The Global Health Network Webinar Report

An Introduction to the AMR Knowledge Hub:

"Global Health Research Priorities for Responding to the AMR Silent Pandemic"

Contents

The Global Health Network platform operates like an open, trusted online science park for health research and is used by thousands of researchers world-wide, especially in limited resource settings, with the focus on Global Health. Within this platform we have developed the AMR Knowledge Hub to support stronger coordination, knowledge sharing and faster progress in Antimicrobial Resistance research and practice across the Globe. It provides an open resource for a global community of practice for all researchers, healthcare and laboratory teams in all organisations working in AMR around the world. The AMR Knowledge Hub is dynamic as we continuously review the global AMR knowledge and research landscape to identify gaps and needs on access to resources, guidelines, and policy recommendations.

We have developed this hub because the UN's Interagency Coordinating Group on AMR stated in 2019, drug-resistant diseases could force up to 24 million people into extreme poverty by 2030 and cause 10 million deaths each year by 2050. Its financial impact would be on a scale similar to the 2008 financial crisis and the COVID-19 pandemic. This Knowledge Hub is coordinated by a strategic advisory board from across partner organisations in Africa, Asia and Latin America. It is supported by The Global Health Network and a pilot award from Pfizer with the aim of widening this open alliance through a consortia funding model.

1. Introduction

On the 13th of July 2021 TGHN held webinar, as part of the Research in Focus series, which had the following objectives:

1. To introduce The Global Health Network AMR Knowledge Hub to the global AMR community
2. To share experiences from the field on research and knowledge gaps to be addressed for an effective global AMR pandemic response
3. To discuss how the COVID-19 pandemic response experience could be used to combat the silent pandemic of AMR in LMICs

There were 2 presentations followed by approximately 40 minutes in which panellists answered questions of attendees to the webinar.

Chair:

- **Dr Welile Sikhondze** - *AMR Knowledge Hub Coordinator, The Global Health Network*

Speakers:

- **Dr Bruce Altevogt** - *Vice President and Head External Medical Engagement for the Hospital Business Unit, Pfizer, USA*
- **Dr Titus Divala** - *Commonwealth Scholar and Helse Nord RHF Fellow, London School of Hygiene and Tropical Medicine, UK*
- **Dr Fatema Rafiqi** - *Research Programme Manager for the Antimicrobial Resistance Benchmark, Access to Medicines Foundation, Netherlands*
- **Mr Adam Zerda** - *Director of AMR Strategy and Development, BD, USA*
- **Dr Greg Frank** - *Director of Global Public Policy, MSD, USA*
- **Dr Jean-Louis Tissier** - *Vice President of Public and Government Affairs AMR, bioMérieux, France*
- **Dr José Procopio Senna -** *Senior Research Specialist, Institute of Immunobiological Technology (Bio-Manguinhos), Fiocruz, Brazil*
- **Dr Yewande Alimi** - *AMR Programme Coordinator, Africa CDC, Ethiopia*
- **Dr Claude Mabilat** - *Director at Global Medical Affairs, bioMérieux, France*

A total of 850 people registered for this event, from 103 different countries. On the day, 318 people attended the event.

