Meeting on Monitoring of Antimicrobial Resistance: Outcome and Goal Indicators

MEETING REPORT

16 August 2017

Background
On 8-9 June 2017, a group of technical experts from around the world came together to discuss indicators to monitor and evaluate country and global efforts to tackle antimicrobial resistance (AMR), as part of the Global Action Plan on AMR (GAP). The meeting was convened by WHO in collaboration with the World Organisation for Animal Health (OIE) and Food and Agriculture Organization of the United Nations (FAO), as the One Health Tripartite, and included experts from human health, animal health and agriculture backgrounds. The primary purpose of the meeting was to identify a set of performance indicators that can be used to track and communicate progress in achieving GAP goals at country and global levels. The intention was to focus indicator discussions on identifying outcome and goal measures, however the meeting ended up also emphasizing process and output measures, especially on the animal health side.

What follows below is a session-by-session meeting synopsis. For each session, a brief description of the session’s purpose is given, followed by presentation messages, discussion summary and resulting action points.

Session I: Meeting opening
WHO AMR leadership (Marc Sprenger and Hajime Inoue) opened the meeting by situating the event within the context of global momentum around AMR. Marc Sprenger shared highlights from the first annual global AMR country progress survey that focuses on process indicators, while Hajime Inoue spoke of the increasing importance of AMR on the global political agenda (G7/G20), and of the significance of the current meeting as its outcomes will feed into the AMR Inter-Agency Coordinating Group (IACG). Meeting chair, Marc Mendelson, closed the session with a brief overview of anticipated meeting process, goals and expected outcomes.

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1 See list of participants in Annex 1.
2 The “Tripartite” refers to the three One Health organizations that collaborate on AMR: WHO, FAO and OIE.
3 The results of the country self-assessment are available at https://extranet.who.int/sree/Reports?op=vs&path=%2FWHO_HQ_Reports/G45/PROD/EXT/amrcsat_Menu.
Session II: Proposed M&E approach: framework, outcomes and goals

**Purpose:**
To share proposed Tripartite M&E approach for GAP and AMR and to discuss proposed framework outcomes and goals.

**Presentation messages**
- The Tripartite M&E approach is based on considerable consultation within and beyond the tripartite organisations. Following the expert meeting, the proposed M&E approach will be revised and go to public consultation this summer.
- Outcome and goal measures need to be easily communicable for maximum impact.
- The tripartite will develop a minimum indicator data set that most countries should be able to collect within a five-year timeframe. Realistic, ambitious but not overly so.
- The GAP strategic objective 5 on research and development (R&D) and making the case for investment is not a focus of this meeting as 1) others are already addressing M&E in this area and 2) indicators are less difficult than for other objectives.

**Discussion summary**
- General outcome A is to slow the development of resistance (both emergence and spread). This may take time to achieve and could take years to be able to show that resistance levels are trending down. Be careful not to have unrealistic expectations.
- In some contexts slowing the development of resistance may not be ambitious enough: high resource countries can expect to reverse resistance levels over time in some scenarios, and therefore it would be realistic to set national targets on this basis. However, for other countries the existing and expected factors that are driving resistance are likely to increase AMR levels, so slowing emergence and spread would be a good start.
- We need to communicate the counterfactual of what would occur if we don’t act now, in order to help make the political case.
- Need to identify useful and feasible indicators. Aspiration should match pragmatism. Need to be careful not to disengage low resource countries by setting indicators that are too challenging.
- By organizing the discussions of potential indicators around the five strategic objectives (or at least four of them here), there is the risk of missing key outcomes and how indicators might influence the causal pathways to them. It is
therefore important to revisit whether the final set of indicators convergently covers key causal pathways for tackling AMR.

- While strategic objective 5 is not a focus of this meeting, it is important to make the economic case for investment in AMR explicit. It is important also to track product development on the animal side as well as for human health.

- While M&E for resistance in HIV, TB and malaria are not being explicitly included in the discussion on indicators, because there are already indicators and systems for data collection in place, WHO has an important role in learning from the experience of these disease programmes (and is actively currently doing so). In future it is important to coordinate and look for common platforms across antibiotics, HIV, TB and malaria, for example, to strengthen capacity for genetic sequencing.

- Make sure we are capturing the quality of medicines in both human and animal use under “appropriate/optimized use”. Quality needs to be explicit, and should include consideration of counterfeit medicines.

- Important to also monitor unintended consequences (e.g. morbidity associated with infectious diseases due to inappropriate restrictions on antibiotic access).

- While it is important that most countries can report on agreed upon indicators, it should not be required that all countries report on all, depending on national disease situations; e.g. Norway may not report on *Salmonella typhi*, but it would still be a useful indicator at global level.

- Appropriate use: use of antibiotics is rising in low-income countries as access and incomes improve. It could be helpful to establish the appropriate level of use for a country, taking into account that there may be over-use among some parts of the population (or food production sectors) and under-use by others. One idea is development of an index like the Gini Coefficient to measure equity in access to high quality antibiotics across different groups.

*Action points*

- Ensure medicine quality is reflected in indicators and M&E approach paper.

- Develop a checklist of what concerns to avert (unintended consequences, disparate impact, etc.).

- Countries will be able to select from a “menu” of indicators, reflecting which are most relevant to their given setting; in addition, some indicators will be standard for global-level reporting.
Session III: Other ongoing M&E framework and indicator development efforts

**Purpose**
To familiarize participants with other M&E frameworks looking at AMR, and begin to consider how indicators might best be harmonized across frameworks.

