

External Evaluation to monitor progress towards the objectives of the Global AMR R&D Hub

Case study on the impact of the COVID-19 pandemic on the Global AMR R&D Hub's capacity to achieve desired outcomes

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Executive summary

INTRODUCTION

- Purpose of the case study** This executive summary presents the key findings from the assessment of the impact of the COVID-19 pandemic on the Global AMR R&D Hub's capacity to achieve desired outcomes. These findings will primarily inform the evaluation questions focusing on the Hub's impact and sustainability among others in the draft final report of the evaluation.
- Methodology** We evaluated the extent to which the Hub's capacity to achieve its desired short-term objectives has been affected through the analysis of the impact at the operational level, and long-term objectives at the strategic level. The assessment at the operational and strategic levels was informed by the mapping of 15 key AMR R&D initiatives, desk research and review of the Hub's operational documents. These findings were complemented with the feedback from the interviews with the Hub's Secretariat, BoM, and external stakeholders in the global AMR R&D field.

KEY FINDINGS

- Operational level** The Hub was flexible enough to adapt its operational activities to the emerging challenges and needs in 2020. Most of the technical activities, such as the launch of the Dashboard, continued despite the pandemic. Despite the fact that the pandemic diverted some attention from the Dashboard and AMR R&D topic towards COVID-19, the Dashboard successfully assumed the role of an aggregator for informational resources about AMR R&D.
- The Hub also established new partnerships with other major initiatives in the AMR R&D field, and produced the analytical outputs based on the Dashboard data to derive options for political action. Regarding communication activities, the Hub actively participated in and organised various virtual events and conferences, which further increased the visibility of the Hub's activities. Through the involvement of new members in the BoM and SG, the Hub addressed the gaps in global representation, particularly LMICs, non-human sector and diagnostics.
- Strategic level** In the area of efficient and sustainable allocation of global investments in AMR R&D which concerns the Hub's first pillar, COVID-19 has to a certain extent impacted investment to the AMR R&D field. Some public and private funders decreased their investments in AMR R&D and increased to COVID-19 R&D. However, funding initiatives with a primary focus on AMR R&D maintained their funding in the field or even increased it. Despite that, the need to identify AMR R&D investment gaps, promote increased investments into push and pull incentives, and support the filling of product pipelines with priority candidates remain.
- Coordination and collaborative global efforts in AMR R&D, which are covered in the Hub's second pillar, increasingly shifted towards COVID-19. However, the pandemic revealed the importance of the One Health approach, global coordination, and collaboration, including involvement of LMICs, private sector, and sustainable investments. After the pandemic ends, these aspects could gain leverage to be further promoted in the AMR R&D field.
- In terms of promotion of knowledge and evidence-based practice for policy and decision-makers in AMR R&D which fall in the Hub's third pillar, there is increasing attention dedicated to COVID-19. However, this is also linked to increased awareness about the threat of AMR due to the increasing use of antimicrobials during the pandemic. The lessons learned from the global COVID-19 pandemic may help reinstate AMR on the public health agenda at the global and national level.

1. Introduction

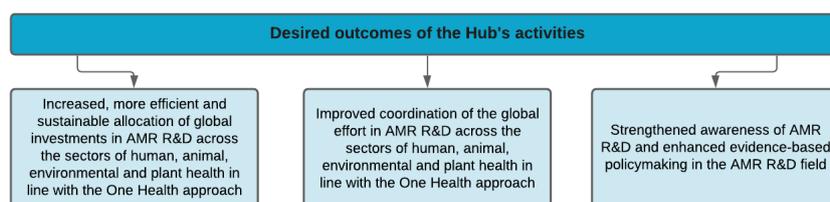
The overarching assumption of the Theory of Change (ToC)¹ model for the evaluation of the Global AMRR&D Hub’s operation was that AMR is a global R&D priority. Since the outbreak of COVID-19 was recognised as a global public health emergency at the start of 2020, the global focus and resources have been increasingly diverted to either mitigating the impact of the pandemic or planning for it.² The WHO R&D Blueprint facilitated a coordinated and accelerated response to COVID-19 which included an unprecedented programme to develop a vaccine, research into potential pharmaceutical treatments and strengthened channels for information sharing between countries.³ Considering these actions and a close link between the issue of AMR and the pandemic, the ongoing global public health crisis may result in a significant shift of the priorities and capabilities within the global AMR R&D field. Taking this into account, this **case study analyses the impact of the COVID-19 pandemic on the Hub’s capacity to achieve its desired outcomes.**

The Hub’s Strategy Paper⁴ sets out the **three pillars** where the Hub’s activities and outputs are expected to lead to specific desired outcomes, including:

- **Guide and support evidence-based decision making**
- **Enhance collaboration and coordination;**
- **Promote awareness, knowledge and visibility.**

These pillars have been defined by the Hub in line with its objectives foreseen in the founding document, the Terms of Reference (ToR)⁵. The desired outcomes of the Hub’s activities and outputs are summarised for each of these pillars in Figure 1. To analyse the extent to which the Hub was able to achieve these outcomes, **we compared the Hub’s planned activities and outputs with its actual outcomes** achieved up to early December 2020. This assessment focused on the **extent to which the progress has been affected by the ongoing pandemic.**

FIGURE 1. DESIRED OUTCOMES OF THE HUB’S ACTIVITIES AND OUTPUTS IN THREE STRATEGIC PILLARS



Source: compiled by the study team based on the Theory of Change model adapted from PPMI (2020). External Evaluation to monitor progress towards the objectives of the Global AMR R&D Hub Inception report. Available at: https://globalamrhub.org/wp-content/uploads/2020/02/Global-AMR-RD-Hub-evaluation_Inception-report_final_2020-01-17.pdf.

¹ PPMI (2020). External Evaluation to monitor progress towards the objectives of the Global AMR R&D Hub Inception report. Available at: https://globalamrhub.org/wp-content/uploads/2020/02/Global-AMR-RD-Hub-evaluation_Inception-report_final_2020-01-17.pdf

² Available at: Policy Cures Research COVID-19 R&D tracker: <https://www.policycuresresearch.org/covid-19-r-d-tracker> ; the OECD Global Science Forum (GSF) Research Funding initiative: <https://community.oecd.org/community/cstp/gsf/research-funding> ; RESIN: COVID-19 R&D funding interactive dashboard:

<https://app.powerbi.com/view?pageName=ReportSection&r=eyJrIjoiMjRlMzRkOTctOTA5OC00MjkxLWVhZmQ0tOGY3ZTk1NzVhYjZkIiwidCI6IjRhNTM3OGY5LTU5ZjQtNGQzZS1iZTg5LTUyOWQwM2FkYTlkOCIsImMiOiJh9>

³ WHO (2020). R&D Blueprint and COVID-19. Available at: <https://www.who.int/teams/blueprint/covid-19>

⁴ Global AMR R&D Hub (2020). Strategy Paper for the Global AMR R&D Hub. Available at: <https://globalamrhub.org/wp-content/uploads/2020/07/Decision03.2020.StrategyPaper1.pdf>

⁵ Global AMR R&D Hub (2019). Terms of Reference. Available at: https://globalamrhub.org/wp-content/uploads/2019/08/ToR_Global_AMR_RD_Hub.pdf

There was a number of actions initiated by the Hub to achieve the desired outcomes may be categorised into operational and strategic activities and outputs. To this end, the analysis of the impact of the pandemic on the Hub's capacity to achieve desired outcomes was twofold:

- **Impact at the operational level** was explored primarily through 6 interviews with the Hub's Secretariat between June and July 2020 and review of the Hub's operational documents (e.g. Work Plan 2018-2021, Dynamic Dashboard Roadmap, Collaboration Framework), Hub's website, Dynamic Dashboard, and event-related material.
- **Impact at the strategic level** was analysed primarily through the 5 interviews with the BoM, SG, and other external stakeholders in October-November 2020, review of documents published⁶, dashboards launched⁷ and events organised by key initiatives in the field of AMR and AMR R&D⁸, and additional desk research.