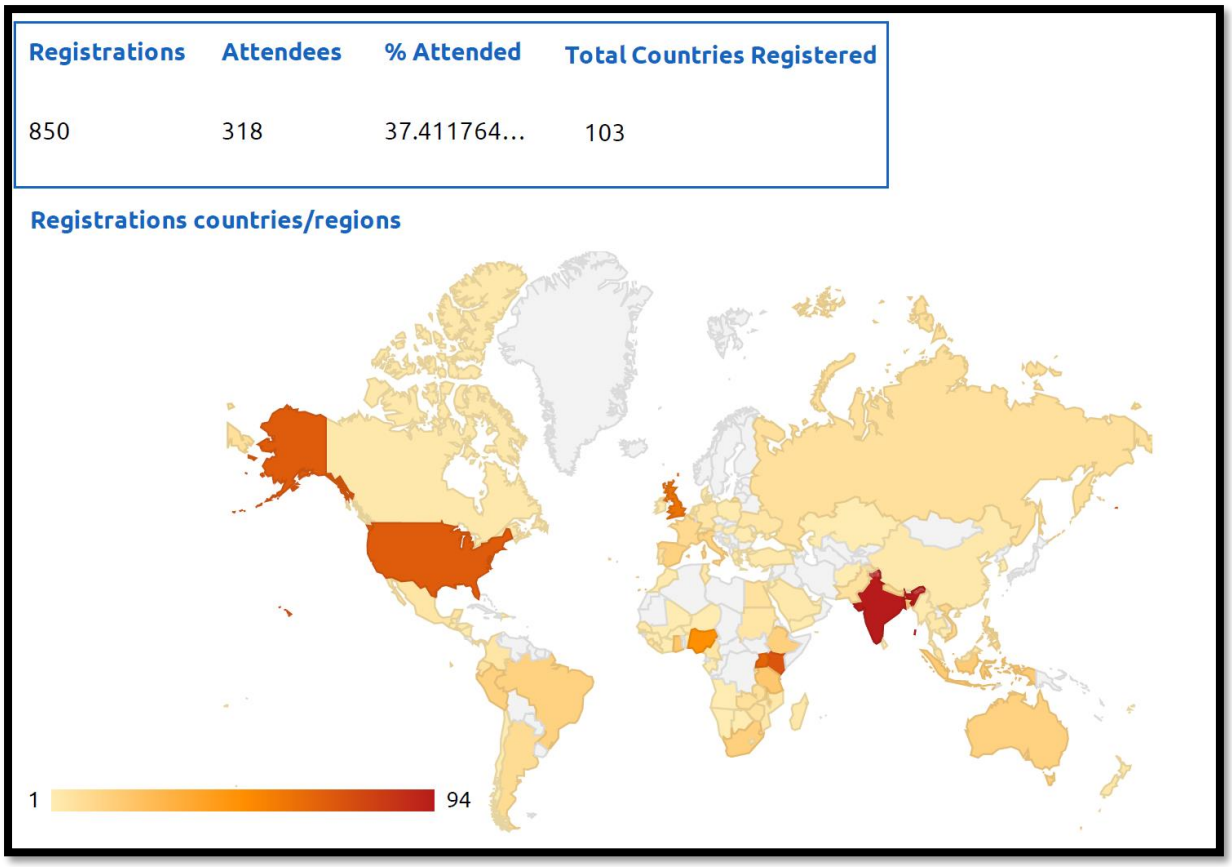

Figure 1 – Registrant and attendee data and a heat map showing the geographical distribution of registrants, from over 100 countries across the world, covering LMICs and HICs. The scale bar shows how colour corresponds to number of registrants from each country.

2. Questions asked upon registration

Upon registration, attendees were also asked if they had any general comments, or questions for the panellists. Some of these were addressed directly, some indirectly, and some were not answered but may offer an insight into the priorities and concerns of those wanting to be involved in the next steps of the AMR hub:

How can we plan AMR Surveillance on a daily basis in a hospital setting?
How can we make people more aware of the AMR pandemic? Many people, especially in India, are not aware of it. Even our university does not provide us at the AMR lab adequate funding since they do not consider it important enough.
What makes AMR attract less attention especially from decision makers at policy level, as compared to other pandemics despite the huge number of lives it claims globally?
There is a need for an aggressive publicity campaign using all forms of media to communities on the use of antibiotics!
Please see WHO's timely request for input on research priorities: https://www.who.int/news-room/articles-detail/invitation-to-participate-in-a-survey-on-research-questions-for-the-development-of-a-one-health-priority-research-agenda-on-antimicrobial-resistance
First, we need to extensively influence the public or communities to change the behaviors of self-medications especially the antimicrobials. Also the governments and regulatory bodies need to smart up and bring strong and serious regulating laws against improper use of antibiotics.

3. Summary of Individual Presentations

Introduction from Pfizer

Dr Bruce Altevogt - *Vice President and Head External Medical Engagement for the Hospital Business Unit, Pfizer, USA*

Pfizer is very pleased to support this initiative; last year the company tried to identify gaps in what it was supporting, and the TGHN AMR hub caught Pfizer's interest, with its aim of increasing access to information and best practices to the public health community. As an open and free resource coordinated by an advisory board made up of stakeholders from organisations in Africa, Latin America, Asia and Europe, this hub will play an important role in coordinating and supporting AMR research across the globe

This introductory webinar is the first step in the ongoing engagement between scientists with a professional interest from around the world, which will include Working Groups that will develop strategies and interventions to deal with AMR and expand the reach of this knowledge. New partners are welcomed, from the private sector to government institutions to other NGOs – we all have a shared aim and interest in enabling more, better and equitable AMR research

Should broad-spectrum antibiotics remain part of Tuberculosis (TB) diagnostic algorithms?

Dr Titus Divala - *Commonwealth Scholar and Helse Nord RHF Fellow, London School of Hygiene and Tropical Medicine, UK*

This first presentation shared findings from the ACT-TB clinical trial, conducted in Malawi, which examined the accuracy and consequences of using trial-of-antibiotics for TB diagnosis – to find out more and access the study documents, visit the Study Profile on the AMR Knowledge Hub.

TB and AMR – the 'cousin epidemics': Both of these diseases have the capacity to slow our progress in the United Nations Sustainable Development Goals (SDGs). TB has long been the predominant infectious killer, second only to COVID-19 in 2020 (1.8 million deaths to TB's 1.4 million deaths). AMR, on the other hand, is also a major killer and economic burden; some models project that by 2050 it could become the leading killer, causing 10 million global deaths annually. Drug-resistant TB mortality constitutes a third of AMR mortality – the relationship between the two diseases is well described, and arises due to the prolonged nature of TB treatment and also the limited access to (often poor quality) diagnostics and healthcare

The gap in TB diagnosis is complemented by clinical approaches that utilise antibiotic use: The latest global TB report shows that out of 7.5 million TB notifications in 2019, 3.6 million (48%) had bacteriological confirmation and the remainder were managed as TB cases based only on clinical diagnosis. Susceptibility testing only occurred in 2.2 million cases (29%).