**Presentation messages**
- The DPSIR\(^4\) framework (under publication review) was presented as a climate change framework that can be adapted to AMR.
- Indicators under discussion during the meeting were considered likely to be relevant for both the DPSIR framework and the proposed WHO/FAO/OIE M&E approach.

**Discussion summary**
- It is important to learn from previous unsuccessful efforts to monitor AMR, to increase chances that the current effort will be sustainable.
- There was some discussion on the robustness of country self-assessments and data reported on progress and results. Validation of country reporting to IHR is currently via Joint External Evaluation (JEE) process, which has an AMR section. However, this is voluntary – countries choose to have a JEE. In addition, as part of the Global Antimicrobial Resistance Surveillance System (GLASS), WHO is reviewing and validating AMR surveillance data with countries. Participants considered these approaches as well as the idea of an external party being contracted to independently validate country progress reporting.
- Civil society has a key role within countries in questioning reported data and building accountability. There are valuable ways in which other civil society efforts might re-analyze data, complement ongoing data, and lift up key issues not addressed by WHO, FAO and OIE’s monitoring.

**Action points**
- Should countries be required to refer to data sources alongside survey completion? Should there be an indicator of quality of data provided by country? Further work is needed to determine how to validate data provided by countries, without creating additional burdens for countries. One proposal was to add one page per country to the global monitoring survey where relevant documentation supporting country responses could be posted.

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\(^4\) Where “D” is for “driver” (human needs and activities that drive the use of antibiotics in the first place); “P” is for “pressure” (in this case, the selective pressure resulting from the use of antibiotics, that has both a quantitative and qualitative component); “S” is for “state” (the current level of resistance); “I” is for “impact” (the health, economic and societal impact of AMR) and “R” is for “response” (how the problem is addressed).
Session IV: Animal health, plant health and environment sectors: an overview of the issues

Purpose
To raise awareness of issues critical to the animal health, plant health, and environment sectors.

Presentation messages
- OIE’s database that monitors antibiotic use in animals has three possible reporting options for quantitative data, in addition to the basic template — aimed to collect relevant administrative information — allowing qualitative data to be reported when quantitative is not available, with the goal of engaging as many countries as possible and becoming more comprehensive over time.
- At the recent OIE General Session, OIE Member Countries requested OIE to put in place a monitoring mechanism for implementation of the OIE strategy on AMR, taking into account the Tripartite collaboration and the work on IACG, and the OIE is currently working on the development of indicators.
- Country level data is not yet published, but the plan is that it should be in future.
- OIE will have a 2nd Global Conference on AMR and Prudent Use of Antibiotics in 2018 – this is an opportunity to showcase improvements and ongoing work.
- Critical issues highlighted by FAO: overall lack of AMR data and insufficient AMU data with significant variation by country; challenges to developing evidence base include the wide potential scope, e.g. number of species/sectors — where to start and difficulty in prioritising limited resources due to lack of evidence to identify high risk sectors; and the need to consider harmonization of data.
- Multiple FAO data sources (FAOSTAT, EMPRES-1, ATLASS, FAOLEX) and non-FAO (IPPC, WB etc.): how might AMR M&E indicator collection build on these?
- Ideally indicators should be measurable and feasible, but also strategic from a technical perspective; given limitations on available data should initially focus on output indicators, but these should be temporary and build the datasets for outcome indicators for future monitoring; selected according to risk (e.g. initial focus on foodborne isolates) but also take into account needs for change in animal health and welfare, crop production and environment.

Discussion summary
- The OIE Performance of Veterinary Services (PVS) tool includes a competency to regulate veterinary medicines and biological including antimicrobials in order to
ensure their responsible and prudent use, and this might be improved upon. Work underway to improve links between PVS and JEE, and PVS assessors participate in some JEE missions.

- Which publicly accessible data sets are available in formats useable for analysis; are there potential issues around data protection, e.g. for use of background datasets?
- The urgency of making data available on the use of antibiotics critically important to human medicine, e.g., colistin, was highlighted. An alternative approach to sourcing such data—if the step up in transparency of voluntary country reports is not politically feasible—would be to ensure that trade data captures the flow of antibiotics destined for animal use in international commerce.
- Given the significant level of activity required in many countries to develop data collection programmes for animals, plants, and the environment, we should consider expansion of M&E to measurement of outputs, at least initially, in order to capture this progress

**Session V & VI: Develop recommendations of and agree upon indicators for specific outcomes 1-4**

**Purpose**
To propose and reach agreement on most promising specific outcome indicators.

**Discussion summary**
Group work discussions identified specific outcome indicators and related short term/proxy measures, which have been incorporated into the indicators proposed in the Tripartite M&E Approach paper, in the version for consultation (annex 3). The annex is copied here as Table 1.

Group discussion highlighted the following:
- It is vital to recognize context and the very different starting point of countries. Several countries are currently unable to report on outcome indicators (especially with regards to the animal and agriculture sectors) and will therefore instead need to begin by monitoring outputs over the short-term. Achieving and measuring outcomes in these settings will be longer-term goals. This will be made clearer in M&E approach that is being revised to include a menu of output indicators (for countries to select and tailor to country plans), short term proxy indicators (some of which will be used for standardized reporting by countries to
the global level) and longer-term outcome indicators (some of which might also be used for global reporting), that may take some time to develop.