Overall, we examined the extent to which the Hub's capacity to achieve its desired **short-term objectives** has been affected through the analysis of the impact **at the operational level**, and **long-term objectives – at the strategic level**. Short-term objectives of the Hub include goals with a defined timeline, for example, the launch of the Dynamic Dashboard. The implementation of short-term objectives relates to the Hub's operational level and depends largely on the day-to-day activities carried out by the Hub's Secretariat. The implementation of long-term objectives relates to the Hub's overall strategy in the global AMR R&D field. The long-term objectives aim to advance various aspects of the AMR R&D field and emphasise the Hub's added value to the field. The findings from this case study will feed primarily into the assessment of the evaluation questions focusing on the Hub's impact and sustainability in the draft final report of the evaluation.

Given that the operational activities and outputs were not specific to any strategic pillar of the Hub, the cross-cutting findings on the impact at the operational level were presented in Section 2. The strategic activities and outputs were split into three pillars of the Hub, and the specific findings for each pillar are presented in Section 3.

2. Impact at the operational level

To evaluate the impact of the COVID-19 pandemic on the Hub's capacity to achieve desired outcomes at the operational level, we focused on the **Hub's activities and outputs planned in the Hub's operational documents in the short-term i.e. between the end of 2019 and 2020**. Given that certain planned activities and outputs fell outside this time frame (starting either in 2018 or 2019 or extending to 2021), we took into account the extended timeline in such cases. **These results were compared to the Hub's actual activities and outputs** based on the interviews with the BoM and the Hub's Secretariat. These findings were also supplemented with the additional review of publications from the Hub's website and the Dynamic Dashboard.

Most of the activities and outputs listed in the Hub's Work Plan 2018-2021⁹ **relate to the establishment of the Dynamic Dashboard** (see Annex 1 for more details). These were already completed to a large extent

⁶ Examples of such documents involve "Antibacterial Agents in clinical development. An analysis of the antibacterial clinical development pipeline" (2019) by World Health Organization; "GARDP Strategy 2020-2025: Uniting Against Antibiotic Resistance"; "Financing Pull Mechanisms for Antibiotic-Related Innovation: Opportunities for Europe" by European Union Joint Action on Antimicrobial Resistance and Healthcare-Associated Infections (EU-JAMRAI)

⁷ Example involves Antibacterial products in clinical development for priority pathogens and WHO antibacterial preclinical pipeline review by the World Health Organisation

⁸ Examples of events involve Workshop to identify AMR related research priorities in Africa by ReAct Africa and Swedish International Development Cooperation Agency (Sida); OIE Sub-Regional Conference on AMR Related Research and Information; JPIAMR Regional Workshop Eastern Europe: The role of a Joint Strategic Research and Innovation Agenda at global level for tackling AMR.

⁹ Global AMR R&D Hub (2018). Work Plan 2018-2021. Available at: https://globalamrhub.org/wp-content/uploads/2019/08/Work_Plan_2018-2021_Global_-AMR_-RD_Hub.pdf

during the years 2018-2019 as the Hub prepared to launch the Dashboard. Although the release of the Dashboard was originally scheduled in December 2019, its development was significantly delayed due to the issues which occurred early in procurement process. Once these issues were resolved, the Hub has successfully taken the lead in the development of the Dashboard which ended with the launch of the Dashboard in March 2020 despite the outbreak of the pandemic.

The **subsequent activities** planned for the period of 2020-2021 were primarily **focused on maintaining the smooth roll out of the Dashboard**. These included the collection and analysis of AMR R&D related data as well as advertising and advocating for the Hub and the importance of the AMR topic itself. In this process, a significant part of the activities was foreseen to focus on the expansion of the Dashboard, especially in 2020, based on the Dynamic Dashboard Roadmap¹⁰. Over the course of 2020, the Hub's day to day activities in the area of Dashboard development mostly included revising Dashboard's visuals, improving the content and functionality of the Hub in line with the feedback from the BoM and other users as well as implementing new functionalities in the Dashboard, such as free text search function and download options of project level data.

To advance the reach of the Dashboard in line with the third strategic pillar, the **Hub published a Collaboration Framework**¹¹ in April 2020 **to establish collaboration aimed at further development and sustainability of the Dynamic Dashboard**. Focus areas for collaboration include obtaining information on AMR R&D projects/investments to be included in the Dynamic Dashboard; developing the evidence base to identify where market interventions are needed to incentivise AMR R&D; and identifying and tracking what is currently in the product pipelines. This document includes clearly defined principles for future collaboration with external partners. The success of this collaboration network relies on establishing effective networks and streamlined data collection processes to support AMR R&D initiatives, researchers, developers, industry, funders and countries to contribute information. The Dashboard's success also greatly depends on its ability to provide timely and useful information back to its stakeholders.

The **Hub's operational activities and outputs** outlined in its key operational documents^{12,13,14} may be categorised into three key areas: **Dashboard-related, analysis-related and communication-related**. These categories emerged as the most operational activities and outputs, such as the communication with BoM and stakeholder group (SG) and provision of reports, were not specific to any strategic pillars of the Hub but were rather cross-cutting.

The activities and outputs in the first group '**Dashboard-related**' mainly cover the provision of data for the Dashboard. Although the release of the Dashboard was originally scheduled in December 2019, its development was significantly delayed due to the issues early in procurement process. Once these issues were resolved, the Hub has successfully taken the lead in the development of the Dashboard. However, the **delayed launch of the Dashboard coincided with the first peak of the COVID-19 outbreak** worldwide in March 2020. Thus, some of the global attention which was expected for the Dashboard was directed at the pandemic at the time. The key impact of the pandemic on the Hub's Dashboard-related activities and outputs was the decrease in the amount of research activities on the topic of AMR due to the shift of attention towards COVID-19. **Despite that, the Hub's collection of data in 2020 continued as planned**. As of early December 2020, a total

¹⁰ Global AMR R&D Hub (2019). Dynamic Dashboard Roadmap. Available at: https://globalamrhub.org/wp-content/uploads/2019/08/Roadmap_Dynamic_Dashboard_Global_AMR_RD_Hub.pdf

¹¹ Global AMR R&D Hub (2020). Collaboration Framework. Available at: <https://globalamrhub.org/wp-content/uploads/2020/08/Collaboration-framework-of-the-Global-AMR-RD-Hub.April2020.pdf>

¹² Global AMR R&D Hub (2018). Work Plan 2018-2021. Available at: https://globalamrhub.org/wp-content/uploads/2019/08/Work_Plan_2018-2021_Global_-_AMR_-_RD_Hub.pdf

¹³ Global AMR R&D Hub (2019). Dynamic Dashboard Roadmap. Available at: https://globalamrhub.org/wp-content/uploads/2019/08/Roadmap_Dynamic_Dashboard_Global_AMR_RD_Hub.pdf

¹⁴ Global AMR R&D Hub (2020). Collaboration Framework. Available at: <https://globalamrhub.org/wp-content/uploads/2020/08/Collaboration-framework-of-the-Global-AMR-RD-Hub.April2020.pdf>

of 8,093 projects from 152 funders with a total investment of EUR 5.68 billion were captured in the Dashboard.¹⁵

Overall, the **development of the Dynamic Dashboard consists of the four stages** as showed in Annex 2. While some of them were already completed as of early December 2020, other stages remain to be addressed. The first stage was dedicated to the development and launch of the Dynamic Dashboard, including its first gallery on investments covering the human bacterial infections related AMRR&D data. The content of the Investment gallery is updated daily and is expected to encompass all the One Health sectors in the future. The launch of the animal health AMR R&D data in July 2020 represented the completion of the second stage of the development of the Dynamic Dashboard. At the end of August 2020, the Hub launched the Pipeline¹⁶ and the Incentives¹⁷ galleries which constituted the completion of third stage of the Dashboard's development. In August 2020, Dashboard also presented the data of research organisations under the Investments Gallery. The last stage of Dashboard's development is planned for March 2021 when the Hub will incorporate the plant and environment health related AMR R&D data into the Dashboard.

In the second group, '**Analysis-related**', the activities and outputs **focused more on the analysis and use of the data which have been collected**. The Hub was successful in gathering more experts and establishing new partnerships with other major initiatives in the AMR field (see Annex 1). The COVID-19 pandemic gained increased attention during the months of February and March 2020, limiting the importance of AMR during that time. Despite a delay, the Hub was able to produce the key analytical outputs in 2020 which included the annual report of the Global AMR R&D Hub's Dynamic Dashboard,¹⁸ covering the state of public and philanthropic investments in AMR R&D, and the overview of the Dashboard's galleries. In addition, the Hub has also published the recommendations to the G20 following the first analysis report of Dynamic Dashboard data.¹⁹

The third and final group, concerning '**Communication-related**' activities and outputs, **focused on the efforts undertaken by the Hub to raise the awareness about its work and the topic of AMR R&D**. Through involvement of new members in the BoM and SG, the Hub addressed the gaps in global representation, particularly LMICs, non-human sector and diagnostics. Even though the pandemic caused some events to be cancelled or rescheduled, the Hub was still successful in actively participating in and organising various events and conferences (see Annex 1). As a result, its Dashboard successfully assumed the role as an aggregator for informational resources about AMR R&D. Although more time is needed to evaluate the extent to which the data can be useful for various stakeholders, these efforts already helped to increase the visibility of the Hub and the importance of the AMR R&D topic to some extent despite the pandemic. Based on the findings from the interview programme, the Hub could use its links to the G20 and the UN to stress the importance of AMR R&D further at the national level in various countries in the aftermath of the pandemic.

Overall, the **impact of COVID-19 on the Hub's capacity to achieve desired outcomes at the operational level was limited**. Most of the technical activities were not impacted and continuous progress was made despite the outbreak of the pandemic. If there were any delays or changes to the operational activities and outputs, they were mostly caused by the issues which were not related to the pandemic or those which impacted the means of collaboration worldwide (e.g. most of the in-person meetings were transferred to virtual space in 2020). In terms of the positive impact, the pandemic brings a major opportunity for the Hub to increase the awareness and visibility of the topic of AMR. Given the concentration of focus on the global public health

¹⁵ Global AMR R&D Hub (2020). The 2020 annual report of the Global AMR R&D Hub's Dynamic Dashboard. Available at: <https://globalamrhub.org/wp-content/uploads/2020/11/GlobalAMRHubReportDD.Nov2020.pdf>

¹⁶ Global AMR R&D HUB. Pipeline Gallery overview. Available at: <https://globalamrhub.org/dynamic-dashboard/pipeline-gallery/>

¹⁷ Global AMR R&D Hub | Newsletter. Launch of Incentives Gallery. Available at: <https://archive.newsletter2go.com/?n2g=guv621jn-5bk8qzir-5erpq3sn-2m8>

¹⁸ Available at: <https://globalamrhub.org/wp-content/uploads/2020/11/GlobalAMRHubReportDD.Nov2020.pdf>

¹⁹ <https://globalamrhub.org/wp-content/uploads/2020/11/RecommendationsG20.Nov2020web.pdf>

crisis, the Hub could use the current circumstances to gain more attention and establish itself as a key advocate of AMR R&D with additional proactive measures.

3. Impact at the strategic level

To evaluate the impact of the COVID-19 pandemic on the Hub's capacity to achieve desired outcomes at the strategic level, we focused on the **Hub's activities and outputs planned in the Hub's Strategy Paper²⁰ in the long-term**. These results were **compared to the Hub's actual activities and outputs** based on the interviews with the BoM and external stakeholders, representing mainly the industry and research funders. These findings were supplemented with the additional review of publications on the impact of COVID-19 in the global AMR R&D field as well as the comparison of mapping results for the key initiatives and organisations dedicating efforts to AMR R&D in 2015-2018 and 2019-2020.

The analysis of the impact of the pandemic on the Hub's capacity to achieve desired strategic outcomes **in three strategic pillars of the Hub** outlined in Section 1. These pillars corresponded to the desired outcomes of the Hub's activities and outputs, such as the efficient and sustainable allocation of global investments in AMR R&D, coordination of the global effort in AMR R&D, and awareness of AMR R&D and enhanced evidence-based policymaking.

3.1. Efficient and sustainable allocation of global investments in AMR R&D

One of the desired outcomes of the Hub's activities and outputs involve the improved monitoring and understanding of the global AMR R&D activities, gaps, and investment opportunities. This impact area corresponds to the first strategic pillar of the Hub, namely, to guide and support evidence-based decision making, as well as the following objectives of the Hub:

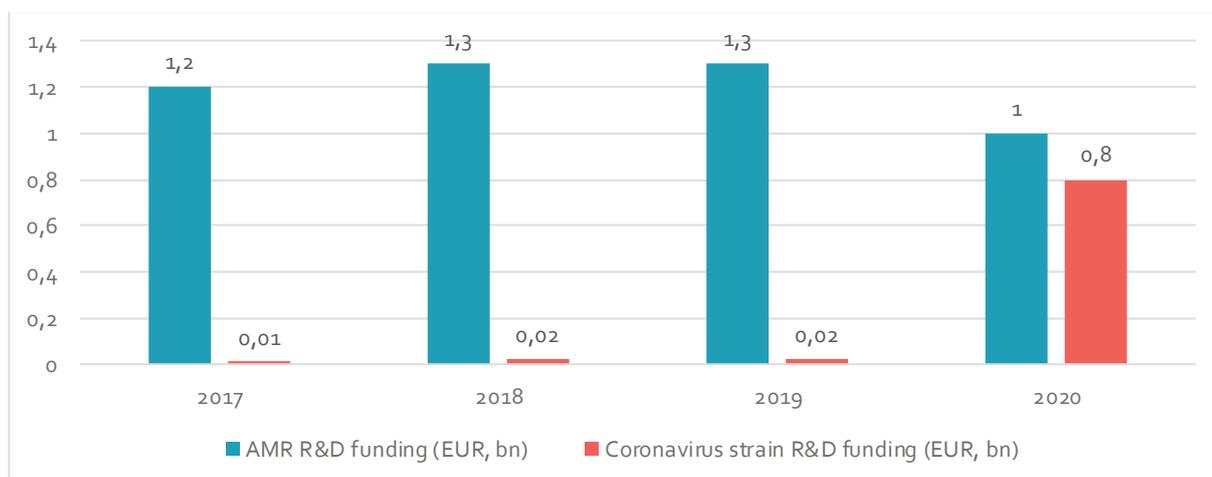
- To inform high-level decision makers on R&D pipelines and other relevant aspects of AMR R&D, in order to identify and prioritise R&D gaps and help focus high-level decision-making;
- To promote increased investments into push and pull incentives for AMR R&D in order to maximize the impact of national and international research activities;
- To support the filling of product pipelines with priority candidates, using an appropriate mix of incentives, in order to develop deployable products, while recognizing the importance of access, prudent use, and stewardship.

To evaluate the impact of the pandemic on the Hub's capacity to achieve desired outcomes in this strategic area, we **analysed the extent to which the overall level of investment in AMR R&D changed** between the period prior to the outbreak of COVID-19 and during the pandemic. Although the current level of investments in AMR R&D could be limited due to the increased attention to COVID-19, it is unclear whether this will affect the AMR R&D field in the long-term, especially after the COVID-19 pandemic ends. However, our consultations with relevant stakeholders confirmed the need for a strategy for efficient and sustainable allocation of global investments in the AMR R&D field.

The review of our 15 key initiatives showed that the **funders, having a primary attention to AMR R&D, increased their investments to AMR R&D by the year despite the COVID-19 pandemic**. The five funders²¹ among the analysed 15 key initiatives and organisations continued to increase the funding dedicated to the

²⁰ Global AMR R&D Hub (2020). Strategy Paper for the Global AMR R&D Hub. Available at: <https://globalamrhub.org/wp-content/uploads/2020/07/Decision03.2020.StrategyPaper1.pdf>

²¹ CARB-X, GARDP, JPIAMR, Innovative Medicines Agency (IMI), Wellcome Trust

FIGURE 2. FUNDING DEDICATED TO AMR R&D VERSUS CORONAVIRUS STRAIN R&D BY COUNTRIES

Source: compiled by the study team based on the data from countries in the Global AMR R&D Dynamic Dashboard and COVID-19 R&D Dashboard established by the University of Southampton (2020).

The shift in the **global health R&D funding, particularly from the public sector and industry, towards COVID-19 R&D has been noted during the interviews** with external stakeholders. While some funders decreased their funding to AMR R&D due to the COVID-19, others continued increasing the funding. Some interviewed stakeholders confirmed that while funding priorities could shift during the pandemic, overall, the funding for AMR R&D will be maintained, especially by those funders, for example, CARB-X and JPIAMR which dedicate their primary attention to AMR R&D field. Given the very recent and rapid increase in the COVID-19 R&D funding, it may be too early to assess whether the decrease in AMR R&D funding is linked to COVID-19. Nevertheless, many of the interviewees recognised the importance of monitoring the impact of the pandemic on AMR R&D funding in the upcoming period.

3.2. Coordination of the global effort in AMR R&D

The Hub's desired outcome of the enhanced global collaboration and coordination among stakeholders in AMR R&D field corresponds to the second strategic pillar and the Hub's objective to foster international research collaboration among different partners globally, including industry and academia. To evaluate the impact of the pandemic on the Hub's capacity to achieve desired outcomes in this strategic area, we analysed the **extent to which various aspects of global effort in the AMR R&D field changed**, including the implementation of the One Health approach, country and international organisations' participation in major AMR R&D initiatives, including Low- or Middle-Income Countries (LMICs), collaborations, including industry involvement, and provision of push and pull incentives across the One Health sectors. The assessment was carried out between the period prior to the outbreak of COVID-19 and during the pandemic.

We reviewed the extent to which the implementation of the One Health approach in the AMR R&D field has changed between 2015-2018 and 2019-2020 based on the mapping of 15 key initiatives. Our mapping efforts revealed that the **global collaboration in the AMR R&D field was still mostly limited to the sectors of human and animal health**, and directed less towards the sectors of environmental and plant health in 2019-2020.³³ However, the lessons learned from the current pandemic may translate to the increasing attention to

³³ During the period of 2015-2018, the most attention in AMR R&D field was dedicated to human health, followed by the animal health, while the limited attention was dedicated to environmental and plant health sectors.

the One Health approach. Our desk research revealed that the application of the One Health approach could potentially improve the governance of response to infectious diseases,³⁴ where policymakers, funders, and the public will need a health–environment system risk management to go beyond currently existing measures regarding COVID-19.³⁵

Similarly, our mapping efforts revealed that in 2019-2020, **15 key AMR R&D initiatives did not attract any new members from LMICs**. Further desk research revealed that while many high-income countries such as United Kingdom and United States struggle to contain the pandemic, many LMICs remain particularly vulnerable in face of the current healthcare emergency in terms of their operational capacities. This is caused mainly by their fragile healthcare systems and limited financial resources.³⁶ The pandemic in many ways resemble the threat of AMR due to its cross-border nature which also highlights the interconnectedness between countries, and the global research response to COVID-19 should involve LMICs to solve the challenges caused by the pandemic globally.³⁷ During our baseline assessment, the importance to involve LMICs was emphasised by the Global Action Plan on AMR by World Health Organisation in order to fully address the complexity of AMR field, and the need for LMICs involvement was further highlighted by the pandemic. The lessons learned from the current pandemic show that there is a **need for coordination of global effort, especially in research, to avoid duplications and to increase benefits from research findings for LMICs**.

Our mapping efforts further showed an **increased attention to the role of the industry in AMR R&D** which was emphasised by the studies, publications, and documents of the key initiatives in the period of 2019-2020, compared to 2015-2018. In the context of COVID-19, industry's involvement is also crucial, especially in the areas of vaccine development.³⁸ To accelerate the development and access of COVID-19 diagnostics, therapeutics, and vaccines, the World Health Organisation expressed the commitment to engage and coordinate stakeholder efforts, involving industry and the private sector.³⁹ As noted by some interviewed stakeholders, collaboration and coordination activities are currently shifted towards COVID-19 R&D, and they could be less available to collaborate in AMR R&D field. However, the attention to AMR R&D collaborations and coordination could shift back once the pandemic is over.

Lastly, our mapping efforts revealed that in the AMR R&D field the **greater attention is still dedicated to push rather than pull incentives**. The need of pull incentives is especially urged by small- to mid-size enterprises (SMEs), as well as other global stakeholders.⁴⁰ A notable example of push incentive which started in 2019 involves the United Kingdom's pilot, where the National Health Service (NHS) aims to pay approximately EUR 20.7 million per year to pharmaceutical companies to develop drugs against AMR, which would work as a subscription model.⁴¹ COVID-19 pandemic could shift the perspective of funders and governments, showing a real global threat of infectious disease, and increasing their attention to the need of

³⁴ Ruckert, A., Zinszer, K., Zarowsky, C., Labonté, R., Carabin, H. (2020). "What role for One Health in the COVID-19 pandemic?" *Can J Public Health*. 2020 Oct; 111(5): 641–644. Doi: 10.17269/s41997-020-00409-z

³⁵ De Garine-Wichatitsky, M., Binot, A., Morand, S., Kock, R., Roger, F., Wilcox, B.A., Caron, A. (2020). "Will the COVID-19 crisis trigger a One Health coming-of-age?" *The Lancet Planetary Health*. DOI: [https://doi.org/10.1016/S2542-5196\(20\)30179-0](https://doi.org/10.1016/S2542-5196(20)30179-0)

³⁶ Verhagen, L.M., de Groot, R., Lawrence, C.A., Taljaard, J., Cotton, M.F., Rabie, H. (2020) "COVID-19 response in low- and middle-income countries: Don't overlook the role of mobile phone communication". *International Journal of Infectious Diseases*, 99, 334–337. <https://doi.org/10.1016/j.ijid.2020.07.069>

³⁷ Stewart, R., El-Harakeh, A., Cherian, S.A. (2020). Evidence synthesis communities in low-income and middle-income countries and the COVID-19 response. *The Lancet*, 396(10262). DOI: [https://doi.org/10.1016/S0140-6736\(20\)32141-3](https://doi.org/10.1016/S0140-6736(20)32141-3)

³⁸ Available at: <https://amractionfund.com/resource/pharmaceutical-companies-are-doing-much-more-than-battling-covid-19/>

³⁹ Available at: <https://www.who.int/news/item/24-04-2020-commitment-and-call-to-action-global-collaboration-to-accelerate-new-covid-19-health-technologies>

⁴⁰ Available at: <https://amr-conference.com/news/conference-summary-push-for-pull-incentives/>

⁴¹ Available at: <https://www.gov.uk/government/news/development-of-new-antibiotics-encouraged-with-new-pharmaceutical-payment-system>

pull incentives in the AMR R&D field.⁴² Some interviewed stakeholders also emphasised that the need for pull incentives in the field still remains urgent, as it was before the pandemic started.

Overall, **coordination and collaborative global efforts in AMR R&D increasingly shifted towards COVID-19**. During the pandemic, aspects such as the One Health approach, global coordination, including the involvement and coordination of LMICs and private sector, and sustainable investments proved to be necessary to tackle the pandemic globally. These aspects are also needed to sufficiently address the challenge of AMR globally. As a result, COVID-19 could bring an increased attention to One Health, LMICs and industry involvement, and pull incentives, however, further efforts are needed to include and promote the importance of these aspects in the AMR R&D field.

3.3. Awareness of AMR R&D and enhanced evidence-based policymaking

The desired outcome of promoted knowledge and evidence-base used for policy and decision-makers in AMR R&D corresponds to the third strategic pillar of the Hub, namely to promote awareness, knowledge and visibility. This impact area is targeted through the implementation of the following Hub's objectives:

- To facilitate the efficient allocation of resources;
- To inform policy makers on AMR R&D and keep attention on AMR at high political levels;
- To raise and maintain public awareness and visibility through communication of the work of the Global AMR R&D Hub and its results.

To evaluate the impact of the pandemic on the Hub's capacity to achieve desired outcomes in this strategic area, we analysed the **extent to which the channels of communication for AMR R&D and awareness as well as the visibility of AMR R&D field changed**. The assessment compared the situation between the prior to the outbreak of COVID-19 and during the pandemic. Although many information channels dedicated an increasing attention to provide information regarding COVID-19, the pandemic could also potentially increase attention to AMR R&D due to the increased use of antimicrobials during the pandemic.

The **15 key AMR R&D initiatives maintained a similar level of attention to the topic of AMR R&D between 2019 and 2020** despite the outbreak of the pandemic (see Annex 3 for more details). The key organisations, initiatives, and funders still maintained attention to AMR R&D, however, there was no substantial increase in a number of AMR R&D information channels in 2019-2020, as the number stayed similar to that in the baseline period (2015-2018). The only exception was the Antibacterial preclinical pipeline review information channel launched by the WHO in 2019 (before the outbreak of the pandemic) as well as the Dynamic Dashboard launched during the pandemic.

The lack of increase in the number of information sources regarding AMR R&D could be related to the fact that **there was a substantial number of new information channels and other types of resources dedicated to COVID-19 which emerged in 2020**. Around half of the key initiatives invested in establishing dashboards and other types of resources on their websites dedicated to COVID-19. Another half of the initiatives addressed the topic of COVID-19 via news articles, while some organised specific dedicated online events. While international organisations, such as Africa CDC, OECD, and WHO developed and launched dashboards to provide information regarding the ongoing pandemic, others, especially initiatives and funders with the primary attention to AMR R&D offered statements, news sections, or sections of websites to provide information on COVID-19.

⁴² Available at: <https://pharmaphorum.com/market-access-2/covid-19-helping-to-support-momentum-on-antimicrobial-innovation/>

Further desk research showed that the **COVID-19 pandemic could deepen the issue of AMR due to the increased use of antibiotics for related bacterial respiratory infections.**⁴³ The Wellcome report on the global response to AMR⁴⁴, for example, cited that COVID-19 has imposed upward and downward pressure on resistant infections through various processes, including professionals' increased belief that antibiotics are required in inpatient settings but decreased their use in outpatient settings. The net effect of the pandemic has yet to be determined. The further awareness on AMR R&D and research efforts are needed, as a result of this upward pressure, for rapid and affordable diagnostic tests that differentiate between bacterial and viral respiratory tract infections; the short- and long-term impact of wide use of biocides for environmental and personal disinfection including cross resistance to antimicrobials; and potential alternatives for sustainable environmental and personal disinfection.⁴⁵ The increased awareness to AMR and AMR R&D issues are especially needed during the pandemic, as ignoring these issues could further deepen the AMR.

The **lessons learned from the ongoing pandemic could potentially result the increased political and societal awareness regarding AMR R&D.** The Wellcome report emphasises the need for the global health community to strengthen off of the current momentum in order to create a complete infectious disease threats agenda. Most of the interview respondents also advocated this need given that the ongoing global pandemic presents a tangible threat worldwide, which could also repeat with AMR if the topic of AMR R&D is not sufficiently addressed in a timely manner. Other interview stakeholders, however, were concerned that the attention of the research community has shifted from AMR R&D to COVID-19. For instance, certain infrastructures and research networks, which have been initially established for AMR R&D, are now being used for COVID-19 R&D. Moreover, the interviewed stakeholders emphasised that while the political willingness to resolve the AMR R&D challenges increased, the current pandemic also simultaneously increases the use of antimicrobials and in such a way, potentially the levels of AMR.

Overall, the number of **information channels dedicated predominantly to AMR R&D remained largely the same between 2019-2020** compared to the baseline period, while significant efforts were increasingly shifted towards the ongoing pandemic. However, the awareness of AMR R&D could still increase during the pandemic. The lessons learned from the global pandemic raises the awareness about AMR R&D issues, while increasing use of antimicrobials during the pandemic feeds the threat of AMR further.

⁴³ Available at: <https://www.jpamr.eu/considerations-for-antibiotic-resistance-in-the-covid-19-pandemic/>

⁴⁴ Wellcome Trust (2020). The Global Response to AMR: Momentum, success and critical gaps. Available at: <https://wellcome.org/reports/global-response-amr-momentum-success-and-critical-gaps>

⁴⁵ Available at: <https://www.who.int/bulletin/volumes/98/7/20-268573/en/>

Annexes

Annex 1. Overview of the Hub's progress on its activities on operational level and COVID-19 impact

Below, we present a comprehensive overview of the Hub's progress in each area of its activities. We analysed the Hub's activities and outputs planned, the timeline foreseen to achieve these outcomes, progress achieved up to date, and to what extent the COVID-19 pandemic has impacted the Hub's work in each specific area.

| KEY ACTIVITIES AND OUTPUTS | FORESEEN TIMELINE | PROGRESS ACHIEVED UP TO END OF NOVEMBER 2020 | IMPACT OF THE PANDEMIC |
|--------------------------------------------------------------------------------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. DASHBOARD-RELATED | | | |
| 1.1 Collect (and prioritise) further topics to be included in the Dynamic Dashboard | 2020-2021 | The Dynamic Dashboard, containing Investment Gallery (all sectors and human health related AMR R&D data) was launched in March 2020. The investment section of the Dynamic Dashboard is updated daily. The Hub also launched the Pipeline of Antibacterial in Clinical Development Gallery and the Incentives Gallery in August 2020. The next update of this Gallery is planned in early 2021, after the WHO will have published its next pipeline analysis. | The Dashboard was launched despite the difficulties caused by the pandemic which related to the limited access the data, delays with the IT consultants, virtual communication within the team. Data collection for Incentives Gallery particularly slowed down as experts tended to engage mostly with the topic of COVID-19. |
| 1.2 Start collecting and uploading data identified for animal, plant and environment | 2020 | Launched the animal health AMR R&D data in the investment gallery of the Dynamic Dashboard in July 2020. Incorporation of the plant and environment health AMR R&D investments planned for March 2021. | Although it has become much more difficult to gather AMR data even in the animal health sector, this activity was already partially completed successfully despite the circumstances. |
| 1.3 Ongoing work to update data and identify new sources of data | 2020 | New sources of data are added continuously. Over the course 2020, the Hub established data sharing partnerships with initiatives like STAR-IDAZ, WHO, GÖG and Pew Charitable Trusts. | Impact on the Hub from a technical point of view is quite limited. |
| 1.4 Obtaining information on AMR R&D projects/investments to be included in the Dynamic Dashboard | 2020 - ongoing | At the time of the launch in March 2020, the Dashboard included 4,976 human drug-resistant bacterial projects by 81 different funders with a total of 2.4 billion EUR. As of December 2020, a total of | Microbiologists shifted their focus towards COVID-19 which has impacted the progress with AMR research. During the interviews with external stakeholders, the evaluation team identified that research on AMR may be |

| KEY ACTIVITIES AND OUTPUTS | FORESEEN TIMELINE | PROGRESS ACHIEVED UP TO END OF NOVEMBER 2020 | IMPACT OF THE PANDEMIC |
|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | 8,093 projects from 152 funders with a total investment of 5.68 billion EUR were captured. | significantly limited until March 2021. |
| 2. ANALYSIS-RELATED | | | |
| 2.1 Analyse gathered information to derive options for political action | January-June 2020 | The first analysis report i.e. 2020 Annual Report of the Global AMR R&D Hub's Dynamic Dashboard ⁴⁶ and Recommendations to the G20 following the first analysis report of Dynamic Dashboard data ⁴⁷ were published in November 2020. They were based on the analysis of the data available for two full years (i.e. 2017 and 2018). | Partial impact due to the amount of information and attention to COVID-19 during the first months of 2020. Window of opportunity to increase the relevance of the Dashboard because of the political and societal shift of attention towards the pandemic. Lessons learned from the COVID-19 pandemic are important for the future outbreaks which might be AMR-related. |
| 2.2 Identify existing R&D mapping exercises, initiatives and activities for AMR R&D in animal, plant and environmental health | 2020 | Continuous progress visible as the Hub has established a new partnership with STAR-IDAZ; negotiated with the WHO and the Pew Charitable Trusts which currently provide high-level data of the clinical pipelines. | Impact on the Hub from a technical point of view is quite limited. |
| 2.3 Extensive consultations with relevant experts in animal, plant and environmental health sectors on data categorization and analysis | Q2 2019 - 2020 | Successfully gathered a group of AMR experts working in the sectors of animal health and agriculture. | Only virtual meetings are available due to the pandemic. |
| 2.4 Developing the evidence base to identify where market interventions are needed to incentivise AMR R&D | 2020 - ongoing | Collection of data is underway. Notes on the incentives have been included in the annual report. | High usage of antibiotics during the pandemic might have long-term effects in the field of AMR. |
| 2.5 Identifying and tracking what is currently in the product pipelines | 2020 - ongoing | Notes on the pipelines have been included in the annual report. | Impact on this activity is quite limited. |
| 3. COMMUNICATION-RELATED | | | |

⁴⁶ <https://globalamrhub.org/wp-content/uploads/2020/11/GlobalAMRHubReportDD.Nov2020.pdf>

⁴⁷ <https://globalamrhub.org/wp-content/uploads/2020/11/RecommendationsG20.Nov2020web.pdf>

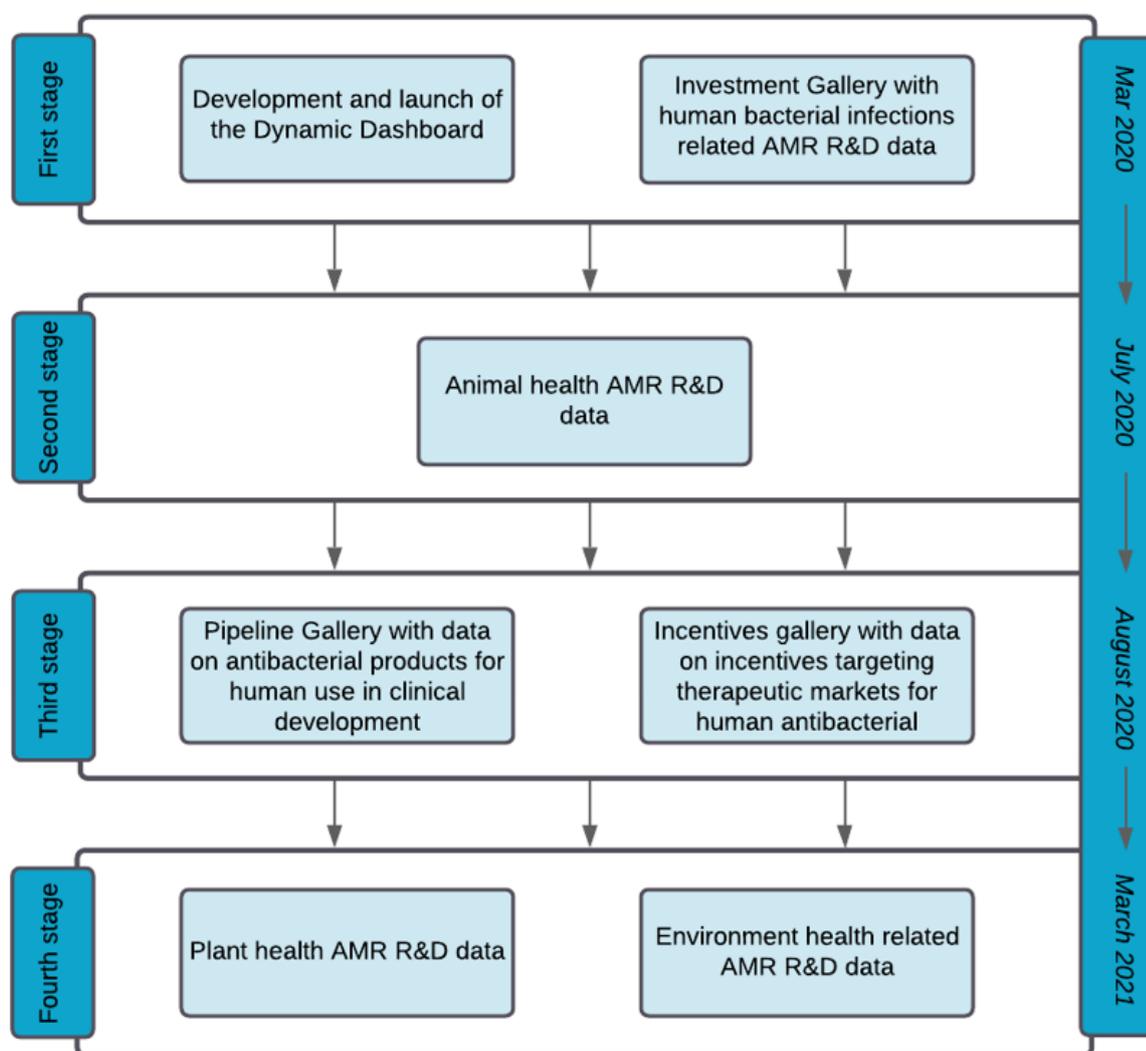
| KEY ACTIVITIES AND OUTPUTS | FORESEEN TIMELINE | PROGRESS ACHIEVED UP TO END OF NOVEMBER 2020 | IMPACT OF THE PANDEMIC |
|--------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.1 Feed results of the analysis back to Hub members and other stakeholders | Dec 2019 - ongoing | More time is needed to evaluate the extent to which the data can be useful for various stakeholders. | Impact on this activity is quite limited. |
| 3.2 Public relations activities such as presentation of the Hub and its achievements at international meetings and conferences | 2018 - ongoing | <p>The Hub has invested in raising the visibility of its activities, and the Dynamic Dashboard in particular, by:</p> <ul style="list-style-type: none"> - Participating in the 4th Annual AMR Conference. - Organising 2 live webinars on the topic of 'How to use the Global AMR R&D Hub's Dynamic Dashboard'. - Giving an update on the work of the Hub for analysing push and pull incentives in the 2020 AMR workshop in context of G20 (HWG). - Participating in the panel discussion on "Developing Antibiotics for children to achieve SDG 3" in WHS 2020. - Participating in the One Health EJP Annual Scientific Meeting 2020. | <ul style="list-style-type: none"> - Some events were cancelled/rescheduled while others were successfully moved to the virtual space. - Limited networking opportunities due to the virtual events. |
| 3.3 Advocacy for the Hub and the importance of the topic AMR itself | 2018 - ongoing | The Dashboard successfully assumed the role as an aggregator for informational resources. Virtual conference 'Translating AMR R&D mapping into policy and action' was organised in December 2020. The main goal of the conference was to inform how the Global AMR | Increase of public awareness that conscious use of antimicrobials has a crucial role in the future of public health. Political will to improve the financing and the role of public health research has been substantially increased because of the pandemic. |

| KEY ACTIVITIES AND OUTPUTS | FORESEEN TIMELINE | PROGRESS ACHIEVED UP TO END OF NOVEMBER 2020 | IMPACT OF THE PANDEMIC |
|--------------------------------------------------------------------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | | R&D Hub, using its Dynamic Dashboard, can support the AMR R&D needs in the different regions and countries, by highlighting gaps that need to be filled and helping to identify collaboration or partnership opportunities. | The Hub has an opportunity to make an even stronger case about the importance of AMR during this pandemic, for instance through more active collaboration with the UN and G20. |
| 3.4 The Board of Members will be provided reports at each meeting | Dec 2019 - ongoing | In line with the Hub's Rules of Procedure, these reports are confidential. | N/A |
| 3.5 Annual reports will be published on the Hub website | Every June of the following year | The report was published on the website in November 2020. | Impact on this activity is quite limited. Mostly caused by the delayed launch of the Dashboard. |
| 3.6 Expansion of the Hub's BoM and SG | | Sweden joined as a Member of the Board in April 2020. Recruited four additional members (AAAMR, AdvaMedDx, UNITAID and WFO) to the Stakeholder Group in July 2020. Additional members in SG filled in the gaps in global representation, particularly LMIC, non-human sector and diagnostics. | Impact on this activity is quite limited. |
| 3.7. Work with external contractors | 2019-ongoing | <ul style="list-style-type: none"> - IT company has been contracted in 2019 to support the development, launch, and maintaining of the Dynamic Dashboard. - PPMI has been contracted in 2019 to carry out external evaluation to monitor progress towards the objectives of the Global AMR R&D Hub. - BIOCOM has been contracted in 2020 in support of our | Some meetings with contractors shifted online but overall limited impact on this activity. |

| KEY ACTIVITIES AND OUTPUTS | FORESEEN TIMELINE | PROGRESS ACHIEVED UP TO END OF NOVEMBER 2020 | IMPACT OF THE PANDEMIC |
|----------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| | | communication strategy, including employing social media - IT consultants have been contracted to support Hub’s daily activities. - Three studies contracted to support the development of Incentives Gallery. | |

Source: compiled by the study team based on the review of the Hub’s operational documents (e.g. Work Plan 2018-2021, Dynamic Dashboard Roadmap, Collaboration Framework, Terms of Reference), Hub’s website, Dynamic Dashboard, Dynamic Dashboard Library, and event-related material, interviews with the Hub’s Secretariat between June and August 2020 as well as the BoM, SG, and other external stakeholders in October-November 2020.

Annex 2. Four key stages of the Dynamic Dashboard development



Note: Research organisations information was added to the Dynamic Dashboard in November 2020 but is not included in the figure.
 Source: compiled by the study team based on announcements in the Hub's website.

Annex 3. Information channels established by key initiatives

We have analysed different types of information challenges launched by the key AMR R&D initiatives to address the topics of AMR and COVID-19. The number of existing channels for AMR communication among the key initiatives in 2019-2020 increased slightly compared to 2015-2018. Regarding the information channels established between 2019-2020, almost all of the analysed initiatives, funders, and organisations dedicated effort to launched additional forms of communication channels, however, they were mostly dedicated to the topic of COVID-19, including dashboards and dedicated sections of their websites. The only key initiative, which presented no specific communication on COVID-19 was the Joint Action Antimicrobial Resistance and Healthcare-Associated Infections (EU-JAMRAI). In the table below, we present the key types of information channels established along with the name and description of the information channel.

| NAME OF THE INITIATIVE/FUNDER | TYPE OF INFORMATION CHANNEL | NAME OF INFORMATION CHANNEL | BRIEF DESCRIPTION OF INFORMATION CHANNEL |
|--------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Africa Centres for Disease Control and Prevention (Africa CDC) | Dashboard | Coronavirus Disease 2019 (COVID-19) ⁴⁸ | Latest updates on the COVID-19 crisis from Africa CDC |
| Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator (CARB-X) | News articles | News ⁴⁹ | Examples of articles include: COVID-19 May Worsen the Antibiotic-Resistance Crisis, or Antibiotic treatment for COVID-19 complications could fuel resistant bacteria |
| Food and Agriculture Organization of the United Nations (FAO) | Resources section | Novel Coronavirus (COVID-19) ⁵⁰ | The Coronavirus Disease 2019 (COVID-19) is a global health crisis, and FAO is playing a role in assessing and responding to its potential impacts on people's life and livelihoods, global food trade, markets, food supply chains and livestock. |
| Global Antibiotic Research and Development Partnership (GARDP) | News articles | News & Resources ⁵¹ | Examples include articles such as: Early Lessons From the COVID-19 Can Help Tackle Silent Pandemic of Drug-Resistant Infections, Says New GARDP Report |
| Health for Animals | Response statement | COVID-19: How We Are Acting ⁵² | This crisis requires action from all in order to protect our future. Health for Animals and our Members, manufacturers of veterinary medicines, diagnostics and other animal health products, are taking responsibility in the response. |
| Innovative Medicines Initiative (IMI) | News articles | News, Newsletter ⁵³ | Examples include articles such as Two IMI projects to work with EMA on COVID-19 |
| Joint Programming Initiative on Antimicrobial Resistance (JPIAMR) | Webinars and news | Webinars and news ⁵⁴ | Examples include webinar series such as AMR research in a post-pandemic world |

⁴⁸ Available at: <https://africacdc.org/covid-19/>

⁴⁹ Available at: <https://carb-x.org/?s=COVID-19>

⁵⁰ Available at: <http://www.fao.org/2019-ncov/en/>

⁵¹ Available at: <https://gardp.org/?s=COVID-19>

⁵² Available at: <https://healthforanimals.org/185-covid-19-how-we-are-acting.html>

⁵³ Available at: <https://www.imi.europa.eu/site/search?keywords=COVID-19>

⁵⁴ Available at: <https://www.jpiaamr.eu/?s=COVID-19>

| | | | |
|-----------------------------------------------------------------------|---------------------------------|----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Organisation for Economic Co-operation and Development (OECD) | Dashboard | Tackling Coronavirus (COVID-19): Contributing to a global effort ⁵⁵ | What are countries doing to contain the spread of the coronavirus? How are countries helping people, small businesses and the economy to weather the crisis and beyond? This Country Policy Tracker helps you to navigate the global response. |
| Re-Act (Action on Antibiotic Resistance) | Resources section | COVID-19 and antibiotic resistance ⁵⁶ | Articles that ReAct has published relating to COVID-19 and antibiotic resistance |
| International Research Consortium on Animal Health (STAR-IDAZ) | Online workshop | Pandemic: a one health view of emerging infectious diseases ⁵⁷ | A global interactive webinar was organised in a cooperation between the Collaborative Working Group on Animal Health and Welfare Research (CWG-AHW) and the Global Strategic Alliances for the Coordination of Research on the Major Infectious Diseases of Animals and Zoonoses and its related International Research Consortium (STAR-IDAZ IRC). |
| United Nations Environmental Programme (UNEP) | Resource section | Featured Topic COVID-19 ⁵⁸ | Contains resources such as reports and booklets, factsheets, infographics, etc |
| Wellcome Trust | Response statement | Coronavirus (Covid-19): supporting global research and development ⁵⁹ | We want to help the world overcome Covid-19. Research is the best way to save lives – but more investment in accessible treatments, tests and vaccines is urgently needed to change the course of the pandemic. |
| World Health Organization (WHO) | Dashboard and resources section | Coronavirus disease (COVID-19) pandemic ⁶⁰ | Includes questions and answers, travel advice, situation reports, and Coronavirus Disease (COVID-19) Dashboard |
| World Organisation for Animal Health (OIE) | Website section | COVID-19 Portal ⁶¹ | OIE's response to COVID-19 pandemic |

Sources: compiled by the study team based on 14 key AMR R&D initiatives.

⁵⁵ Available at: <https://www.oecd.org/coronavirus/country-policy-tracker/>

⁵⁶ Available at: <https://www.reactgroup.org/news-and-views/covid-19-and-antibiotic-resistance/>

⁵⁷ Available: <https://www.star-idaz.net/app/uploads/2020/08/PANDEMIC-Webinar-Report-030820.pdf>

⁵⁸ Available at: <https://wesr.unep.org/#>

⁵⁹ Available at: <https://wellcome.org/what-we-do/our-work/coronavirus-covid-19>

⁶⁰ Available at: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>

⁶¹ Available at: <https://www.oie.int/scientific-expertise/specific-information-and-recommendations/questions-and-answers-on-2019novel-coronavirus/>