There is such a large diagnostic gap with TB because it is hard to diagnose thanks to its nonspecific history and physical examination, as well as the challenges posed by its complicated biology. Microscopic investigations are hindered by low bacterial concentrations, bacterial culture by long generation time which means it is not feasible in clinical settings, immunological investigation is non-prognostic, and molecular investigations are hindered by poor biomarkers. Poor investment in research and development exacerbates the diagnostic challenges.

The less discussed AMR-TB overlap relates to the difficulties in diagnosing TB. It is very common for clinicians to take a sputum sample for TB smear or Xpert; if this is positive then it is a conclusive result, and you can treat the patient for TB. Due to the high number of false negatives, however, a negative result in the presence of respiratory symptoms is not conclusive. It is common to prescribe broad spectrum antibiotics in case they have bacterial pneumonia. If someone responds to the treatment and gets better, the illness is presumed to be unrelated to TB; no response to the antibiotics is suggestive of TB – this approach, known as 'trial-of-antibiotics', is common in both national and global guidelines.

The research question of the ACT-TB trial was '*Does trial-of-antibiotics accurately predict TB status?*'

ACT-TB study design:

- **Population** – Adult patients with respiratory symptoms
- **Index test** – Trial-of-antibiotics (any broad-spectrum antibiotic course given with the goal of ruling out TB in a symptomatic adult)
- **Reference test** – Any mycobacteriology test (smear microscopy, GeneXpert, Mtb culture)
- **Outcome** – Sensitivity & specificity: Proportion of mycobacteriology-positive or mycobacteriology-negative participants correctly identified by trial-of-antibiotics
- **Design** – Cross-sectional, cohort and randomised controlled studies
- The full methodology is explained in detail in the open-access protocol

Overview of results of the systematic review: Out of 9,410 articles, only 8 were included in the review, and none were randomised controlled trials. The evidence base for trial-of-antibiotics diagnostic use is therefore very narrow. There was no consistent choice of antibiotics, no consensus on the number of courses (1-2) or duration of treatment (5-14 days). Furthermore, there were inconsistencies and subjectiveness on the definition of the resolution of the symptoms.

Meta-analysis of **sensitivity** of trial-of antibiotics vs microbiology showed that there was a wide variation of estimates of sensitivity – as low as 15% and as high as 97%. The overall estimate of sensitivity achieved after combining all of the data was 67% (95% CI 0.42-0.85), with very high heterogeneity (I^2 = 96%).
Meta-analysis of **specificity** of trial-of-antibiotics vs microbiology again showed was a wide variation in estimates of specificity – as low as 41% and as high as 96%. The overall estimate of specificity achieved after combining all of the data was 73% (95% CI 0.58-0.85), and heterogeneity was again very high (I^2 = 99%).

So, should this trial-of-antibiotic diagnostic approach continue to be used? The End-TB Strategy has targets for diagnostic tests that can be used in the developing world. The following table compares current trial-of-antibiotic diagnostic tests to the End-TB's optimal target profiles for a TB triage test or TB smear microscopy replacement test. Based on the results of this systematic review the only criterion which trial-of-antibiotics diagnosis comes close to adhering to is the specificity: it does not come close to fulfilling the sensitivity, time to result, provider cost or target user criteria.

	Trial of antibiotics (azithromycin arm)	Optimal target profile for a tuberculosis triage test under End-TB Strategy	Optimal target profile for a tuberculosis smear microscopy replacement test
Sensitivity	67% (95% CI: 42, 85)	> 95%	> 95%
Specificity	73% (95% CI: 58, 85.1)	> 80%	> 98%
Time to result	>7 days	< 5 minutes	< 20 minutes
Provider cost	Clinician, consultation time, and antibiotics	< US$ 1.00	< US$ 6.00
Target user	Clinically trained health worker	Community health workers	Similar or less than TB microscopist
Setting	primary-care or higher	Community level or village level	primary-care

Conclusions of the systematic review:

- ***Despite being in use for decades, trial-of-antibiotics has little to no evidence to support its diagnostic value***
- ***The little available evidence suggests poor accuracy, and therefore there is a high risk for misdiagnosis of patients and the development of AMR***
- ***Well-designed studies are urgently needed to inform global policy***

These conclusions inspired a protocol for a Randomised Clinical Trial to investigate the benefits and harms of the trial-of-antibiotics approach to TB diagnosis. As the data is currently being peer-reviewed the results could not be presented in this webinar. Objectives of the trial were to determine the diagnostic value of trial-of-antibiotics in TB screening algorithms, the clinical impact of trial-of-antibiotics in the context of high HIV prevalence and the impact of trial-of-antibiotics on AMR. The three arms of this unblinded RCT were: standard care; Azithromycin 500mg, taken once daily for 7 days; Amoxicillin 1g, taken thrice daily for 5 days. The trial setting was in two primary care centres in Blantyre, Malawi. Participants were selected from clinically stable patients who had been (not too severely) unwell for at least 14 days and had not had any recent antibiotics, TB treatment or preventative therapy. Out of 5,825 patients screened, 1,583 were eligible with 530, 527 and 526 patients assigned to each arm of the trial. Co-primary outcomes were diagnostic and clinical impact, with a secondary outcome of AMR impact. The follow up concluded in May 2020 – while still under peer review, they suggest that trial-of-antibiotics is of limited diagnostic value, no clinical benefit and has a risk of AMR.