- Explore incentive frameworks more carefully: how do they work, and what might be changed to incentivize behavior change (increased awareness, improved use)?
- There are many possible target groups that countries should keep in mind given their particular context (public, including children, practitioners, policy-makers etc.).
- How to better engage consumers and civil society? How to increase consumer pressure to bring about change? Capture examples of where has worked well.
- Could we create standard measures of “awareness” or “knowledge” across all sectors? More complicated on producer side, but possible on consumer?
- How to incentivize/require countries to distinguish between therapeutic use and growth promotion use in reporting use of antimicrobials in animal health?
- Monitoring vaccine availability and uptake could be a proxy for measuring effective infection prevention. What data is accessible on vaccine production, quality and use, and what other factors, e.g. economics, come into play? Does vaccine use necessarily correlate to reduction in antimicrobial use?
- Data is collected by residue monitoring programmes linked to export of animal and non-animal food products; is there value in accessing this data/ expanding these programmes further, bearing in mind associated costs?
- While data belong to Member Countries, it is important to encourage transparency of and access to data as much as possible, including publishing reports. Data transparency is, itself, an important measure of good practice.

**Action points**

- M&E approach should:
  - Make pathways from outputs to outcomes to goals more explicit: consider developing either a few examples or a menu of output-level indicators that clearly link to the outcome and goal level indicators that countries can consider when measuring NAP implementation.
  - Make explicit that this is a journey, countries may find themselves in different places depending on the topic and sector, and any movement forward (to the right along the framework) is progress
- Consider making link between survey and output indicators more explicit.
Session VII (part 1): Ongoing M&E indicator development efforts focused on GAP general outcomes

Purpose
To familiarize participants with other interesting M&E outcome indicator development efforts and begin to consider how indicators might best be harmonized across frameworks.

Presentation messages
- GLASS: in early implementation phase, targets 8 pathogens for now, 62 drug-bug combinations, sentinel or comprehensive data surveillance, moving to syndrome-based surveillance via introduction of sample-based surveillance. No genetic resistance data for the moment.
- ESGAP: Inventory of indicators linked to targets and incentives for antimicrobial stewardship at national level (AMS). Existence of AMS staffing standards could be a process indicator.
- CARA/CDDEP/DRI: monitor country progress and exert pressure in a positive way to ensure commitments are achieved. CDDEP dashboard indicators: data from an independent point of view – not reported by country governments, could complement Tripartite monitoring. The drug resistance index (DRI) aggregates bacterial resistance to multiple antibiotics, taking into account how much each antibiotic is used, to give a standard index per bacteria.
- WHO Tricycle project developed by AGISAR: protocol development and piloting over next 2-3 years on integrated simple surveillance of ESBL E. coli in humans, food chain (chicken) and environment.
- ECDC/EFSA/EMA outcome indicator development: at request of EC, defining indicators now, want to align with WHO. Considering on the animal side AM sales by km/body weight, total sales volume, % of E. coli fully susceptible to a group of antibiotics. With draft secondary indicators: sales of 3rd - and 4th generation cephalosporins, quinolones and polymixins.
- WHO medicines department: developing standard tools for monitoring antimicrobial consumption linked to the GLASS platform, use in hospitals and community, and availability and price of medicines: through data on sales and point prevalence surveys. SDG indicator on access to medicines has been agreed: methodology is still in development, likely to rely on facility surveys.

Discussion summary
- If CARA works with same indicators as Tripartite, and obtains different results, then this could stimulate discussion and increase accountability at country level.
The concern about using global medians as a benchmark to signal overuse or underuse was raised: for example, both India and the U.S. appear to have use levels above the global median, yet India likely has significant underuse of antibiotics in segments of its population. How would the approach be adapted in such countries that are above the global median?

Important to ensure that data source is evident and data is representative, and that sample size and computing/extrapolation are clear. Limitations need to be explicit where data is not representative.

OIE has data on which countries use colistin in animal health based on their report, but this information is not published by country name in the first report on AMU. Colistin is on IACG’s agenda; also GHSA is looking at how colistin is being used across sectors.

The use of trade data to track the flow of antibiotics, particularly of those drugs critically important to human medicine, between countries could help accelerate the transparency of country-level colistin use as reported in the voluntary data submitted to OIE. However, the World Customs Union would need to work on distinguishing human vs. veterinary use of these drugs in the UN COMTRADE dataset.

Suggestion to expand ESBL tricycle project to include vegetables and fruit.

Companion animals are getting insufficient attention (although their resistance profiles are generally thought to be similar to that of their owners). OIE is improving data collection in this area: its data collection format was recently expanded to cover companion animals so that these will be better captured in the 2nd round data collection.

**Action points**

- Keep measures harmonized to maximize impact and build accountability.

**Session VII (part 2) and session VIII: Identifying and discussion around general outcome indicators**

**Purpose**

To begin to reach agreement on general outcome indicators.

