Report of the Meeting of the WOAH Working Group on Antimicrobial Resistance

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Founded as OIE

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1. Welcome and opening of meeting

The Working Group on Antimicrobial Resistance (AMR) (hereafter referred to as 'the Group') met between 4–6 October 2022 at the World Organisation for Animal Health (WOAH, founded as OIE) Headquarters in Paris, France.

Dr Javier Yugueros-Marcos, Head of the Antimicrobial Resistance and Veterinary Products (AMR&VP) Department, welcomed the Group members, thanked them for their participation in the Group meeting and congratulated them for their hard work. He informed the Group that, in the context of the Quadripartite alliance for AMR, all partners (World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP)) will be contacted to appoint or confirm observer representatives to this Group. He deeply thanked the continuous and proficient contributions that Dr Gerard Moulin has provided to the Group, since its inception, wishing him all the best during his upcoming retirement. In addition to this, Dr Yugueros-Marcos mentioned that, after seven years since the launch of the Global Action Plan (GAP) for AMR and six years since the launch of WOAH AMR Strategy, this Group's meeting kicked off a brainstorming process on how both these key documents could be updated from the animal health perspective, within the context of the upcoming United Nations General Assembly (UNGA) High Level Meeting on AMR in 2024. As such, the composition of the Group will progressively be adapted to the outcome of these strategic updates, keeping the balanced representation the Group has always had. Meanwhile, he reminded everyone of the importance of the Group's current workplan, emphasizing the need for the Group to adapt and organise itself to ensure a timely delivery.

1.1. Adoption of the agenda

The adopted Agenda and List of Participants are presented in Annexes I and II of this report, respectively. The summary of the discussions held by the Group during the Brainstorming sessions is available in Annex III.

1.2. Appointment of rapporteur

Dr Tomoko Ishibashi chaired the Group and Prof Moritz van Vuuren acted as the rapporteur.

2. Landscape I and II

2.1. Quadripartite work on AMR

2.1.1. Updating the Global Action Plan on AMR

Dr Olafur Valsson informed the Group that the GAP on AMR was developed by WHO in 2015 and was subsequently endorsed by FAO and WOAH. The GAP informed the UNGA Political Declaration on AMR of 2016, including commitment by UN Members to develop Nation Action Plans (NAP). Currently, 148 countries developed NAPs on AMR (Quadripartite Tracking AMR Country Self-Assessment Survey [TrACSS], as of October 2021). The global architecture and the political attention on AMR have substantially changed over the last seven years. There have been requests by UN Members to update the GAP based on these developments. The Senior Management Group (SMG) of the AMR-Quadripartite Joint Secretariat (QJS) agreed to update the GAP after discussion. Whereas most of the GAP remains valid and a complete revision is unlikely, an update of key areas is desirable. A robust consultation process with Members and other stakeholders is seen as critical, and each organisation is considering how this consultation could be carried out, through the AMR-QJS. The Group welcomed the update, asking for timelines associated with the GAP update. The aim is to have the GAP ready for the United Nation General Assembly (UNGA) High Level Meeting on AMR, in September 2024.

2.1.2. Multi-Stakeholder Partnership Platform on AMR

The AMR Quadripartite organisations have agreed the terms of reference for the Partnership Platform, and are currently drafting the operational rules, ideally for approval by the SMG at their next meeting on the 31 October 2022.

The Platform is envisaged to be launched during the World Antimicrobial Awareness Week (WAAW) from 18-24 November 2022.

2.1.3. The Third Global High-Level Ministerial Conference on AMR in Oman 24-25 November 2022

The AMR-QJS has been collaborating closely with the organisers of the ministerial meeting in Oman. Four parallel sessions are suggested and there are high expectations for the outcomes of the meeting. WOAH will

be represented by the WOAH Director General (DG), the Deputy Director General for International Standards and Science (DDG-ISS) and the Head of the AMR & VP Department. WOAH has taken the lead on one of the parallel sessions on political engagement and financing. The session is suggested to be co-moderated by Dame Sally Davies along with WOAH DDG-ISS. Invitations have been sent to high level officials of countries and global resource partners to sit on the panel for the session. A Manifesto will collate the findings and recommendations emanating from this meeting, for its eventual endorsement by the Ministers of Health, Agriculture and Environment at the Conference. It is the intention of the Government of Oman that the content of the Manifesto will inform specific and bold political commitments for the upcoming UN General Assembly High Level Meeting on AMR in 2024.

The Group welcomed this update and asked to have access to the Manifesto draft. The draft document was shared with the Group so that it can provide feedback before the global virtual technical consultation planned for 17 October 2022.

2.1.4. Global Leaders Group information note on AMR and animal health and welfare

The Global Leaders Group (GLG) has requested the AMR-QJS to draft an information note on AMR and animal health and welfare. WOAH is leading the process with inputs from the other Quadripartite organisations and GLG members. The aim is to have the note published on the GLG web page before the end of 2022. The focus of the note is on 'equitable access to quality antimicrobials', 'strengthening animal health systems through prevention and biosecurity measures', 'respecting and improving animal welfare' and 'securing the resources needed'. Non-food producing animals will also be covered. The GLG strongly advocates the phasing out of the use of critically important antimicrobials (CIAs) for growth promotion. The document aims to encourage countries to participate in data collection on antimicrobial use (AMU) and AMR in animals and will include recommendations to countries and international fora on how to use these data. The Group noted this initiative.

2.2. Update on AMR Multi-Partner Trust Fund

Mr Ben Davies informed the Group that the Tripartite organisations, the WHO, FAO and WOAH, launched the AMR Multi-Partner Trust Fund (AMR MPTF) in 2019. UNEP became a co-signatory of the AMR MPTF in 2021.

The objective of the AMR MPTF is to catalyse collaboration between the Quadripartite at country, regional and global level to support One Health action on AMR in low- and middle-income countries (LMICs) and to drive global-level action. Aligned to the delivery of the UN Sustainable Development Goals (SDG) agenda, the AMR MPTF is scheduled to run until 2030.

Ten countries are currently in receipt of grant finance to develop, implement and scale up One Health AMR NAPs with Quadripartite cooperation. Four global programme grants support AMR investments in Legislation, Monitoring & Evaluation, Environment and the Tripartite Integrated System for Surveillance on AMR and AMU (TISSA) in animals, humans, food and plants.

Each country project received 1 USD million grant over a period of 2-3 years. Strategic planning is needed to ensure that the project has the expected impact. The Quadripartite organisations manage the funding for in-country activities. The national level impact depends on the presence and commitment of in-country multisectoral working groups to engage with government counterparts and on the willingness from governments to implement the projects. The investment needs to tackle AMR and deliver NAPs have not been quantified. The mechanism to include 'AMR' in national budgets and how to make the investment sustainable is not yet known. The Group raised the issue that the resource partners are only from Europe; it was clarified that the MPTF has a resource mobilisation unit to address this imbalance. There are results available from MPTF projects at country level that will be showcased at the Third High-Level Ministerial Meeting in Oman to engage potential additional funders.

2.3. FAO update on activities on AMR

Dr Jeffrey Lejeune provided the update for the FAO's activities on AMR.

2.3.1. inFARM

The five pillars of the FAO AMR action plan (2021-2025) and other activities related to the Quadripartite are aligned with the GAP. As part of the FAO's action plan, the organisation is committed to develop the International FAO Antimicrobial Resistance Monitoring (inFARM) data platform. To inform the development of the prototype, the FAO has been in regular contact with the WOAH AMU team. That platform will focus on

collection of AMU data in plant production and AMR in animals and food as per FAO mandate. The information collected from the three organisations is intended to feed into TISSA. This is a dynamic Tripartite platform intended to display in a user-friendly manner on a global and regional basis, validated and official data provided by countries to the Tripartite, on patterns and trends in AMU and AMR in humans, animals, food and plants. It recognises that different sectors may be at different levels of advancement. Overall, the aim is to provide a systematic voluntary approach to collecting, analysing, interpreting and sharing data with a view to strengthen country capacity for the surveillance and monitoring of AMR and AMU in agriculture.

The platform will also have a public interface to support countries willing to share their data publicly. The FAO is currently piloting the platform with 20 countries, at least three of which are LMICs. It is taking a progressive approach with priority bacterial species of interest to public health, animal health and indicator bacteria. A global roll out is planned for 2023 through annual open calls for data.

2.3.2. RENOFAM (Reduce the Need for Antimicrobials on Farms Initiative)

This is a global initiative to translate guidelines and policies on AMR in agriculture into ground level action. The FAO wants to see commitment to change and actions to reduce AMU at farm level by improving best practices such as biosecurity and disease prevention. This initiative will be launched during the World Antimicrobial Awareness Week (WAAW) 2022.

2.3.3. ACT (AMR Codex Texts) project for the implementation of Codex standards to support containment and reduction of foodborne antimicrobial resistance.

Codex has published the Code of Practice, the guidelines on integrated monitoring and surveillance and the guidelines for risk analysis of foodborne AMR. Codex has a strategic plan where they want to see their strategic text adopted. The Republic of Korea invested in the implementation of the texts (ACT project) to support two countries in South America (Columbia, Bolivia) and four countries in South East Asia (Mongolia, Republic of Korea, Pakistan, Nepal). The aim is to promote the uptake of Codex Standards that will lead to better management of foodborne AMR according to the needs of the six participating countries. It also aims to develop and implement an integrated monitoring and surveillance system of AMR and AMU in food production in the targeted countries. The experiences gained in the project countries will be shared to plan future programmes in other countries and regions.

2.3.4. Fleming Fund

A 30-month project has been approved (2022-2025). The project will focus on data generation (on AMR) to support evidence-based decision making in the food and agriculture sector. The expected outcome is an increased and improved data generation (AMR-specific and -sensitive), its analysis, sharing, and utilisation for evidence-based decision making within the food and agriculture sector. It has five outputs: strengthen laboratory and surveillance capacities; practices to reduce AMR transmission along the food chain; evidence-based AMR economic argument in food and agriculture; sub-standard and falsified (SF) antimicrobials in food and agriculture; country-owned processes and initiatives for NAPs.

The Group thanked Dr Jeffrey Lejeune for the updates on the FAO AMR activities. The Group noted the overlaps in goals and countries between the FAO initiatives and MPTF activities and asked whether there is room for collaboration. FAO will be exploring collaborations and complementarity between FAO and MPTF-Quadripartite initiatives (e.g., environmental component on the agriculture sector).

2.4. Update on non-WOAH antimicrobial lists:

2.4.1. WHO CIA List

Dr Jorge Matheu informed the Group that the WHO Expert committee on 'Selection and Use of Essential Medicines' developed the AWaRe (WHO access, watch, reserve, classification of antibiotics for evaluation and monitoring of use) classification in 2017 as a tool to support antibiotic stewardship programmes. Antibiotics are classified as Reserve (last resort options for multi-drug resistant infections), Watch (highest resistance potential) and Access (lower resistance potential). The revised Critically Important Antimicrobials (CIA) for human medicine list has three decision trees: antibiotics licensed for human use only; antibiotics for use in animals and humans; and antibiotics for use in animals only. There was confusion over the prioritisation criteria 1 and 2 in the previous list which led to the revision of the prioritisation factors. It was decided to link prioritisation factor 1 with the AWaRe list. Based on the new definitions of the prioritization factors macrolides will be removed from the Highest Priority CIA (HP-CIA) category but will remain as critically important on the CIA list. The HP-CIAs now include 3rd and 4th generation cephalosporins, quinolones and fluoroquinolones,

polymyxins, aminoglycosides (i.e., as one or more antibiotic substance in this class are in the reserve or watch lists) and phosphonic acid derivatives (i.e., fosfomycin is used to treat drug resistant Gram-negative infections). The WHO is discussing with the Essential Medicines List (EML) group to keep the alignment of the AWaRe classification with the WHO CIA list. The 7th revision is planned to be finalised in October 2022 and available for public consultation during November-December 2022 with a view to be published in February 2023.

The Group raised some concerns about aminoglycosides being categorised at the same level as the 3rd and 4th generation cephalosporins and quinolones with the new criteria. The Group also queried how the AWaRe list was adopted and whether some rules should have been established due to the AWaRe list being 'substance based' whilst the CIA list decisions are 'class based'.

It was further noted by Dr Matheu that the EML was being revised and that the AWaRe list had already been revised in 2021. The two groups are working together to assess the use in countries. The CIA list is a WHO document. WOAH welcomed the opportunity to be part of the public consultation of the document this time instead of being treated as an observer as in CIA list's past revisions.

2.4.2. World Veterinary Association (WVA) and World Small Animal Veterinary Association (WSAVA) Lists of Essential Medicines

Dr Stephen Page provided an update on the current progress of the development of the World Veterinary Association (WVA) and Brooke List of Essential Medicines. Draft essential veterinary medicines lists have been prepared for each of the eight selected species groups (aquaculture, bees, equids, large ruminants, porcine, poultry, rabbits and small ruminants). The WVA Pharmaceutical Stewardship Working Group is currently working on a timeline with its partner organisation, Brooke, to determine timelines and steps to completion, including incorporation of comments from WVA member associations.

Dr Page reminded the Group that the World Small Animal Veterinary Association (WSAVA) developed the List of Essential Medicines for Cats and Dogs in 2020. Furthermore, he informed the Group that recently the WSAVA conducted a survey with its members on the availability of core essential medicines for cats and dogs. The results of a survey will be presented at the 47th WSAVA World Congress in Lima, Peru in October 2022. The survey revealed the importance of access to essential medicines to support the health and welfare of dogs and cats. In response to the survey, the initial list of essential medicines will be revised and updated.

The Group thanked Dr Page for the update on the WVA-Brooke Essential Medicines Lists.

2.5. Substandard and falsified (SF) products project

Dr Andrés Garcia Campos provided the update to the Group. The Fleming Fund supports this project which aims, amongst others, to create a global information and alert system for the WOAH Member Focal Points for Veterinary Products (FPVPs), using a similar structure as that successfully used by WHO for surveillance of Substandard and Falsified (SF) medical products. WOAH's proposed global information and alert system aims to receive notifications of SF veterinary products from its network of National FPVPs, and to subsequently inform all Members through alerts of incidents of SF veterinary products to facilitate their removal from circulation. This system will support a better understanding of SF veterinary products and their contribution to AMR.

Since activities have been resumed in July 2022, 14 Members across all WOAH regions have enrolled in the pilot stage providing alerts of confirmed and suspected SF products and providing information about veterinary legislation for surveillance, laboratory testing capacity and traceability. WOAH aims to review the initial pilot outcomes to improve the system based on feedback from participants in the pilot programme and from stakeholders (i.e., WHO), and plans to extend this pilot stage to 40 Members from all regions by 2023. In parallel, WOAH is involved in the discussions of the EU project "Working Together to Fight Antimicrobial Resistance" in the Americas, in terms of the development of an application or "App" for the identification and reporting of falsified veterinary medical products in the market by users from the Americas and Asia -where a similar EU project is also ongoing-so that the reporting can be compatible with the new alert system.