Recommendations based on this work can be split into two groups. On a programmatic level, it can be recommended that we urgently harmonise global and national TB guidelines on the role of broad-spectrum antibiotics and establish antimicrobial stewardship programs that target TB-related prescribing. On a research and clinical development level, we should urgently identify key respiratory pathogens by global region and repurpose pre-existing host biomarkers to inform rapid development of relevant diagnostic panels. We should also develop accurate, affordable, and point-of-care diagnostics that can be used at the most peripheral parts of the health system and provide results within the timeframe of a consultation for TB and other viral and bacterial respiratory pathogens.

The Antimicrobial Resistance Benchmark: An Independent Report on Pharma's Response to AMR

Dr Fatema Rafiqi - *Research Programme Manager for the Antimicrobial Resistance Benchmark, Access to Medicine Foundation, Netherlands*

This presentation provided insight into how the Access to Medicine Foundation strives to stimulate and guide pharmaceutical companies to provide access to medicines and to limit drug-resistant infections

The Access to Medicine Foundation

The Foundation was founded in 2005 on the basis that to address global health challenges it is important to ensure the largest pharmaceutical companies and their stakeholders are cooperating and have some form of consensus. In 2008, the Foundation published its first Access to Medicine Index, ranking the top 20 pharmaceutical companies on their policies and practices for improving access to medicine. Since then, the research scope of the Foundation has expanded to track these large companies' progress in terms of their attitudes to global health. To do this, they monitor the practices of these companies and compare them to one another. They also identify best practices and areas for improvement. The Foundation is a non-profit organisation funded by the British and Dutch governments, the Bill & Melinda Gates Foundation, and the Wellcome Trust. Importantly, the Foundation does not receive funding from the pharmaceutical industry. The Access to Medicine Foundation research program includes the Access to Medicine Index, the AMR Benchmark (the first independent analysis of the pharmaceutical industries' actions to tackle drug resistance), the Access to Vaccines Index as well as publication of thematic studies and advancing the debate on medicine access and AMR. The Foundation's work has been covered by both local and international media. It has also attracted the investor community, with more than 100 investors (managing a combined USD$19trn of assets) using the Foundation's research to monitor how pharmaceutical companies deal with risks and opportunities related to access to medicine and AMR. These investors have signed the Foundation's investor statement, committing to using Access to Medicine Foundation's research in their analysis and engagement with companies.

The AMR Benchmark

The AMR Benchmark research programme measures what pharmaceutical companies are doing to limit the rise of AMR. These companies range from large, research-based companies to generic medicine manufacturers and small- and medium-sized enterprises. The Benchmark is a two-year program, and there have so far been two iterations, with the third being worked on currently, due in late 2021. Alongside the Benchmark report, the methodology for the Benchmark is published – for the third iteration of the report, the methodology was published in October 2020.

The Benchmark triggers change in three ways. Firstly, it aids the development of a consensus on what society expects from pharmaceutical companies to limit AMR, clarifying the responsibilities placed on the industry. Secondly, the programme analyses new data and tracks changes against society's expectations covering priority areas in **Research & Development**, **Responsible Manufacturing**, and **Appropriate Access & Stewardship**. Thirdly, the programme guides and incentivizes company actions, by sharing best practices, strengthening accountability, mobilizing investors, and working with public-private partnerships.

2020 Benchmark report – Methodology

The 2020 report featured 4 key findings across the 3 research areas mentioned above. It identified 11 best practices and 21 R&D pipelines for priority bacterial and fungal infections and provided detailed report cards for the 30 most important companies in the field of antibacterial and antifungal R&D, manufacturing and supply of both medicines and vaccines (8 large research-based companies, 9 generic medicine manufacturers and 13 small- and medium-sized enterprises). The report had a geographic scope, but for access indicators it focused on those countries in which disease burden is high and access to medicine is low. Within each research area, there were several indicators on which companies are assessed (see below table):

Research & Development	**Responsible Manufacturing**	**Appropriate Access & Stewardship**
R&D Investments	Environmental risk-management strategy	Registration of on-patent products
Pipeline size	Disclosure on environmental risk management	Registration of off-patent/gen. products
Novelty of pipeline	Manufacturing high-quality antibacterials	Accessibility of on-patent products
Vaccines in the pipeline		Accessibility of off-patent products
Projects targeting critical priorities		Ensuring continuous supply
Intellectual capital sharing		Educational stewardship activities
Access & stewardship planning		Appropriate promotional practices
		Stewardship-oriented packaging adaptations
		Antimicrobial surveillance

2020 Benchmark report - Findings

Overall, the 2020 report found that there is plenty of room for improvement: While companies were making progress in the right direction, this progress was slow. The 4 key findings are described below.

Firstly, there were signs of progression in access and stewardship planning during late-stage R&D, albeit from a low base. It is important for novel antibiotics to be supported by access and stewardship plans before going on the market. The report found that of 32 late-stage antibiotic projects, just 8 (25%) were supported by Access and Stewardship plans. While up from the 2018 Benchmark report (2 out of 28, 7%), there needs to be a greater level of planning to ensure access of these new medicines to those that need them, and to ensure that they will be kept within the appropriate stewardship measures.