**Discussion summary**

Group work discussions led to identification of general outcome indicators which have been incorporated into the Tripartite M&E Approach paper, in annex 4 (general outcome indicators are copied below as Table 2). Group discussion highlighted the following:
General Outcome A – Slowing development of resistance

- Include timeline(s) for indicators: short/long term,
- One option might be to monitor one or more priority pathogens across sectors? E.g. E. coli and/or salmonella. Identify three main food borne pathogens and top commodities? However, the difficulty lies in identifying one pathogen that works well across all sectors. For example, Shigella is not appropriate for any sector beyond human health, and E. coli is not appropriate for aquaculture.
- Important to balance doing this extremely well, and need to generate quick results to keep political momentum. Need for measures of progress (even if only input, process and output indicators) that can report on and show progress in 2018; the next country progress survey could include some of these measures. Make sure the framework responds both to short -term needs (communication of progress to UNGA) and to the medium to long-term ones (performance measurement of GAP implementation).
- GLASS is working on development of the Emerging Resistance Reporting framework, which seeks to capture emergence of new forms of resistance better than currently. Emergence of AMR needs to be tracked, and the capacity to detect, verify and report emerging resistance can be a process indicator.
- Find ways to link AMR concerns with the global security narrative, as concerns about global health security drives funding in global health right now.

General Outcome B – appropriate use with access when needed

- Setting a use target, while highly controversial, can motivate action. Collect data on use and evolve towards country targets for appropriate use. The use target must be based on data sufficiently local and representative to be relevant. The sampling bias of a surveillance network that, say, captures high-end users of antibiotics and perhaps high drug resistance levels might suggest a use target not appropriate to a better designed sample, where the findings of first-line drug use, resistance, and the need for shifting to second-line antibiotics might differ.
- Consider defining a short-list of priority countries that are considered representative for global impact and report for these.
- The impact of antimicrobial use in humans, animals and plants on the environment remains a huge gap; the environment also represents a potentially

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5 A conversation with James Wood after the meeting indicated that there are risks to focusing on specific pathogen(s), rather than on the prevalence of resistant genes, given transmission of resistance between pathogens. This implies monitoring of commensal E. coli – and could go further and use whole genome sequencing.
big reservoir for transmission. Indicator might be that in 2-5 years we have a standard protocol and/or system in place for monitoring in this sector.

- The Drug Resistance Index requires further evaluation to assess how it might be constructed such that the composite measure would not mask important underlying trends. Further work could also explore whether an aggregate index is preferable to a way of visualizing the component measure.
- Building on the WHO-HAI Medicine Prices project, an affordability index might be developed to capture this important dimension of access. It is important not to conflate low prices with overuse, nor to see high prices as a mean of ensuring rational use.
- Indicator around antibiotics ‘lost’ – e.g. that are no longer produced.
- Is it possible to get an estimate of black market antibiotics by comparing total global production and that tracked through legitimate sales?

**Action points**
- Table 3 highlights issues for possible research and/or requiring further work to develop or refine indicators.

**Session IX: Discussion and views on measuring the GAP goal and overarching goal**

**Purpose**
To share information on current modelling efforts, gather views on how best to assess overall health impact (human and animal) and AMR GAP impact.

**Presentation messages**
- IHME’s burden of disease project tackles both proposed goals, primarily though estimates of premature mortality. The data is linked to Geospatial mapping.
- WHO’s collaborating center (SH) is just beginning a workstream that is collecting an inventory of current evidence on impact and burden of AMR on human and animal health, and will assist WHO with planning and implementation of generic surveillance protocols to assess impact of AMR.
- CDDEP is working on trying to determine the attributable deaths due to sepsis in newborns. Also looking at impact of vaccines and resistance and burden among the elderly in the United States/Europe.

**Discussion summary**
- Ideally quantify resistance impact on morbidity as well as on mortality.
- Few studies quantify how much more likely someone is to die from a resistant infection vs. not resistant – need more studies on attributable mortality.
Example - Champs study on causes of mortality in babies and still births identified multi drug resistant infections but not whether they caused mortality.

- IHME is starting to study possible reductions in HAI infections due to good infection prevention and control and stewardship.

**Action points**

- Consider how to build consistency across different approaches to modelling impact of AMR.
- Further work on developing simple monitoring methods for lower capacity settings, including for surveillance of health care associated infections (including surgical site infections).

**Conclusions and next steps**

The meeting closed around agreement on the following next steps:

1. WHO/FAO/OIE will revise the approach paper, taking into account the indicators identified during the workshop. Given the current reality in many settings, process and output indicators will be elaborated for animal health, plant health and human health sectors to provide an initial ‘menu’ of indicators, recognising that it will take time to establish reliable measurement of outcomes and goals.

2. Once revised, the approach paper will be circulated to all participants for review, and posted online for public consultation.

3. The timeline we are aiming for is: revisions to paper completed by end-July. Public consultation August to end September. M&E tripartite approach finalized during fall 2017.

4. Continued engagement of the group would be welcome, through informal discussion and teleconferences.
**Annex I: List of Participants**

**Meeting on Monitoring of antimicrobial resistance (AMR): outcome and goal indicators**  
8-9 June, 2017  
*Room M505, World Health Organization, Geneva*

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization/Institution</th>
<th>Country</th>
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<tbody>
<tr>
<td>Enis Baris</td>
<td>World Bank</td>
<td>United States of America</td>
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<td>Eduardo Hage Carmo</td>
<td>Unión de Naciones Suramericanas (UNASUR)</td>
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<td>Joseph Domenech</td>
<td>STAG-AMR member</td>
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<td>Centre for Disease Control</td>
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Marc Sprenger
Liz Tayler
Veronica Walford
Table 1: Proposed Indicators for Specific Outcomes (incorporating recommendations from the meeting)

Proposed indicators suggested here for specific outcomes 1 to 5 (corresponding to GAP strategic objectives 1 to 5) are linked to the results framework and recommendations of the expert meeting. The indicators can be used at national level and could also be collated at global level. The list is longer than desirable, and the tripartite intends to reduce the number of indicators under each specific outcome following the consultation.