Furthermore, the first steps have been taken to initiate the creation of an electronic expert group for the development of guidelines on post-marketing surveillance of veterinary product quality. This will help initiate the engagement to build a global network of laboratories testing veterinary product quality by region, and to interact and collaborate with stakeholders (e.g., FAO) for field level surveillance of veterinary product quality.

The Group thanked Dr Garcia for his update on the SF project. It recommended careful consideration of the capacities with the establishment of a network of laboratories and emphasised the importance to link to similar FAO projects.

3. Update on Chapter 6.10. 'Responsible and prudent use of antimicrobial agents in veterinary medicine'

Dr Tomoko Ishibashi updated the Group on the Terrestrial Animal Health Standards Commission (TAHSC)'s September 2022 meeting discussion regarding the revised Chapter 6.10. Dr Ishibashi reported that the TAHSC commended the Group for its comprehensive and high-quality work. It considered the changes proposed by the Group and made additional minor amendments to the revised text to improve clarity and to ensure alignment with other chapters of the Terrestrial Code. Dr Ishibashi confirmed that the rationales for the changes proposed by the subgroup were available in the subgroup report to be annexed to the TAHSC report and the rationales for amendments made by the Code Commission were described in the TAHSC report from September 2022.

The draft revised chapter will be circulated for Member comments between November and December 2022.

4. Revision of TAHC chapters (after Ch 6.10)

The WOAH Secretariat presented, for the Group's consideration, the list of potential *Terrestrial Code* and *Terrestrial Manual* chapters to be revised after Chapter 6.10. Based on the recent advances achieved on the global data collection for AMU and AMR and on Chapter 6.10, the Group recommended that the next chapter(s) to be revised should be Chapter 6.8 and Chapter 6.9. The Group acknowledged that the terminology used in Chapter 6.7. will be revised to assess if and when it needs to be updated. New work on chapters will not commence before April 2023 because the outcome of the revision of chapter 6.10 must first be finalized. The Group will discuss this plan further at their next meeting.

5. WOAH Antimicrobial Use (AMU) Database

5.1. ANIMUSE: ANImal AntiMicrobial USE

Dr Morgan Jeannin updated the Group on the latest highlights for the ANIMUSE Global Database, the new WOAH database on antimicrobials intended for use in animals launched on the 19 September 2022. The Group was informed that invitation letters had been sent to Members to connect to the platform in time for the start of the 8th round of AMU data collection. Dr Jeannin clarified that for each Member, access to the platform was offered to the Delegate, to the FPVPs and to two additional contact points. The portal has technical information for policy makers to support their work and allows Members to report issues and to seek assistance if needed.

Dr Jeannin updated the Group on the timeline of the project with an emphasis on the upcoming in-person trainings of main users. The Group was introduced to the data dashboards available for both the public and within the confidential country portals. It was also explained to the Group that the animal biomass is calculated in a unique way for the purpose of the ANIMUSE and Global Burden of Animal Diseases (GBADs) project. Data used to calculate animal biomass are mainly derived from WAHIS along with FAOSTAT data to complement it. The latest data from WAHIS are from 2019. This data gap from 2019 onwards will be addressed by the new WAHIS platform. Peer-reviewed articles on the calculation of the animal biomass approach by WOAH[1] and external assessment of the WOAH methodology were published recently[2].

Mr Mduduzi Magongo updated the Group on the ANIMUSE helpdesk functionality. He highlighted the key automated processes to streamline and respond to countries' issues efficiently. He explained that the platform was secured as data submitted by countries were protected through encryption. Mr Magongo presented the ANIMUSE security factsheet, highlighting the several security measures in place. These measures include data encryption, SSL (Secure Socket Layer) security certificates, multifactor authentication, threat detection and monitoring, country specific portals and system audits. Thus, concerns about the security of the platform raised by the Group at its April 2022 meeting, had been addressed.

Mr Magongo also indicated that countries have the possibility to provide feedback, recommendations, or suggestions through this platform.

The Group was asked for feedback on useful or relevant aspects to include in the interactive dashboard. The Group discussed the relevance for the users of the different geographical representations of the AMU data presented.

The Group thanked the presenters for providing an update on ANIMUSE and congratulated the team for the impressive progress made. Dr Javier Yugueros-Marcos thanked the Group for its contribution to this work and emphasised the importance of sharing the work with FAO and WHO so that integrated surveillance can be conducted.

[1] https://www.frontiersin.org/articles/10.3389/fvets.2019.00317/full
[2] https://academic.oup.com/jac/advance-article/doi/10.1093/jac/dkab441/6481777

Dr Matheu commented that this will be conducted through TISSA and Dr Lejeune is considering using a similar approach for FAO's inFARM system.

5.2. Results of the 7th round and procedures for the 8th Round

Dr Delfy Góchez provided key figures of the 7th round of data collection and highlighted the improvement of data reporting through the rounds. She mentioned that during the 7th round, it was particularly difficult to achieve a good participation from the Members, especially Africa, potentially attributed to the lack of face-to-face meetings over the past two years during the pandemic. In response to this, the first in-person ANIMUSE training will be taking place in English- and French-speaking countries in Africa before the end of 2022.

Dr Delfy Góchez provided an update on the current stage of the 8th round of data collection launched mid-September with ANIMUSE. As of 4 October, 13% of the Members had successfully logged into ANIMUSE and two countries were in the progress of filling out the annual questionnaire through the platform.

Furthermore, the results from a survey on the pertinence of the AMU annual report conducted with a representation of countries and different stakeholders outside WOAH were presented. Thirty-five responses were analysed, and, even if most of the responders agreed that all the sections of the report were valuable, the most relevant sections were those related to the analysis of AMU quantities and the rounding up of results (e.g., growth promoters and country barriers). Respondents suggested that, in addition to the current format of the annual report and the factsheet, a summary report and interactive graphs would be useful.

The Group acknowledged that the AMU report will improve over time, as more and better data become available. For example, import and export data is available in some countries and could be collected. As the use of antimicrobial classes shifts due to climate change, and to changes in protein production and in the burden of animal diseases, data beyond the regional level should be explored. At the same time, the Group warned that disclosing reporting of AMU data at country level may have repercussions for some participants. They encouraged WOAH to maintain the current level of aggregation at regional and global level when reporting while getting close to targeted selection of participants to increase awareness of more focused and local analyses.

To improve the impact of reporting, the Group suggested; 1) to move towards deeper and more targeted analyses of sections bringing value to participants, especially those with immediate impact on NAPs, and 2) to emphasize the importance and value of maintaining such high level of participation, while continuing to improve the quality of the data collected – "get more data, get better data".

The Group also commented on the fact that it would be important to understand how antimicrobial growth promoters are used in countries. The Group thought that reporting of AMU at regional and species level would be informative, especially if combined with tailored training of participants on how to use the data.

Finally, the Group proposed that the report's main findings be published in a peer-reviewed journal to attract more attention, in the same way the WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS) did a few years ago in The Lancet[3].

5.3. Global Burden of Animal Diseases (GBADs)

Ms Edna Massay Kallon presented the systematic assessment approach of economic burden of diseases and health issues in animals being developed by the GBADs[4]. GBADs is co-led by WOAH and the University of Liverpool in a consortium with other organisations and research institutes. The consortium is working to develop a systematic approach for the assessment of the economic burden of animal diseases; to provide estimates of net loss of production, expenditure, and trade impacts; and to identify where the burdens occur, the causes and risk factors and to whom it occurs. The GBADs approach will support countries in the decision-making process on allocating the investment needed for improving animal health. The project is currently focused on the development of methodologies for terrestrial animals and is looking at whether and how the methodologies can be adopted for aquatic animals. To test the GBADs methods, there is an active case study in Ethiopia, one that has started in Indonesia and one that will start in Senegal in 2023.

One of the outputs of this program is a Resource Allocation Decision support suite of Tools (RADSST) to help policy makers incorporate economic analysis in their decision-making process on the allocation of investments. The team will collate longitudinal and cross-sectional data. Longitudinal data will allow a time-series analysis of changes of burden of disease in the context of changes noted in policy. GBADs is also linked to the Global Burden of Diseases

[3] https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(18)30060-4/fulltext
[4] https://gbads.woah.org/index.html

(GBDs) in humans as the Institute of Health Metrics and Evaluation (IHME) co-leads the Human health team of GBADs and a representative from IHME is a member of GBADs Internal Steering Committee.

Within the current GBADs project, the team is looking into developing a model to assess the impact of AMR and AMU on production and the wider impact on the economies. This work is funded by the Fleming Fund for a 3-year workplan. The team will look at: (i) the cost of antimicrobials and alternative technologies, (ii) impact of AMU and AMR on production, (iii) wider impact on the economy and (iv) the negative externalities on public and environmental health. The team would like to do case studies for AMR and would welcome the Group's suggestions of countries to consider.

The Group thanked Ms Kallon for the update on the GBADs project. It recognised its value for improving the knowledge of the economic burden of AMR. The Group suggested that GBADs consider linking up with MPTF countries, with Members already contributing to ANIMUSE, and consider looking into databases of whole genome sequencing (e.g., FDA runs the whole genome sequencing tracker) to obtain more data. The Group mentioned that predictive models could be used to inform Members on how to improve their AMU to prevent the negative impact on public health. The Group mentioned that costs of labour derived from AMR should also be included in the tool. The Group commented that GBADs should reach out to UNEP or WHO WASH programme colleagues to consider environmental health. The Group recommended that GBADs be linked with MPTF AMR Environment Global Programme and their series of webinars.

5.4. AMU field level data update

Dr Idrissa Savadogo updated the Group on the WOAH work on field level AMU. WOAH AMU team is developing an inventory aimed at recording AMU field level projects developed in countries. The information recorded in the inventory includes the location of the project, the methodological approach used and the reporting mechanisms of the results of the project. These projects are usually conducted by veterinary services, research institutes, universities, etc. The initiative of developing an inventory emerged from the results of surveys conducted during FPVP training seminars showing that in certain cases, FPVPs were not involved and sometimes unaware of field level AMU monitoring projects ongoing in their countries. This inventory could be made available in ANIMUSE and therefore accessible to national authorities (FPVPs and Delegates) allowing them to complement imports and sales data for more informed decision-making. In the coming months the AMU team will pilot the inventory with Members during ANIMUSE training events. The inventory will be filled with projects by liaising with FPVPs, researchers and relevant stakeholders. The objective of this project is to display the inventory Form and analysis of methodologies in ANIMUSE and to define clear inclusion criteria for projects to be added to the inventory. Preliminary findings show that there is currently lack of harmonisation of the methodologies used for qualitative and quantitative data collection.

The Group thanked Dr Savadogo for his update and asked for clarification on how the inventory will be used. The Group recommended to have a mid- and long-term strategy for the use of data collected at field level. The Group recommended that the AMU team maps what can be obtained in terms of indicators for AMU at field level for each type of study design.

6. Aquatic Animal Health

6.1. WOAH *ad hoc* Group on Technical Reference Document of Antimicrobial Agents of Veterinary Importance for Aquatic Animals

Dr Dante Mateo presented the work done on the Technical Reference Document Listing Antimicrobial Agents of Veterinary Importance for Aquatic Species (hereafter referred to as the Aquatic Species Technical Reference Document). The WOAH *ad hoc* Group (AHG) on Technical References for Aquatic Animals working on the Aquatic Species Technical Reference Document held their two last meetings in June and August 2022. The AHG finalised the Aquatic Species Technical Reference Document with the feedback given by external experts that reviewed the final draft. The external experts were selected based on their complementary expertise, geographical and gender balance. There were two organisations included among them: HealthforAnimals, and the World Veterinary Association (WVA).

The Aquatic Species Technical Reference Document contains an introductory text about the scope, methodology, differences with respect to the multispecies list (OIE List of Antimicrobial Agents of Veterinary Importance), a rationale for the appendices related to diseases and antimicrobial classes, and a table of antimicrobial agents. It also includes three appendices with the list of AHG members (Appendix 1a), expert reviewers (Appendix 1b), main bacterial diseases (Appendix 2), and the antibiotic classes used (Appendix 3). The Aquatic Species Technical Reference Document includes 26 antibiotics authorized for use in food-producing fish and crustaceans. Thirteen antibiotics identified as used in the original multispecies list were not included and six were added. The list of main bacterial diseases contains 23 diseases affecting fish and five affecting crustaceans. There are 12 antimicrobial classes/sub-classes identified for fish bacterial infections and five for those affecting crustaceans. In addition to those changes,

the *ad hoc* Group also suggested to add sulfisozole sodium, an antibiotic identified for use in aquaculture, in the original multispecies list as previously missing. Also, the replacement of 'ormetoprim + sulfamethoxine' by 'ormetoprim + sulfonamide' is suggested. This combination is wider (similar to 'trimethoprim + sulfonamide') and includes 'ormetoprim + sulfadimethoxine', a combination authorized for use in aquaculture.

Dr Mateo thanked the members of the AHG and the external experts who participated to the development of the reference technical document for aquatic animal species.

The Group thanked Dr Mateo and the AHG for the hard work in delivering this list and commended the high level of expertise of the members of AHG that contributed to this piece of work. The Group endorsed the Technical Reference Document for Aquatic Animals (Annex IV). The current data provides an overview of the antimicrobial use in various fish sub-categories which will help raise awareness in countries. The Group recommended that further differentiation is made to be able to have AMU at species level. Dr Javier Yugueros-Marcos thanked the Group for its contribution, and thanked the AHG members for their fantastic work to bring the list of antimicrobial agents of veterinary importance up to date, providing a useful tool for professionals to refer to, when prescribing and overseeing the use of antimicrobials in aquatic animal species.

6.2. Strategy for Aquatic Animal Health

Dr Dante Mateo informed the Group on the progress of other activities related to the workplan on AMR in Aquaculture, some of which are considered within the activities for the implementation of the Aquatic Animal Health Strategy.

A sub-categorization of aquatic animals was recently added to ANIMUSE. Based on responses sent by Members between September 2020 and May 2021, 62 out of 80 Members, that included aquatic animals in their reported AMU quantities, used the new fish sub-categories added to the aquatic food-producing animals. Twenty-four Members included ornamental fish.

Members identified a problem of interpretation for the category "All-aquatic food-producing animals". When an antibiotic label is not species-specific (e.g. "fish"), some Members interpret it as the antibiotic being authorised for all species and therefore, they mark "all" in the Template (or IT platform for ANIMUSE). If the label indicates "fish", Members should mark "Fish-Undefined". Ideally, label information should be contrasted with real use. Removing the option "all" from ANIMUSE should be considered as it is not a common occurrence. WAHIAD will update its biomass categories on fish as a result of this survey's findings.