Another finding was that pharmaceutical companies were missing opportunities to make antibiotics available. Very few were registering new antibiotics in countries where there is the greatest need: of 13 on-patent antibiotics, just 3 were registered in 10 or more countries in which access is a priority. 6 were registered in 1-9 of these countries, while the remaining 4 products were not registered in any

of them. Furthermore, older, clinically useful antibiotics were not widely supplied: only 14 of the 24 'forgotten antibiotics' were being supplied to one or more countries; the remaining 10 were not being supplied to any of the countries in which access is a priority.

There was more progress in how pharmaceutical companies tackle overselling antimicrobials. As one of the key drivers for the emergence of AMR is the inappropriate use of antimicrobials, tackling overselling of these drugs is a priority. 10 companies (compared to 5 in 2018) were taking measures to decouple financial bonuses for sales representatives and sales volumes; some of these had fully decoupled such bonuses from sales, while some had stopped deploying sales agents for at least some of their products.

Finally, the report found that Pfizer was the first company to share raw data on the spread of resistance (they have now been joined by Merck & Co.). While more companies have surveillance programmes (13 in 2020, compared to 9 in 2018), these two companies are the only ones to share their raw data.

2021 report – Biotechs are saving the world from superbugs. Can they also save themselves?

In the 3rd iteration of the Benchmark programme, the small- and medium-sized companies were not assessed against the larger pharmaceutical companies. As large pharmaceutical companies have largely ceased production of antimicrobials, smaller biotech companies have taken over the reins in terms of antimicrobial R&D. There are currently 55 antibiotics in late-stage development, with 41 projects (75%) in the pipelines of these biotech companies, which are often in a constant struggle to secure finances. Thus, the antimicrobial production pipeline is alarmingly small when compared to the magnitude of the threat of the rise of AMR. Some of the more resilient of these biotech companies are, however, finding new opportunities, and it is these that the 2021 report focusses on. Given that most of these smaller biotech companies haven't brought products to market, and that novel antibiotics tend to generate low revenues, these companies often need to spend more time on trying to secure funding than on conducting research.

The Foundation therefore released a standalone report that focusses on 4 biotech companies that are finding partners, based on emerging markets, that are willing to not only share the risks and costs of clinical development but also of commercialization. These 4 companies are based in the US but are expanding their networks to partner with relevant stakeholders in emerging markets such as India, South Africa and China. This not only attenuates the risk of their operations and provides more resources and sources of funding, but it also expands the global access to these drugs at scale and at an affordable rate.

2021 Benchmark report

The company scope of the 2021 report is therefore different to that of the 2020 report: it does not assess the small- and medium-sized enterprises. Instead, it examines the actions of 17 companies – 8 large research-based pharmaceutical companies and 9 generic medicine manufacturers. The geographic scope, on the other hand, will be similar to the 2020 report: all indicators will be global other than the access indicators, which will focus on 102 LMICs. Furthermore, the disease scope (bacterial and fungal infections) and product scope (drugs and vaccines) will be the same as the 2020 report. The large research-based pharmaceutical companies will be assessed on **Research & Development, Manufacturing** and **Appropriate Access & Stewardship**. The generic medicine

manufacturers will be assessed in **Responsible Manufacturing** and **Appropriate Access & Stewardship** only.

4. Open discussion

After the presentations, the speakers and panelists responded to questions relating both to the individual presentations, and to AMR more generally:

Dr Divala, please could you highlight again what the recommendations you would suggest are to reduce the practice of antibiotic use for the diagnosis of pulmonary (and extrapulmonary and paediatric TB) in clinical settings.	'*There is always a dilemma when managing a patient with symptoms suggestive of TB, mainly because they are often general and could indicate a number of illnesses. What this research has confirmed so far is that in a setting in which HIV and general mortality is low, the use of trial-by-antibiotics in an outpatient setting is not necessarily helpful. One recommendation is therefore that clinicians should only prescribe antibiotics if there is a high index of suspicion for bacterial pneumonia, for example. In terms of R&D, there is a need not only to develop better diagnostics for TB but also for other respiratory infections so that the distinction between symptoms can be made more easily*' – **Dr Divala**
Dr Fatima, with regards to the AMR Benchmark Programme, what was the reasoning for covering antibacterial and antifungal resistance, and not antiviral resistance?	'*This is a very important question. It is really due to the market circumstances, partnerships available and structuring available to antibacterials antifungals compared to antivirals. We decided to have a more focused approach for this, and the previous, iteration of the Benchmark. The first Benchmark had a broad scope, focusing on all types of antimicrobials. It was the consensus that a narrower focus was more relevant for the last two iterations of the Benchmark report*.' – **Dr Rafiqi**
'Firstly, I wanted to take the opportunity to expand on the questions that have been asked regarding the regional research priorities Secondly, how do we ensure that access and stewardship are balanced?'	'*Given that this new hub is focused on global health research networks and AMR, I have 2 thoughts. Firstly, regarding Dr Rafiqi's presentation and what the Access to Medicine Foundation is doing, there's a tremendous amount of time and money spent on R&D of new drug development. Much less is spent on understanding how to preserve and optimise the use of the antimicrobials we are currently using. One of the calls to action for this groups can be to consider the research questions that speak to how we preserve these antimicrobials, and how we can set up the right environments so that new medicines come through, their efficacy is maintained. Accessibility in a way that is fair and equitable is important.* *This second question is especially hard to answer in parts of the world which are increasing new capacities for managing these antimicrobials. Firstly, a lot of policy work needs to be done – only half of the world's countries have action plans for AMR, and the majority of those are unfunded. How we encourage the funding and development of these national action plans is something we could think about. Secondly, how do you set up the right processes to manage new drugs that are available, and how do you ensure that non-prescription access is limited but equitable*.' – **Mr Zerda**
How could we get past the funding challenges	'*Good antimicrobials must be selective, of low toxicity. Currently we have broad spectrum antibiotics that can favour the rise of AMR. Perhaps an*

