:** (Tripartite guidance on this is forthcoming.) The plan should include a situation analysis, providing baseline information on key aspects of the plan. Routine monitoring should be focused on the areas where change is anticipated first and aligned to the implementation plan. Wherever possible, the plan should build on existing systems and programmes to minimize transaction costs and increase sustainability. Even in advance of finalizing their framework, countries should start to develop and review key indicators when possible; and
- **review the core indicators and consider how to collect data for them:** Most NAPs already include activities to strengthen AMR and AMU surveillance systems, which will provide some of the data required. Other data may need to be collected in other ways – for example, through surveys that assess service quality or farm practices. Some may be addressed by adding questions to existing surveys; others will require new surveys, or audits of clinical or food production practices.

5.2 Global-level next steps

The Tripartite organizations will continue working with countries and partners to:

- **test the list of core indicators in a sample of countries**, verifying detailed definitions for each indicator, exploring how data can best be collected and reviewing usefulness and validity;
- **further develop indicators and measurement tools**, which includes various activities from documenting and developing data collection tools for the existing core indicators to exploring new or alternative indicators and measurement tools (see "Beyond core indicators");
- **incorporate suitable environmental metrics** which, as an understanding of how to address and measure AMR in the environment improves, will need to be developed and integrated into the core indicator list and country efforts;
- **provide support and facilitate knowledge-sharing**, through global agencies and regional organizations that can help countries develop and implement their M&E plans by providing technical expertise and creating opportunities for documenting and sharing experience through, for example, a community of practice. Over time, such efforts can build up a database of best practices and useful supplementary indicators and approaches; and
- **build capacity for collecting data from various data systems and for analysing and using data** at the national and global levels.

BEYOND CORE INDICATORS

Further work is required to consider other indicators and measurement tools. This includes work to:

- enhance the links with SDG indicators, for example, by embedding AMR into the SDG indicators' meta data (work on this has already begun under the IACG);
- build consensus on whether to develop a standard, composite index across multiple bacteria and antimicrobials, as a summary measure of resistance levels;
- develop a global database for AMR data for the animal health and food production sectors;
- agree on modelling approaches to assess AMR's impact on mortality and morbidity, recognizing that data are not always available and that not all deaths of people with a resistant infection are caused by the resistance, and to assess impact on animal health and welfare as well as on food security and livelihoods;
- encourage partners to develop and test methods for elements of the GAP results chain that lack clear measurement tools, or where existing methods are too costly or impractical (for example, measuring the impact of behaviour change); and
- support efforts to understand transmission across the human, animal and environmental interfaces, which can be monitored by tracking the levels of resistance mechanisms, such as ESBL, in animals, the environment and human carriers, and those with E.coli infections (e.g. the Tricycle protocol).

Annex 1.
Summary of the results chain for the global action plan and the response to antimicrobial resistance

Table A1.1. Full result statements for the goals, outcomes and outputs in the GAP results chain

LEVEL	RESULT STATEMENT
GOALS	Overarching goal: Reduced impact of infectious diseases on human and animal health
	GAP goal: Continued ability to treat and prevent infectious diseases with effective and safe medicines
	Slower development of resistance (reduced emergence and spread of resistance or reduced levels)
OUTCOMES	1: Improved awareness of AMR and behaviour change among policy-makers, farmers, veterinary and health workers, food industry and the general public
	2: Strengthened knowledge and evidence base used for policy and practical decisions
	3: Reduced incidence of infection in health facilities, farms and communities as well as reduced environmental contamination, due to effective prevention
	4: Optimized use of antimicrobials in human and animal health; phased out animal use for growth promotion
	5: Increased R&D on new medicines, diagnostics, vaccines and other interventions related to priority pathogens
OUTPUTS	1.1 Campaigns to raise awareness and understanding of AMR risks and response in human health
	1.2 Campaigns to raise awareness and understanding of AMR risks and response in animal health, plant health, food production, food safety and the environment
	1.3 Training and professional education on AMR in the human health sector
	1.4 Training and professional education on AMR in the veterinary sector
	1.5 Training and professional education on AMR in farming (animal and plant), food production, food safety and the environment
	1.6 Strengthened veterinary services
	2.1 Monitoring system for consumption and appropriate use of antimicrobials in human health
	2.2 Monitoring system for AMU in animals (terrestrial, aquatic) and plant production
	2.3 National monitoring system for AMU[a] in plant production
	2.4 Surveillance system for AMR in humans
	2.5 Surveillance system for AMR in animals (terrestrial, aquatic), plants, food and the environment
	2.6 Research on resistance and improving AMU conducted and published
	3.1 IPC in human health care
	3.2 Good health, management and hygiene practices to prevent infections and reduce the use of antimicrobials in animal and plant production and AMR transmission in food production

[a] Includes antibiotic and antifungal agents.

	3.3 Scaled up water supplies, sanitation, hygiene and immunization to reduce the spread of infections in communities and health facilities
	4.1 Optimized AMU in human health
	4.2 Optimized AMU in animal health
	4.3 Optimized AMU in plant health
	4.4 Legislation and/or regulations to prevent contamination of the environment with antimicrobials
	5.1 Estimated funding needs and economic case for investment in AMR responses
	5.2 Coordinated efforts, with defined priorities and established mechanisms to incentivize relevant R&D
	5.3 Increased investment in R&D to address AMR and prevent infection

Annex 2.
Proposed additional standard antimicrobial resistance progress indicators

The indicators proposed are linked to the results chain and listed in consideration of the recommendations of the expert meeting and feedback from the public consultation. These indicators are considered important and useful, although their data can be challenging or relatively costly to collect or may only be relevant for some countries. To minimize the data collection burden on countries, these indicators are not included in the core list for global monitoring by all countries (Table 1). In cases where the data are available, however, countries will be asked to share them.