Dr Mateo also informed the Group on the global survey conducted to gain a better understanding of the overall needs and gaps relevant to AMR and AMU in Member's aquaculture production. The survey was addressed to FPs for Aquatic Animals and FPVPs. The survey had a good response rate: 31 Members from Africa, 24 from Americas, 19 from Asia and the Pacific, 32 from Europe, and 10 from the Middle East. Most of the respondents were FPs for Aquatic Animals. Preliminary findings of this survey show that 44.9% of Members are making efforts to collect AMU in aquaculture at field level, and 30.6% have plans to do so within the next three years. Analysis will be finalised in the following weeks, starting with results from Africa and the Middle East. With the information gained, a virtual pilot training is planned for Asia by the end of the year or early next year.

Finally, Dr Mateo briefly mentioned the progress and plans in other activities of the workplan on AMR in Aquaculture, including from the AMR aquaculture network, upcoming global events, communication tools, FP training events, publications, Performance of Veterinary Services (PVS) pathway and field level AMU data collection in aquaculture.

The Group thanked Dr Mateo and congratulated him for the progress made with the implementation of the workplan on aquatic animal health.

7. Update on the Technical Reference Document of Antimicrobial Agents of Veterinary Importance for Swine Foot and Mouth Disease. Global Control Strategy

WOAH Secretariat informed the Group that feedback was sought from external WOAH experts on swine health regarding the impact of *Chlamydia suis* infection in swine health as had been agreed at the last Group meeting in August 2022. The WOAH Secretariat informed the Group that the experts stated that chlamydiosis was not relevant for swine production and that no antimicrobial veterinary product was licensed for treatment of *C. suis* infection for use in swine. The Group decided that this pathogen was not to be added to the Swine Technical Reference Document and endorsed the version presented for its consideration at its August 2022 meeting (Technical Reference Document for Swine Annex V, respectively).

8. Other Technical Reference Documents - discussion

WOAH Secretariat presented proposals to the Group on the methodologies to adopt for the preparation of the upcoming Technical Reference Documents.

8.1. Large ruminants

The Group decided that the Technical Reference Document will only cover cattle (*Bos taurus and B. indicus*) with references to antimicrobial agents authorised for use in buffalo (*Bubalus bubalis*), due to their importance as livestock in certain geographical regions.

8.2. Companion animals

The Group agreed that the Companion Animal Technical Reference Document will only cover domestic cats (*Felis catus*) and dogs (*Canis lupus familiaris*) considering their overwhelming weight in so called companion animals and substantial difference in the environment between these two and other animal species which are occasionally kept as companion animals.

8.3. Other species

WOAH Secretariat reminded the Group that the remaining species to be addressed are: small ruminants (goats and sheep), camelids, equids, bees and rabbits. The Group decided that small ruminants would be addressed separately from bovines. The Group decided that the methodology to be used to develop the remaining Technical Reference Documents for other species will be discussed in due course.

8.4. Methodology

The Group decided that *ad-hoc* Groups (AHGs) would be set up to develop the list for bovine animals and the one for cats and dogs. The Secretariat will prepare the Terms of Reference for both AHGs for the Group's consideration. Dr. Stephen Page and Mrs Barbara Freischem will contribute to both AHGs and Prof Moritz van Vuuren will contribute to the AHG addressing the Technical Reference Document for bovine animals. Similar methodological approaches to that adopted for the previous Technical Reference Documents will be used. The Group decided that the main List of Antimicrobials of Veterinary Importance would be updated in two stages: once after the completion of these two Technical Reference Documents (i.e. bovine animals, and cats and dogs), and again, once the review of other species had been completed. The Group will discuss the process for the revision of the categorisation of the OIE List in due course.

9. Quick updates

9.1. Antiparasitic drug resistance

To follow up on the update provided in April 2022, Dr Javier Yugueros-Marcos presented to the Group the latest status of activities related to the responsible use of antiparasitic drugs. The topic was brought to the attention of the Scientific Commission on Animal Diseases (SCAD) and the TAHSC, for consideration of the following questions at their last meeting in September 2022:

- Based on the publication by the Electronic Expert Group on Antiparasitic Resistance (EEG-APR), would it be useful & pertinent to develop a *Terrestrial Code* chapter on responsible and prudent use of anthelmintic chemicals to help control anthelmintic resistance in grazing livestock species?

- Would it be appropriate to develop a *Terrestrial Code* chapter for other parasitic and animal species?

- If so, which parasitic or animal species should be prioritised?

Feedback from both Commissions was similar and agreed that the publication was very well written and gave the foundations for the development of a standard in the future. However, the Commissions did not consider this as a key priority. The Commissions questioned the value and practicality of developing a standard which did not refer to a WOAH listed disease or a public health concern. In the short term, the Commissions recommended the Group to promote responsible and prudent use of such products among Members, to raise awareness amongst veterinarians, farmers and other relevant stakeholders. In addition, the Commissions suggested that the Group develop guidelines covering helminths affecting animals, and consider the need for similar guidelines for ectoparasites, in particular those responsible for vector-borne diseases.

With this feedback, the EEG-APR will complete its mapping & prioritisation exercise and define a roadmap of actions to be undertaken by WOAH, in collaboration with FAO, who is also working on antiparasitic resistance. It is worth noting that a similar presentation-feedback exercise should be conducted with the Aquatic Animal Health Standards Commission as soon as their agenda allows it.

The Group thanked Dr, Yugueros-Marcos for the update and requested to be informed of further developments, as this is part of the recommendations from the 2nd Global Conference on AMR held in Marrakesh and must align in some way with the outcome of the reviewed chapter 6.10 on antimicrobials.

9.2. AMR Monitoring & Evaluation

The Monitoring and Evaluation plan and associated indicators for the WOAH Strategy for AMR have now been finalised and the first report is currently in preparation. The evaluation will be conducted annually and consolidated internally before it is converted into an external assessment involving Members.

The Group thanked Dr Yugueros-Marcos for the update. The Group suggested to include an indicator for AMU stewardship as part of WOAH's Monitoring and Evaluation plan.

10. Roadmap 2023-2024

The Group revised and agreed on the roadmap for upcoming activities. Please refer to Annex VI

11. Any other business

None raised.

12. Date of next meeting

The next face-to-face meeting of the Group will take place in Paris WOAH headquarters on 28-30 March 2023.

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…/Annexes

Annex I. Agenda

MEETING OF THE WOAH WORKING GROUP ON ANTIMICROBIAL RESISTANCE

Paris, 4 to 6 October 2022

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Day 1 (Tuesday 4 October)

1. Welcome and opening of meeting
   1.1 Adoption of the agenda
   1.2 Appointment of rapporteur
2. Landscape I
   2.1 Quadripartite work on AMR
   2.2 Update on AMR Multi-Partner Trust Fund
   2.3 FAO update on activities on AMR
   2.4 Update on non-WOAH lists:
      2.4.1. WHO CIA List
      2.4.2. WVA List of Essential Medicines
   2.5 Falsified and substandard products project
3. Update chapter 6.10. Responsible and prudent use of antimicrobial agents in veterinary medicine
4. Revision of TAHC chapters (after Ch 6.10)

Brainstorming I (WG AMR only)

Day 2 (Wednesday 5 October)

5. WOAH Antimicrobial Use (AMU) Database
   5.1. ANIMUSE
   5.2. Results of the 7th round and procedures for the 8th Round
   5.3. Global Burden of Animal Diseases
   5.4. AMU field level data update

Brainstorming II (WG AMR only)

Day 3 (Thursday 6 October)

6. Aquatic Animal Health
   6.1. WOAH *ad hoc* Group on Technical Reference Document of Antimicrobial Agents of Veterinary Importance for Aquatic Animals
   6.2. Other activities on AMR in aquaculture – including the Strategy for Aquatic Animal Health
7. Update on the Technical Reference Document of Antimicrobial Agents of Veterinary Importance for Swine
8. Next steps- methodology discussion
   8.1. Large ruminants
   8.2. Companion animals
   8.3. Other species
   8.4. Methodologies
9. Quick updates:
   9.1. Antiparasitic drug resistance
   9.2. AMR Monitoring & Evaluation
10. Roadmap 2023-2024
11. Any other business
12. Date of next meeting

Annex II. List of Participants

MEETING OF THE WOAH WORKING GROUP ON ANTIMICROBIAL RESISTANCE

Paris, 4 to 6 October 2022

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MEMBERS

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Dr Yukitake Okamura
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Annex III. Brainstorming Sessions

MEETING OF THE WOAH WORKING GROUP ON ANTIMICROBIAL RESISTANCE

Paris, 4 to 6 October 2022

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The Group held two brainstorming sessions to discuss two topics that are on WOAH's future agenda: 1) the update of WOAH AMR Strategy, 2) the update of the main list of antimicrobials of veterinary importance.

On the first topic, the Group considered that the overall framework of the **WOAH AMR Strategy** is still fit for purpose. Its four pillars (1 – improve AMR awareness & understanding, 2 – strengthening knowledge through surveillance & research, 3 – support good governance & capacity building and 4 – encourage implementation of international standards) are still relevant and useful to guide actions on which to focus. The Group highlighted areas where actions should be emphasized for the Strategy's future update, including:

Data (improvement of data quantity and quality to enrich scientific basis, continuous improvement of tools to collect and store data and promotion of effective use of data to move from monitoring to surveillance),

antimicrobial stewardship (from a definition to a full action plan that includes prevention, diagnostics and alternatives to antimicrobials, involving all actors in animal health and welfare)

The Group also noted the importance to consider future (or recent) challenges such as the emergence of pathogens and its link to climate change and to changes in animal production systems.

The Group discussed whether it would be feasible to organise a third Global Conference on AMR in Q4 2023 to comment and endorse a refreshed WOAH AMR Strategy. They considered that while such event would be a useful platform for this, the timing to align with the update of the GAP (planned in 2024) was too tight. They proposed to discuss further options on how to update the WOAH AMR Strategy and how to feed these updates into the revision of the GAP.

On the second topic, the Group considered that the OIE List of Antimicrobial Agents of Veterinary Importance (hereafter referred to as the "main list"), defined upon accessibility and therapeutic criteria, still had value to safeguard animal health. The Technical Reference documents already developed and in the pipeline are based on the main list. They provide an update on antimicrobials available for use in each animal species, including indications for major bacterial pathogens. The Group also highlighted the importance, relevance and value of the recommendations embedded in the main list, as those consider also public health concerns and provide guidance on how to use antimicrobials within a One Health approach. The Group recommended to make both, the Technical Reference documents and the Main List recommendations more visible and easily available for Members.

Finally, the Group evoked that, after completion of the two Technical Reference documents on bovine animals and dogs and cats, it would be appropriate to consider updating the main list using a new survey among Members, reviewing the accessibility and therapeutic criteria.

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Annex IV. Technical Reference Document Listing Antimicrobial Agents of Veterinary Importance for Aquatic Species

An appendix to the List of antimicrobial agents of veterinary importance

MEETING OF THE WOAH WORKING GROUP ON ANTIMICROBIAL RESISTANCE

Paris, 4 to 6 October 2022

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1. Scope

The objective of this *Technical Reference Document Listing Antimicrobial Agents of Veterinary Importance for Aquatic Species* (hereafter referred as Aquatic Technical Reference Document) is to provide additional specific and updated information to the *List of Antimicrobial Agents of Veterinary Importance*. By identifying antimicrobial agents used in aquatic species, it aims to contribute to the development and update of national treatment guidelines, advice on prevention and best practice management, risk management, and risk prioritisation to minimise and contain antimicrobial resistance (AMR). This document is not intended to serve as a treatment guide.

This document is focused on antibiotics used in food producing aquatic animals represented by species of two groups: fish and crustaceans. Although the use of antibiotics in the mollusc, amphibian and ornamental fish industries is also recognized, these applications are not within the scope of this document.

Only those antibiotics in authorized products labelled for the treatment of infections in fish and crustaceans are considered. It is acknowledged that extra-label/off-label use often occurs in aquaculture, especially in those countries where there are few antibiotic alternatives. In some countries, where regulations are minimal, or difficult to implement, there are antibiotic products being marketed, individually, or in combination with other molecules, that are commonly used in aquaculture establishments. Antibiotics exclusively used extra-label/off label (without evidence of on-label use in any country), or in unauthorized/not well-established combinations, are not considered in the Aquatic Technical Reference Document.

Use of antibiotics in fish species are represented by the abbreviation 'PIS' in the Table of antimicrobial agents used in fish and crustacean aquaculture of this document, following the designation in the main *List of Antimicrobial Agents of Veterinary Importance*. Use of antibiotics in crustacean species have been allocated the new designation 'CRU'. It should be kept in mind that the antibiotics listed in the Aquatic Technical Reference Document may not all be available or appropriate to treat all susceptible fish and crustacean species affected by each pathogen. Given the multiplicity of species utilized in aquaculture, that varies according to geographical areas, environmental water temperatures and salinities, the use of veterinary medicinal products varies accordingly.

It is acknowledged that the situation is very diverse in different regions for licensing, availability, extra label/off-label use, and susceptibility to antimicrobial agents, and that the general information provided in this document should be interpreted in light of the local context. For instance, the authorisation of antibiotics for use in some aquatic species might not be the same in all countries to treat the same bacterial pathogen.

Aquatic animal-related recommendations stated in the World Organisation for Animal Health (WOAH, founded as OIE) Standards and Guidelines (namely in the Aquatic Animal Health Code and the *List of Antimicrobial Agents of Veterinary Importance*) should be considered in conjunction with this document.

2. Methodology to prepare this document

An *ad hoc* Group on Technical Reference for Aquatic Animals was nominated by WOAH to develop the Aquatic Technical Reference Document. The *ad hoc* Group's members (Appendix 1a) consisted of representatives of the WOAH Working Group on Antimicrobial Resistance (AMR) and experts from various geographical areas with complementary expertise.

As a first step, data of antibiotics used in aquaculture worldwide was compiled. The information obtained from product labels and official lists of authorized antibiotics from various countries was used to prepare a preliminary table of important bacterial pathogens of fish and crustaceans, and the classes of antibiotics used to treat the diseases caused by these pathogens. This information was complemented by an evidence-guided literature review undertaken by the *ad hoc* Group. Various globally focused reviews of aquatic animal diseases published in the last ten years (2012-2022) were consulted for fish and crustacean pathogens and recommended treatments.