to novel drug development?	*alternative is finding non-conventional antibacterial products, such as bacteriophage strategies, that target single bacteria to decrease the selective pressures. These new approaches could be used in association with older antibiotics. We have heard, however, that there isn't enough investment in novel antimicrobials as it is hard for companies to support the costs of clinical trials which have a high chance of failure. Many companies favour small modifications to existing molecules that are likely to have good results. In my opinion, for new strategies we need more investment from governments to support clinical trials for these new drugs and approaches.*' – **Dr Senna**
Further points concerning the development of national action plans mentioned by **Dr Zerda**	'*France released its national action plan 5 years ago. While it is good, there are issues: for example, diagnostics is not very well highlighted. Dr Divala has already pointed out that diagnostics are very important in the fight against AMR; the in vitro diagnostic industry is therefore very involved in the fight against a rise in AMR. Secondly, I'd like to refer to the very well-known 2016 report by Lord O'Neill (in collaboration with the Wellcome Trust) regarding the fight against AMR. He said that improving diagnostics is the single biggest potential gamechanger in the fight against AMR. Regarding the development of new diagnostic systems, they are important in terms of improving clinical outcomes. They should be rapid, easy to use, informative and affordable – but this is one of the problems: that good diagnostics are hard to develop due to the very high standards required of them. We may need to change the paradigm, demonstrating the value of diagnostic tools and to work with policy makers so that private-public partnerships etc can develop and provide the right diagnostic products.*' – **Dr Tissier** '*To elaborate on the lack of funding for national action plans on antimicrobial resistance, it's not that nothing can be done if they aren't implemented – people in clinical settings, for example, can take it into their own hands, encouraging good practices and establishing surveillance plans in their hospitals. For example, bioMérieux is a sponsor of a programme called Global PPS which runs a point prevalence survey that provides a snapshot of antibiotic consumption and use. It is a matter of willingness to do this – training and results are free and standardised in Antwerp, where the project is led.*' – **Dr Mabilat** You can view National Antimicrobial Resistance Action Plans from Asia, Africa and Latin America, as well as featured recent research and regional surveillance systems, on the Regional Response pages of the AMR Knowledge Hub: https://amr.tghn.org/regional-response/
	'*At the African CDC and the continental technical agency of the African Union we have seen that several companies have developed, or are in the process of implementing, national action plans. One issue is that not many countries prospectively researched the cost of implementation of such a plan or the development of AMR-mitigating implementations. We are therefore driving the process of domestic financing: the only way that we can have AMR interventions that are sustainable is when national governments start to invest in these activities. We have also seen a very siloed approach, separate from other health system activities. We are trying to change AMR from something that is seen as individual and*

	distinct, to something that is interlinked throughout health systems. There are so many possibilities that we have to tackle AMR: like we have seen during the COVID-19 pandemic, shared regional resources can be very useful – for example our extensive genomic sequencing network: not all of our 55 member states have the capacity to undertake this research but together, regionally, we can do this. This regional, and global, approach is something that will help us to tackle the rise of AMR. Most importantly, however, we have seen the benefit of public-private partnerships in COVID-19. While most AMR research has previously been done on a public level, with government-driven research, exploration of public-private partnerships could bring many benefits in AMR. So we really want to start seeing national action plans, but rather than a donor-driven approach here at Africa CDC we want to see a more holistic, long-term, sustainable approach. We need political backing, though, and we are starting to see this: the heads of state in Africa have, through the African Union, committed to advancing AMR research and interventions surrounding AMR.' – **Dr Alimi**
Dr Altevogt and Dr Frank, how feasible is the One Health approach to AMR, given that with AMR we are not just looking at humans, but also animals and food products.	'*In short, the answer is a holistic One Health approach, in which human medicine, veterinary care and environmental factors are all considered, is something we need to be striving for. We need to be cognisant that the solutions to each will be different, but we need to ensure that we understand how they interact with each other. It would be dangerous for good progress in one sector to be lauded while not much has be done in the other sectors, which could increase the risk of AMR. The UN and WHO have coordinated the Global Leaders Group on AMR that is advocating for a One Health approach. Approaches include simple changes to how we practice medicine, to use of vaccines in animal health settings and other actions along those lines.'* – **Dr Frank** '*I agree, we need to make sure that we are assessing the multifaceted causes and impacts of AMR, but we can't let that become too daunting for us to take action: there are very few organisations large enough to drive change at so many levels. While we need to ensure that we understand how each element in the system interacts, we need to recognize where each one of our individual organisations can take action to address AMR. For example, the AMR Industry Alliance has had a significant impact on minimizing AMR arising from the manufacturing process of antibiotics. While that is very important, there are so many other significant contributors; everyone needs to do their part.'* – **Dr Altevogt**
How can we ensure that the public is well engaged and informed so that any global policies put in place are translated to behavioural change and usage at the implementation level?	'*Education and raising awareness is vital, and the AMR Hub will be a great tool in furthering the discussion and sharing AMR resources. At bioMérieux we took the opportunity to raise awareness of AMR during an Antibiotic Resistance Awareness Week. We also provide documentation, such as important research articles and notebooks written by experts, to healthcare professionals. We also have a range of cartoons that teach lay people about better antibiotic practices. '* – **Dr Tissier & Dr Mabilat** '*This is a very good question, and is the foundation of AMR success. My response is that we need to find a way of packaging AMR stewardship*