Short term or proxy indicators have been proposed recognising that many countries will not be able to measure progress on outcomes in the short term, either because there are not yet systems for data collection and/or because there will be little progress to measure in that timeline. The short term or proxy indicators are intended to show whether there is progress towards measuring and achieving the outcomes. The intention is that the majority of countries should be able to report their progress on these within the next five years, including to regional and global levels.

Outcome indicators should be collected and reported when possible and available. Those countries that have the capacity to do so are expected to monitor outcomes. It is recognised that some countries will take years to build up systems for collecting and analysing representative data and to make progress on achieving the outcomes; however, it is envisaged that the majority of countries will be able to collect and report outcome data within the next 10 years.

Blue shading denotes indicators specific to animal, plant production and environment sectors. No shading (white background) includes indicators for human health and in some cases, indicators that are relevant across sectors.

<table>
<thead>
<tr>
<th>Specific outcome</th>
<th>Short term/proxy indicators for outcomes (most countries should be able to report within 5 years)</th>
<th>Outcome indicators (some are already collected; expect most countries to be able to report within 10 years).</th>
</tr>
</thead>
</table>
| 1. Improved awareness of AMR & behaviour change among policy makers, farmers, veterinary and human health workers, food industry and the general public. | 1.1: Government-supported antimicrobial awareness campaign(s) undertaken, by target group.  
1.2: Country has a One Health AMR communications strategy in place.  
1.3: Tailored national communications materials aimed at farmers / veterinarians / agricultural workers easily available in official language.  
1.4: % of health education institutions that have incorporated AMR educational modules in their core curricula /in Day 1 competencies.  
1.5: Number of conferences and/or education sessions (trainings) on AMR/year given to target actors (farmers / veterinarians / agricultural workers and/or number of target actors trained/year.  
1.6: Veterinary and/or animal health worker governing body exists within country. | Awareness levels on AMR, understanding/attitudes and behaviours by target group.  
Suggested:  
1.9: % of public who know use of antibiotics causes resistance.  
1.10: % who know inappropriate to use antibiotics for common cold or viruses.  
1.11: % of actors (e.g. policy-makers, veterinarians, animal health workers, farmers, food processing workers) that have knowledge (TBD) about AMR.  
1.12: Knowledge and attitudes of health workers on AMR and implications for antimicrobial use and infection prevention (detailed questions TBD).  
Trends in behaviour for target groups:  
General population  
1.13: % of antibiotic use in community based on a prescription.  
1.14: Use of left over antibiotics (in community).  
1.15: Use of antibiotics for a cold or flu.  
Behaviour of farmers, veterinarians, other animal health workers:  
1.16: % of veterinary/plant antimicrobial sales that are critically important |
### Specific outcome

<table>
<thead>
<tr>
<th>Short term/proxy indicators for outcomes</th>
<th>Outcome indicators</th>
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<tbody>
<tr>
<td><strong>Specific training on AMR included in veterinary and animal health/veterinary paraprofessional training.</strong></td>
<td><strong>Outcome indicators</strong> (some are already collected; expect most countries to be able to report within 10 years.</td>
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<tr>
<td><strong>1.8:</strong> Whether country has in the last 5 years had a) Performance of Veterinary Services (PVS) evaluation b) PVS gap analysis c) PVS follow up d) another systematic process to evaluate and strengthen vet services.</td>
<td>antimicrobials ⁶.</td>
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<td><strong>1.7:</strong> Specific training on AMR included in veterinary and animal health/veterinary paraprofessional training.</td>
<td><strong>1.17:</strong> % of veterinary AMs authorised/used ⁷ for non-therapeutic purposes (e.g. for growth promotion).</td>
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<tr>
<td><strong>1.6:</strong> Whether country has in the last 5 years had a) Performance of Veterinary Services (PVS) evaluation b) PVS gap analysis c) PVS follow up d) another systematic process to evaluate and strengthen vet services.</td>
<td><strong>1.18:</strong> AMs sold/used in plant production.</td>
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### 2. Strengthened knowledge and evidence base is used for policy and practice decisions.

| 2.1: Country collects national data on total sales or consumption of antibiotics for human use. | 2.15: Country regularly reports AM use data in animals (sales or supply or actual use), broken down by species, sector and administration route, to OIE database. |
| 2.2: Country has a system for active feedback to prescribers on their prescribing. | 2.16: Country regularly reports use data in non-human/animal health sectors, e.g. plant production. |
| 2.3: Number/proportion of production sectors collecting data on veterinary/plant AM sales/use. | 2.17: Number of sectors that have amended food production management practices to minimize development or transmission of AMR. |
| 2.4: Country makes data on antimicrobial sales or use in animals available to national stakeholders. | 2.18: Evidence that relevant body has reviewed surveillance data and adjusted recommendations (e.g. essential medicines list, treatment guidelines and/or |