Additional sources of information used were the original answers to a questionnaire sent to WOAH Members in 2006, which formed the basis for the current List of Antimicrobial Agents of Veterinary Importance. The answers to this questionnaire provide information on antimicrobials used to treat pathogens by animal species. Other sources of information were:

- List of antimicrobials authorised for aquatic species in countries/regions
- Existing specific treatment guidelines
- WOAH *ad hoc* Group report on vaccines that can reduce the use of antimicrobials
- Preliminary results of a survey on AMR in aquaculture to WOAH Members (2022)

Once the Aquatic Technical Reference Document was completed by the *ad hoc* Group, it was submitted to a panel of external experts (Appendix 1b) for review. These aquatic animal experts were identified through the WOAH Collaborating Centre network and the *ad hoc* Group members networks. Experts were selected ensuring adequate gender and geographical representation.

The experts were asked to provide feedback on the table of antimicrobial agents, the list of major bacterial pathogens and diseases (Appendix 2), and the proposed indications for use of antimicrobial classes (Appendix 3).

The *ad hoc* Group took into consideration the feedback provided by the peer reviewers to consolidate the Aquatic Technical Reference Document. Endorsement of the final version of the Aquatic Technical Reference Document was sought from the Working Group on AMR and the relevant WOAH Headquarters Administration Staff.

3. Summary of differences between the antibiotics listed in the Swine Technical Reference Document and the *List of Antimicrobial Agents of Veterinary Importance*

A number of antibiotics that were previously considered by the *List of Antimicrobial Agents of Veterinary Importance* as “used” in fish species, were not included in this Aquatic Technical Reference Document due to a lack of evidence of products currently authorized for use in aquaculture containing such molecules. This concerned: josamycin, kanamycin, miloxacin, mirosamycin, novobiocin, spectinomycin, spiramycin, streptomycin, sulfafurazole, sulfamethoxine, and tobicillin.

Similarly, despite authorizations for bicozamycin and sarafloxacin were identified, these were not included in the Aquatic Technical Reference Document as products containing these molecules are not available on the market.

Conversely, there were antibiotics previously considered as “not used” for which there are currently products authorized and available for use in aquaculture. These included chlortetracycline, ciprofloxacin, neomycin, tiamulin, and sulfadiazine.

The molecule sulfisozole sodium, not considered to be used for any species in the original multispecies *List of Antimicrobial Agents of Veterinary Importance*, is currently authorized to be used in aquaculture. Therefore, its addition is recommended to the original multispecies list. The wider combination term ‘ormetoprim + sulfonamide’ is recommended to replace ‘ormetoprim + sulfamethoxine’, in the original multispecies list, following the example of ‘trimethoprim + sulfonamide’. This combination would include sulfonamides other than sulfamethoxine used with ormetoprim, such as ormetoprim + sulfadimethoxine, authorized for used in aquaculture.

The nomenclature of the antimicrobial agents in the Aquatic Technical Reference Document was updated with their Non-Proprietary Names (INNs) in line with international standards. The old names of the antimicrobial agents were kept as synonyms in the Table.

Finally, based on the assessment of the chemical formula of two sulfonamides that had been previously misnamed, ‘sulfadimethoxazole’ and ‘sulfamethoxine’, their names were modified accordingly, taking into account existing INNs, into ‘sulfamethoxazole’ and ‘sulfametoxydiazine’, respectively.

4. Criteria for inclusion of pathogens, diseases and antimicrobial classes in the appendices

The list of major bacterial pathogens and diseases affecting aquatic species (Appendix 2) is not intended to be a comprehensive list of all bacterial diseases affecting fish and crustaceans, but to cover those that represent the major health and economical concerns affecting fish and crustacean aquaculture. A criterion to include them in the appendix was availability of information for the treatment indications in product labels and country treatment guidelines for aquaculture.

Bacterial pathogens causing diseases in fish or crustaceans for which there is no treatment or treatment is not documented in products labels, were not considered for this document. Examples of such pathogens are

Mycobacterium sp. (causative organism of mycobacteriosis in marine, brackish and freshwater fish), Midichloria-like organism (MLO) (causative organism of red mark syndrome (RMS) or strawberry disease in rainbow trout) *Moritella viscosa* (causative organism of winter ulcer disease in salmonids and marine fish), *Pasteurella skyensis* and *P. atlantica* (causative organisms of pasteurellosis in salmon), *Tenacibaculum finnmarkense* (causative organism of tenacibaculosis in salmonids), *Vibrio parahaemolyticus* (causative organism of acute hepatopancreatic necrosis diseases (AHPND) in Penaeid shrimps/prawns), *Weissella ceti* (causative organism of weisellosis in rainbow trout).

The names of the pathogens, in Appendix 2, are listed alphabetically and follow the updated taxonomy. However, where there have been recent taxonomic revisions, older names are also indicated. The names of the diseases caused by the listed pathogens are those most used. The names of susceptible hosts are broadly categorized or grouped under the main taxonomical families (or orders) with examples in parenthesis when appropriate.

The antimicrobial classes and sub-classes covered in Appendix 3 are only those that include antibiotics which products are authorized for use in aquaculture.

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6. Abbreviations

VCIA Veterinary Critically Important Antimicrobial Agents
VHIA Veterinary Highly Important Antimicrobial Agents
VIA Veterinary Important Antimicrobial Agents

7. Appendices

Appendix 1a: Members of the *ad hoc* Group on Technical Reference for Aquatic Animals.
Appendix 1b: Experts/organizations reviewers.
Appendix 2: List of major bacterial pathogens and diseases affecting aquatic species.
Appendix 3: Antimicrobial classes used in veterinary medicine for aquatic infections.

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Table of antimicrobial agents used in fish and crustacean aquaculture

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
AMINOCOUMARIN			x	Novobiocin	AVI, BOV, CAP, OVI	Not used	
AMINOCYCLITOL	x			Spectinomycin	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
AMINOGLYCOSIDES	x			Dihydrostreptomycin	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	The aminoglycoside + 2 deoxystreptamine neomycin is used to treat infections caused by *Aeromonas*, *Edwardsiella* and *Vibrio* in fish and crustaceans.
				Streptomycin	API, AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
AMINOGLYCOSIDES + 2 DEOXYSTREPTAMINE	x			Amikacin (Synonym: amikacillin, amikacin)	EQU	Not used	
				Apramycin	AVI, BOV, LEP, OVI, SUI	Not used	
				Astromycin (INN) (Synonims: Fortimycin)	BOV, LEP, OVI, SUI	Not used	
				Framycetin	BOV, CAP, OVI	Not used	
				Gentamicin	AVI, BOV, CAM, CAP, EQU, LEP, OVI, SUI	Not used	
				Kanamycin	AVI, BOV, EQU, SUI	Not used	
				Neomycin	API, AVI, BOV, CAP, **CRU**, EQU, LEP, OVI, **PIS**, SUI	Used	
				Paromomycin	AVI, BOV, CAP, OVI, LEP, SUI	Not used	
				Tobramycin (Synonym: Tobramicin)	EQU	Not used	

[5] Criteria for categorization described in the *List of Antimicrobial Agents of Veterinary Importance*
[6] Species abbreviations described in *List of Antimicrobial Agents of Veterinary Importance*
[7] Abbreviations for aquatic species in relation to the *List of Antimicrobial Agents of Veterinary Importance*: **PIS**: molecules considered as used in finfish; **CRU**: new species denomination for molecules considered as used in crustaceans

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
AMPHENICOLS	x			Florfenicol (vet only)	AVI, BOV, CAP, **CRU**, EQU, LEP, OVI, **PIS**, SUI	Used	Amphenicols are broad spectrum antibiotics used for treatment of a wide range of bacterial diseases of freshwater and marine fish
				Thiamphenicol	AVI, BOV, CAP, OVI, **PIS**, SUI	Used	
ANSAMYCINS - RIFAMYCINS		x		Rifampicin (synonym: rifampin)	EQU	Not used	
				Rifaximin	BOV, CAP, EQU, LEP, OVI, SUI	Not used	
ARSENICALS			x	Nitarsone	AVI, SUI	Not used	
				Roxarsone	AVI, SUI	Not used	
BICYCLOMYCIN			x	Bicozamycin (Synonym: Bicyclomycin)	BOV, SUI	Not used	
CEPHALOSPORINS		x					
Cephalosporin 1st G				Cefacetrile (Synonyms: Cephacetrile, Cefacetril, Cephacetril)	BOV	Not used	
				Cefalexin (Synonyms: Cephalexin, Cephacillin, Cephalexine, Cefalexine)	AVI, BOV, CAP, EQU, OVI, SUI	Not used	
				Cefalonium (vet only) (Synonyms: Cephalonium, Cefalonum)	BOV, CAP, OVI	Not used	
				Cefalotin	EQU	Not used	
				Cefapirin (INN) (Synonyms: Cephapirin, Cefapyrin)	BOV	Not used	
				Cefazolin (Synonyms: Cephazolin, Cephazoline, Cephazolidin)	BOV, CAP, OVI	Not used	
Cephalosporin 2nd G				Cefuroxime	BOV	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
Cephalosporin 3rd G	x			Cefoperazone	BOV, CAP, OVI	Not used	
				Ceftiofur (vet only)	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
				Ceftriaxone	BOV, OVI, SUI	Not used	
Cephalosporin 4th G				Cefquinome (vet only)	BOV, CAP, EQU, LEP, OVI, SUI	Not used	
FUSIDANE			x	Fusidic acid	BOV, EQU	Not used	
IONOPHORES		x		Lasalocid	AVI, BOV, LEP, OVI	Not used	
				Maduramicin	AVI	Not used	
				Monensin	API, AVI, BOV, CAP	Not used	
				Narasin	AVI, BOV	Not used	
				Salinomycin	AVI, LEP, BOV, SUI	Not used	
				Semduramicin	AVI	Not used	
LINCOSAMIDES		x		Lincomycin	API, AVI, BOV, CAP, OVI, **PIS**, SUI	Used	Lincosamides are mainly used for infections caused by *Streptococcus* spp. and *Lactococcus* spp.
				Pirlimycin (vet only)	BOV, SUI	Not used	
MACROLIDES	x						Macrolides are broad spectrum antibiotics for treatment and control of bacterial diseases in aquatic animals, both for marine and freshwater species. They are used for infections with *Streptococcus* spp., *Lactococcus* spp., intracellular bacteria such as *Renibacterium salmoninarum* and *Francisella* sp., and against *Chlamydia* sp.
Macrolides 14-membered ring				Erythromycin	API, AVI, BOV, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
				Oleandomycin	BOV	Not used	
Macrolides 15-membered ring				Gamithromycin (vet only)	BOV	Not used	
				Tulathromycin (vet only)	BOV, SUI	Not used	
Macrolides 16-membered ring				Carbomycin	AVI	Not used	
				Josamycin	SUI	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
				Kitasamycin (vet only)	AVI, **PIS**, SUI	Used	
				Mirosamicin (INN) (Synonyms: Mirosamycin, Miporamicin)	API, AVI, SUI	Not used	
				Spiramycin	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
				Terdecamycin	SUI	Not used	
				Tildipirosin (vet only)	BOV, SUI	Not used	
				Tilmicosin (vet only)	AVI, BOV, CAP, LEP, OVI, **PIS**, SUI	Used	
				Tylosin (vet only)	API, AVI, BOV, CAP, LEP, OVI, SUI	Not used	
				Tylvalosin (vet only)	AVI, SUI	Not used	
Macrolides 17-membered ring				Sedecamycin (Synonym: Lankacidin A)	SUI	Not used	
ORTHOSOMYCINS			x	Avilamycin (vet only)	AVI, LEP, SUI	Not used	
PENICILLINS	x						Semi-synthetic penicillins (amoxicillin and ampicillin) are widely used in aquaculture for treatment of bacterial diseases in most species of farmed fish, particularly for infections with *Aeromonas* spp., *Photobacterium* sp., and *Streptococcus* spp.
Natural penicillins (including esters and salts)				Benethamine penicillin	BOV	Not used	
				Benzylpenicillin (Synonym: Penicillin G, Benzylpenicillin G, Benzopenicillin, Benzyl Penicillin)	AVI, BOV, CAM, CAP, EQU, LEP, OVI, SUI	Not used	
				Procaine Benzylpenicillin (INN) (Synonyms: Benzylpenicillin procaine, Procaine G penicillin) / Benzathine Benzylpenicillin (INN) (Synonyms:	AVI, BOV, CAM, CAP, EQU, OVI, SUI	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
				Benzathine penicillin, Benzathine Penicillin G)			
				Penethamate hydriodide (vet only)	BOV	Not used	
Amidinopenicillins				Mecillinam (Synonyms: Amdinocillin, Hexacillin, Penicillin HX)	BOV, SUI	Not used	
Aminopenicillins				Amoxicillin (Synonym: Amoxycillin)	AVI, BOV, CAP, EQU, OVI, **PIS**, SUI	Used	
				Ampicillin	AVI, BOV, CAP, EQU, OVI, **PIS**, SUI	Used	
				Hetacillin (Synonym: Phenazacillin)	BOV	Not used	
Aminopenicillin plus betalactamase inhibitor				Amoxicillin + clavulanic acid	AVI, BOV, CAP, EQU, OVI, SUI	Not used	
				Ampicillin + sulbactam	BOV, SUI	Not used	
Carboxypenicillins				Ticarcillin	EQU	Not used	
				Tobicillin		Not used	
Ureidopenicillins				Aspoxicillin	BOV, SUI	Not used	
Phenoxypenicillins				Pheneticillin (Synonyms: phenethicillin, Penicillin B)	EQU	Not used	
				Phenoxymethylpenicillin (Synonyms: Penicillin V, Pen V, Penicillin phenoxymethyl, Phenoxymethyl penicillin, Beromycin, Oraxillin)	AVI, SUI	Not used	
Antistaphyloccocal penicillins				Cloxacillin (Synonym: Methocillin S)	BOV, CAP, EQU, OVI, SUI	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
				Dicloxacillin (Synonym: Dicloxacyline)	BOV, CAP, EQU, OVI, SUI	Not used	
				Nafcillin (Synonym: Naphcillin)	BOV, CAP, OVI	Not used	
				Oxacillin (Synonyms: Oxazocillin, MPI-Penicillin)	BOV, CAP, EQU, OVI, SUI	Not used	
PHOSPHONIC ACID DERIVATIVES		x		Fosfomycin (Synonyms: Phosphomycin, Phosphonomycin)	AVI, BOV, **PIS**, SUI	Used	Fosfomycin, a Phosphonic acid derivatives, are used to treat infections with *Photobacterium damselae* and Edwardsiellosis in marine fish, and infections with *Streptococcus iniae* in tilapia.
PLEUROMUTILINS		x		Tiamulin (vet only) (Synonym: Thiamutilin)	AVI, CAP, LEP, OVI, **PIS**, SUI	Used	Pleuromutilins such as tiamulin are used to treat infections with *Tenacibaculum dicentrarchi* in salmon.
				Valnemulin (vet only)	SUI	Not used	
POLYPEPTIDES		x		Bacitracin	AVI, BOV, LEP, SUI, OVI	Not used	
				Enramycin	AVI, SUI	Not used	
				Gramicidin	EQU	Not used	
Polymyxins				Polymyxin B (Synonym: Polymixin B)	BOV, CAP, EQU, LEP, OVI	Not used	
				Colistin (INN) (Synonym: Polymyxin E)	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
QUINOLONES							First generation quinolones such as flumequine and oxolinic acid, and second-generation fluoroquinolones, such as enrofloxacin, and ciprofloxacin, are used to treat a wide variety of
Quinolones 1G		x		Flumequine (INN) (Synonym: Flumequin)	AVI, BOV, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
				Miloxacin		Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
				Nalidixic acid (Synonyms: Nalixidate, Nalidixinic acid, Nalidic acid)	BOV	Not used	bacterial infections in marine and freshwater species, and crustaceans. Fluoroquinolones are subject to specific recommendations in the OIE List of Antimicrobial Agents of Veterinary Importance
				Oxolinic acid	AVI, BOV, LEP, **PIS**, SUI, OVI	Used	
Quinolones 2G (Fluoroquinolones)	x			Ciprofloxacin	AVI, BOV, **PIS**, SUI	Used	
				Danofloxacin (vet only)	BOV, CAP, LEP, OVI, SUI	Not used	
				Difloxacin	AVI, BOV, LEP, SUI	Not used	
				Enrofloxacin (vet only)	AVI, BOV, CAP, **CRU**, EQU, LEP, OVI, **PIS**, SUI	Used	
				Marbofloxacin (vet only)	BOV, EQU, LEP, SUI	Not used	
				Norfloxacin	AVI, BOV, CAP, LEP, OVI, SUI	Not used	
				Ofloxacin	AVI, SUI	Not used	
				Orbifloxacin (vet only)	BOV, SUI	Not used	
				Sarafloxacin		Not used	
QUINOXALINES			x	Carbadox (vet only)	SUI	Not used	
				Olaquindox (vet only) (Synonym: Olachindox)	SUI	Not used	
SULFONAMIDES	x			Phthalylsulfathiazole (vet only) (Synonyms: Sulfathalidine, Phthalazol, Phthalylsulphathiazole, Phthalylsulfonazole)	SUI	Not used	Sulfonamides are used typically in combination with diaminopyrimidines in infections caused by a wide range of bacterial diseases in freshwater and marine fish.
				Sulfacetamide (Synonyms: Sulphacetamide, Acetosulfamine, Acetosulfamin, N-Acetylsulfanilamide)	AVI, BOV, OVI	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
				Sulfachlorpyridazine (Synonym: Sulfachloropyridazine)	AVI, BOV, SUI	Not used	
				Sulfadiazine (Synonyms: Sulphadiazine, Sulfapyrimidine, Sulfadiazin, Sulfazine, Sulfadiazene)	AVI, BOV, CAP, OVI, **PIS**, SUI	Used	
				Sulfamethoxazole (INN) (Synonyms: Sulfadimethoxazole, Sulphamethoxazole, Sulfisomezole)	AVI, BOV, SUI	Not used	
				Sulfadimethoxine (Synonyms: Sulphadimethoxine, Sulfadimethoxin, Sulfadimethoxydiazine)	AVI, BOV, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
				Sulfadimidine (Synonyms: Sulfamethazine USAN, Sulfadimethyldiazine, Sulfamezathine, Sulfamethazine, Sulfadimerazine)	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
				Sulfadoxine (Synonyms: Sulphadoxine, Sulforthomidine, Sulphormethoxine, Sulfadoxin)	AVI, BOV, EQU, OVI, SUI	Not used	
				Sulfafurazole (Synonyms: sulfisoxazole USAN, Sulphafurazole, Sulfisoxazol, Sulfafurazol)	BOV	Not used	
				Sulfaguanidine (Synonyms: Sulfaguanidin, Sulphaguanidine,	AVI, CAP, OVI	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
				Sulfanilguanidine, Sulfoguanidine)			
				Sulfamerazine (Synonyms: Sulphamerazine, Sulfamerazin, Sulfamethyldiazine)	AVI, BOV, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
				Sulfamethoxydiazine (INN) (Synonyms: Sulfamethoxine, Sulfameter, Sulfamethoxydiazine, Sulfamethoxypyrimidine	AVI, SUI	Not used	
				Sulfamonomethoxine (Synonyms: Sulfamonomethoxin, Sulfamonmethoxine)	AVI, **PIS**, SUI	Used	
				Sulfanilamide (Synonyms: Sulphanilamide, Sulfamine, Sulfonylamide)	BOV, CAP, OVI	Not used	
				Sulfapyridine (Synonym: Sulphapyridine)	BOV, SUI	Not used	
				Sulfaquinoxaline (Synonyms: Sulfabenzpyrazine, Sulphaquinoxaline)	AVI, BOV, CAP, LEP, OVI	Not used	
				Sulfamethoxypyridazine (Synonyms: Sulphamethoxypyridazine, Sulfapyridazine, Sulfametoxipiridazine)	AVI, BOV, EQU, SUI	Not used	
				Sulfisozole sodium	**PIS**	Used	
				Ormetoprim (INN) (Synonyms: Ormethoprim,	AVI, **PIS**	Used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation[5]			Molecules	Species[6 7]	Used/not used in fish/crustacean	Specific comments for aquatic species by class
	VCIA	VHIA	VIA				
Sulfonamides + diaminopyrimidines				Ormetorprim) + sulfonamide[8]			
				Trimethoprim (synonym: Trimetoprim) + sulfonamide	AVI, BOV, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
DIAMINOPYRIMIDINES				Baquiloprim	BOV, SUI	Not used	
				Ormetoprim (INN) (Synonyms: Ormethoprim, Ormetorprim)	AVI	Not used	
				Trimethoprim (Synonym: Trimetoprim)	AVI, BOV, CAP, EQU, LEP, OVI, SUI	Not used	
STREPTOGRAMINS			x	Virginiamycin (vet only) (Synonym: Pristinamycin)	AVI, BOV, OVI, SUI	Not used	
TETRACYCLINES	x			Chlortetracycline	AVI, BOV, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	Tetracyclines are broad spectrum antibiotics used for treatment of a wide range of bacterial diseases of freshwater and marine fish, and crustaceans.
				Doxycycline (Synonyms: Doxytetracycline, Doxycyclin)	AVI, BOV, CAM, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
				Oxytetracycline (Synonyms: Oxyterracine, Oxytetracyclin, Oxitetracyclin)	API, AVI, BOV, CAM, CAP, **CRU**, EQU, LEP, OVI, **PIS**, SUI	Used	
				Tetracycline (Synonym: Tetracyclin)	API, AVI, BOV, CAM, CAP, EQU, LEP, OVI, **PIS**, SUI	Used	
THIOSTREPTON			x	Nosiheptide	SUI	Not used	