	information for various audiences. For example, there is a patient angle to the threat of AMR, and we can learn ways in which institutions are engaging communities for COVID-19 related work. We also need to package information for healthcare institutions and for clinical settings. The latter is the trickiest, but the easiest way is to ensure harmonisation and evidence-based practices in treatment guidelines so that antibiotic use is streamlined, and diagnostic tools are used as much as access allows.' – **Dr Divala** '*Every now and then we as experts say lots and expect laypeople and NGOs to understand. As well as all this fantastic work, we need to work with the civil society organisations as they are unique in terms of how they have been able to drive behavioural change (for example in terms of HIV, TB etc). In our work, we are also starting to look at groups such as women, young professionals, and farmers associations to be the leaders in the response to AMR. In terms of an enabling environment, I really agree with Dr Divala about national treatment and patient management guidelines. This is a gap that we have identified ourselves, and we are working with countries to create context-applicable local guidelines. Another concern, particularly for us, is regulations around falsified and substandard medications. I haven't heard anyone else talk about it yet, and I suspect it may be particular to the African continent, but there is a need for national governments and regional bodies to start to look around and implement legislation around these substandard medicines. We need systems in place to completely remove these from the market. When it comes to agriculture, you need incentives to stop a farmer giving his animals antibiotics. As technical experts these are things that we need to start thinking about: how to translate our knowledge into well packaged, understandable information.*'– **Dr Alimi** '*One specific example that Dr Alimi spoke about is the tremendous amount of grassroots awareness building that is happening. For example, there is a student led initiative called Students Against Superbugs Africa. They are active on social media and are thinking of new ways to reach people and educate them about AMR – for example, the development of an educational video game. Those types of effort, that will educate the next generation, is incredible opportunity and another opportunity that this hub can explore.*' – **Mr Zerda** '*I just wanted to pick up on Dr Zerda's comment on putting a face on AMR. I wanted to clarify that everything we do with this hub Is fundamentally to support the patient community. I wanted to make sure we don't leave this webinar without a specific call out to our patient community and partners, encouraging them to get in touch with us and telling us what they need in order for us to prevent AMR from impacting these communities.*' – **Dr Altevogt** '*I am optimistic that we will find new drugs, molecules and solutions to this problem. I do, however, worry that access to these new treatments won't be equitable. These solutions need to be available for everyone.*' – **Dr Senna**

5. Written Q&A

As well as the spoken Q&A session, some questions were also responded to via the Zoom Q&A function during the webinar:

What are the research priorities in AMR agenda in Latin America, particularly in hospital setting where vulnerable populations such as indigenous people are cared for in South America?	Great question regarding local research priorities. I am personally interested in hearing from other, local, colleagues. I encourage you to view a recent piece in the Lancet on research priorities for antimicrobial stewardship. I did not see an author from Latin America specifically, but I expect these questions to be quite global in nature. https://www.sciencedirect.com/science/article/pii/S2666776221001381
What are the main international sources of funding for AMR research?	Here is a link to the funding page on the AMR Knowledge Hub, where you can find a list directing you to sources of funding for AMR research across the world: https://amr.tghn.org/funding/
How can I, and others from my country, become involved with this initiative?	We will start working groups to soon. Sign-ups will be on the AMR hub on the TGHN website, but you can also email us at info@theglobalhealthnetwork.org and get in touch with Dr Welile.
I have noted that there is little or no research (in the Global South) on how use of antimicrobial household products (soaps, hand sanitizers, cleaners...) have on AMR. Any research anywhere on how the increased indiscriminate use of these products as a result of Covid 19, will impact AMR? Any plans to involve non pharmaceutical companies in AMR research?	This is a good point. I am aware of research linking their use to higher rates of AMR, but as you pointed out most of this is based in high income countries. I recall seeing a letter in Science earlier this year highlighting how the COVID pandemic, and its increased use of these products, will be contributing to AMR. https://science.sciencemag.org/content/371/6528/474.1 It is a fair point on the need to engage those stakeholders involved in this area
Thank you Dr. Rafiqi. The question I have is are there some settings that are more prone to developing the resistance and	Hi, thank you for your question. These points are well-documented in the literature with the known drivers, including overuse and misuse of antibiotics. I would also suggest reviewing our website for a synthesis of this information with respect to the performance of pharmaceutical companies in stewardship measures. Hope this helps! www.accesstomedicinefoundation.org

what are the known drivers?	
Dr Rafiqi, is there any scope of hospitals other than pharmaceutical industries for your institution.? Do you have significant raw data from hospital settings?	Thank you for the question Sadia. Our focus is with the pharmaceutical industry and not hospitals, unfortunately. While we do not discount this for future studies, and I will take this forward. Thanks again!
Thank you tour presenters. One small thing we always forget to give attention in the fight to combat AMR is creating public awareness programs. In public health a well-informed patient or client is an heal person. I follow GARD P and from my experience I believe that creating AMR media based awareness programs, social media blogs can help in this generous fight.	Hi, this is an excellent point! We are looking to make community engagement central to the work of the AMR Knowledge Hub. We have a Community Engagement resources area here: https://amr.tghn.org/resources/community-engagement/ If you know of any projects that we could share, we welcome you to get in touch by email at info@theglobalhealthnetwork.org
Further questions and comments from participants:	
Will AMR research community have the appetite to explore the pathophysiology of infection in individuals with chronic co morbid conditions with a non-infectious disease, and discover the role of existence of chronic Noncommunicable conditions or risk factors in the path of developing AMR?	
Dear Fatima, is there any scope of hospitals other than pharmaceuticals for your institution? I mean you can have significant raw data from hospital settings.	
We would also like more panellists from various countries where AMR is quite worrying. This would help understand the real scenario in each countries as well help fill in the diagnostic gaps	
One small thing we always forget to give attention in the fight to combat AMR is creating public awareness programs. In public health a well-informed patient or client is an heal person. I follow GARD P and from my experience I believe that creating AMR media based awareness programs, social media blogs can help in this generous fight. First, we need to extensively influence the public or communities to change the behaviors of self medications especially the antimicrobials. Also the governments and regulatory bodies need to smart up and bring strong and serious regulating laws against improper use of antibiotics.	

6. Call to Action and Next Steps

If you are involved in research on Antimicrobial Resistance, please get in touch and share any relevant protocols, experiences, or advice.

For AMR-related resources please visit the AMR Knowledge Hub; This is an open and free resource for a global community of practice for all researchers, healthcare and laboratory teams in all organisations working in AMR research. Here you can find:

- Internal and external resources grouped into Diagnostics, Therapeutics and Vaccines R&D, One Health, Surveillance, Community Engagement and Implementation Research.
- Region-specific information, resources and research
- Free and trusted eLearning courses on key topics relating to AMR
- A regularly updated list of potential funding opportunities for those looking to undertake AMR research
- Information on events hosted by the AMR Knowledge Hub and other organisations

Over the next few days please send in your comments and feedback on this workshop. For those who want to get involved in the AMR Knowledge Hub, you Can get in touch here: info@theglobalhealthnetwork.org

7. Registration and Attendee Report

Countries - Top 20

Registrations	Count	Attendees	Count
India	94	The United Kingdom	33
Kenya	71	India	26
The United States	68	Uganda	25
Uganda	64	Kenya	22
The United Kingdom	59	Nigeria	19
Nigeria	47	The United States	17
Malawi	23	Italy	12
Ghana	19	Brazil	10
Tanzania	19	Malawi	10
Indonesia	17	Indonesia	9
Bangladesh	16	Tanzania	9
Ethiopia	15	France	8
South Africa	15	South Africa	7
Australia	14	Vietnam	6
Spain	14	Bangladesh	5
Peru	14	Argentina	5
Brazil	14	Australia	5
Italy	13	Ghana	5
Vietnam	11	Belgium	5
Nepal	10	Nepal	4

Attendee institutions (top 20 recorded)

Academia (university, college, ...)	121
Hospital (Public)	23
Non-government organisation (NGO)	19
Other research organisation	15
Government research organisation	14
Government Ministry	14
Hospital (Private)	13
Regulatory organisation	10
Industry (including Pharma)	10
Other	7
Consultancy	5
Academia (university, college, ...), Hospital (Public)	5
International organisation (IGO)	4
Public Health institute	4
Commercial Research Organisation	4
Community Health Centre/Facility	3
Academia (university, college, ...), Hospital (Private)	3
Academia (university, college,...),Non-government organisation (NGO)	3
Academia (university, college, ...), Government research organisation	2

Attendee job title (top 20 recorded)

Research investigator	38
Student	34
Other	26
Member of a research team	25
Academic (teacher in university or other institute of higher education)	21
Laboratory team	16
Medical Doctor	16
Nurse / Midwife / public health professional	14
Other clinical role	9
Working for government department or ministry	5
Working for research regulatory bodies	5
Member of a research team, Student	5
Member of a research team, Medical Doctor	5
Working for a research funding organisation	4
Academic (teacher in university or other institute of higher education), Member of a research team	4
Academic (teacher in university or other institute of higher education), Medical Doctor	3
Member of a research team, Laboratory team	3
Research investigator, Academic (teacher in university or other institute of higher education)	3
Health care assistant and other hospital support staff	2
Working in research policy/policymaker	2
Academic (teacher in university or other institute of higher education), Laboratory team	2
Research investigator, Member of a research team, Laboratory team	2
Member of a research team, Medical Doctor, Student	2
Research investigator, Academic (teacher in university or other institute of higher education), Member of a ...	2