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⁷ These would measure changes in behaviour for different groups: the regulators (what is authorised), professionals (prescription practices), and farmers (actual use).
<table>
<thead>
<tr>
<th>Specific outcome</th>
<th>Short term/proxy indicators for outcomes (most countries should be able to report within 5 years)</th>
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</thead>
<tbody>
<tr>
<td>2.5</td>
<td>Country reports data on antimicrobial sales or use in animals to OIE database.</td>
<td>prevention guidelines), in light of AMR data.</td>
</tr>
<tr>
<td>2.6</td>
<td>National reference laboratory for AMR surveillance in human health designated and participating in an external quality assurance scheme [GLASS indicator].</td>
<td>2.19: % of hospitals where AMR data is provided on regular basis to local prescribing hospital based physicians on regional or local level.</td>
</tr>
<tr>
<td>2.7</td>
<td>National AMR surveillance programme organizes and runs external quality assurance for all laboratories participating in GLASS, for bacterial identification and antimicrobial susceptibility testing [GLASS indicator].</td>
<td>2.20: National body in charge of national strategy to contain AMR receives information on AMR rates and progress of implementation of surveillance systems at least once per year and discusses implications for national strategy.</td>
</tr>
<tr>
<td>2.8</td>
<td>Country has veterinary public health lab network with capacity to conduct standardized, repeatable, antimicrobial susceptibility testing for key isolates (veterinary/food borne pathogens and commensals) based on recognised international standards.</td>
<td>2.21: Country has reviewed existing legislation and developed a framework for revision of legislation to achieve effective system of regulation of manufacture, distribution, supply and administration of medical and non-medical AMs.</td>
</tr>
<tr>
<td>2.9</td>
<td>Country has national (or access to regional) reference laboratory for veterinary public health.</td>
<td>2.22: Animal health, plant health and human health have integrated surveillance systems.</td>
</tr>
<tr>
<td>2.10</td>
<td>Country has implemented a national system of surveillance for one or more key isolates from animals/plants/ environment.</td>
<td>2.23: Integrated analysis and reporting of AMR within country.</td>
</tr>
<tr>
<td>2.11</td>
<td>Country collects non-human health AMR surveillance data including prevalence of ESBL commensal E.coli in healthy animals in 2 key food producing species.</td>
<td></td>
</tr>
<tr>
<td>2.12</td>
<td>Country has published and reported AMR surveillance data.</td>
<td></td>
</tr>
<tr>
<td>2.13</td>
<td>Country has database for collection and reporting of resistance data on non-human-health isolates.</td>
<td></td>
</tr>
<tr>
<td>2.14</td>
<td>Availability of antimicrobial susceptibility tests in plant and animal health, e.g. tests available for specified pathogen and animal species for specific presentation and class of antimicrobial.</td>
<td></td>
</tr>
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</table>
| **3. Effective prevention reduces infection incidence in health facilities, farms & communities, and reduces environmental contamination.** | 3.1: National Infection prevention and control (IPC) program is in place.  
3.2: % of acute health care facilities with IPC program in place.  
3.3: % of health facilities with at least basic water supply*.  
3.4: % of health facilities with at least basic sanitation*.
3.5: % of health facilities with at least basic hand hygiene*.  
3.6: % of health facilities with a functional built environment (including water and sanitation), and necessary materials and equipment to perform IPC, as per national standards.  
3.7: Number of infection control programmes OR % of diseases (in key food producing animal species) that are covered by an infection control programme.  
3.8: Number of sectors within country with guidance available on good agricultural practices in official or local language.  
3.9: Level of access to veterinary advice and care within country (e.g. number of qualified vets to animal population).  
3.10: Country legislates minimum standards of husbandry/ housing/ biosecurity for food animal production, e.g. in accordance with OIE and Codex standards and guidelines.  
3.11 Country legislates regulation of production/access to medicated feed.  
3.12: Country has adopted and is compliant with OIE and Codex standards and guidelines on infection prevention/food safety. | 3.16: % of health facilities monitoring hand hygiene compliance of health workers according to the WHO direct observation method or similar method.  
3.17: Surgical site infection incidence rate1 including % resistant (in accordance with GLASS) when feasible.  
3.18: Rate of readmissions due to surgical site infection.  
3.19: Bloodstream Infections per 1000 patient days (inpatients, admitted >48 hrs).  
3.20: Rate of neonatal sepsis including % of those caused by resistant bacteria (in accordance with GLASS) or new-borns with suspected severe bacterial infection who receive appropriate antibiotic therapy.  
3.21: *Clostridium difficile* incidence in hospitals and community.  
3.22: % of commercial farms that have implemented a biosecurity programme.  
3.23: % of farms surveyed compliant with standards of responsible and prudent antimicrobial use in animals, including good husbandry and hygiene practices.  
3.24: % of population using safely managed drinking water services (SDG6 indicator).  
3.25: % of population using safely managed sanitation services, including a hand-washing facility with soap and water (SDG6 indicator).  
3.26: Coverage with pneumococcal conjugate vaccine (3 doses), rotavirus, measles and Hib vaccines.  
3.27: % of children with full immunisation coverage according to national immunization guidelines.  
3.28: Level of vaccine coverage within animal populations nationally for priority diseases. |
<table>
<thead>
<tr>
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<tr>
<td>3.13</td>
<td>Country includes relevant vaccines in their human immunisation program: Hib, pneumococcal conjugate vaccine, rotavirus, measles, flu.</td>
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</tr>
<tr>
<td>3.14</td>
<td>Country has determined priority animal diseases(^8) for which vaccination would reduce the use of antimicrobials.</td>
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<tr>
<td>3.15</td>
<td>Proportion of these priority animal diseases for which vaccine is available in country.</td>
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</table>