[8] Replacing Ormetoprim + Sulfadimethoxine in the *List of Antimicrobial Agents of Veterinary Importance*

Appendix 1a

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Appendix 2

LIST OF MAJOR BACTERIAL PATHOGENS AND DISEASES AFFECTING AQUATIC SPECIES SPECIES

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Pathogens[9]	Examples of diseases	Examples of susceptible host species
Fish		
Aeromonas spp. (*A. caviae, A. hydrophila, A. veronii*)	Motile *Aeromonas septicaemia*	Cyprinids (carps), Salmonids (salmon, trout), Siluriformes (catfish)
Aeromonas salmonicida	Furunculosis	Cichlids (tilapia), marine fish (various species), Salmonids (salmon, trout)
Chlamydia sp.	Epitheliocystis	Cichlids (tilapia), Siluriformes (catfish)
Edwardsiella ictaluri	Enteric septicaemia of catfish	Siluriformes (catfish)
Edwardsiella piscicida (formerly *E. tarda*)	Edwardsiellosis	Anguilliformes (eel), Cichlids (tilapia), marine fish (various species), Plecoglossids (ayu), Salmonids (trout), Siluriformes (catfish)
Flavobacterium branchiophilum	Bacterial gill disease	Salmonids (salmon, trout)
*Flavobacterium columnare (*formerly *Flexibacter columnaris)*	Columnaris disease	Cichlids (tilapia), Cyprinids (carp), Salmonids (salmon, trout), Siluriformes (catfish)
Flavobacterium psychrophilum	Bacterial cold water disease, rainbow trout fry syndrome	Plecoglossids (ayu), Salmonids (salmon, trout)
Francisella spp.	Francisellosis	Cichlids (tilapia), marine fish (various species), Siluriformes (catfish)
Lactococcus garvieae, L. petauri	Piscine Lactococcosis	Cichlids (tilapia), marine fish (various species), Salmonids (trout)
Nocardia spp.	Nocardiosis	Cichlids (tilapia), marine fish (various species)
Photobacterium damselae subsp. *piscicida (formerly Pasteurella piscida), P. damselae* subsp. *damselae*	Pseudotuberculosis, pasteurellosis, photobacteriosis	Cichlids (tilapia), marine fish (various species), Salmonids (salmon, trout),
Piscirickettsia salmonis	Piscirickettsiosis	Salmonids (salmon, trout)
Pseudomonas spp.	Pseudomoniasis, *Pseudomonas septicaemia*	Siluriformes (catfish)

[9] In parenthesis are examples of common pathogenic species

Pathogens[9]	Examples of diseases	Examples of susceptible host species
Pseudomonas anguilliseptica	Red spot disease, Pseudomoniasis	Anguilliformes (eel)
Renibacterium salmoninarum	Bacterial kidney disease	Salmonids (salmon, trout)
Streptococcus spp. (*S. iniae, S. agalactiae*)	Streptococcosis	Cichlids (tilapia), marine fish (various species), Salmonids (salmon, trout), Siluriformes (catfish)
Tenacibaculum dicentrarchi	Tenacibaculosis	Salmonids (salmon, trout)
Tenacibaculum maritimum (formerly *Flexibacter maritimus*)	Marine flexibacteriosis, tenacibaculosis	Marine fish (various species), Salmonids (salmon, trout)
Vibrio anguillarum (formerly *Listonella anguillarum*)	Classical vibriosis	Cichlids (tilapia), Plecoglossids (ayu), marine fish (various species), Salmonids (salmon, trout), Siluriformes (catfish)
Vibrio spp. (*V. harveyi, V. ordalii*)	Atypical vibriosis	Marine fish (various species), Salmonids (salmon)
Aliivibrio salmonicida (formerly *Vibrio salmonicida*)	Cold water vibriosis	Plecoglossids (ayu), Salmonids (salmon, trout)
Yersinia ruckeri	Enteric redmouth disease, yersiniosis	Salmonids (salmon, trout)
Crustaceans		
Aeromonas spp.	*Aeromoniasis*	Penaeid shrimp/prawn
Aerococcus viridans	Gaffkemia, red tail	American lobster
"Candidatus hepatobacter penaei"	Necrotising hepatopancreatitis	Penaeid shrimp/prawn
Rickettsia spp.	Rickettsiosis	Penaeid shrimp/prawn
Vibrio spp. (*V. harveyi, V. alginolyticus*)	Vibriosis	Penaeid shrimp/prawn

Appendix 3

ANTIMICROBIAL CLASSES USED IN VETERINARY MEDICINE FOR AQUATIC SPECIES INFECTIONS

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FINFISH	*Aeromonas* spp. (*A. caviae, hydrophila, A. veronii*) - Motile aeromonas septicaemia	*Aeromonas salmonicida* – Furunculosis	*Chlamydia* sp. - Epitheliocystis	*Edwardsiella ictaluri* – Enteric septicaemia of catfish	*Edwardsiella piscicida* – Edwardsiellosis	*Flavobacterium branchiophilum* – Bacterial gill disease	*Flavobacterium columnare* – Columnaris	*Flavobacterium psychrophilum* – Cold water disease, rainbow trout fry syndrome	*,Francisella* spp. – Francisellosis	*Lactococcus garvieae, L. petauri* – Lactococcosis	*Nocardia* sp. – Nocardiosis	*Photobacterium damselae piscicida, P. damselae subsp damselae* – *Photobacteriosis, pseudotuberculosis, pasteurellosis*	*Piscirickettsia salmonis* – Piscirickettsiosis
AMINOGLYCOSIDES + 2 DEOXYSTREPTAMINE	X	X		X	X								
AMPHENICOLS	X	X		X	X	X	X	X	X	X		X	X
LINCOSAMIDES										X			
MACROLIDES			X			X	X		X	X			
PENICILLINS	X	X										X	
PHOSPHONIC ACID DERIVATIVES					X							X	
PLEUROMUTILINS													
QUINOLONES 1st Gen	X	X			X			X				X	X
QUINOLONES 2ND G (FLUOROQUINOLONES)	X	X			X		X	X		X		X	
SULFONAMIDES	X	X					X				X	X	
SULFONAMIDES + DIAMINOPYRIMIDINES	X	X		X	X		X					X	
TETRACYCLINES	X	X	X		X	X	X	X	X	X		X	X

FINFISH (cont.)	*Pseudomonas* spp. – Pseudomoniasis, Pseudomonas septicaemia	*Pseudomonas anguilliseptica* – Red spot disease, pseudomoniasis	*Renibacterium salmoninarum* – Bacterial kidney disease	*Streptococcus* spp. (*S. agalactiae, S. iniae*) – Streptococcosis	*Tenacibaculosis dicentrarchi* – Tenacibaculosis	*Tenacibaculum maritimum* – Marine flexibacteriosis, tenacibaculosis	*Vibrio anguillarum* – Vibriosis	*Vibrio* spp. (*V. harveyi, V. ordalii*) – Atypical vibriosis	*Alivibrio salmonicida* – Cold water vibriosis	*Yersinia ruckeri* – Redmouth disease
AMINOGLYCOSIDES + 2 DEOXYSTREPTAMINE							X			
AMPHENICOLS			X	X		X	X	X	X	X
LINCOSAMIDES				X						
MACROLIDES			X	X						
PENICILLINS				X						
PHOSPHONIC ACID DERIVATIVES				X						
PLEUROMUTILINS					X					
QUINOLONES 1st Gen		X				X	X	X		X
QUINOLONES 2ND G (FLUOROQUINOLONES)	X		X	X		X	X		X	X
SULFONAMIDES				X			X	X	X	
SULFONAMIDES + DIAMINOPYRIMIDINES				X		X	X			X
TETRACYCLINES	X		X	X		X	X	X	X	X

CRUSTACEANS	*Aeromonas* spp. – Aeromoniasis	*Aerococcus viridans* – Gaffkemia, red tail	*Candidatus Hepatobacter vanamei* – *Necrotising hepatopancreatitis*	*Rickettsia* spp. – Rickettsiosis	*Vibrio* spp. – Vibriosis
AMINOGLYCOSIDES + 2 DEOXYSTREPTAMINE	X				X
AMPHENICOLS			X		X
QUINOLONES 2ND G (FLUOROQUINOLONES)	X			X	X
TETRACYCLINES	X	X	X	X	X

Annex V. Technical Reference Document Listing Antimicrobial Agents of Veterinary Importance for Swine

An appendix to the List of antimicrobial agents of veterinary importance

MEETING OF THE WOAH WORKING GROUP ON ANTIMICROBIAL RESISTANCE

Paris, 4 to 6 October 2022

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1. Scope

The objective of this *Technical Reference Document Listing Antimicrobial Agents of Veterinary importance for Swine* (hereafter, referred as the "Technical Reference Document), is to provide additional, species specific information without serving as a treatment guideline. By identifying antimicrobial agents used in swine, it can contribute to the development and update of national treatment guidelines, advice on veterinary medical use of veterinary medicinal products and best practice management, risk management, and risk prioritisation to minimise and contain antimicrobial resistance (AMR).

It should be kept in mind that the antimicrobials listed in this technical reference document may not all be available in all countries or be appropriate for use in all stages of the production cycle.

It is acknowledged that the situation is very diverse in different regions for licensing, availability, off-label use, and resistance to antimicrobial agents, and that the general information provided in this document should be interpreted in light of the local context. Antimicrobials used solely for non-medical purposes (i.e. growth promotion) or used off-label for treatment of certain infectious diseases in some geographical regions were not included in the document.

Swine-related recommendations stated in the World Organisation for Animal Health (WOAH) Standards and Guidelines (namely the WOAH List of Antimicrobial Agents of Veterinary Importance, hereafter the "WOAH List") should be considered alongside this document.

2. Methodology to prepare this document

A subgroup from the Antimicrobial Resistance Working Group (Appendix 1a) was nominated by WOAH to work on the development of the Swine Technical Reference Document. As a first step, an evidence-guided rapid review was undertaken by the Subgroup to prepare a preliminary table of important bacterial pathogens of swine animals and the antimicrobial agents used to treat these pathogens.

For the preparation of this table of swine pathogens, two globally focused reviews of swine diseases published in the last 20 years were consulted for swine pathogens and recommended treatments. The most detailed review was that contained within Diseases of Swine (Zimmerman *et al.* 2019) and to a lesser extent, within Pig Diseases (Taylor, 1999). To commence the project, a thorough review of the chapters devoted to bacterial diseases (Chapters 47 - 64, pages 743-1002) was undertaken and a table of disease names, causative pathogens and treatment options was compiled.

To assess the completeness of the information extracted from Zimmerman *et al.* (2019), the relevant content in three contemporary guidance documents (the Australian Veterinary Association's Antimicrobial prescribing for pigs 2020; the Swedish Veterinary Association's Guidelines for the use of antibiotics in production animals: cattle, pigs, sheep and goats from 2013 and the Terrestrial Animal Health Code 2021) were examined and new information integrated into the summary draft table of pathogens.

Additional sources of information used were:

- The original answers to a questionnaire sent to WOAH Members in 2006, which formed the basis for the current WOAH List. The answers to this questionnaire contain information on antimicrobials used to treat pathogens by animal species.
- List of antimicrobials authorised for the named species in countries
- Existing specific treatment guidelines
- OIE *ad hoc* Group report on vaccines that can reduce the use of antimicrobials

The end product of the review was a table presenting the following information:

- Disease;
- Pathogen involved;
- Antimicrobial class;
- Antimicrobial sub-class;
- Molecule;
- Comments and other considerations.

Once this table was established by the Subgroup, it was submitted to a panel of external swine health experts (Appendix 1b). These experts were identified through the WOAH Collaborating Centres and the Working Group members and WOAH networks. The experts represented geographical areas with sizeable swine populations and different areas of expertise in swine health management and industry. The experts were asked to address gaps in knowledge identified by the Subgroup and to provide feedback concerning the tables of antimicrobials, list of major pathogens and diseases and the proposed indications for use of antimicrobial groups.

The Subgroup took into consideration the feedback provided by the experts to consolidate the Technical Reference Document. The Subgroup consulted with international non-governmental animal health organisations with whom the WOAH has established a cooperation agreement to also provide feedback on the consolidated Technical Reference Document: HealthforAnimals and the World Veterinary Association.

Endorsement of the final version of the Swine Technical Reference Document was sought from the AMR Working Group and WOAH hierarchy.

3. Summary of differences between the antibiotics listed in the Swine Technical Reference Document and the *List of Antimicrobial Agents of Veterinary Importance*

The Subgroup agreed that the **following molecules should be included as "used"** on the Swine Technical Reference Document, and to **keep the reference to swine (SUI)** in the List: spectinomycin, dihydrostreptomycin, streptomycin, apramycin, gentamicin, kanamycin, neomycin, paromomycin, florfenicol, thiamphenicol, rifaximin, nitarsone, roxarsone, bicozamycin, cefalexin, cefazolin, ceftiofur, ceftriaxone, cefquinome, lincomycin, erythromycin, tulathromycin, josamycin, kitasamycin, mirosamycin, spiramycin, tildipirosin, tilmicosin, tylosin, tylvalosin, avilamycin, benzylpenicillin, benzylpenicillin procaine, amoxicillin, ampicillin, amoxicillin + clavulanic acid, phenoxymethylpenicillin, fosfomycin, tiamulin, valnemulin, bacitracin, enramycin, colistin, flumequine, oxolinic acid, ciprofloxacin, danofloxacin, difloxacin, enrofloxacin, marbofloxacin, norfloxacin, ofloxacin, orbifloxacin, carbadox, phthalylsulfathiazole, sulfachlorpyridazine, sulfadiazine, sulfamethoxazole, sulfadimethoxine, sulfadimidine, sulfadoxine, sulfamerazine, sulfamonomethoxine, sulfapyridine, trimethoprim + sulfonamide, virginamycin, chlortetracycline, doxycycline, oxytetracycline and tetracycline. Sulfamethoxypyridazine was also included as "Used" and moved under "Sulfonamides" class; this antimicrobial agent had been kept previously under "sulfonamides + diaminopyrimidines". This change will also need to be enacted in the Poultry Technical Reference Document and the WOAH List. The change in the WOAH List will be conducted after the main species-specific Technical Reference Documents are finalised.

The Subgroup agreed that the **following molecules should be included as "used"** on the Swine Technical Reference Document, and to **add a reference to swine (SUI)** in the WOAH List: gamithromycin, penethamate hydriodide, polymyxin B (will need to add footnote indicating that this is included as a topical rather than a systemic treatment as a critically important antimicrobial as classified by WHO), sulfacetamide, sulfaguanidine, sulfanilamide (will need to add footnote indicating that is included as a topical rather than a systemic treatment, and may need to check for other antimicrobial agents used topically), sulfaquinoxaline, ormetoprim + sulfonamides (Note: the Subgroup supported the change of the listing of "ormetoprim + sulfadimethoxine" to "ormetoprim + sulfonamides" in line with the terminology used for antimicrobial combinations containing trimethoprim. This change will be enacted in the Poultry Technical Reference Document and in the WOAH List; for the latter, the change will be implemented once all of the main species-specific reference technical documents are finalised).

The Subgroup agreed that the **following molecules should not be included** on the Swine Technical Reference Document (**no change required on the WOAH List**): novobiocin, amikacin, framycetin, tobramycin, rifampicin, cefacetrile, cefalonium, cefalotin, cefapirin, cefuroxime, cefoperazone, fusidic acid, lasalocid, maduramicin, monensin, narasin, semduramicin, oleandomycin, carbomycin, benethamine penicillin, hetacillin, ticarcillin, tobicillin, aspoxicillin, pheneticillin, nafcillin, gramicidin, miloxacin, nalidixic acid, sulfafurazole and ormetoprim.

The Subgroup agreed that the **following molecules should not be included** on the Swine Technical Reference Document, and to **remove the reference to swine (SUI) in the WOAH List**: astromicin, salinomycin, pirlimycin, terdecamycin, sedecamycin, mecillinam, ampicillin + sulbactam, aspoxicillin, cloxacillin, dicloxacillin, oxacillin, olaquindox, sulfametoxydiazine, baquiloprim, trimethoprim and nosiheptide.

The Subgroup agreed to **update the nomenclature of the antimicrobial agents** in the Swine Technical Reference Document with their **Non-Proprietary Names (INNs) in line with international standards**. The old names of the antimicrobial agents were kept as synonyms in the list. The names of antimicrobial agents will also be updated in the Poultry Technical Reference Document and in the WOAH List; the latter will be updated after all the main species-specific technical reference documents are finalised: astromycin (previously listed as fortimycin), cefapirin (cefapyrin), mirosamicin (mirosamycin), procaine benzylpenicillin (benzylpenicillin procaine), benzathine benzylpenicillin (benzathine penicillin), polymyxin B (polymixin B), colistin (polymyxin E), flumequine (flumequin). Furthermore, two sulfonamides that had been previously misnamed were renamed taking into account existing INNs. These will be updated in the Poultry Technical Reference Document and the WOAH List. The latter will be updated after all the main species-specific technical reference documents are finalised): Sulfamethoxazole (previously named as sulfadimethoxazole) and sulfametoxydiazine (sulfamethoxine).

The Subgroup discussed several **antimicrobial agents proposed for inclusion** on the Swine Reference Technical Document that were not previously included on the WOAH List. The Subgroup agreed to add halquinol (class: halogenated hydroxiquinoline) under the VIA category pending re-evaluation of categorisation at a later stage. The new antimicrobial agent and class will not be added to the WOAH List until all main species-specific reference technical documents are finalised. The class and the category attributed will be revised at that time.

The Subgroup agreed that **toltrazuril and amprolium should not be added** to the Swine Technical Reference Document and the OIE List as this is an anticoccidial agent without antibacterial activity. The Subgroup agreed not to include any anticoccidial substances without known antimicrobial action in the list as this is not within the remit of the Group. Furthermore, **bambermycin and efrotomycin were also not added** in the Swine Technical Reference Document as this antimicrobial agents are licensed only for veterinary non-medical use (i.e. growth promotion) in swine .

Thiostrepton has been reclassified as a thiopeptide as this the most accurate classification for nosiheptide according to current scientific evidence.

It was noted by the Subgroup that **Arsenicals** have been withdrawn from the market in some countries/regions due to the detection of tissue residues containing inorganic arsenic, a carcinogen.

4. Criteria for inclusion of pathogens, diseases and antimicrobial classes in the appendices

The list of major bacterial pathogens and diseases affecting swine (Appendix 2) is not intended to be a comprehensive list of all bacterial and microparasitic diseases affecting swine, but to cover those that represent the major health and economical concerns affecting swine reared in commercial production systems. A criterion to include them in the appendix was availability of information for the treatment indications in product labels and country treatment guidelines for swine.

Bacterial and microparasitic pathogens causing diseases in swine for which there is no treatment or treatment are not documented in products labels, were not considered for this document.

The names of the pathogens, in Appendix 2, are listed alphabetically and follow the updated taxonomy. However, where there have been recent taxonomic revisions, older names are also indicated. The names of the diseases caused by the listed pathogens are those most commonly used.

The antimicrobial classes and sub-classes covered in Appendix 3 are only those that include antibiotics which products are authorized for use in swine.

5. References

1. CUTLER R., GLEESON B., PAGE S., NORRIS J., BROWNING G. (2020). Antimicrobial prescribing guidelines for pigs. 60 pages. https://www.ava.com.au/siteassets/resources/fighting-antimicrobial-resistance/antimicrobial-prescribing-guidelines-for-pigs.pdf

2. The Swedish Veterinary Association (2013). Guidelines for the use of antibiotics in production animals. Cattle, pigs, sheep and goats. 55 pages. https://www.svf.se/media/vd5ney4l/svfs-riktlinje-antibiotika-till-produktionsdjur-eng-2017.pdf

3. Iowa State University. College of Veterinary Medicine. Veterinary Diagnostic and Production Animal Medicine. Swine Disease Manual. https://vetmed.iastate.edu/vdpam/FSVD/swine/index-diseases/ . Last updated: 2021. Accessed on the 28th December 2021.

4. OIE (2021). *Terrestrial Animal Health Code*. Paris, France, World Organisation for Animal Health (OIE).

5. TAYLOR D. J. (1999). Pig Diseases. Seventh edition. Bacterial Diseases:108-252.

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6. Abbreviations

VCIA Veterinary Critically Important Antimicrobial Agents
VHIA Veterinary Highly Important Antimicrobial Agents
VIA Veterinary Important Antimicrobial Agents

7. Appendices

Appendix 1a: Members of the Subgroup on Technical Reference Document for Swine.

Appendix 1b: WOAH external experts on swine health and non-governmental animal health organisations acting as external reviewers for the Technical Reference Document on Swine.

Appendix 2: List of major pathogens and diseases affecting swine species.

Appendix 3: Antimicrobial classes used in veterinary medicine for swine infections.

Table of antimicrobial agents used in swine

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
AMINOCOUMARIN			x	Novobiocin	AVI, BOV, CAP, OVI, PIS	Not used	
AMINOCYCLITOL	x			Spectinomycin	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	Aminocyclitol (Spectinomycin) can used to treat infections caused by pathogens such as *Bordetella bronchiseptica*, *Escherichia coli*, *Glaesserella parasuis*, *Lawsonia intracellularis*, *Mycoplasma* spp., *Pasteurella multocida*, *Proteus vulgaris*, *Pseudomonas aeruginosa* and *Salmonella* spp.
AMINOGLYCOSIDES	x			Dihydrostreptomycin	AVI, BOV, CAP, EQU, LEP, OVI, **SUI**	Used	Aminoglycosides can be used to treat infections caused by pathogens such as *Actinobacillus suis*, *Bordetella bronchiseptica*, *Brachyspira hyodysenteriae*, *E. coli* and *Lawsonia intracellularis*, *Pasteurella multocida*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella* spp. and *Staphylococcus* spp.
				Streptomycin	API, AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
AMINOGLYCOSIDES + 2 DEOXYSTREPTAMINE	x			Amikacin (Synonym: amikacillin, amicacin)	EQU	Not used	
				Apramycin	AVI, BOV, LEP, OVI, **SUI**	Used	
				Astromycin (Synonyms: Fortimycin)	BOV, LEP, OVI	Not used	
				Framycetin	BOV, CAP, OVI	Not used	
				Gentamicin	AVI, BOV, CAM, CAP, EQU, LEP, OVI, **SUI**	Used	
				Kanamycin	AVI, BOV, EQU, PIS, **SUI**	Used	
				Neomycin	API, AVI, BOV, CAP, EQU, LEP, OVI, **SUI**	Used	
				Paromomycin	AVI, BOV, CAP, OVI, LEP, **SUI**	Used	
				Tobramycin (Synonym: Tobramicin)	EQU	Not used	
AMPHENICOLS	x			Florfenicol (vet only)	AVI, BOV, CAP, EQU, LEP, OVI,	Used	The wide range of applications and the nature of the

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
					PIS, **SUI**		diseases treated make amphenicols extremely important for veterinary medicine. Amphenicols can be used to treat respiratory disease caused by *Actinobacillus pleuropneumoniae*, *Bordetella bronchiseptica*, *Glaesserella parasuis*, *Mycoplasma hyopneumoniae, Mycoplasma hyorhinis, Pasteurella multocida, Salmonella* spp. *and Streptococcus suis.*
				Thiamphenicol	AVI, BOV, CAP, OVI, PIS, **SUI**	Used	
ANSAMYCINS - RIFAMYCINS		x		Rifampicin (synonym: rifampin)	EQU	Not used	Ansamycins are used for the topical treatment of skin conditions in swine animals caused by different pathogens such as *Staphylococcus* spp.
				Rifaximin	BOV, CAP, EQU, LEP, OVI, **SUI**	Used	
ARSENICALS			x	Nitarsone	AVI, **SUI**	Used	Arsenicals have been withdrawn from the market in some countries/regions due to the detection of tissue residues containing inorganic arsenic, a carcinogen. Used to treat *Brachyspira hyodysenteriae*.
				Roxarsone	AVI, **SUI**	Used	
BICYCLOMYCIN			x	Bicozamycin (Synonym: Bicyclomycin)	BOV, PIS, **SUI**	Used	Bicyclomycin is used to treat *E. coli* and *Salmonella* spp. Infections.
CEPHALOSPORINS		x					Third and fourth generation cephalosporins are subject to specific recommendations in the OIE List of Antimicrobial Agents of Veterinary Importance. Third and fourth generation cephalosporins are indicated for treat several diseases caused by Gram-negative and Gram-positive bacteria such as *Actinobacillus pleuropneumoniae*, *E. coli*, *Glaesserella parasuis*, *Pasteurella multocida*, *Salmonella* spp., *Staphylococcus* spp., and *Streptococcus* spp.
Cephalosporin 1st G				Cefacetrile (Synonyms: Cephacetrile, Cefacetril, Cephacetril)	BOV	Not used	
				Cefalexin (Synonyms: Cephalexin, Cephacillin, Cephalexine, Cefalexine)	AVI, BOV, CAP, EQU, OVI, **SUI**	Used	
				Cefalonium (vet only) (Synonyms: Cephalonium, Cefalonum)	BOV, CAP, OVI	Not used	
				Cefalotin	EQU	Not used	
				Cefapirin (Synonyms:	BOV	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
				Cephapirin, Cefapyrin)			
				Cefazolin (Synonyms: Cephazolin, Cephazoline, Cephazolidin)	BOV, CAP, OVI, **SUI**	Used	
Cephalosporin 2nd G				Cefuroxime	BOV	Not used	
Cephalosporin 3rd G	x			Cefoperazone	BOV, CAP, OVI	Not used	
				Ceftiofur (vet only)	AVI, BOV, CAP, EQU, LEP, OVI, **SUI**	Used	
				Ceftriaxone	BOV, OVI, **SUI**	Used	
Cephalosporin 4th G				Cefquinome (vet only)	BOV, CAP, EQU, LEP, OVI, **SUI**	Used	
FUSIDANE			x	Fusidic acid	BOV, EQU	Not used	
IONOPHORES		x		Lasalocid	AVI, BOV, LEP, OVI	Not used	Ionophores are essential for animal health because they are used to control intestinal parasitic coccidiosis where there are few or no alternatives available, and also have antimicrobial properties. This class is currently only used in animals.
				Maduramicin	AVI	Not used	
				Monensin	API, AVI, BOV, CAP	Not used	
				Narasin	AVI, BOV	Not used	
				Salinomycin	AVI, LEP, BOV	Not used	
				Semduramicin	AVI	Not used	
LINCOSAMIDES		x		Lincomycin	API, AVI, BOV, CAP, OVI, PIS, **SUI**	Used	Lincosamides are very important for the treatment of infections caused by Gram positive and anaerobic bacteria such as *Bacteroides* spp., *Brachyspira hyodysenteriae*, *Erysipelothrix rhusiopathiae*, *Fusobacterium* spp., *Lawsonia intracellularis* and *Mycoplasma* spp., *Staphylococcus* spp. and *Streptococcus* spp.
				Pirlimycin (vet only)	BOV	Not used	
MACROLIDES	x						

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
Macrolides 14-membered ring				Erythromycin	API, AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	The wide range of applications and the nature of the diseases treated make macrolides extremely important for veterinary medicine. Macrolides are indicated to treat respiratory diseases caused by *Actinobacillus pleuropneumoniae*, *Bordetella bronchiseptica*, *Brachyspira hyodysenteriae*, *Glaesserella parasuis*, *Lawsonia intracellularis*, *Mycoplasma hyopneumoniae*, *Pasteurella multocida*, and *Streptococcus* spp.
				Oleandomycin	BOV	Not used	
Macrolides 15-membered ring				Gamithromycin (vet only)	BOV, **SUI**	Used	
				Tulathromycin (vet only)	BOV, **SUI**	Used	
Macrolides 16-membered ring				Carbomycin	AVI	Not used	
				Josamycin	PIS, **SUI**	Used	
				Kitasamycin (vet only)	AVI, PIS, **SUI**	Used	
				Mirosamicin (Synonyms: Mirosamycin, Miporamicin)	API, AVI, PIS, **SUI**	Used	
				Spiramycin	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
				Terdecamycin		Not used	
				Tildipirosin (vet only)	BOV, **SUI**	Used	
				Tilmicosin (vet only)	AVI, BOV, CAP, LEP, OVI, **SUI**	Used	
				Tylosin (vet only)	API, AVI, BOV, CAP, LEP, OVI, **SUI**	Used	
				Tylvalosin (vet only)	AVI, **SUI**	Used	
Macrolides 17-membered ring				Sedecamycin (Synonym: Lankacidin A)		Not used	
ORTHOSOMYCINS			x	Avilamycin (vet only)	AVI, LEP, **SUI**	Used	Avilamycin is used in the treatment of *E. coli* infections
PENICILLINS	x						
Natural penicillins				Benethamine penicillin	BOV	Not used	The wide range of applications and the nature of the

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
(including esters and salts)				Benzylpenicillin (Synonym: Penicillin G, Benzylpenicillin G, Benzopenicillin, Benzyl Penicillin)	AVI, BOV, CAM, CAP, EQU, LEP, OVI, **SUI**	Used	diseases treated make penicillins extremely important for swine. Agents within this class are used in swine to treat infections caused by pathogens such as *Actinobacillus pleumopneumoniae*, *Actinobacillus suis, Actinobaculus suis*, *Brachyspira hyodisenteriae, Erysipelothrix rhusiopathiae*, *E. coli*, *Clostridium perfringens, Glaesserela parasuis, Pasteurella multocida*, *Staphylococcus* spp., *Streptococcus* spp.
				Procaine Benzylpenicillin (Synonyms: Benzylpenicillin procaine, Procaine G penicillin) Benzathine Benzylpenicillin (Synonyms: Benzathine penicillin, Benzathine Penicillin G)	BOV, CAM, CAP, EQU, OVI, **SUI**	Used	
				Penethamate hydriodide (vet only)	BOV, **SUI**	Used	
Amidinopenicillins				Mecillinam (Synonyms: Amdinocillin, Hexacillin, Penicillinn HX)	BOV	Not used	
Aminopenicillins				Amoxicillin (Synonym: Amoxycillin)	AVI, BOV, CAP, EQU, OVI, PIS, **SUI**	Used	
				Ampicillin	AVI, BOV, CAP, EQU, OVI, PIS, **SUI**	Used	
				Hetacillin (Synonym: Phenazacillin)	BOV	Not used	
Aminopenicillin plus betalactamase inhibitor				Amoxicillin + clavulanic acid	AVI, BOV, CAP, EQU, OVI, **SUI**	Used	
				Ampicillin + sulbactam	BOV	Not used	
Carboxypenicllins				Ticarcillin	EQU	Not used	
				Tobicillin	PIS	Not used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
Ureidopenicillins				Aspoxicillin	BOV	Not used	
Phenoxypenicillins				Pheneticillin (Synonyms: phenethicillin, Penicillin B)	EQU	Not used	
				Phenoxymethylpenicillin (Synonyms: Penicillin V, Pen V, Penicillin phenoxymethyl, Phenoxymethyl penicillin, Beromycin, Oraxillin)	AVI, **SUI**	Used	
Antistaphyloccocal penicillins				Cloxacillin (Synonym: Methocillin S)	BOV, CAP, EQU, OVI	Not used	
				Dicloxacillin (Synonym: Dicloxacycline)	BOV, CAP, EQU, OVI	Not used	
				Nafcillin (Synonym: Naphcillin)	BOV, CAP, OVI	Not used	
				Oxacillin (Synonyms: Oxazocillin, MPI-Penicillin)	BOV, CAP, EQU, OVI	Not used	
PHOSPHONIC ACID DERIVATIVES		x		Fosfomycin (Synonyms: Phosphomycin, Phosphonomycin)	AVI, BOV, PIS, **SUI**	Used	Phosphonic Acid Derivatives are indicated for control and treatment of swine diseases caused by pathogens such as: *Actinobacillus pleuropneumoniae*, *E. coli*, *Pasteurella multocida*, *Salmonella* spp., *Staphylococcus aureus* and *Streptococcus* spp.
PLEUROMUTILINS		x		Tiamulin (vet only) (Synonym: Thiamutilin)	AVI, CAP, LEP, OVI, **SUI**	Used	Pleuromutilins are used in treatment of systemic and enteric diseases in swine caused by *Actinobacillus pleuropneumoniae*, *Brachyspira hyodisenteriae, B. pilosicoli, Glaesserella parasuis*, *Lawsonia intracellularis, Mycoplasma hyopneumoniae*, *Pasteurella multocida* and *Streptococcus suis.*
				Valnemulin (vet only)	**SUI**	Used	
POLYPEPTIDES		x		Bacitracin	AVI, BOV, LEP, OVI, **SUI**	Used	Polypeptides have a specific action on the enteric microbiota, especially *Brachyspira hyodysenteriae*, *Clostridium perfringens*, *Staphylococcus* spp. and
				Enramycin	AVI, **SUI**	Used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
				Gramicidin	EQU	Not used	*Streptococcus* spp.
Polymyxins				Polymyxin B[10] (Synonym: Polymixin B)	BOV, CAP, EQU, LEP, OVI, **SUI**	Used	Polymyxins are indicated mainly for the treatment and control of diarrhea caused by gram-negative bacteria such as: *E. coli* and *Salmonella* spp. and in case of mixed infections. Colistin is subject to specific recommendations in the OIE List of Antimicrobial Agents of Veterinary Importance.
				Colistin (Synonym: Polymyxin E)	AVI, BOV, CAP, EQU, LEP, OVI, **SUI**	Used	
QUINOLONES							
Quinolones 1G		x		Flumequine (Synonym: Flumequin)	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	Quinolones of the 1st generation are used in the treatment of respiratory infections caused by *Bordetella* spp., *E. coli* and *Pasteurella* spp.
				Miloxacin	PIS	Not used	
				Nalidixic acid (Synonyms: Nalixidate, Nalidixinic acid, Nalidic acid)	BOV	Not used	
				Oxolinic acid	AVI, BOV, LEP, PIS, OVI, **SUI**	Used	
Quinolones 2G (Fluoroquinolones)	x			Ciprofloxacin	AVI, BOV, **SUI**	Used	Quinolones 2G (Fluoroquinolones) are used to treat infections caused by pathogens such as *Actinobacillus pleuropneumoniae*, *Actinobacillus suis*, *Bordetella bronchiseptica*, *Erysipelothrix rhusiopathiae*, *E. coli*, *Glaesserella parasuis*, *Klebsiella* spp., *Mycoplasma hyopneumoniae*, *Pasteurella multocida*, *Proteus mirabilis*, *Salmonella* spp., *Staphylococcus* spp., *Streptococcus dysgalactiae*, *Streptococcus pneumoniae*, *Streptococcus suis* and *Trueperella pyogenes*. Fluoroquinolones are subject to specific recommendations in the OIE List of Antimicrobial
				Danofloxacin (vet only)	BOV, CAP, LEP, OVI, **SUI**	Used	
				Difloxacin	AVI, BOV, LEP, **SUI**	Used	
				Enrofloxacin (vet only)	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
				Marbofloxacin (vet only)	BOV, EQU, LEP, **SUI**	Used	
				Norfloxacin	AVI, BOV, CAP, LEP, OVI, **SUI**	Used	
				Ofloxacin	AVI, **SUI**	Used	

[10] Polymyxin B is only used topically in swine.

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
				Orbifloxacin (vet only)	BOV, **SUI**	Used	Agents of Veterinary Importance.
				Sarafloxacin	PIS	Not used	
QUINOXALINES			x	Carbadox (vet only)	**SUI**	Used	Carbadox has been withdrawn from the market in some countries/regions due to the detection of carcinogenic tissue residues.Carbadox is used for the treatment of gastrointestinal infections caused by *Brachyspira* spp., *Lawsonia intracellularis* and *Salmonella* spp.
				Olaquindox (vet only) (Synonym: Olachindox)		Not used	
SULFONAMIDES	x			Phthalylsulfathiazole (vet only) (Synonyms: Sulfathalidine, Phthalazol, Phthalylsulphathiazole, Phthalylsulfonazole)	**SUI**	Used	The wide range of applications and the nature of the diseases treated make sulfonamides (sulfas) extremely important for swine. Sulfonamides are used to treat infections caused by pathogens such as *Actinobacillus pleuropneumoniae*, coccidea, *E. coli*, *Glaesserela parasuis*, *Pasteurella multocida*, *Salmonella* spp., *Staphylococcus* spp., *Streptococcus* spp. Often used in combination with trimethoprim.
				Sulfacetamide (Synonyms: Sulphacetamide, Acetosulfamine, Acetosulfamin, N-Acetylsulfanilamide)	AVI, BOV, OVI, **SUI**	Used	
				Sulfachlorpyridazine (Synonym: Sulfachloropyridazine)	AVI, BOV, **SUI**	Used	
				Sulfadiazine (Synonyms: Sulphadiazine, Sulfapyrimidine, Sulfadiazin, Sulfazine, Sulfadiazene)	AVI, BOV, CAP, OVI, **SUI**	Used	
				Sulfamethoxazole (Synonyms: Sulfadimethoxazole Sulphamethoxazole, Sulfisomezole)	AVI, BOV, **SUI**	Used	
				Sulfadimethoxine (Synonyms: Sulphadimethoxine, Sulfadimethoxin,	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
				Sulfadimethoxydiazine)			
				Sulfadimidine (Synonyms: sulfamethazine, Sulfadimethyldiazine, Sulfamezathine, Sulphamethazine, Sulfadimerazine)	AVI, BOV, CAP, EQU, LEP, OVI, **SUI**	Used	
				Sulfadoxine (Synonyms: Sulphadoxine, Sulforthomidine, Sulphormethoxine, Sulfadoxin)	AVI, BOV, EQU, OVI, **SUI**	Used	
				Sulfafurazole (Synonyms: sulfisoxazole, Sulphafurazole, Sulfisoxazol, Sulfafurazol)	BOV, PIS	Not used	
				Sulfaguanidine (Synonyms: Sulfaguanidin, Sulphaguanidine, Sulfanilguanidine, Sulfoguanidine)	AVI, CAP, OVI, **SUI**	Used	
				Sulfamerazine (Synonyms: Sulphamerazine, Sulfamerazin, Sulfamethyldiazine)	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
				Sulfamethoxydiazine (Synonyms: Sulfamethoxine, sulfameter, Sulfamethoxydiazine, Sulfamethoxypyrimidine)	AVI, PIS	Not used	
				Sulfamonomethoxine (Synonyms: Sulfamonomethoxin, Sulfamonmethoxine)	AVI, PIS, **SUI**	Used	
				Sulfanilamide (Synonyms: Sulphanilamide, Sulfamine,	BOV, CAP, OVI, **SUI**	Used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
				Sulfonylamide)			
				Sulfapyridine (Synonym: Sulphapyridine)	BOV, **SUI**	Used	
				Sulfaquinoxaline (Synonyms: Sulfabenzpyrazine, Sulphaquinoxaline)	AVI, BOV, CAP, LEP, OVI, **SUI**	Used	
				Sulfamethoxypyridazine (Synonyms: Sulphamethoxypyridazine, Sulfapyridazine, Sulfametoxipiridazine)	AVI, BOV, EQU, **SUI**	Used	
Sulfonamides + diaminopyrimidines				Ormetoprim (Synonyms: Ormethoprim, Ormetorprim) + Sulfonamide	AVI, PIS, **SUI**	Used	
				Trimethoprim (synonym: Trimetoprim) + sulfonamide	AVI, BOV, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
DIAMINOPYRIMIDINES				Baquiloprim	BOV	Not used	
				Ormetoprim (Synonyms: Ormethoprim, Ormetorprim)	AVI	Not used	
				Trimethoprim (Synonym: Trimetoprim)	AVI, BOV, CAP, EQU, LEP, OVI	Not used	
STREPTOGRAMINS			x	Virginiamycin (vet only)	AVI, BOV, OVI, **SUI**	Used	Virginiamycin important antimicrobial for the treatment of infections caused by *Brachyspira hyodysenteriae* and *Lawsonia intracellularis.*
TETRACYCLINES	x			Chlortetracycline	AVI, BOV, CAP, EQU, LEP, OVI, **SUI**	Used	The wide range of applications and the nature of the diseases treated make tetracyclines extremely important for swine. This class alone or in combination is critically important in the treatment of a wide range of diseases caused by *Actinobacillus pleuropneumoniae*, *Bordetella bronchiseptica*, *Erysipelothrix rhusiopathiae*, *E.*
				Doxycycline (Synonyms: Doxytetracycline, Doxycyclin)	AVI, BOV, CAM, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
				Oxytetracycline (Synonyms: Oxyterracine, Oxytetracyclin,	API, AVI, BOV, CAM, CAP, EQU,	Used	

ANTIMICROBIAL AGENTS (CLASS, SUB-CLASS)	Categorisation			Molecules	Species	Used/not used in pigs	Specific comments for swine by class
	VCIA	VHIA	VIA				
				Oxitetracyclin) Oxyterracyne)	LEP, OVI, PIS, **SUI**		*coli*, *Klebsiella* spp., *Lawsonia intracellularis*, *Mycoplasma hyopneumoniae*, *Pasteurella multocida*, *Salmonella* spp., *Staphylococcus aureus* and *Streptococcus suis*.
				Tetracycline (Synonym: Tetracyclin)	API, AVI, BOV, CAM, CAP, EQU, LEP, OVI, PIS, **SUI**	Used	
THIOPEPTIDES			x	Nosiheptide		Not used	
HALOGENATED HYDROXYQUINOLINES[11]			x	Halquinol	**SUI**	Used	Treatment of diarrhoea caused by *E. coli* and *Salmonella* spp.

[11] This is a new antimicrobial agent; it has received a temporary categorization by the Working Group on Antimicrobial Resistance pending approval by Members.

Appendix 1a

MEMBERS OF THE SUBGROUP ON TECHNICAL REFERENCE DOCUMENT ON SWINE

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Dr Gérard Moulin
FRANCE

Dr Donald Prater
UNITED STATES OF AMERICA

Dr Moritz van Vuuren
SOUTH AFRICA

Ms Babara Freischem
THE NETHERLANDS

Dr Stephen Page
AUSTRALIA

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Appendix 1b

WOAH EXTERNAL EXPERTS ON SWINE HEALTH AND NON-GOVERNMENTAL ANIMAL HEALTH ORGANISATIONS ACTING AS EXTERNAL REVIEWERS FOR THE TECHNICAL REFERENCE DOCUMENT ON SWINE

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Dr Edgar Wayne Johnson
Enable Agricultural Technology Consulting Ltd, CHINA

Dr Jan Dahl
Danish Agriculture & Food Council, DENMARK

Dr Jalusa Deon Kich
Brazilian Corporation on Agricultural Research (EMBRAPA), BRAZIL

Dr Katsumasa Kure
Japanese Veterinary Association for Swine Veterinarians, JAPAN

Dr Lourdes Migura
Centre de Reserca en Sanitat Animal (CReSA), SPAIN

Dr Andreas Palzer
Ludwig-Maximilians-Universität München, GERMANY

Dr Tom Spencer
SOUTH AFRICA

Dr Liz Wagström
National Pork Producers Council
UNITED STATES

HealthforAnimals
BELGIUM
https://www.healthforanimals.org/

World Veterinary Association (WVA)
BELGIUM
https://worldvet.org/

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Appendix 2

LIST OF MAJOR PATHOGENS AND DISEASES AFFECTING SWINE SPECIES

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Pathogens	Examples of diseases
Bacteria	
Actinobacillus pleuropneumoniae	Pleuropneumonia
Actinobacillus suis	Pneumonia, septicaemia
Actinobaculum suis (Eubacterium suis)	Cystitis, pyelonephritis
Bordetella bronchiseptica	Nonprogressive atrophic rhinitis, pneumonia
Brachyspira (Serpulina, Treponema) hyodysenteriae, B. hampsonii, B. suanatina	Swine dysentery
Brachyspira pilosicoli	Porcine colonic spirochetosis (PCS) or intestinal spirochetosis
Clostridium perfringens type A	Mild enteritis, sometimes pseudomembranous chronic enteritis, significant stunting of growth of affected pigs, sudden death in sows.
Clostridium perfringens type C	Neonatal haemorrhagic, necrotic enteritis type C
E. coli	Colibacillosis, edema disease, cystitis, enteritis, mastitis, lactation failure, neonatal septicemia
Erysipelothrix rhusiopathiae	Erysipelas: Septicaemia, arthritis, endocarditis
Glaesserela (Haemophilus) parasuis	Glässer's Disease, fibrinous polyserositis and arthritis
Klebsiella pneumoniae	Septicaemia in piglets, severe coliform mastitis
Lawsonia intracellularis	Acute proliferative haemorrhagic enteropathy (PHE), chronic porcine proliferative enteropathy (PPE)
Mycoplasma hyopneumoniae	Enzootic pneumonia
Mycoplasma hyorhinis	Polyserositis, arthritis
Mycoplasma hyosynoviae	Arthritis
Mycoplasma (*Hemoplasma*, Eperythrozoon) *suis*	Anaemia, icterus, infertility, lactation failure, ear and tail necrosis, pericarditis, unthriftiness
Pasteurella multocida	Progressive atrophic rhinitis, pneumonia, septicaemia
Rhodococcus equi	Granulomatous bronchopneumonia, lymphadenitis

Pathogens	Examples of diseases
Bacteria	
Salmonella enterica	Enterocolitis, meningitis, pneumonia, septicaemia
Staphylococcus aureus	Neonatal septicaemia, subcutaneous abscesses, arthritis, mastitis, vaginitis, metritis and agalactia.
Staphylococcus hyicus	Exudative epidermitis
Streptococcus suis	Septicaemia, meningitis, arthritis, endocarditis, polyserositis
Streptococcus spp.	Navel infection, polyarthritis, pneumonia, polyserositis, impetigo-like infectious dermatitis, upper respiratory disease, pneumonia, pleuritis, pericarditis, mastitis, lymphadenitis, infertility syndromes.
Trueperella (*Corynebacterium, Actinomyces, Arcanobacterium*) *pyogenes*	Vertebral osteomyelitis, arthritis, pneumonia, endocarditis, mastitis, subcutaneous and deep tissue abscesses
Yersinia spp.	Enterocolitis
Coccidia	
Eimeria debliecki, E. neodebliecki, E. scabra, and *E. spinosa*	Diarrhoea, unthriftiness in piglets
Cystoisospora (Isospora) suis	Diarrhoea in piglets

Appendix 3

ANTIMICROBIAL CLASSES USED IN VETERINARY MEDICINE FOR SWINE INFECTIONS

	Actinobacillus pleuropneumoniae infection	A. suis and A. equuli infection	Actinobaculum suis infection	Bordetella bronchiseptica infection	Brachyspira hyodysenteriae, B. hampsonii, B. suanatina infection	B. pilosicoli infection	Coccidia infections	Clostridium perfringens infections	Erysipelothrix spp. infection	E. coli infection	Glaesserella parasuis infection	Klebsiella pneumoniae infection	Lawsonia intracellularis infection	Mycoplasma hyopneumoniae infection	M. hyorhinis and M. hyosynoviae infection	Pasteurella multocida infection	Rhodococcus equii infection	Salmonella spp. infection	Staphylococcus spp.	Streptococcus spp. infections	Trueperella pyogenes infection	Yersinia spp. infection
AMINOCYCLITOL				X						X	X		X	X		X		X				
AMINOGLYCOSIDES				X						X			X					X	X			
AMINOGLYCOSIDES + 2 DEOXYSTREPTAMINE				X	X	X				X			X					X	X			
AMPHENICOLS	X			X							X			X	X	X		X		X		
ANSAMYCINS - RIFAMYCINS																			X			
ARSENICALS					X																	
BICYCLOMYCIN										X								X				
CEPHALOSPORINS	X									X	X					X	X	X	X	X		
LINCOSAMIDES					X				X				X	X	X				X	X		
MACROLIDES	X			X	X						X		X	X		X	X			X		
ORTHOSOMYCINS										X												
PENICILLINS	X	X			X			X	X	X	X					X	X		X	X	X	
PHOSPHONIC ACID DERIVATIVES	X									X						X			X	X		

	Actinobacillus pleuropneumoniae infection	A. suis and A. equuli infection	Actinobaculum suis infection	Bordetella bronchiseptica infection	Brachyspira hyodysenteriae, B. hampsonii, B. suanatina infection	B. pilosicoli infection	Coccidia infections	Clostridium perfringens infections	Erysipelothrix spp. infection	E. coli infection	Glaesserella parasuis infection	Klebsiella pneumoniae infection	Lawsonia intracellularis infection	Mycoplasma hyopneumoniae infection	M. hyorhinis and M. hyosynoviae infection	Pasteurella multocida infection	Rhodococcus equii infection	Salmonella spp. infection	Staphylococcus spp.	Streptococcus spp. infections	Trueperella pyogenes infection	Yersinia spp. infection
PLEUROMUTILINS	X				X	X					X		X	X		X				X		
POLYMYXINS										X								X				
POLYPEPTIDES (OTHER THAN POLYMYXINS)					X			X											X			
QUINOLONES	X	X		X					X	X	X	X		X		X	X	X	X	X	X	X
QUINOXALINES					X	X							X					X				
SULFONAMIDES	X						X			X	X					X		X	X	X		
SULFONAMIDES + DIAMINOPYRIMIDINES	X						X			X	X					X		X	X	X		
STREPTOGRAMINS					X								X									
TETRACYCLINES	X			X					X	X		X	X	X		X		X	X	X		
QUINOLINES										X								X				

Annex VI. Updated Work Programme for the WOAH Working Group on Antimicrobial Resistance

MEETING OF THE WOAH WORKING GROUP ON ANTIMICROBIAL RESISTANCE

Paris, 4 to 6 October 2022

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Subject	Issue/Action	Status	Timeline
OIE List of Antimicrobial Agents of Veterinary Importance, subdivision by species	Poultry subdivision pilot exercise, including development of pilot methodology	completed	April 2021
	Adaptation/application of the methodology to swine	completed	October 2022
	Consideration of other species: completed an initial discussion on prioritisation	completed	April 2022
	Aquatics	completed	October 2022
	Bovine animals	ongoing	April 2024 (tentative)
	Cats and dogs	to start early 2023	April 2024 (tentative)
	Discussion on other animal species [small ruminants, camels, companion animals…]	completed	October 2022
	Discussion on the addition of companion animals	completed	April 2021
	Review of the Main OIE List	future work	
OIE Global AMU database	Transition of data collection from spreadsheet to a database system, expert advice	completed	October 2022
	Refinement of the numerator, denominator (biomass), and reporting	ongoing	
	Having a quantitative reporting option on species level	future work	April 2023
Field level data	Creation of repository of studies and methodologies for data collection	ongoing	TBC
	Creation of guidelines in collaboration with FAO for development of guidelines for Asia and Pacific region	ongoing	TBC
	Guidelines for data collection of aquatic species at field level	ongoing	TBC
OIE work on antiparasitics	Overseeing or supervising	ongoing	
	Update on OIE antiparasitic resistance work	completed	April 2022
Terrestrial and Aquatic OIE Code chapters related to	Submission of first draft of revised TAHC Chapter 6.10 to Terrestrial Animal Health Standards Commission	completed	August 2022

Subject	Issue/Action	Status	Timeline
AMR	Update of the Chapters: TAHC 6.10	in progress	October 2023, TBC
	Discussion of update of other TAHC chapters	future work	March 2023
Alternatives to Antimicrobials (ATA)	Information on categorisation of products	future work	
	Review of related existing information in the OIE Manual	future work	
Substandard and falsified products	Supervising	ongoing	
	Update on OIE work on substandard and falsified veterinary products app project	ongoing	
Monitoring and Evaluation framework for the OIE Strategy on AMR	Framework development	completed	October 2021
	Update on progress and implementation	ongoing	