Table A2.1. Proposed additional standard antimicrobial resistance progress indicators

OVERARCHING GOAL: Reduced impact of infectious diseases on human and animal health			
Standard Indicator	**Indicator level**	**Possible national data sources**	**Global data collection**
Prevalence of bloodstream infections caused by a: Carbapenem resistance in Enterobacteriaceae – *E.coli, Klebsiella* b: *S. pneumoniae* resistant to penicillins	Goal	–	GLASS

Outcome 1: Improved awareness of AMR and behaviour change among policy-makers, farmers, veterinary and health workers, food industry and the general public			
Standard Indicator	**Indicator level**	**Possible national data sources**	**Global data collection**
Percentage of public who know use of antibiotics contributes to resistance	Outcome	Survey of public or campaign follow-up	_
Percentage of public who know it is inappropriate to use antibiotics for a common cold or viruses	Outcome	Survey of public or campaign follow-up	_

Outcome 2: Strengthened knowledge and evidence base used for policy and practical decisions			
Standard Indicator	**Indicator level**	**Possible national data sources**	**Global data collection**
Percentage of hospitals where AMR data are provided on a regular basis (at least annually) to local prescribing hospital-based physicians, at the regional or local level	Outcome	Survey of hospitals	_
Qualitative and quantitative data on the sorption and fixation of antimicrobial agents and the abundance of AMR bacteria in soils	Outcome	Survey of soils	Global Soil Information System and SoilSTAT

Outcome 3: Reduced incidence of infection in health facilities, farms and communities as well as reduced environmental contamination, due to effective prevention			
Standard Indicator	**Indicator level**	**Possible national data sources**	**Global data collection**
Percentage of acute health care facilities with an IPC programme in place that addresses the core components defined by WHO Global Guidelines 2016[a]	Output	Survey of health facilities, or routine reporting or supervision reports	WHO IPC Global Survey
Percentage of health facilities that measure incidence rates of bloodstream infections	Outcome	Hospital reports or quality survey	–
Percentage of target population covered by all vaccines included in their national programme: SDG indicator 3.b.1	Outcome	Administrative data or coverage surveys	Country reporting for SDG 3
Immunization coverage for a: Typhoid b: Influenza	Outcome	Immunization reporting	Joint Reporting Form (JRF) WHO/UNICEF
Countries that implement minimum requirements for infection prevention for plant health and production, in accordance with International Plant Protection Convention and FAO standards and guidelines	Output	–	–
Percentage of acute tertiary health care facilities with a functional built environment, materials and equipment to perform IPC	Outcome	Health facility assessments and other sources	National infection prevention and control programme

Outcome 4: Optimized use of antimicrobials in human and animal health; phased out animal use for growth promotion			
Standard Indicator	**Indicator level**	**Possible national data sources**	**Global data collection**
Percentage of prescribers in human medicine who are covered by the system for active feedback on the quality and/or quantity of their antibiotic prescribing	Outcome	Prescriptions review system report	–
Percentage of acute health care facilities with an antimicrobial stewardship programme in place	Outcome	Survey of health facilities, or routine reporting or supervision reports	–
Percentage of labs serving the national AMR surveillance sites covered by external quality assurance	Output	–	GLASS
Percentage of all primary care consultations in which an antibiotic is prescribed or dispensed	Output	Survey of health facilities, or routine reporting or supervision reports	–

[a] See http://www.who.int/gpsc/ipc-components/en/

Standard Indicator	Indicator level	Possible national data sources	Global data collection
Countries that have reviewed legislation and regulations within the last five years and have a plan to achieve effective regulation of the manufacture, distribution, supply and administration of antimicrobials	Output	Annual review of AMR NAP	TrACSS
Number of substandard and falsified medical antimicrobial products reported to the WHO Global Surveillance and Monitoring System	Outcome	Medicines regulation agency records	Reports received by WHO System
Countries that conduct regular and risk-based post-market surveillance on antimicrobials a: For humans b: For animals (terrestrial, aquatic)	Output	Annual review of AMR NAP	TrACSS
Stock-outs (non-availability) of specified antibiotics at the central warehouse, regional or district medical stores and distributors	Outcome	Stock reporting systems, private medical distributors	TrACSS

Outcome 5: Increased R&D on new medicines, diagnostics, vaccines and other interventions related to priority pathogens			
Standard Indicator	**Indicator level**	**Possible national data sources**	**Global data collection**
National estimates of investment needs and funding gaps to address AMR (in US$)	Output	Costing of NAPs on AMR	TrACSS
Implementation of AMR NAP: a: Extent to which planned activities were completed b: Percentage of the budget released by mid-year (or as planned by quarter) c: Percentage of planned budget spent	Output	Review of NAP implementation	TrACSS

Annex 3.
Reference sheets for the recommended core output and outcome indicators

Detailed technical reference sheets for the recommended core output and outcome indicators have been developed. They can be downloaded from the following webpage:

https://www.who.int/antimicrobial-resistance/global-action-plan/monitoring-evaluation/tripartite-framework/en/

World Health Organization

For more information contact:
World Health Organization
Antimicrobial Resistance Secretariat
Avenue Appia 20
1211 Geneva 27
Switzerland
E-mail: whoamrsecretariat@who.int
Web site: http://www.who.int/antimicrobial-resistance/en/

ISBN 978-92-4-151566-5