4. Optimized use of antimicrobials in human and animal health; animal use for growth promotion phased out.

| 4.1 | Country has AM guidelines and regulates the prescription and sale of AMs for human use. | 4.17: % of prescriptions that are supported by a clinical diagnosis. |
| 4.2 | Country has a national target for AM use per capita in human health. | 4.18: % of empirical prescribing of antibiotics in line with guidelines or hospital prescribing policy. |
| 4.3 | Country has targets for antibiotic prescribing, with systems or incentives to encourage appropriate behaviours. | 4.19: Watch and Reserve antibiotic use compared to Access antibiotics or ratio of sales of Watch to Reserve antibiotics. |
| 4.4 | Country has access/watch/reserve AM categories in national guidelines or essential medicine list for human health care. | 4.20: National prescribing guidelines updated to reflect local and epidemiological antimicrobial susceptibility data (for human and animal health). |
| 4.5 | Country conducts aftermarket quality assurance testing on AMs on sale. | 4.21: Compliance with surgical prophylaxis guidelines. |
| 4.6 | Country has regulatory framework for veterinary medicines in accordance with OIE terrestrial and aquatic codes and CODEX texts on food borne AMR. | 4.22: % of Sexually Transmitted Infection prescriptions in line with guidelines. |
| 4.7 | Country has publicly accessible list of all AM products authorised for national use. | 4.23: % of diarrhoea treatment in line with guidelines. |
| 4.8 | Country regulates use of antimicrobials in plant production. | 4.24: % of drugs available that are licensed for sale in country. |
| 4.9 | Country does not permit use of medically important antimicrobials for growth promotion. | 4.25: Risk based testing of drug quality/presence of a quality process for AMs (to be further defined). |
| 4.10 | Country has recommendations to restrict use of specific antimicrobial classes listed as Critically Important for humans and animals. | 4.26: % of tracer antibiotics with enough active ingredient. |
| 4.11 | Country has national or regional level veterinary prescribing guidelines in official language available for priority food producing species. | 4.27: % of antimicrobials in local market that are unauthorized and sub-standard antimicrobials. |

\(^{8}\) i.e. diseases with greatest impact on animal health and production in key food producing species that are relevant regarding the use of antimicrobials in animals.
<table>
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<tr>
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<td>species, being used and regularly updated.</td>
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<tr>
<td><strong>4.12</strong></td>
<td>Country instigates programme of AM residue testing in animal and non-animal origin foodstuffs.</td>
<td></td>
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<tr>
<td><strong>4.13</strong></td>
<td>Country implements regulatory measures on residues based on Codex standards and guidelines.</td>
<td></td>
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<tr>
<td><strong>4.14</strong></td>
<td>Maximum residue levels (MRLs) are recognized; withdrawal periods are required to be based on these MRLs.</td>
<td></td>
</tr>
<tr>
<td><strong>4.15</strong></td>
<td>Authorised withdrawal periods are legally required to be displayed on antimicrobial packaging.</td>
<td></td>
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<tr>
<td><strong>4.16</strong></td>
<td>Country has regulations for discharge of antimicrobials into the environment.</td>
<td></td>
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<tr>
<td><strong>4.31</strong></td>
<td>% of AM use in animals based on prescriptions with veterinary oversight.</td>
<td></td>
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<tr>
<td><strong>4.32</strong></td>
<td>Antimicrobial susceptibility testing is being done appropriately/when needed.</td>
<td></td>
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<tr>
<td><strong>4.33</strong></td>
<td>Proportion of wastewater safely treated (SDG6 indicator).</td>
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<tr>
<td><strong>4.34</strong></td>
<td>Availability of antibiotics in veterinary outlets in public and private sectors, compared with treatment guidelines.</td>
<td></td>
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</tbody>
</table>

**5. Increased R&D on new medicines, diagnostics, vaccines & other interventions related to priority pathogens.**

| **5.1**         | National estimates available of investment needs and funding gaps.                             |                                                                                                     |
| **5.2**         | Proportion of NAP activities and budget implemented.                                             |                                                                                                     |
| **5.3**         | New mechanisms in place to incentivise R&D (e.g. prizes, advance market commitments, pilots for delinking costs of product development from sales income). |                                                                                                     |
| **5.4**         | Mechanisms in place to facilitate equitable access to existing and new products.                |                                                                                                     |
| **5.5**         | Global Framework for Development and Stewardship to combat AMR agreed.                          |                                                                                                     |
| **5.6**         | Commitments and expenditure on R&D for priority pathogens (new products, new drug combinations, diagnostics, vaccines, etc.). |                                                                                                     |
| **5.7**         | Level of funding raised for the Global Antibiotic Research and Development Facility.             |                                                                                                     |
| **5.8**         | Global R&D pipeline: Numbers and targeted infections of antimicrobial medicines, alternative treatments, vaccines and diagnostics in the R&D pipeline (assessed against baseline and research priorities). |                                                                                                     |

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Table 2: Proposed General Outcome Indicators (incorporating recommendations from the meeting)

This table identifies proposed standard (core) indicators related to the general outcomes and goals defined in the results framework. The indicators are shown for the global level; most will rely on reporting from countries to compile the results. In the short term, some countries will not have data available for all the indicators, therefore proxy measures will be used. As country monitoring and surveillance systems develop, the number of countries able to provide data on outcomes will increase.

Blue shading denotes indicators specific to the animal, plant production and environment sectors.

<table>
<thead>
<tr>
<th>Result level</th>
<th>Proposed indicators: Global level</th>
</tr>
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</table>
| General outcome A: slower development of resistance. | Patterns and trends in resistance in human health in the following, analysed by region; for large population countries; for countries which have data available:  
A.1: Carbapenem resistant enterobacteriaceae  
A.2: Methicillin-resistant *Staphylococcus aureus* (MRSA)  
A.3: Extended spectrum beta lactamase (ESBL) in *E. coli*  
A.4: Gonococcal resistance  
A.5: Quinolone resistant enterobacteriaceae in community  
A.6: *Salmonella* and *Shigella*  
A.7: *Pneumococcus*  
Metrics - eventually as defined by GLASS: rates, syndrome based approach, potentially aggregated in an index. Separate for community and hospital.  
A.8: % of *E.coli* susceptible to a panel of antimicrobials.  
A.9: Rate of ESBL producing *E coli* in people, animals and environment. |
| | Patterns and trends in resistance in animal production sectors  
Short term (available in most countries within 5 years)  
A.10: Proportion of countries collecting/monitoring ESBL producing commensal *E. coli* (in healthy animals\(^\text{10}\) at slaughter) in priority food producing species.  
A.11: Actual prevalence levels of ESBL in commensal *E. coli* from food producing animal species, as determined from national data.  
A.12: Number of countries collecting antimicrobial sensitivity test data on at least one bacterial species for aquaculture.  
Longer term (available in most countries within 10 years)  
A.13: Change in resistance rates for ESBL/multidrug-resistant commensal *E. coli* (to a defined list of AMs) from priority food producing species.  
A.14: Number of countries monitoring ESBL commensal *E. coli* in major food commodities of non-animal origin. |

\(^{10}\) Countries provide relevant data for their priority food producing species (e.g. prioritization based on production levels)
<table>
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<th>Result level</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>General outcome</strong></td>
<td><strong>Proposed indicators: Global level</strong></td>
</tr>
</tbody>
</table>
| B: more appropriate use of antimicrobials (with access when needed) and less inappropriate use | B.1: Level and trends in human consumption of access, watch and reserve antimicrobials, and the ratio between these, analysed by region and for countries with highly inequitable access.  
B.2: Number of countries achieving national targets for antimicrobial consumption/use (and number above global target if one is set).  
B.3: Equity index of access by country (like a Gini coefficient, to be defined).  
B.4: Access to AMs when needed: Proportion of health facilities that have a core set of relevant essential medicines available and affordable on a sustainable basis. (SDG indicator 3.b.3, with Access antibiotics disaggregated).  
B.5: Affordability of key products – e.g. number of countries with price of a course of a specific, generic second line antibiotic is more than 7 days’ wages.  
B.6: Global shortages of specific classes of antimicrobials as shown by UNICEF inability to procure. |
| **Short term (within 5 years)** | B.7: % or number of countries with specific legislation on use of medically important antimicrobials for growth promotion in food producing animals.  
B.8: % or number of countries that measure sales/use of medically important antimicrobials for growth promotion in food producing animals.  
B.9: Trends in use of medically important antimicrobials used for growth promotion in food producing species, weighted by biomass of species (mg/kg).  
**Longer term (available in most countries within 10 years)** | B.10: Reduction in volume of sales/use of medically important antimicrobials in food producing species weighted by biomass of species (mg/kg), focusing on a reduction in the proportion classified as the highest priority Critically Important Antimicrobials.  
B.11: Number of countries that have systems to collect information on antimicrobial use in plant production.  
B.12: Number of countries that regulate which antimicrobials can be used in plant production. |

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11 See footnote Error! Bookmark not defined.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Indicators requiring further work</th>
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</table>
| AMR Surveillance related (link to GLASS)         | How to define, detect and measure transmission.  

Whether to use or improve on the Drug Resistance Index (DRI) as a standard global indicator, including whether to calculate a separate index for hospital and community settings.                                                                                                                                                                                                                                                                                                                                                           |
| Appropriate use and access related               | Identify feasible ways to measure access and appropriate use of antibiotics e.g. for ARI or fever in children, separately in community and hospital settings.  

Measuring equity of access to antimicrobial medicines with something like the Gini coefficient.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Medicines market and drug quality related        | Standard indicators and methods for measuring quality of medicines in the market and/or availability of unauthorised and sub-standard antimicrobials in the local market  

Global indicator of drug quality  

Estimating the scale of the global market in antibiotics (and hence the black market).  

How to assess 'lost antibiotics' – i.e. antibiotics that are no longer produced (often cheaper options).                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Education and training to improve professional practices (medical, pharmacy and veterinary) | Specify education and training outcome measures e.g. standard measures of knowledge on AMR; competency and capability; behaviour change/practices.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| IPC in human health                               | Developing simple methods for lower capacity settings for monitoring levels of health care associated infections (including Clostridium Difficile) and surgical site infections.  

Assuring sound quality of data reported on hand hygiene compliance (since hand hygiene figures are often overstated).                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |