Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report

Early implementation

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Contents

Foreword

May, 2020

During the past six months, the world has faced a pandemic crisis like no other in a century. The COVID-19 experience has shown that surveillance systems are crucial for the detection and management of new public health threats. Antimicrobial resistance (AMR) is an example of such an emerging threat with permanent humanitarian and economic consequences if not tackled aggressively.

Guiding the world towards optimal public health response and informed decision making requires harmonized data collection. In 2015, the World Health Organization launched the Global Antimicrobial Resistance and Use Surveillance System (GLASS) – the first global system to collect official national AMR data in selected bacterial pathogens causing common infections in humans.

Our aim is to ensure that countries can design cost effective, evidence-based AMR response strategies that are prioritized for impact, in the context of whole of society engagement across the One Health spectrum.

In the span of four years, 91 countries and territories have enrolled in GLASS and this report presents AMR data in over two million patients from 66 countries. It shows disturbing high rates of resistance among antimicrobials frequently used to treat common bacterial infections.

GLASS is poised now to move from its infancy to mature development towards a representative database that will reveal the burden of AMR, trends in resistance, determinants and ultimately, the cost of inaction. Initial limitations due to coverage and interpretation of results from the implementation phase of GLASS will give way to allow for robust estimation of AMR burden.

WHO is grateful for the support from international, regional, and national partners that enabled harmonization and coordination of AMR surveillance efforts. Together we will see GLASS move from a newly launched surveillance system finding its way, to robust data collection incorporating more pathogens, specimens and surveillance approaches to broaden the evidence base and help the world to stem the tide of drug resistance.

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Assistant Director – General
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Summary

AMR represents a major threat to human health with significant global economic and security implications. In 2015, WHO Member States unanimously approved a Global Plan of Action to tackle AMR. Subsequently, Heads of States endorsed the AMR Action Plan and called for concerted action across all sectors in the context of the One Health approach.

WHO launched the Global Antimicrobial Resistance and Use Surveillance System (GLASS) in 2015 to continue filling knowledge gaps and to inform strategies at all levels. GLASS has been conceived to progressively incorporate data from surveillance of AMR in humans, such as monitoring of resistance, use of antimicrobial medicines, AMR in the food chain and in the environment.

GLASS provides a standardized approach to the collection, analysis, interpretation and sharing of data by countries, territories and areas and monitors the status of existing and new national surveillance systems. The various types of AMR-related surveillance activities led by GLASS are grouped into technical modules. Furthermore, GLASS provides support and evidence-based guidelines to assist countries, territories and areas to build capacity and take corrective actions.

GLASS works through all three levels of WHO – headquarters and regional and country offices – and is supported by the WHO AMR Surveillance and Quality Assessment Collaborating Centres Network. It enjoys strong commitment from participating countries, territories and areas and close collaboration with AMR regional networks such as CAESAR (Central Asian and European Surveillance of Antimicrobial Resistance), EARS-Net (European Antimicrobial Resistance Surveillance Network) and ReLAVRA (Latin American Network for Antimicrobial Resistance Surveillance).

Since 2015, GLASS has continued to evolve and currently comprises five technical modules, including surveillance based on routinely collected data (e.g. patient samples collected for clinical purposes and national sales of antimicrobials), and focussed surveillance to generate information for specific purposes. The first GLASS surveillance module, launched in 2016, addresses AMR in bacteria that cause common human infections and against which antimicrobials are becoming increasingly ineffective. The antimicrobial consumption (AMC) module was added in 2019, and the first call for data on national AMC will be conducted in 2020.

As of April 2020, 92 countries, territories and areas are enrolled in GLASS, specifically 91 in the AMR surveillance module and nine in the AMC surveillance module. The aims of this third GLASS report are to:

- describe the elements and status of development of GLASS;
- summarize the results of the data call on 2018 AMR data from participating countries, territories and areas;
- summarize participation of countries, territories and areas and their progress in AMR-related surveillance; and
- summarize AMR surveillance activities globally.

By the end of the data call (31 July 2019), 82 countries, territories and areas were enrolled in the AMR module, comprising 13 low-income, 23 lower–middle-income, 16 upper–middle-income and 30 high-income countries, territories and areas in all WHO regions. Of these, 78 countries, territories or areas reported to GLASS during the data call, of which 66 reported data on AMR. Of these, 12 provided information on the status of their national AMR surveillance systems, 1 reported AMR data for 2018, and 65 countries, territories and areas provided both information on the status of their national surveillance system and AMR data for 2018.

In the AMR module, GLASS captures information on the frequency of resistance among high-priority pathogens that cause infections in humans: *Acinetobacter* spp., *Escherichia coli, Klebsiella pneumoniae, Neisseria gonorrhoeae, Salmonella* spp., *Shigella* spp., *Staphylococcus aureus* and *Streptococcus pneumoniae*. Data on AMR are collected through a case-finding surveillance system, with collation of the results for specimens of blood (*Acinetobacter* spp., *E. coli, K. pneumoniae, Salmonella* spp., *S. aureus* and *S. pneumoniae*), urine (*E. coli, K. pneumoniae*), stool (*Salmonella* spp., *Shigella* spp.) and cervical and urethral specimens (*N. gonorrhoeae*) sent routinely to laboratories for clinical and public health purposes. In 2019, GLASS received data on specimens from 2 365 972 infected patients; of these, 2 164 568 (91%) underwent antimicrobial susceptibility testing (AST). Twenty- eight of the 66 countries, territories and areas that provided information on the proportion of infections due to selected types of AMR also provided information on the population tested with suspected infections.

Capacity to conduct AMR surveillance is still being established in some countries, territories and areas; therefore, the data collected by GLASS-AMR are not yet of sufficient representativeness to allow comparison of trends in AMR among countries, territories and areas, and regions. The data nevertheless show progress in the development and strengthening of national AMR surveillance systems over the past 3 years. Interactive virtualization of the AMR results of single countries, territories and areas is available on the WHO Global Health Observatory GLASS webpage https://www.who.int/gho/glass/en/

The GLASS–One Health module, based on the extended-spectrum β-lactamase (ESBL) *E. coli* Tricycle project, has been pilot-tested in six low-income and lower–middle-income countries, and another nine countries have been selected for implementation in 2020. The aim of the project is to detect the presence of ESBL *E. coli* in animal, human and environmental ecosystems as a first step in the development of a standardized method for integrated AMR surveillance in the context of the One Health approach. The enhanced gonococcal antimicrobial surveillance programme (EGASP) module has been pilot-tested in the Philippines and Thailand, providing an unprecedented set of clinical data related to resistant *N. gonorrhoeae* for finalization of the EGASP protocol, which could be adapted by countries to combat AMR for this pathogen.

The report summarizes not only GLASS activities but also describes developments over the past years in other surveillance programmes led by WHO, including resistance to anti-HIV and anti-tuberculosis (TB) medicines, antimalarial drug efficacy and environmental surveillance of AMR.

GLASS has already collected an unprecedented amount of information on AMR globally and regionally and continues to foster development of national AMR surveillance systems. In the near future, GLASS will fully integrate information on AMC and from targeted surveillance with evidence-based data collection methods and will offer an exceptional platform for data analysis and information-sharing, playing an essential role in the identification and understanding of AMR trends and drivers globally. The support of the WHO regional offices, WHO collaborating centres, other public health institutions and international partners to participating countries, territories and areas, territories and areas continues to be fundamental to the achievements to date.

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Abbreviations and Acronyms

AMR	Antimicrobial resistance
AFR	WHO African Region
AMC	Antimicrobial consumption
AMR	Antimicrobial resistance
AMR/PAHO	WHO Region of the Americas/ Pan American Health Organization
AST	Antimicrobial susceptibility testing
CAESAR	Central Asian and European Surveillance of Antimicrobial Resistance
CLSI	Clinical and Laboratory Standards Institute
EARS-Net	European Antimicrobial Resistance Surveillance Network
ECDC	European Centre for Disease Prevention and Control
EMR	WHO Eastern Mediterranean Region
EQA	External quality assessment
ESBL	Extended-spectrum beta-lactamase
EUCAST	European Committee on Antimicrobial Susceptibility Testing
EUR	WHO European Region
FAO	Food and Agriculture Organization of the United Nations
GAP-AMR	Global Action Plan on Antimicrobial Resistance
GASP	Gonococcal Antimicrobial Surveillance Programme
GLASS	Global Antimicrobial Resistance and Use Surveillance System
GLASS-EAR	GLASS Emerging Antimicrobial Resistance Reporting
GPW	WHO General Programme of Work
HCF	Health-care facility
HICs	High-income countries
HIV/AIDS	Human immunodeficiency virus/ acquired immune deficiency syndrome
IHR	International Health Regulations (2005)
KOICA	Korea International Cooperation Agency
LICs	Low-income countries
LMCs	Lower middle-income countries
MIC	Minimum inhibitory concentration
MOH	Ministry of Health
MRSA	Methicillin-resistant ***Staphylococcus aureus***
NCC	National coordinating centre
NFP	National focal point
NRL	National reference laboratory
OIE	World Organisation for Animal Health
PPS	Point prevalence survey
ReLAVRA	Latin American Network for Antimicrobial Resistance Surveillance (Latinoamericana de Vigilancia de la Resistencia Antimicrobiana)
RIS	Resistant, I, susceptible
RIVM	The Netherlands National Institute for Public Health and the Environment
RO	WHO Regional Office
SDGs	Sustainable Development Goals
SEAR	WHO South-East Asia Region
TB	Tuberculosis
UMCs	Upper middle-income countries
UNEP	United Nations Environment Programme
WPR	WHO Western Pacific Region

WHO Regional offices

AFRO	WHO Regional Office for Africa
AMRO/PAHO	WHO Regional Office for the Americas/ Pan American Health Organization
EMRO	WHO Regional Office for the Eastern Mediterranean
EURO	WHO Regional Office for Europe
SEARO	WHO Regional Office for South-East Asia
WPRO	WHO Regional Office for the Western Pacific


SECTION
01

1. Introduction

1.1 WHO response to the emergence of AMR

The emergence of AMR is a normal evolutionary process for microorganisms (bacteria, fungi, viruses and parasites), which is accelerated by the selective pressure exerted by widespread use and misuse of antimicrobials. The association between antimicrobial use and resistance has been well documented in health care facilities, communities and countries [1, 2]. New AMR mechanisms are emerging and spreading globally, threatening treatment of infectious diseases, resulting in prolonged illness, disability and death and increasing the cost of health care [3]. Moreover, because bacteria are found in human, animal and environmental ecosystems, some of which can exchange AMR genes, it is essential to understand the dynamics of AMR in different sectors in order to mitigate its impact on human health and to rapidly control its spread [4].

WHO initiated a range of AMR-related activities almost 20 years ago, culminating in approval of the Global Action Plan on Antimicrobial Resistance (GAP-AMR) by the Sixty-Eighth World Health Assembly in May 2015 [5]. Two specific AMR indicators were added to the Organization's 13th General Programme of Work (2019–2023): (i) bloodstream infections due to two specific pathogens and (ii) trends in national consumption of antibiotics [6].

Reiterating the impact of AMR on public health, the United Nations Secretary-General stated in May 2019: "Antimicrobial resistance is a global threat to health, livelihoods and the achievement of the Sustainable Development Goals (SDGs)" [7]. As a result, Member States requested inclusion of an AMR indicator in the monitoring framework for the SDGs. WHO therefore proposed an indicator, which was reviewed by experts and in a public consultation. The new AMR indicator, the proportions of bloodstream infections due to selected types of AMR, is linked to target 3.d: Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks.

Intersectoral collaboration is also essential for the coordination of human, animal, plant and environment policies to limit the emergence of AMR in different ecosystems. The Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and WHO signed a memorandum of understanding on AMR in 2018 to ensure tripartite cooperation to combat health risks at the animal–human–ecosystem interface applying a One Health approach. WHO has also engaged with other United Nations agencies to strengthen concerted actions. The Tripartite Organisations have published a monitoring and evaluation framework for the Global Action Plan to assess delivery of the Plan's objectives and inform strategic and operational decision-making on AMR [8].

This report emphasizes the key role of surveillance in monitoring the presence and frequency of AMR globally, and in identifying risk factors and drivers to guide policies, strategies, planning and implementation.

1.2 WHO support for global and regional surveillance of antimicrobial resistance

Surveillance is essential for informing policies and interventions, including stewardship and infection prevention and control. It is the cornerstone for monitoring the emergence and spread of AMR and for evaluating the effectiveness of local, national and global containment and mitigation strategies. In past decades, WHO has helped to establish global, regional and national surveillance systems to monitor trends in drug resistance and therapeutic efficacy against TB, HIV infection, malaria and neglected tropical diseases [9]. WHO collects national data on the burden of drug-resistant infections and reviews the quality of data from 164 countries and territories for multidrug-resistant TB, from 49 countries for resistance to drugs for HIV infection and from 64 countries for drugs to treat malaria, representing most of the world's population and most of the burden of high-impact infectious diseases. The status of and trends in resistance to drugs for these diseases are routinely published in disease-specific reports and in peer-reviewed publications [9].

Large regional AMR surveillance networks have been established in Europe (EARS-Net [10]), Central Asia and Europe (CAESAR [11]) and Latin America (ReLAVRA [12]). As requested by WHO Member States in resolution WHA68.7, WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) was established to standardize the collection of official data on AMR for common bacterial infections in order to provide a clearer, more comprehensive picture of dynamics and drivers of AMR globally [13].

1.3 WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS)

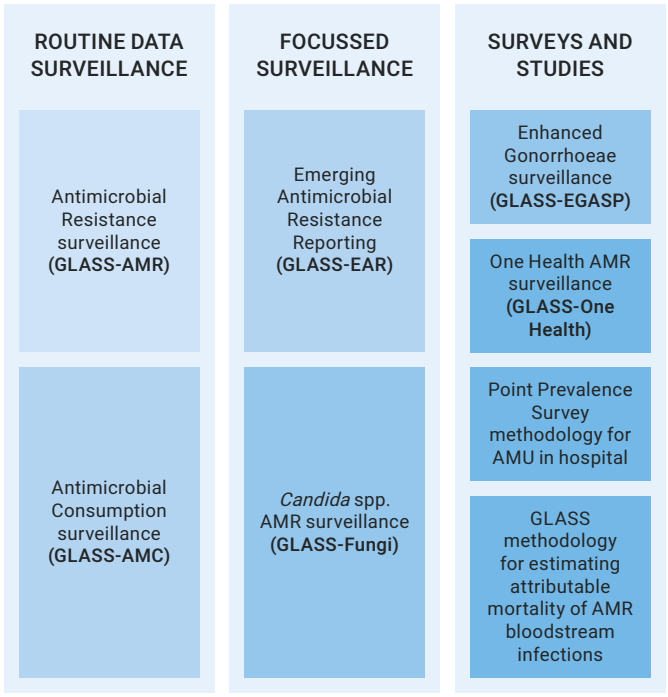
The various types of AMR-related surveillance activities (Fig. 1.1) led by GLASS are grouped into technical modules. The modules comprise surveillance activities built on routinely available data (e.g., patient samples collected for clinical purposes or national sales of antimicrobials) and focussed surveillance activities aimed at generating information for specific purposes, based on countries, territories and areas' needs. GLASS is also engaged in the design and implementation of surveys and studies aimed at helping countries to achieve better quality and representativeness of their data. (Fig 1.1)

GLASS recommends the establishment of three core components to set up a well-functioning national AMR surveillance system: 1) A National Coordinating Centre (NCC); 2) National Reference Laboratory (NRL); and 3) Sentinel surveillance sites for collecting clinical information, diagnostic results and epidemiological data. Countries, territories and areas, territories and areas **may enrol and participate in GLASS before any of these components is in place** [14]. GLASS documents on yearly basis the progress made by enrolled countries, territories and areas, territories and areas in developing and expanding their national surveillance systems. GLASS provides a standardized approach to the collection, analysis and sharing of data on AMR and AMC [14].

WHO provides support to countries through its coordinated, three-level approach (country and regional offices and headquarters) to capacity-building and on-site and remote technical assistance. The support includes that for strengthening and establishing national AMR surveillance systems with guidelines, tools, training, workshops, consultancies, assessments, country visits for laboratory work, data collection and analysis, EQA, governance and coordination. The support also enables countries, territories and areas to participate in GLASS. Support from the WHO AMR Surveillance and Quality Assessment Collaborating Centres Network and international partners have also been essential for national AMR surveillance [15].

The GLASS IT platform (https://extranet. who.int/glass/portal/) for global data on AMR, AMC and AMU, launched by WHO in 2016, is a common environment for sharing data. The platform hosts IT elements for most GLASS technical modules. Since its initial release, the functionality of the platform has been enhanced with new analytical and export tools. Through data visualization, countries, territories and areas can generate and export reports with graphical representations of their data and check their validity against several indicators. The design of the user interface has been updated to provide a simpler, more accessible, user-friendly experience.

Fig. 1.1. Current GLASS activities



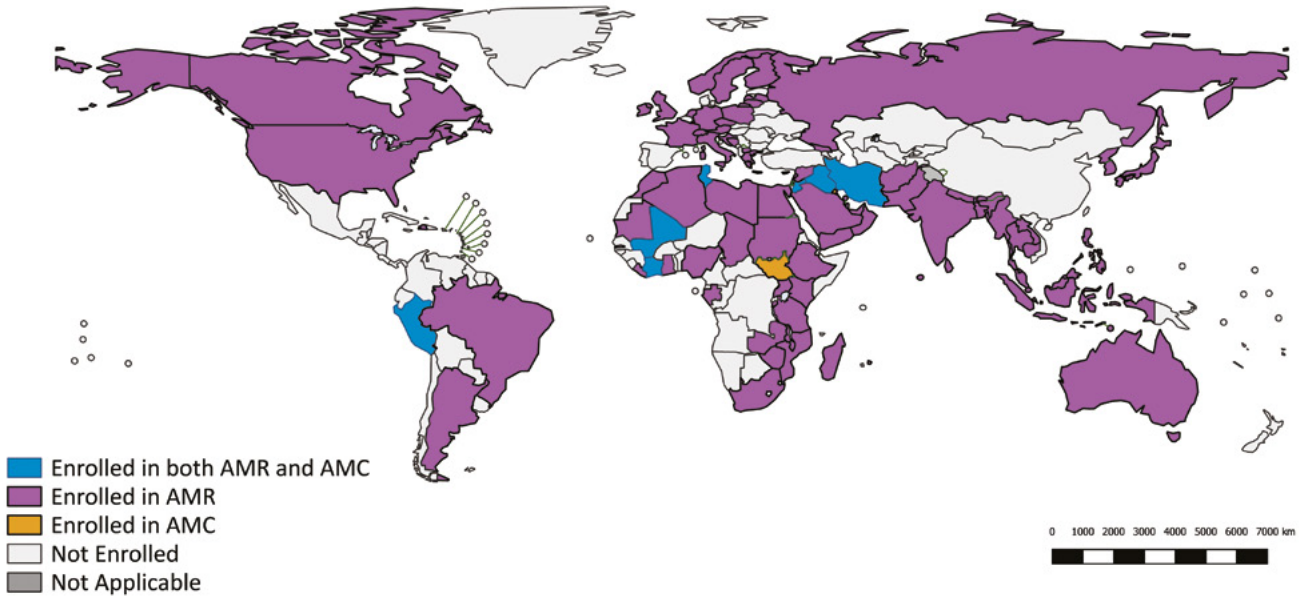
1.3.1 Routine data surveillance

GLASS-AMR provides a standardized approach to the collection, analysis and sharing of national data on AMR in samples collected routinely for clinical purposes for a set of pathogens that cause common human infections [14]. Pathogens currently included in GLASS-AMR are: *Acinetobacter* spp., *E. coli*, *K. pneumoniae*, *N. gonorrhoeae*, *Salmonella* spp., *Shigella* spp., *S. aureus*, and *S. pneumoniae.* Data on AMR are collected in a case-finding surveillance system, with collation of results for specimens from blood (*Acinetobacter* spp., *E. coli*, *K. pneumoniae*, *Salmonella* spp., *S. aureus* and *S. pneumoniae*), urine (*E. coli*, *K. pneumoniae*), stool (*Salmonella* spp., *Shigella* spp.) and cervical and urethral specimens (*N. gonorrhoeae*) sent routinely to laboratories for clinical and public health purposes [14].

GLASS-AMC monitors antimicrobial consumption (AMC) at the national level [1]. AMC data are estimates derived from aggregated data sources (from macro-level, such as import and distribution, to micro-level, such as data on prescriptions and insurance). Consumption indicates which and how much antimicrobials are used in a specific setting over a specific period. Enrolment of countries, territories and areas into the GLASS-AMC module was launched in December 2019, and GLASS plans to start sharing the data collected by both systems by 2021. Countries, territories and areas will be asked to provide three types of information: (1) a list of registered antimicrobial medicines; (2) the quantities of the medicines used in the public and/or private sectors and in community and/or hospital settings for 1 year (January–December); and (3) related contextual information to clarify the data being sent to WHO and their relevance. From this information, WHO will estimate AMC according to the international Anatomical Therapeutic Chemical (ATC) classification and express the results in "defined daily doses" for humans and tonnes for comparison with data on consumption in animal health. Data on AMC provide a basis for countries, territories and areas to understand the patterns and amount of antibiotics used nationally as a basis for policies, regulations and interventions to optimize use of antibiotics [1].

With data on AMR and AMC, GLASS offers a synergized global approach to identifying trends in and drivers of AMR. As of April 2020, 92 countries, territories and areas or territories were enrolled in GLASS, comprising 91 in the GLASS-AMR module and 9 in the GLASS-AMC module (Fig 1.2). Focussed surveillance is implemented in selected countries, territories and areas, with the support of partners.

Fig 1.2 Map of enrolment in GLASS-AMR (by the end of April 2020)



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data source: World Health Organization
Map production: Information Evidence and Research (IER)
World Health Organization

World Health Organization

1.3.2 Focussed surveillance

GLASS-EAR module supports prevention, detection, early warning, risk assessment and response. GLASS-EAR is a tool for standard, transparent, timely, secure reporting and reactive information-sharing. The module defines a workflow, described in the GLASS-EAR framework[16], for timely notification of various stakeholders about emerging AMR, in compliance with the International Health Regulations (2005) (IHR).

In recognition of the growing threat of resistant fungal infections, **GLASS-Fungi** was initiated as a global collaboration for data on antifungal-resistant infections [17]. Few countries have effective surveillance for fungal diseases; consequently, data on their incidence, resistance and public health impact are limited. In view of the broad spectrum of invasive antifungal-resistant infections, work will initially focus on invasive fungal bloodstream infections caused by *Candida* spp., the most common type of invasive fungal disease [18]. Multi-drug resistant *Candida* species, including *Candida auris,* have emerged as the causative agent of many nosocomial infections and associated with outbreaks [19].

1.3.3 Surveys and studies

GLASS-EGASP is a standardized approach to sentinel surveillance of men with urethral discharge and suspected urogenital gonorrhoea attending selected surveillance sites [20]. Demographics and clinical and behavioural information is collected during routine clinical activities, and urethral specimens are sent to selected reference laboratories for quality-assured culture and AMR testing with recognized methods.

In 2018, WHO started the implementation of a model for integrated multi sectoral surveillance based on the extended-spectrum beta-lactamase (ESBL) -producing *E. coli* (the Tricycle Project)[21]. ESBL *E. coli* is a common indicator that can be detected across human samples, poultry and water – specifically sewage, market runoff and river sites in urban areas. **GLASS-One Health** derives from the successful initial implementation of the Tricycle Project in 9 countries (see Table 2.6).

A method for a point prevalence survey of AMU [22] is being pilot-tested in a number of countries, and the GLASS method for estimating mortality from bloodstream infections attributable to AMR will be soon made available.


SECTION
02

2. GLASS data summaries

2.1 GLASS-AMR

A readers' guide to the results and analytical limitations of GLASS-AMR is available in Annex 1.

2.1.1 Participation and reporting

By the end of the third data call on 31 July 2019, 82 countries, territories and areas were enrolled in GLASS-AMR, a 95% increase in enrolment compared to GLASS first data call in 2017. These 82 include a mix of countries, territories and areas in different stages of economic development from across all WHO regions (13 LICs, 23 lower middle-income countries [LMICs], 16 upper middle-income countries [UMICs], and 30 high-income countries [HICs])[23] (Table 2.1).

Of the 82 countries/territories/areas enrolled by the end of the 2019 data call, a total of 78 countries/territories/areas submitted data (Fig 2.1):

- 12 countries and territories provided only the information on the status of their national AMR surveillance systems.
- One country provided AMR rates only
- 65 countries, territories and areas provided the information on the status of their national AMR surveillance systems and 2018 AMR rates;

AMR rates are collected though a case finding surveillance system, which collects sensitivity testing results from four diffident infection sites, eight pathogens (Table 2.2), and a combination of antimicrobials (Annex 1). Both AST results and the number of patients sampled were provided by 42% of the 66 countries territories and areas, as compared with 28% in the previous data call. Thirteen countries, territories and areas that submitted only information on the status of their national AMR surveillance system in the previous call also reported AMR rates in 2019. These consisted of four low-income, five lower–middle-income, three upper–middle-income and one high-income country.

Table 2.1. Reporting activities to GLASS data call

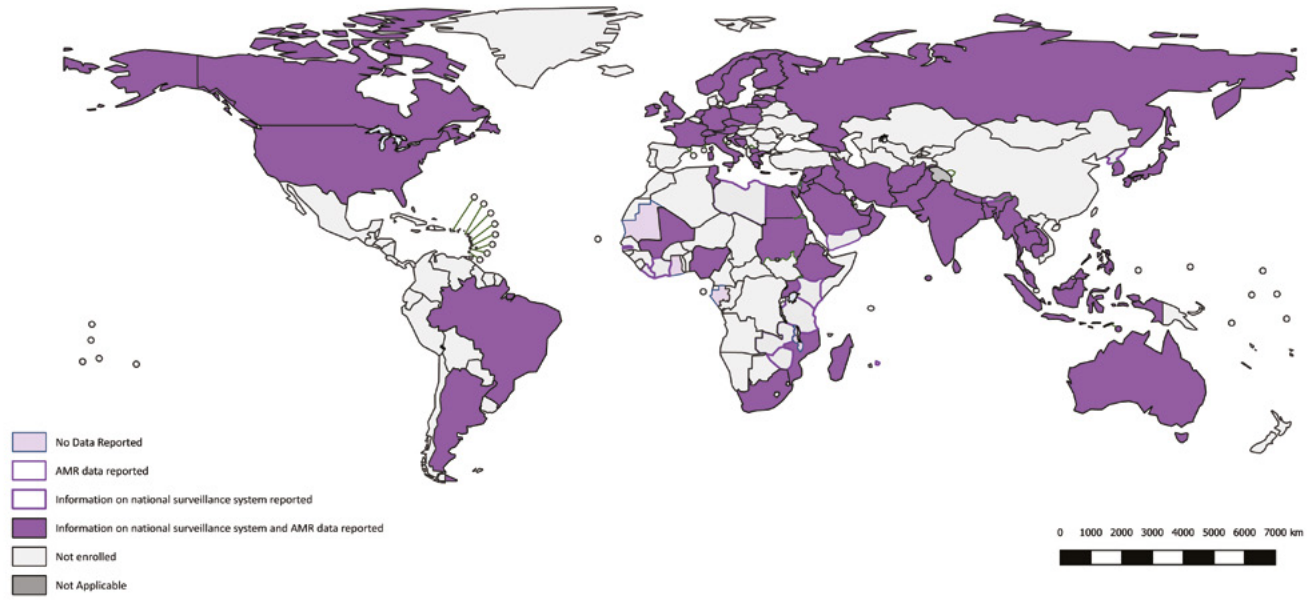
GLASS REPORT 2020	INCOME LEVEL[1]			
	LOW	LOW AND MIDDLE	UPPER AND MIDDLE	HIGH
No data reported (n=4)	Malawi	Ghana	Gabon	
		Mauritania		
Information on national surveillance system reported (n=12)	Democratic People's Republic of Korea	Bhutan	Libya	
	Liberia	Côte d'Ivoire	Mauritius	
	Gambia	Kenya		
	United Republic of Tanzania	Occupied Palestinian Territory, including North Jerusalem		
		Zambia		
		Zimbabwe		
AMR data reported (n=1)	Yemen			

1 The World Bank, 2020 [22. **World Bank Country and Lending Groups** [https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups]

GLASS REPORT 2020	INCOME LEVEL[1]			
	LOW	LOW AND MIDDLE	UPPER AND MIDDLE	HIGH
Information on national surveillance system and AMR data reported (n=66[2])	Afghanistan	Bangladesh	Bosnia and Herzegovina	Argentina
	Ethiopia	Cambodia	Brazil	Australia
	Madagascar	Egypt	Georgia	Austria
	Mali	India	Iran (Islamic Republic of)	Bahrain
	Nepal	Indonesia	Iraq	Canada
	Syrian Arab Republic	Jordan	Lebanon	Croatia
	Uganda	Lao People's Democratic Republic	Malaysia	Cyprus
		Mozambique	Maldives	Czech Republic
		Myanmar	Russian Federation	Finland
		Nigeria	South Africa	France
		Pakistan	Thailand	Germany
		Philippines	North Macedonia	Greece
		Sri Lanka		Ireland
		Sudan		Italy
		Tunisia		Japan
				Latvia
				Lithuania
				Luxembourg
				Malta
				Netherlands
				Norway
				Oman
				Poland
				Republic of Korea
				Saudi Arabia
				Sweden
				Switzerland
				United Arab Emirates
				United Kingdom of Great Britain and Northern Ireland
				United States of America

2 Includes Kosovo: all references to Kosovo in this document should be understood to be in the context of United Nations Security Council resolution 1244 (1999)

Fig. 2.1. Map of countries and territories that provided data only on implementation of surveillance and those that provided data on both implementation and AMR rates



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data source: World Health Organization
Map production: Information Evidence and Research (IER)
World Health Organization

World Health Organization

Overall, 5 551 hospitals, 56 808 outpatient clinics and 1 995 in-outpatients facilities reported data on AMR to GLASS. GLASS also received data from 424 laboratories from 23 countries that cannot yet obtain information from the surveillance sites at which samples were taken. External quality assessment (EQA) of bacterial identification and AST in laboratories reporting to GLASS varied by region. A summary of EQA in NRL and local laboratories participating in national surveillance systems is given in section 2.2.2.3.

In total, 65 (98%) countries, territories and areas submitted results for blood specimens, 42 (64%) for urine specimens, 34 (52%) for stool specimens and 37 (56%) for cervical and urethral specimens. The most frequently reported pathogens were, in order, *E. coli*, *K. pneumoniae*, *Salmonella* spp., *Acinetobacter* spp., *S. aureus*, *S. pneumoniae*, *N. gonorrhoeae* and *Shigella* spp. (Annex 2).

The number of patients with suspected infection from whom a pathogen was isolated varied considerably, from a minimum of 19 to a maximum of 816 879 patients per country. Countries, territories and areas reported information for a combined total of 2 365 972 infected patients. AST varied widely among countries, territories and areas and in the specimen–pathogen–antibiotic combinations tested, with regard to both the choice of isolates tested and the battery of drugs considered. AST results were reported for 2 164 568 patients (Table 2.2).

Table 2.2. Numbers of infected patients and patients with AST results reported to GLASS

INFECTION SITE	TOTAL NUMBER OF INFECTED PATIENTS	PATHOGEN	NUMBER OF INFECTED PATIENTS (BY PATHOGEN)				NUMBER OF PATIENTS WITH AST RESULTS	PATHOGEN	NUMBER OF PATIENTS WITH AST RESULTS (BY PATHOGEN)[a]			
			COMMUNITY	HOSPITAL	UNKNOWN	TOTAL			COMMUNITY	HOSPITAL	UNKNOWN	TOTAL
Bloodstream	**441 794**	*Acinetobacter* spp.	1 780	2 736	12 922	**17 438**	**426 010**	*Acinetobacter* spp.	1 495	2 464	11 526	**15 485**
		E. coli	48 939	35 974	144 701	**229 614**		*E. coli*	46 788	35 544	142 140	**224 472**
		K. pneumoniae	15 306	15 455	44 279	**75 040**		*K. pneumoniae*	14 465	14 951	42 088	**71 504**
		Salmonella spp.	2 947	334	7 907	**11 188**		*Salmonella spp.*	1 528	270	7 113	**8 911**
		S. aureus	12 030	17 408	60 054	**89 492**		*S. aureus*	10 325	17 007	59 728	**87 060**
		S. pneumoniae	3 627	1 274	14 121	**19 022**		*S. pneumoniae*	3 261	1 236	14 081	**18 578**
Urinary tract	**1 888 545**	*E. coli*	405 942	164 385	1 121 325	**1 691 652**	**1 705 167**	*E. coli*	293 063	157 075	1 079 508	**1 529 646**
		K. pneumoniae	64 571	42 206	90 116	**196 893**		*K. pneumoniae*	51 154	40 541	83 826	**175 521**
Gastroenteric	**17 061**	*Salmonella spp.*	2 630	257	9 269	**12 156**	**15 029**	*Salmonella spp.*	1 966	152	8 207	**10 325**
		Shigella spp.	375	42	4 488	**4 905**		*Shigella spp.*	358	29	4 317	**4 704**
Genital	**18 572**	*N. gonorrhoeae*	16 336	1	2 235	**18 572**	**18 362**	*N. gonorrhoeae*	16 195	0	2 167	**18 362**
Total	**2 365 972**		**574 483**	**280 072**	**1 511 417**	2 365 972	**2 164 568**		**440 598**	**269 269**	**1 454 701**	**2 164 568**

a For one of more antibiotics required by GLASS reporting.

2.1.2 Status of reporting national surveillance systems

The total number of countries, territories and areas per WHO region and the number of countries, territories and areas reporting to GLASS in the third data call are shown in Table 2.3. As stated in Annex 1, the indicators are summarized as country proportions and listed by region for the three areas of implementation: coordination, surveillance systems and quality assurance and standards. Proportions are calculated with the total number of countries, territories and areas in each region as the denominator.

Table 2.3. WHO Member States and territories per region enrolled in GLASS that reported information on their national surveillance systems in the third data call

REGION	NO. OF COUNTRIES, TERRITORIES AND AREAS	NO. OF COUNTRIES, TERRITORIES AND AREAS ENROLLED IN GLASS[3]	NO. OF COUNTRIES, TERRITORIES AND AREAS THAT REPORTED INFORMATION FROM THE NATIONAL SURVEILLANCE SYSTEM TO GLASS
African	47	19	15
Americas/PAHO	35	4	4
Eastern Mediterranean	22	17	16
European[4]	54	25	25
South-East Asia	11	10	10
Western Pacific	27	7	7
Total	**196**	**82**	**77**

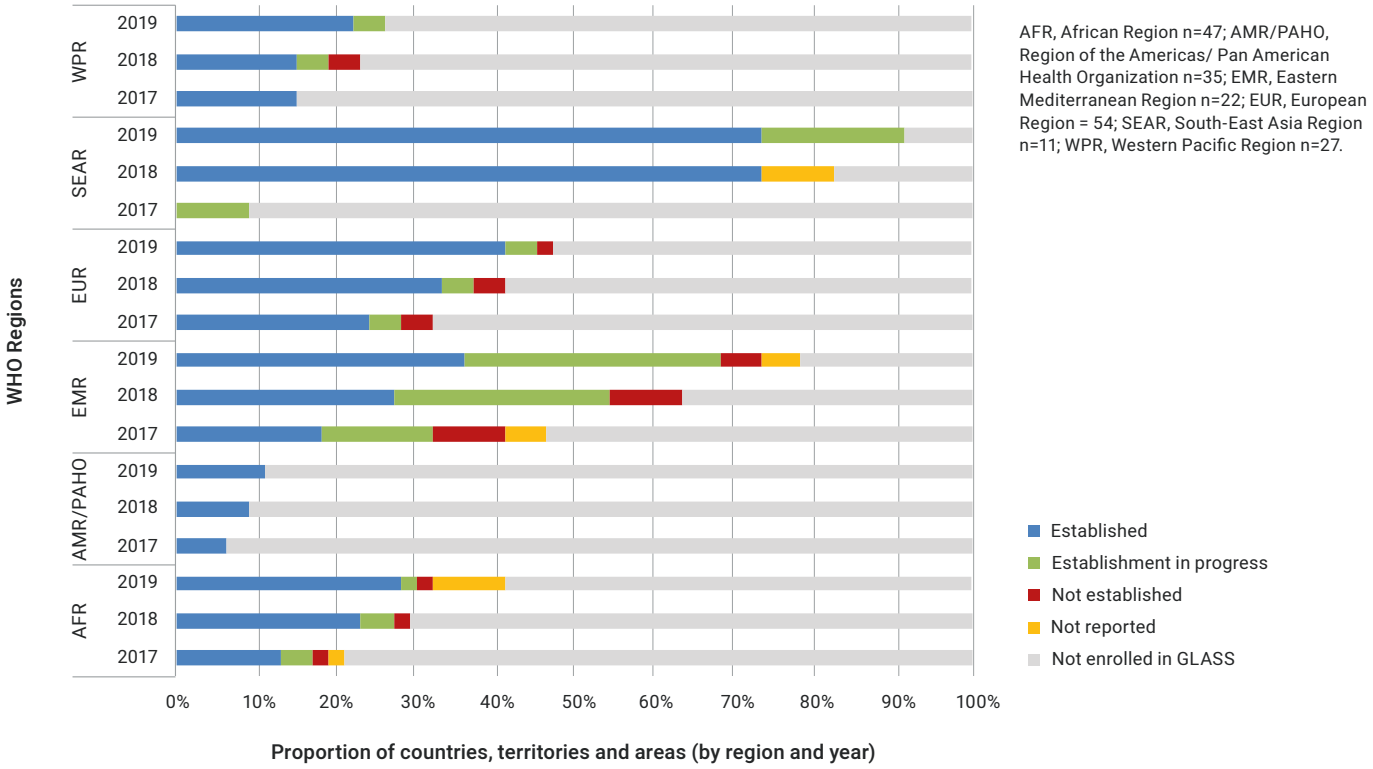
3 At the end of the 2019 data call – 31st July 2019

4 Included Kosovo. All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

2.1.2.1 Coordination

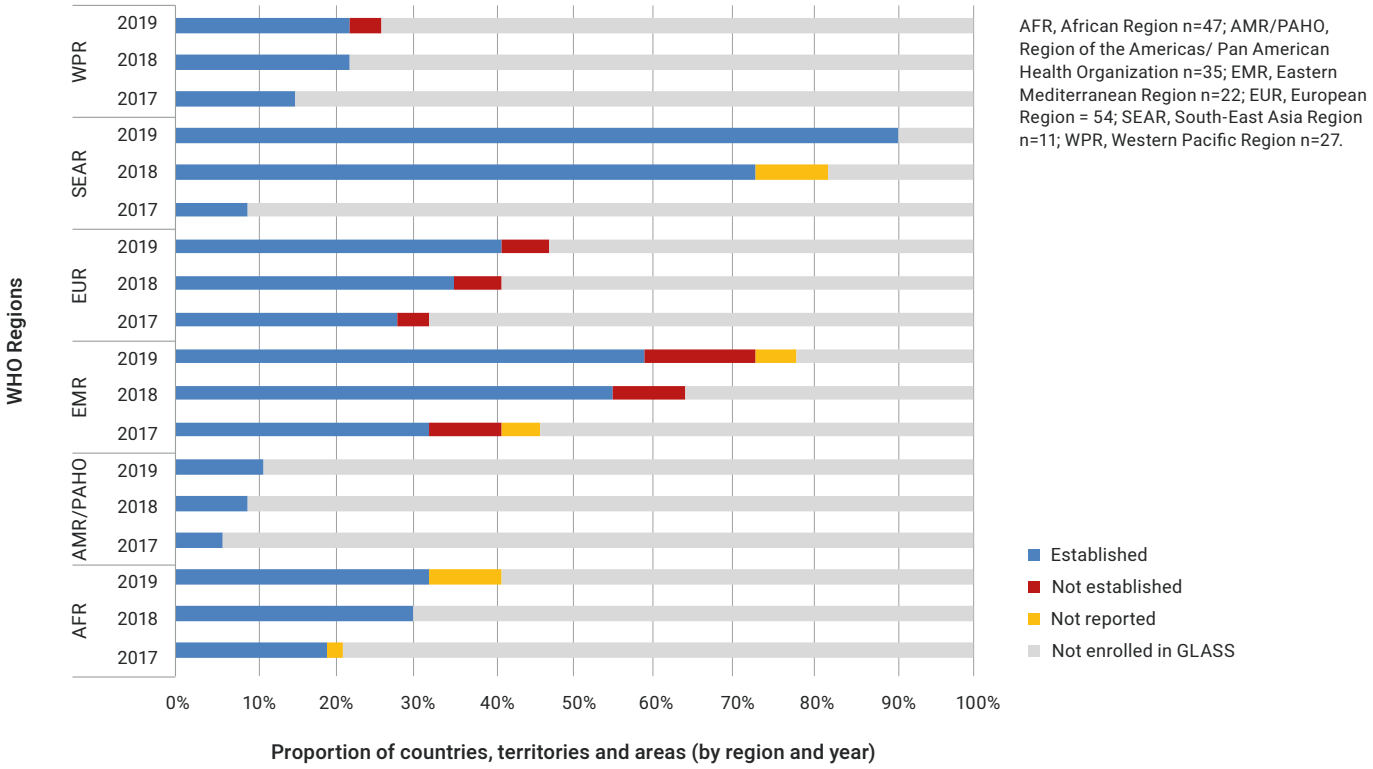
Most of the core components for effective surveillance suggested by GLASS are present in a majority of the countries, territories and areas in all regions: The National Coordination Centre (NCC) and the National Reference Laboratory (NRL) to support national AMR surveillance (Fig 2.2-3). Over the years, GLASS has enrolled countries, territories and areas with both established core components for AMR national surveillance and ones that are still establishing those elements, with a marked evolution of fully functional national coordinating centres. NRLs are usually already nominated by countries, territories and areas. These core components secure the correct flow of information to national bodies and GLASS. They are essential in data preparation and submission and for the coordination and quality of the data generated.

Fig. 2.2. Establishment of national coordinating centre (NCC) in GLASS enrolled countries, territories and areas, by region and year



AFR, African Region n=47; AMR/PAHO, Region of the Americas/ Pan American Health Organization n=35; EMR, Eastern Mediterranean Region n=22; EUR, European Region = 54; SEAR, South-East Asia Region n=11; WPR, Western Pacific Region n=27.

Fig. 2.3. Establishment of national reference laboratory (NRL) in GLASS enrolled countries, territories and areas, by region and year



AFR, African Region n=47; AMR/PAHO, Region of the Americas/ Pan American Health Organization n=35; EMR, Eastern Mediterranean Region n=22; EUR, European Region = 54; SEAR, South-East Asia Region n=11; WPR, Western Pacific Region n=27.

2.1.2.2 Surveillance systems

The national surveillance system structure is monitored according to the number of surveillance sites and local laboratories that perform AST and report AMR data to GLASS (Table 2.4), which are the main sources of data on AMR for national surveillance systems in all regions. The number in each country, territories and areas, and thus the coverage and representativeness, vary considerably, due to factors such as the size and geographical features of the country, the structure of the national health care system, the characteristics of the sites and logistical and economic constraints. The number also depends on the structure of the surveillance that was previously in place, especially if it was based on laboratory reporting only. Although the number of surveillance sites might vary, coverage and representativeness are expected to improve as surveillance systems mature.

Most patient data derive from hospital surveillance sites as compared to outpatient care. However, it is paramount for countries, territories and areas to also monitor AMR in community-acquired infections settings. In addition, the involvement of private hospitals is crucial to generate more representative AMR surveillance data.

With more countries, territories and areas enrolling, GLASS is receiving data from more and more surveillance sites. This helps the continued development of the global system in terms of the quantity and diversity of reported data.

Table 2.4. Numbers of surveillance sites reporting to GLASS, by region and year

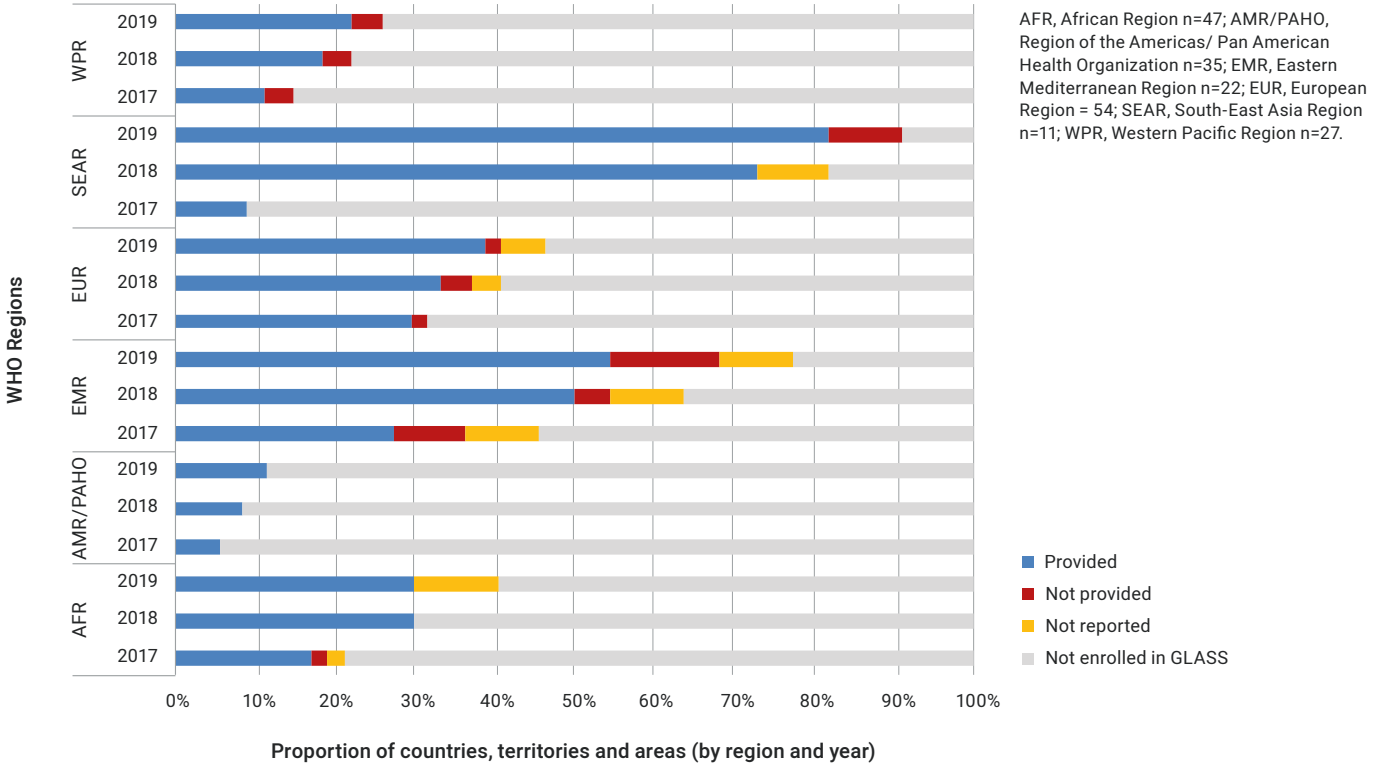
REGION	SURVEILLANCE SITES	2017	2018	2019
		N = 40	N = 67	N = 77
African	Hospitals	30	30	39
	Outpatient facilities	5	5	42
	In- and outpatient facilities			
	Laboratories[a]		5	12
	Total	**35**	**40**	**93**
Americas	Hospitals			4 132
	Outpatient facilities			40 600
	In- and outpatient facilities			
	Laboratories[a]			
	Total	**0**	**0**	**44 732**
Eastern Mediterranean	Hospitals	54	100	168
	Outpatient facilities	109	129	204
	In- and outpatient facilities			
	Laboratories[a]		6	1
	Total	**163**	**235**	**373**
European	Hospitals	131	947	1 117
	Outpatients facilities	6	145	15 901
	In- and outpatient facilities			
	Laboratories[a]	147	412	363
	Total	**284**	**1 504**	**17 381**
South-East Asian	Hospitals	2	28	34
	Outpatient facilities		1	3
	In- and outpatient facilities		13	25
	Laboratories[a]		15	48
	Total	**2**	**57**	**110**
Western Pacific	Hospitals	6	58	67
	Outpatient facilities		68	68
	In- and outpatient facilities	22	2 026	1 973
	Laboratories[a]			
	Total	**28**	**2 152**	**2 108**

a the number of surveillance sites that submit specimens to participating laboratories could not be identified because of the structure of the national surveillance system. The number of laboratories supporting the surveillance system are reported instead

2.1.2.3 External quality assessment

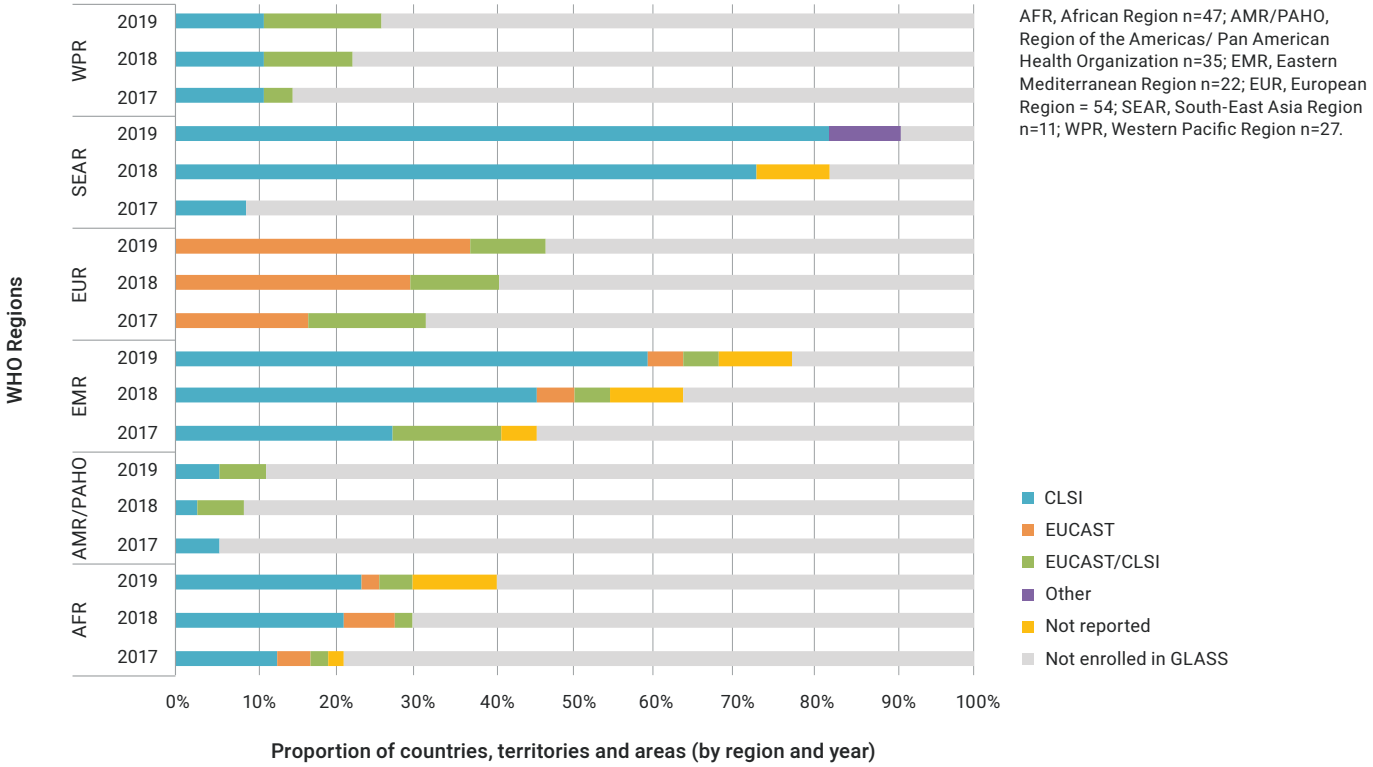
The EQA component of implementation comprises three indicators: provision of assessments to NRL and local laboratories and international standards used by countries, territories and areas. Most NRLs participate in an EQA scheme (Fig. 2.4), and, in most countries, territories and areas enrolled in GLASS, reporting laboratories perform AST according to internationally recognized standards: that of the European Committee on Antimicrobial Susceptibility Testing (EUCAST) or that of the Clinical and Laboratory Standards Institute (CLSI) (Fig. 2.5) [24, 25]. EQA is still not performed in all clinical laboratories that serve national AMR surveillance programmes (Fig. 2.6), although some regions (e.g. the African Region) have made impressive progress in the past 3 years, showing that much can be achieved with countries, territories and areas' willingness and commitment and the support of WHO and other international, regional and national partners for sustainable, high-quality laboratory results. Management of quality is crucial to sustain this initiative.

Fig. 2.4. Provision of EQA to NRLs in GLASS enrolled countries, territories and areas, by region and year



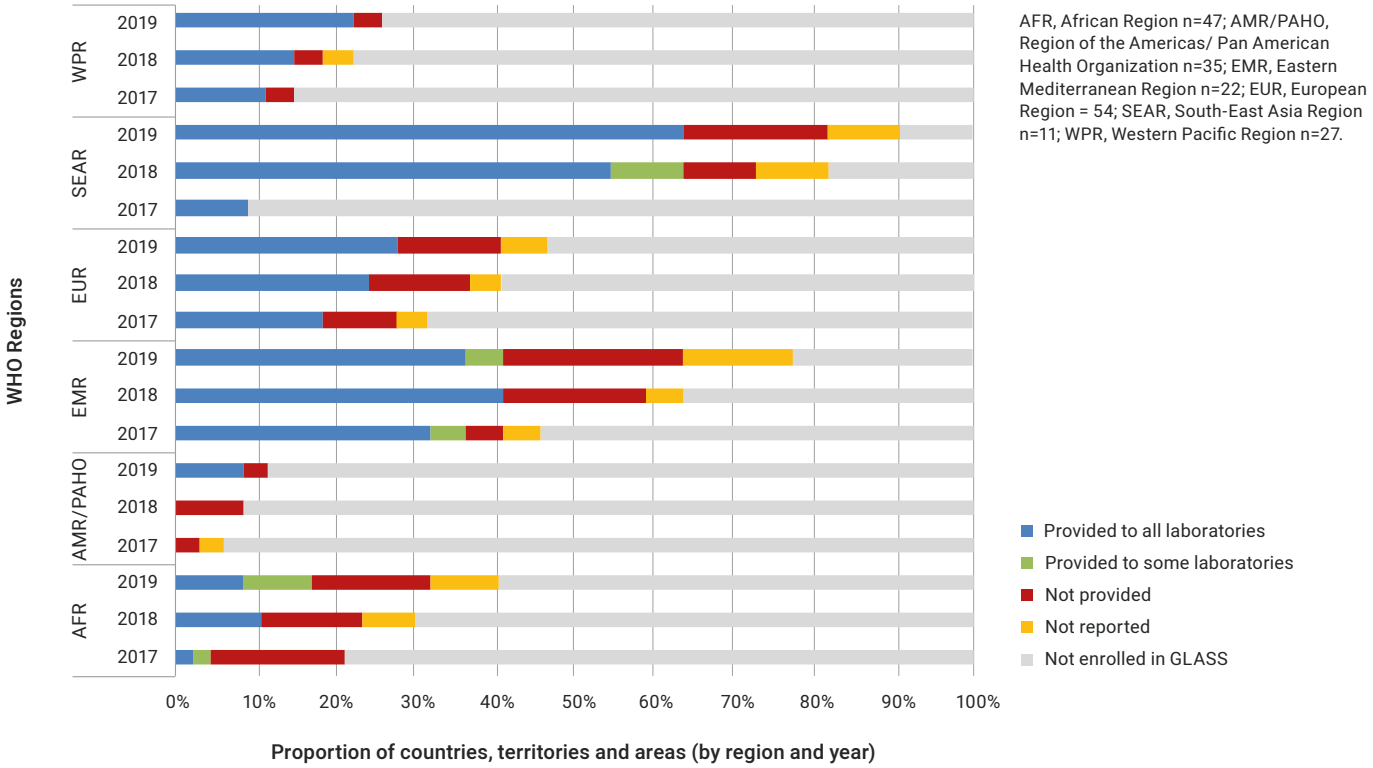
AFR, African Region n=47; AMR/PAHO, Region of the Americas/ Pan American Health Organization n=35; EMR, Eastern Mediterranean Region n=22; EUR, European Region = 54; SEAR, South-East Asia Region n=11; WPR, Western Pacific Region n=27.

Fig. 2.5. International standards for AST used in GLASS enrolled countries, territories and areas, by region and year



AFR, African Region n=47; AMR/PAHO, Region of the Americas/ Pan American Health Organization n=35; EMR, Eastern Mediterranean Region n=22; EUR, European Region = 54; SEAR, South-East Asia Region n=11; WPR, Western Pacific Region n=27.

Fig. 2.6. Provision of EQA to local laboratories that perform AST in GLASS enrolled countries, territories and areas, by region and year



AFR, African Region n=47; AMR/PAHO, Region of the Americas/ Pan American Health Organization n=35; EMR, Eastern Mediterranean Region n=22; EUR, European Region = 54; SEAR, South-East Asia Region n=11; WPR, Western Pacific Region n=27.

2.1.3 National rates of antimicrobial resistance in the WHO Global Health Observatory

I Individual country AMR rates are available online on the GLASS page of the WHO Global Health Observatory https://www.who.int/data/gho/data/themes/topics/global-antimicrobial-resistance-surveillance-system-(glass)/GHO/global-antimicrobial-resistance-surveillance-system-(glass)- to minimize the length of this report. On each country, territories and areas page, a dashboard with a colour-coded system shows the extent of data submission, and a table gives an overview of the data results, and susceptibility for single antibiotics or antimicrobial classes are presented as bar charts in the AMR Proportions tab. It is important to note, that in the beginning of 2019, EUCAST changed the definitions of the S, I and R susceptibility categories where I is defined as "Susceptible, increased exposure" while CLSI keeps the "Intermediate" category. With the introduction of new category definitions GLASS does not anymore merge categories (neither S+I nor I+R) when reporting surveillance data, presenting S, I and R separately. The pages for countries, territories and areas that also submitted sampled population data include two further sets of graphics. The first (AMR Frequency tab) show the frequency of infection with priority pathogens at different anatomical sites and the frequency of infection by pathogens that are resistant to specific antibiotics in the tested population. When the data were available, a second set of graphics (AMR stratified frequency tab) indicates resistance to carbapenems, stratified by age and gender. In the graphs of non-susceptibility, 95% confidence intervals are represented by black lines overlapping the bars.

The rules used by GLASS in data analysis to ensure the reliability of the results are outlined in Annex 3.

2.1.4 Global summary of reported AMR data

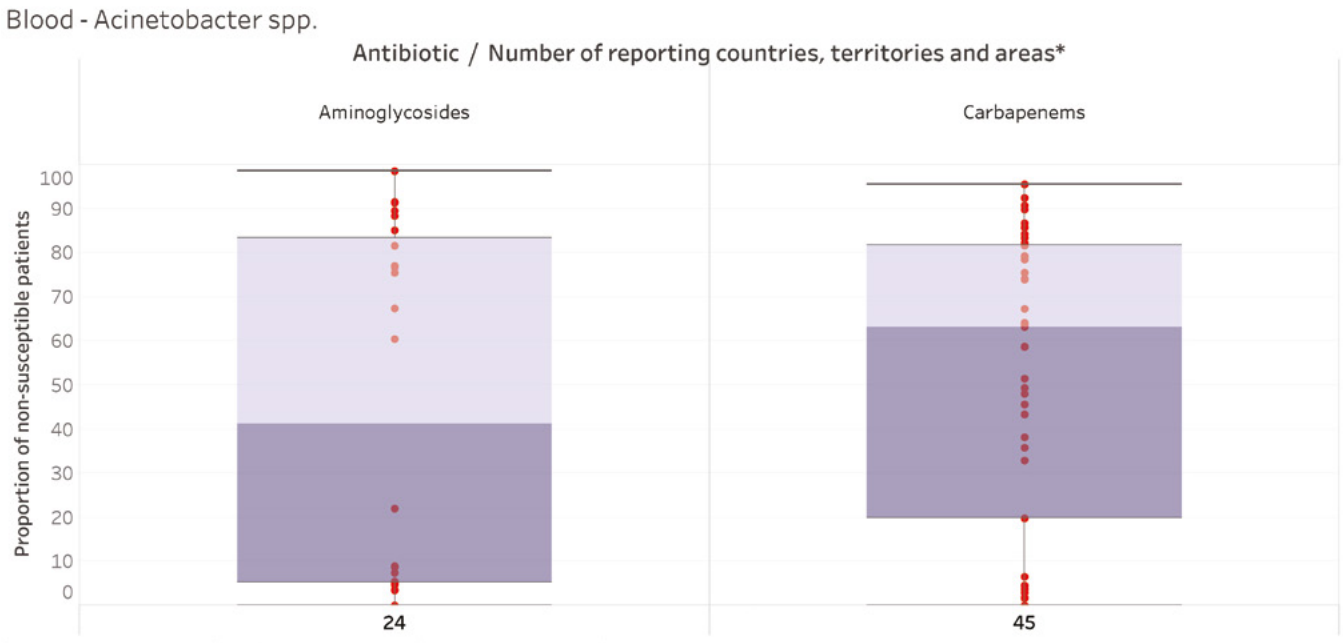
Global summaries of the proportions of patients with resistant infections per combination of specimen, pathogen and antibiotic are presented. The summaries should be interpreted carefully due to data limitations described in Annex 1. To avoid misrepresentation of the epidemiology of global resistance, no comparisons of results among countries, territories and areas or regions has been attempted. Accurate estimates of national and regional rates of AMR are still difficult to obtain.

The numbers of countries, territories and areas for which results are reported are shown below, after application of cut-off values. Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown AST results. Results are shown only if data on a specific antibiotic were submitted by at least 50% of the countries, territories and areas reporting on the specimen-pathogen combination.

Note that, because of the format (aggregated - antimicrobial classes) of EARS-Net reported data, it was chosen for the summary of *Acinetobacter* spp., *E. coli, K. pneumoniae, S. aureus,* and *S. pneumoniae* in blood, to report results in antimicrobial classes. Therefore, results from countries, territories and areas that reported antibiotic rates only and not antibiotic classes rates could not be included.

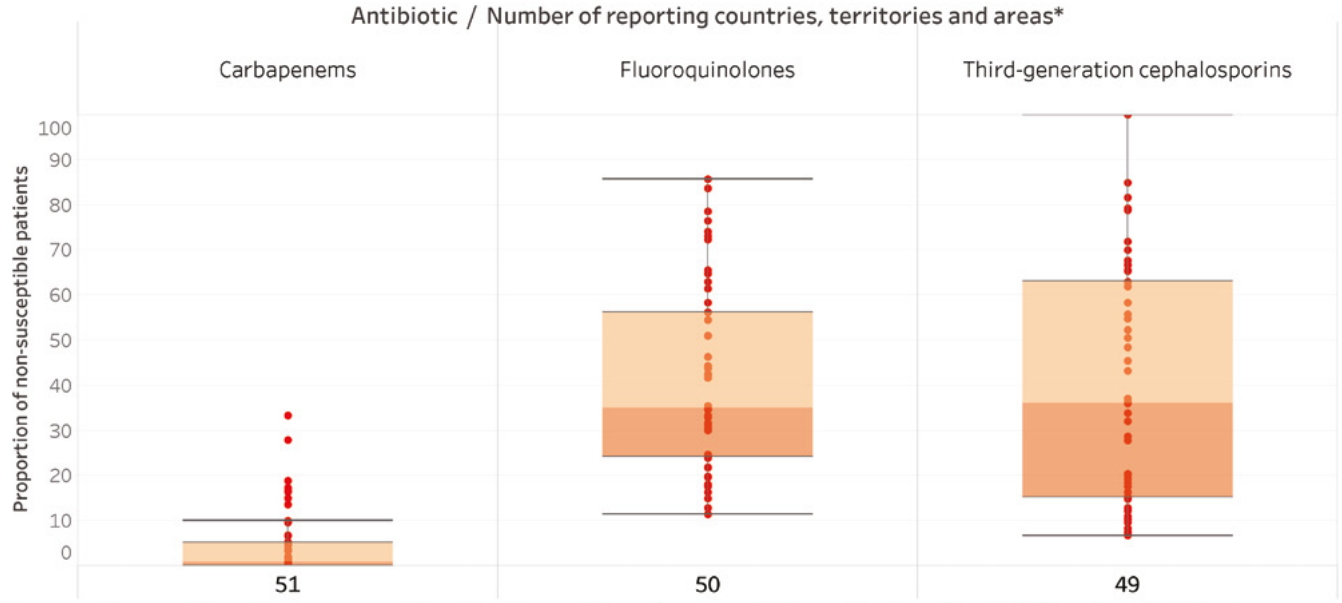
Box-and-whisker plots are used to summarize the proportions of patients with resistant and non-susceptible AST results for specific specimen–pathogen–antibiotic combinations, showing the distribution of values along an axis. "I" results are not shown. The boxes indicate the middle 50% of data (i.e. the middle two quartiles of the data distribution). The "whiskers" display all points within 1.5 times the interquartile range (i.e. all points within 1.5 times the width of the adjoining box). Each red dot represents a country, territories and areas's reported AMR rate. Note that countries, territories and areas might not report or test for all the pathogen–antibiotic combinations listed by GLASS.

2.1.4.1 Bloodstream infections



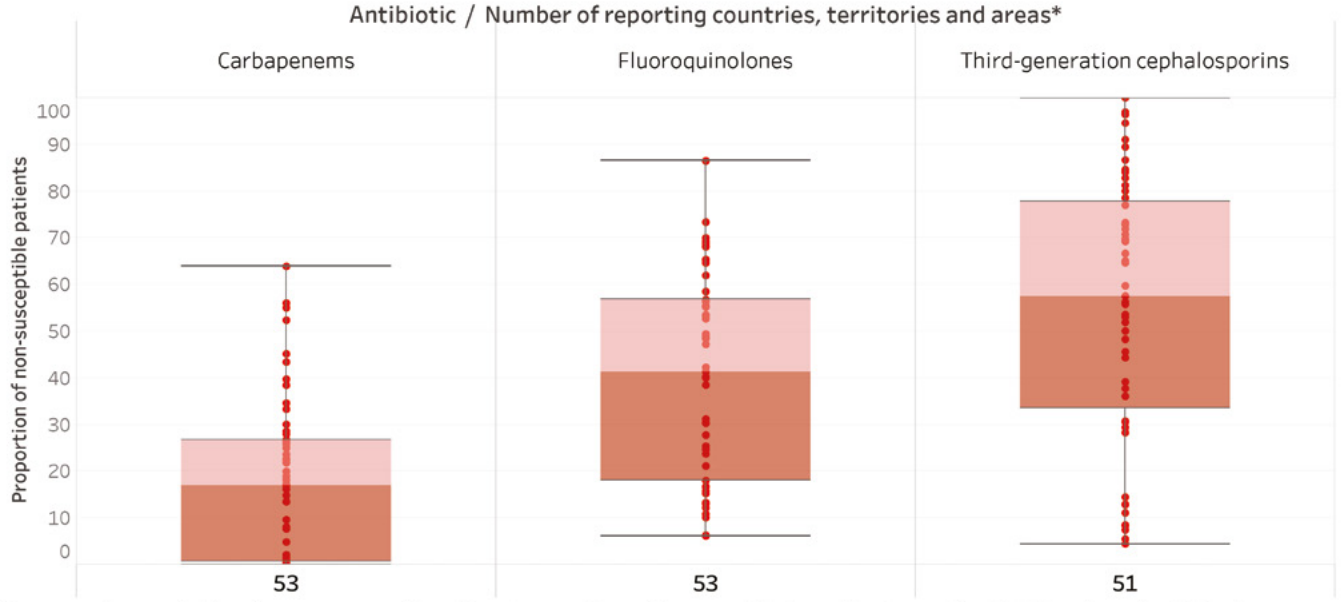
*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

Blood - E. coli



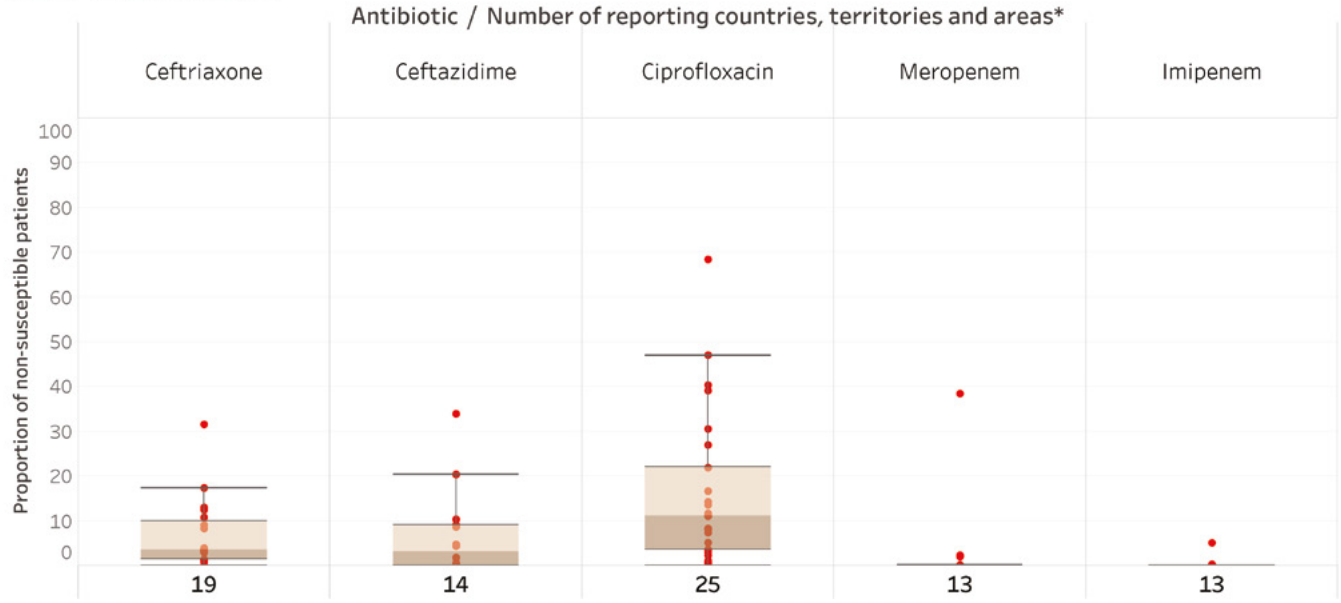
*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

Blood - K. Pneumoniae



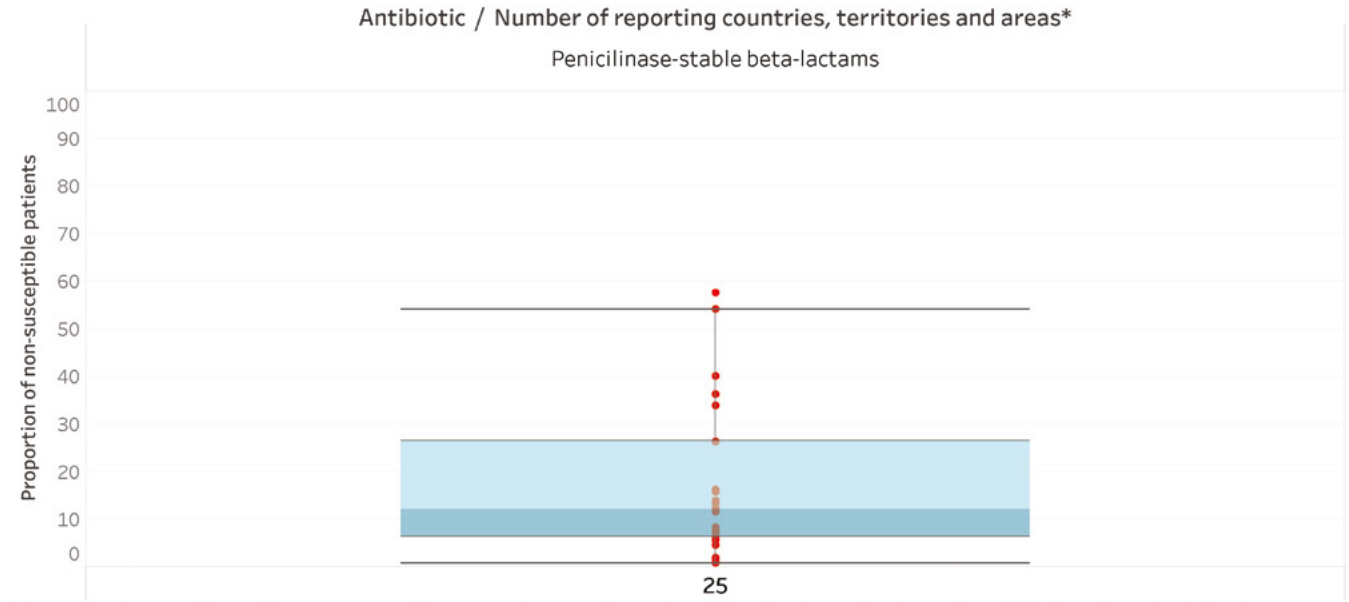
*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

Blood - Salmonella spp.



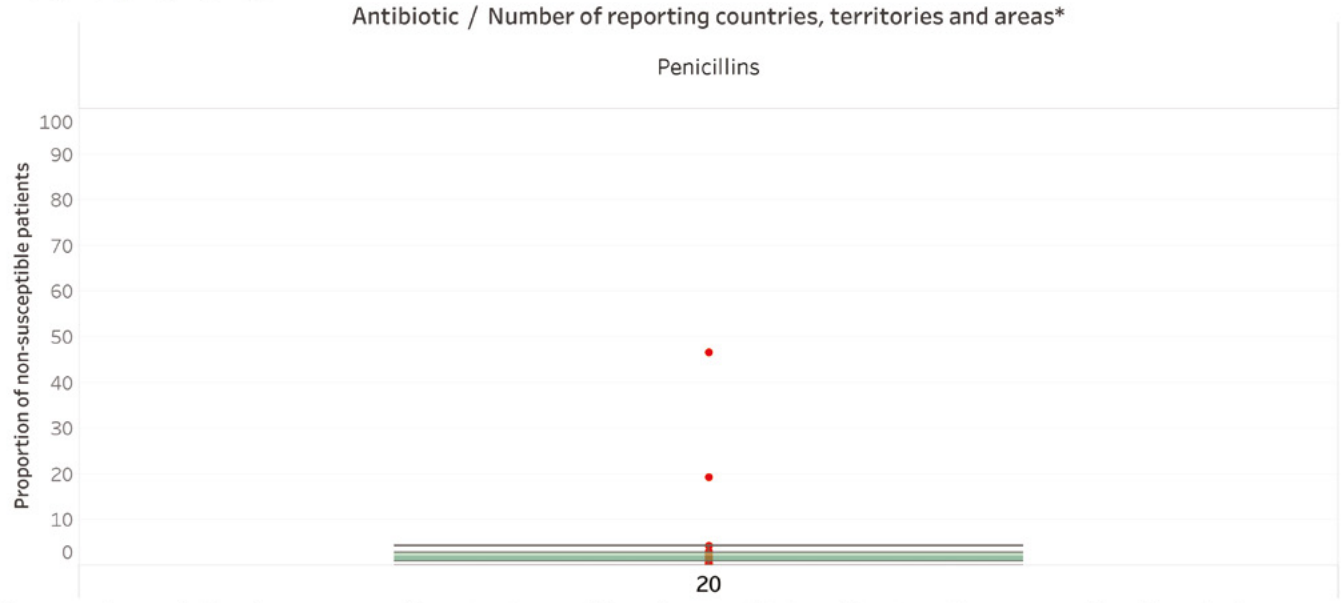
*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

Blood - S. aureus



*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

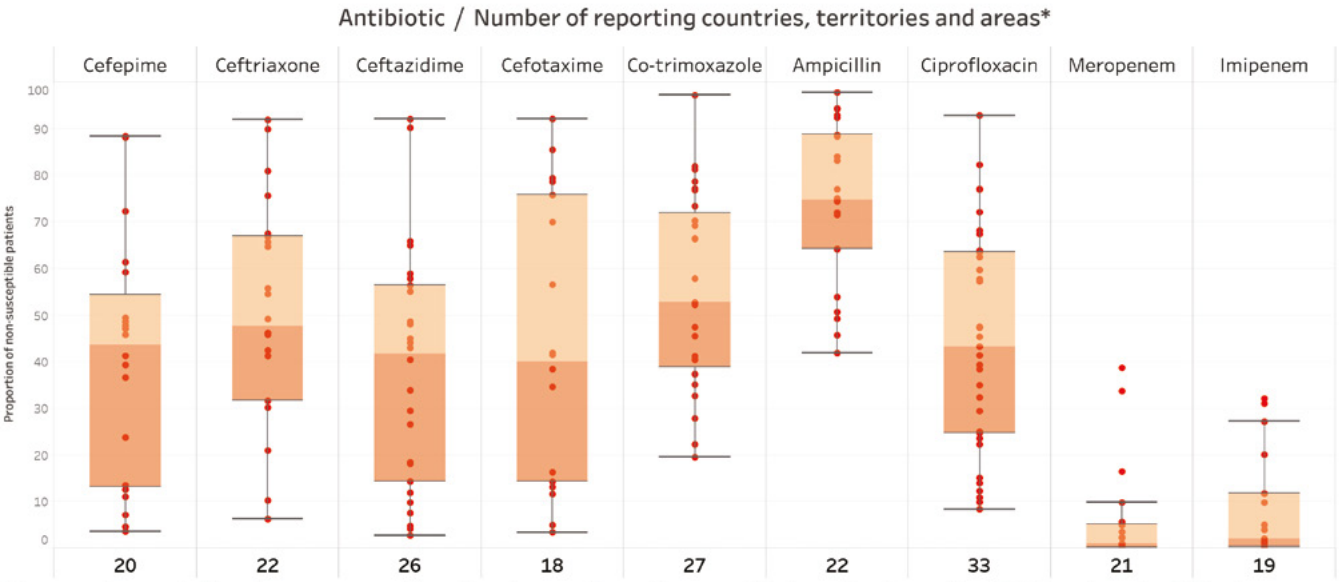
Blood - S. pneumoniae



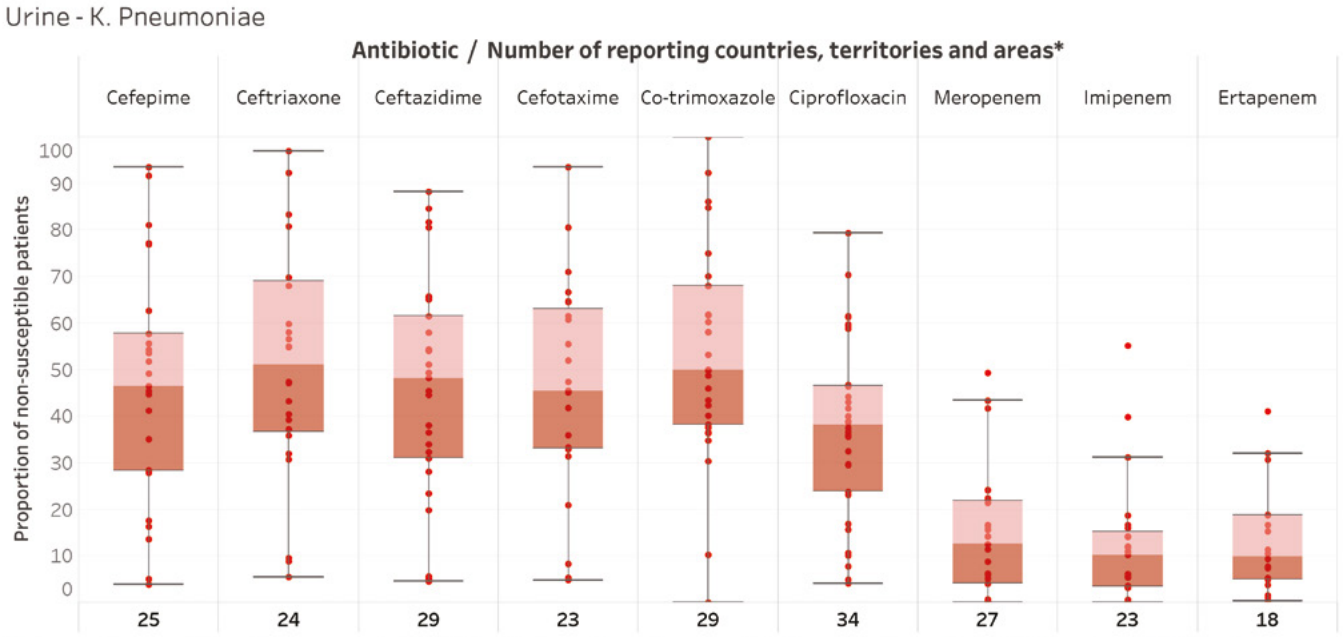
*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

2.1.4.2 Urinary tract infections

Urine - E. coli

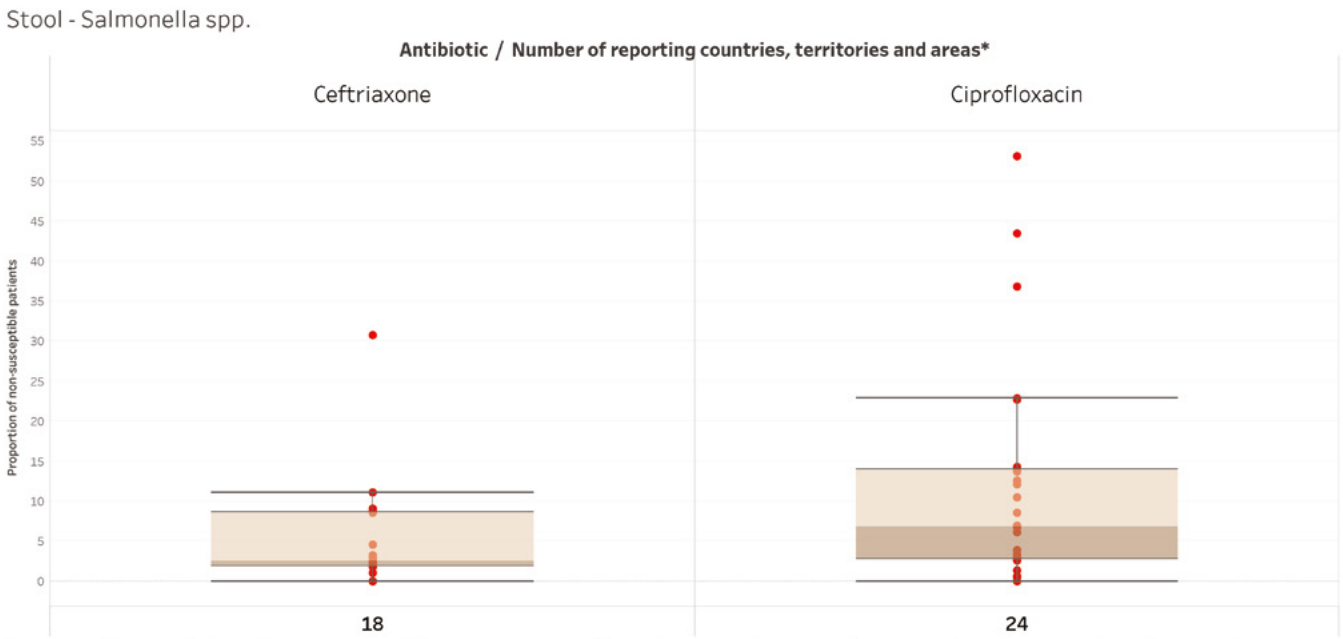


*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

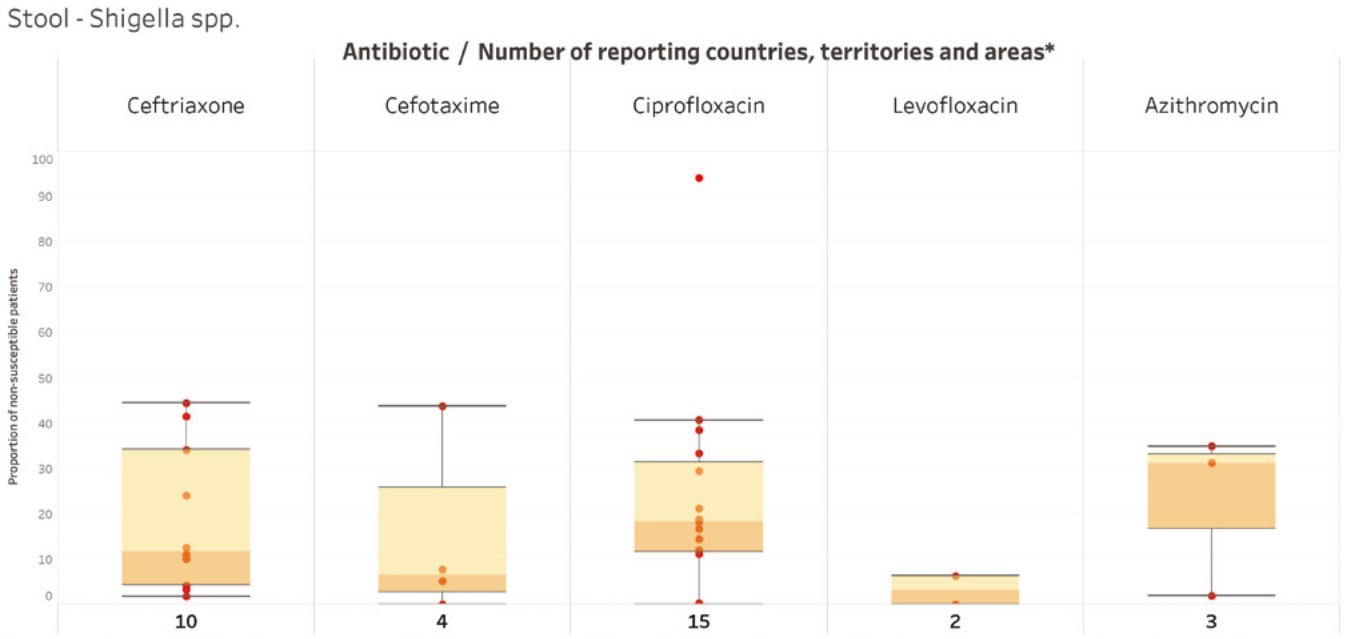


*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

2.1.4.3 Gastroenteric infections

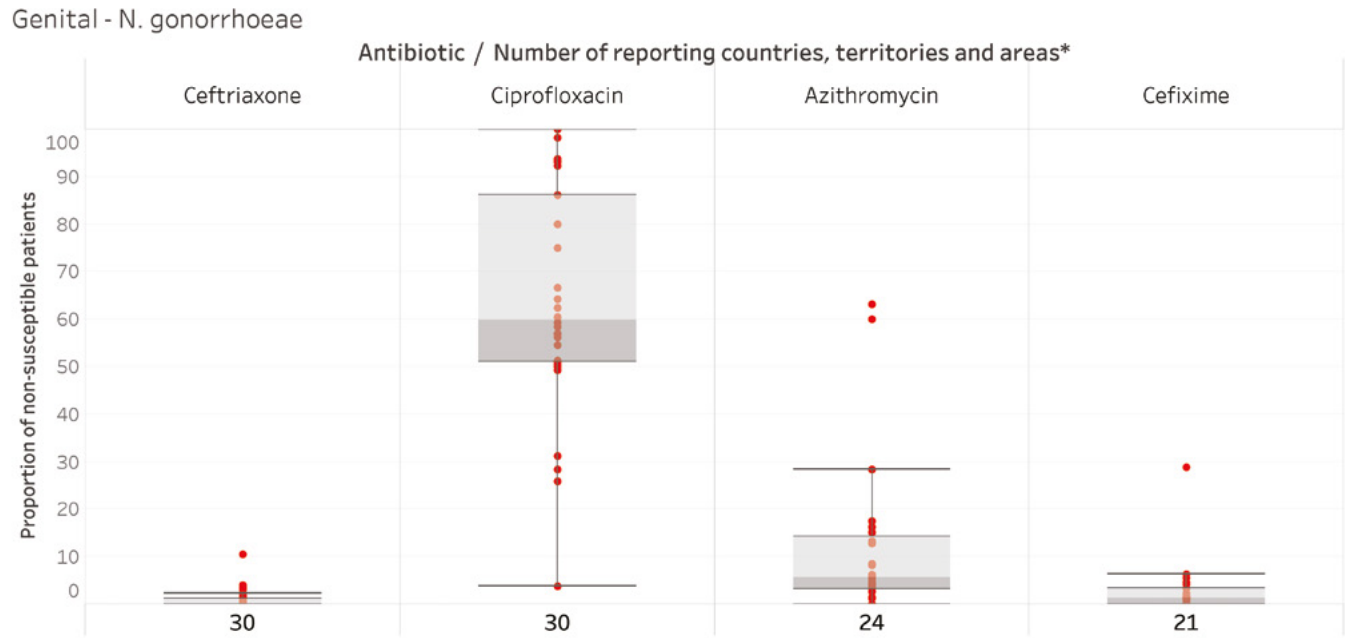


*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.



*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

2.1.4.4 Genital infections



*Rates are shown only if results were reported for > 10 patients and for pathogen–antibiotic combinations with > 10 AST results and < 30% unknown results. Single antibiotic results are shown only if data were submitted by at least 50% of the countries reporting on the specimen-pathogen combination.

2.2 GLASS-EAR

The GLASS-EAR information technology (IT) module, a web-based communication platform for rapid, reactive exchange of technical information on emerging AMR events embedded in the GLASS IT platform, allows GLASS-EAR members to share information on emerging AMR events to assess their importance and stimulate epidemiological and microbiological discussion and coordinated action [16]. The module was launched in 2018 and was improved during upgrading of the GLASS IT platform in 2019, with a new user interface.

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Table 2.5. Summary of confirmed emerging AMR events reported by countries, January–December 2019

EVENT	SOURCE
Increase in number of cases of carbapenem-resistant Enterobacteriaceae	WHO epidemic intelligence
Outbreak of infections caused by extensively drug-resistant (XDR) *K. pneumoniae*	GLASS focal point
Increase in number of cases of New Delhi metallo-β-lactamase-producing carbapenem-resistant Enterobacteriaceae	WHO epidemic intelligence
Outbreak of carbapenem-resistant P. aeruginosa traced to hospitals	GLASS focal point
Increase in number of cases of azithromycin-non-susceptible *Salmonella* Newport infections	WHO epidemic intelligence
First detection of daptomycin resistance in a clinical methicillin-resistant *S. aureus* isolate	GLASS focal point
Increase in number of cases New Delhi metallo-β-lactamase-producing Enterobacteriales	IHR focal point
Bloodstream infections caused by *S. aureus*, Spa-type t11164 in the new-born intensive care unit	WHO epidemic intelligence
First detection of XDR *E. coli* with blaKPC and mcr-1 genes	IHR focal point
First detection of N. meningitidis serogroup Y with no sensitivity to cefotaxime	IHR focal point
Detection of Enterococcus faecalis with resistance to linezolid conferred by the presence of the optrA gene	IHR focal point
Two cases of XDR typhoid fever in	IHR focal point
Cluster of infections caused by resistant *Acinetobacter baumannii*	IHR focal point
Two cases of XDR *N. gonorrhoeae* infection diagnosed	IHR focal point

2.3 GLASS–One Health

WHO "integrated multisectoral surveillance" is conducted within the Tricycle Project, in which ESBL *E. coli* was identified as a common indicator to be detected in human faecal samples, poultry and water bodies (sewage, market runoff and river sites in urban areas). The Project was initially implemented in six WHO Member States (Ghana, Indonesia, Madagascar, Malaysia, Pakistan and Senegal) and is being implemented in three others (India, Jordan and Nepal) (Table 2.6). The protocol has been revised based on the initial implementation.

Training workshops and technical assistance has been provided to countries willing to implement GLASS-One Health.

Table 2.6. Countries enrolled and implementing the Tricycle project as of April 2020

REGION	COUNTRIES ENROLLED AND IMPLEMENTING
African	Ghana, Madagascar, Senegal
Eastern Mediterranean	Jordan, Pakistan
South-East Asia	India, Indonesia, Nepal
Western Pacific	Malaysia

2.4 GLASS–EGASP

The enhanced gonorrhoea AMR surveillance programme (EGASP) seeks to gather more detailed information on the epidemiology of AMR *Neisseria gonorrhoeae* and complements the routine AMR surveillance already embedded in GLASS-AMR. The EGASP method was pilot-tested in the Philippines and in Thailand, and the experience was used in developing a general protocol and standard operating procedures for laboratory work, data collection and management, and development of the EGASP IT module within the GLASS IT platform. Both countries participated biannually in an EQA programme.

EGASP proved to be a feasible, high-quality, reactive system for monitoring trends of AMR in N. gonorrhoeae. Both countries issue monthly EGASP surveillance reports. Those of Thailand were used in 2018 to update treatment guidelines. In both countries, EGASP has been implemented only in the capital cities. Extension to other areas is foreseen, and the countries are progressively integrating the costs of EGASP into programmes for sexually transmitted infection and AMR.

The results from the implementation of EGASP in Thailand and The Philippines are in the text boxes.

THAILAND

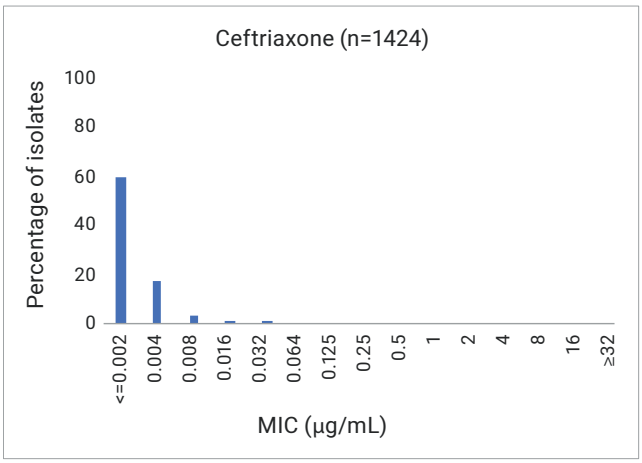
The Department of Disease Control coordinates EGASP in Thailand, in two clinical settings, both in Bangkok, which house reference laboratories. Table 2.7 and Fig. 2.8 summarize results for the period November 2015–December 2018. A total of 2484 episode of urethral discharge were included, of which 1425 (57.4%) were culture-confirmed for *N. gonorrhoeae*. Of these, 1272 patients had had at least one episode of confirmed *N. gonorrhoeae* urethritis, and 106 had had several episodes. The median age was 29 years (range, 14–76). All cases of *N. gonorrhoeae* urethritis were treated with antibiotics according to the national guidelines[4]. No treatment failure was found. Of the 1424 tested isolates, only one had a final "alert value" for azithromycin. Resistance to ciprofloxacin was observed in 91.9% of the isolates.

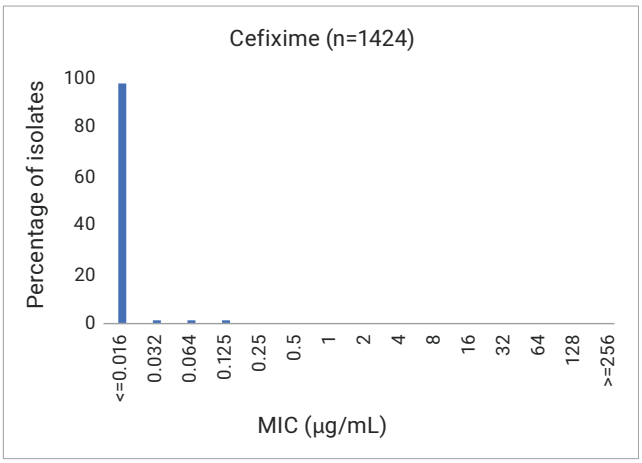
4 The first recommendation for treatment is ceftriaxone 500 mg intramuscularly with treatment for nongonococcal urethritis. The alternative treatment is cefixime 400 mg orally with treatment for nongonococcal urethritis. The treatment for nongonococcal urethritis is: azithromycin 1 g orally single dose, doxycycline 100 mg orally after food twice a day for 14 days, roxithromycin 150 mg orally before food twice a day for 14 days or erythromycin stearate 500 mg orally after food four times a day for 14 days (http://aidssti.ddc.moph.go.th/medias/view/132/574, accessed March 2020).

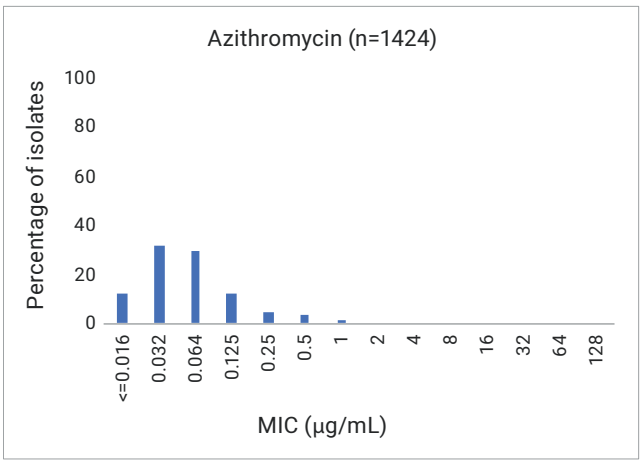
Table 2.7. Summary results, EGASP Thailand, November 2015–December 2018

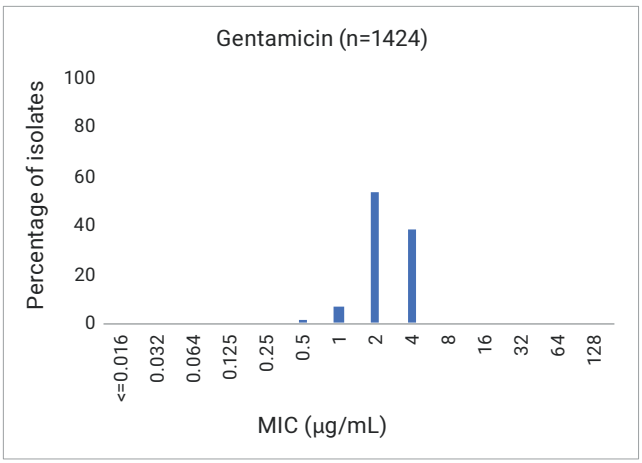
EGASP INCLUSION OVERVIEW	N (%)
Urethritis episodes with specimen collected	2484
Gram stain-positive specimens	1417 (57.0)
Culture positive; confirmed *N. gonorrhoeae* urethritis	1425 (57.4)
N. gonorrhoeae isolates with AST results	1424 (99.9)
No. of men with at least one *N. gonorrhoeae* urethritis episode	1272
No. of men with repeated *N. gonorrhoeae* urethritis episodes	106 (8.3)
Treatment of *N. gonorrhoeae* urethritis episodes (n=1417)	**N (%)**
Primary treatment	
Ceftriaxone 250 mg	1238 (86.9)
Ceftriaxone 500 mg	159 (11.2)
Cefixime 400 mg	7 (0.5)
Azithromycin 2 g	13 (0.9)
Other	1 (0.1)
None	6 (0.4)
Unknown or refused	0 (0.0)
Dual treatment	
Azithromycin 1 g	813 (57.1)
Azithromycin 2 g	20 (1.4)
Doxycycline 100 mg twice a day for 7–14 days	382 (26.8)
Other	188 (13.2)
None	21 (1.5)
Unknown or refused	0 (0.0)
Exposure before first *N. gonorrhoeae* urethritis episode (n=1272)	**N (%)**
Sex history in previous 3 months	
Sex with men	373 (29.3)
Sex with women	824 (64.8)
Sex with men and women	72 (5.7)
Unknown or refused	3 (0.2)
Antibiotic use in previous 2 weeks	
Yes	370 (29.1)
No	897 (70.5)
Unknown or refused	5 (0.4)

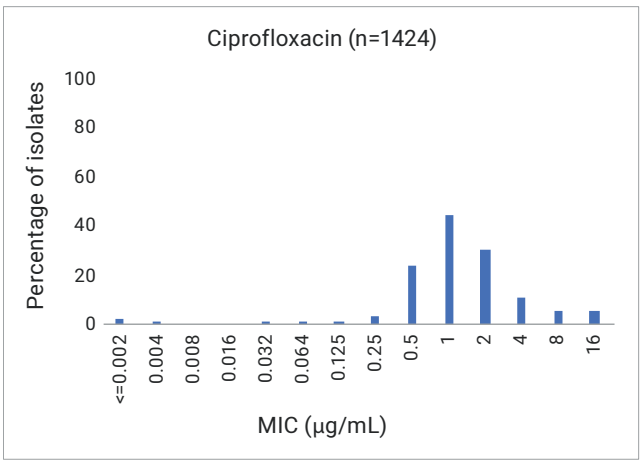
Fig. 2.8. Distribution of minimum inhibitory concentrations (MICs) of *N. gonorrhoeae* isolates, Thailand, November 2015–December 2018











Red lines represent MIC alert values: ceftriaxone MIC ≥ 0.125 µg/mL, cefixime MIC ≥ 0.25 µg/mL, azithromycin MIC ≥ 2.0 µg/mL, gentamicin MIC ≥ 16.0 µg/mL. Black lines represent CLSI breakpoint for resistance (MIC ≥ 1 µg/mL).

THE PHILIPPINES

In the Philippines, EGASP is coordinated by the Department of Health. Four sentinel clinics and two external EGASP reference laboratories were selected, all in Metro Manila. Table 2.8 and Fig. 2.9 summarize the results obtained during the first 6 months of EGASP implementation. Between July and December 2018, 226 new episodes of urethritis were identified, of which 161 (71.2%) involved culture-confirmed *N. gonorrhoeae*. Of these cases, 157 had had at least one episode of diagnosed *N. gonorrhoeae* urethritis, and four had had repeated episodes. Their median age was 23 years (range, 15–55), and all were Filipino. Antibiotics were prescribed in 91.3% of cases, and 79% received dual treatment. Only 27.3% of the primary treatments complied with the national treatment guidelines.[5] No treatment failure was detected. Previous exposure to antibiotics was reported in 14.9% of cases, another sexually transmitted infection in 4.4% and a travel history in 8.6%. Sex with women prevailed (55%). None of the 161 isolates had a final MIC alert value. Resistance to ciprofloxacin was observed in 70.3% of the isolates.

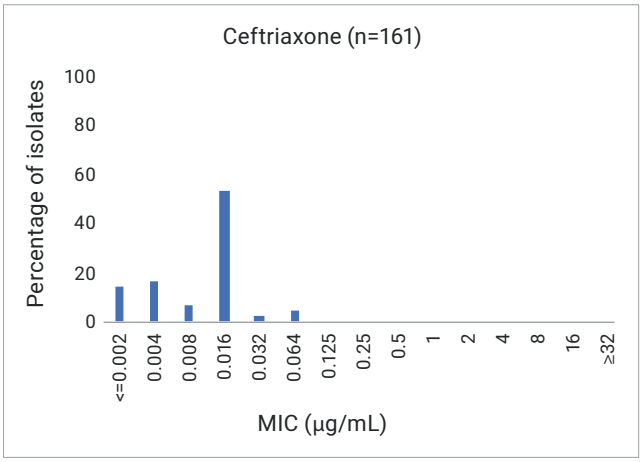
[5] Primary treatment: ceftriaxone 250 mg or cefixime 400 mg. Recommended secondary treatment for gonorrhoea and/or non-gonococcal urethritis: azithromycin 1 g or doxycycline 100 mg twice a day for 7 days.

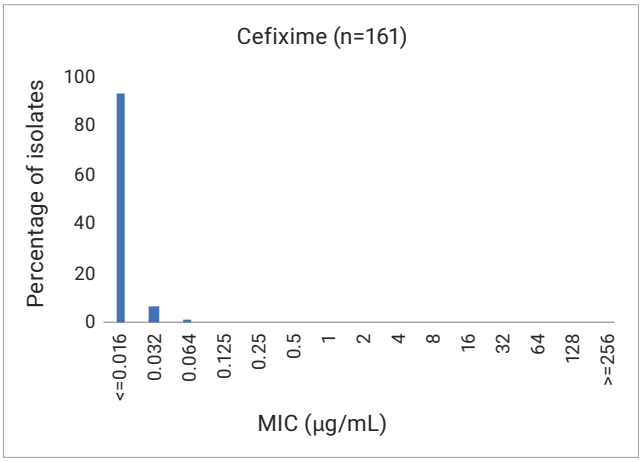
Table 2.8. EGASP Philippines, summary results, July–December 2018

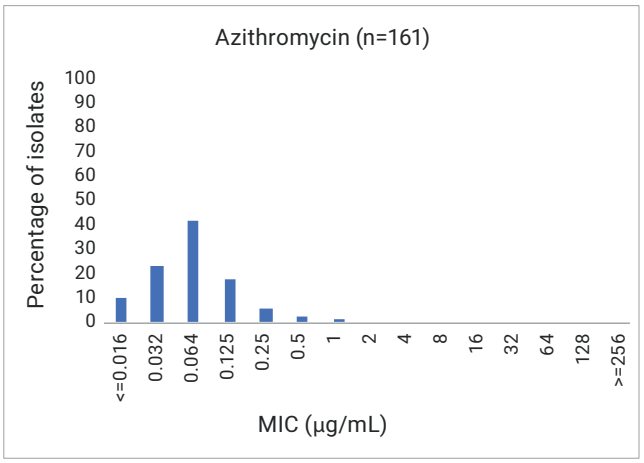
EGASP INCLUSION OVERVIEW	N (%)
Urethritis episodes with specimen collected	226
Gram stain-positive	166 (73.5)
Culture-positive, confirmed *N. gonorrhoeae* urethritis	161 (71.2)
N. gonorrhoeae isolates with AST results	161 (100)
No. of men with at least one *N. gonorrhoeae* urethritis episode	157
No. of men with repeated *N. gonorrhoeae* urethritis episodes	4 (2.5)
Treatment of *N. gonorrhoeae* urethritis episodes (n=161)	**N (%)**
Primary treatment	
Ceftriaxone 250 mg	36 (22.4)
Ceftriaxone 500 mg	56 (34.8)
Ceftriaxone 1 g	39 (24.2)
Cefixime 400 mg	8 (5.0)
Azithromycin 1 g	6 (3.7)
Azithromycin 2 g	0 (0.0)
Other	2 (1.2)
None	14 (8.7)
Unknown or refused	0 (0.0)
Secondary treatment	
Azithromycin 1 g	87 (54.0)
Azithromycin 2 g	0 (0.0)
Doxycycline 100 mg twice a day for 7–14 days	33 (20.5)
Other	7 (4.3)
None	34 (21.1)
Unknown or refused	0 (0.0)
Exposure factors for *N. gonorrhoeae* urethritis episodes (n=161)	**N (%)**
Antibiotic use in the previous 2 weeks	24 (14.9)

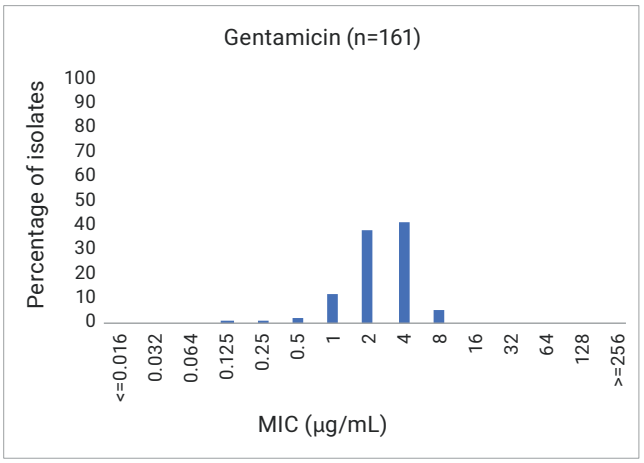
EGASP INCLUSION OVERVIEW	N (%)
Presence of other sexually transmitted infections	**7 (4.4)**
Travel history in previous month	
Within country	11 (6.8)
Outside country	2 (1.2)
Both	1 (0.6)
No travel history	147 (91.3)
Sex history in previous month	
Sex with women	88 (54.7)
Sex with men	39 (24.2)
Sex with men and women	34 (21.1)
Sexual behaviour in previous month	
Vaginal	111 (68.9)
Anal	68 (42.2)
Oral	83 (51.6)
No.of sex partners in previous month	**Median, 2 (0–10)**
Nationality of sex partners	
Filipino	158 (98.1)
Other	3 (1.9)

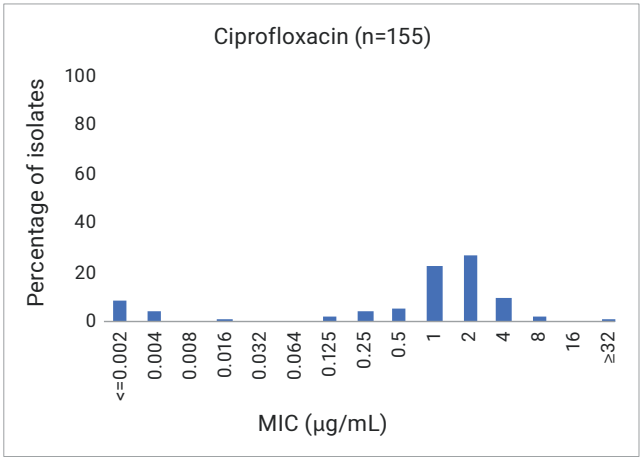
Fig. 2.9. Distribution of MIC values of *N. gonorrhoeae* isolates, EGASP Philippines, July–December 2018











Red lines represent MIC alert values (ceftriaxone MIC ≥ 0.125 µg/mL, cefixime MIC ≥ 0.25 µg/mL, azithromycin MIC ≥ 2.0 µg/mL, gentamicin MIC ≥ 32.0 µg/mL). Black lines represent CLSI breakpoint for resistance (MIC ≥ 1 µg/mL). Ciprofloxacin MIC not yet determined for six isolates because of a shortage of reagents.


SECTION
03

3. Country, territory and area profiles

3.1 Country, territories and areas profiles

The country, territory and area profiles provided a summary of surveillance activities participation for AMR, AMC, HIV infection, TB, malaria and focussed surveillance (Tricycle and EGASP). Indicators were selected to describe the structure of the surveillance system in each country.

The population estimates given in each country profile are from the Population Division of the United Nations Department of Economic and Social Affairs in 2017, the year of AMR data collection [26].

Afghanistan

Population 38.04 million

The country is working to enhance diagnostic capacity and to expand the number of participating surveillance sites and laboratories in coming years.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	✓
Tricycle	
EGASP	

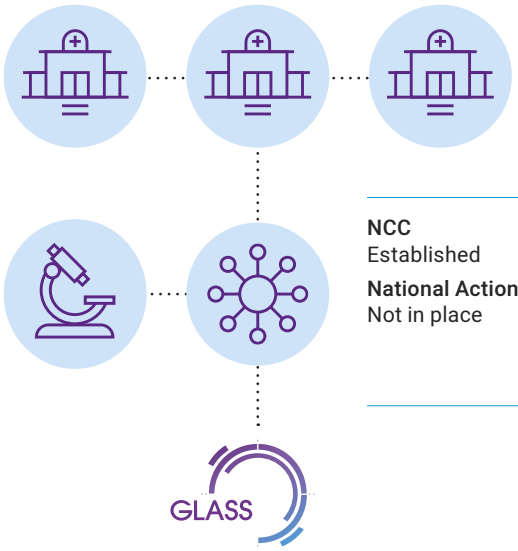
1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1
laboratory participating to the national surveillance sytem[a]

1 laboratory performing AST
EQA not provided



NRL
Established

AST standard
CLSI

EQA
Provided

NCC
Established

National Action Plan
Not in place

in 2019 data call
all national participating laboratories reported to GLASS
(1 laboratory)

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites su bmitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system

Argentina

Population 44.78 million

The "National Antimicrobial Resistance Surveillance Network: WHONET-Argentina" is coordinated by the Antimicrobial Agents Division (NRL in AMR) of the National Institute of Infectious Diseases-ANLIS "Dr. Carlos G. Malbrán", Ministry of Health. Argentina is implementing the National Action Plan on AMR published in 2015. The country participates in ReLAVRA since 2000 and has been enrolled in GLASS in April 2019.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

87 surveillance sites participating to the national surveillance sytem

87 hospitals

0 outpatient facilities

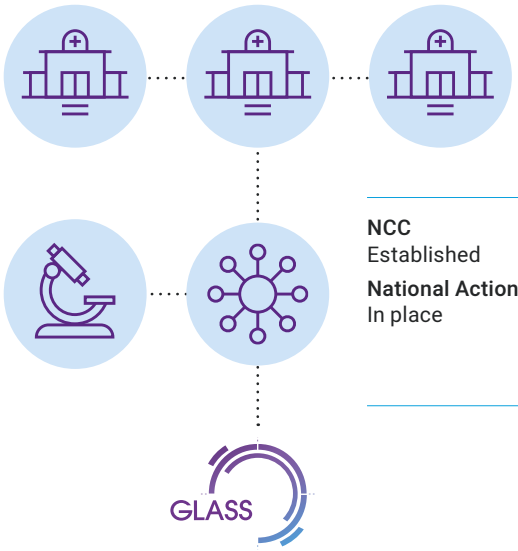
87 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
75 surveillance sites providing data to GLASS (75 hospitals)



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	
Year of most recent survey	2014
Type of survey	pretreatment HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2005
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Australia

Population 25.2 million

Australia has been implementing its first national AMR strategy (2015-2019) and is in the process of drafting the next national AMR strategy for 2020 and beyond. Human health surveillance has been coordinated in the country by the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System since 2014.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1
laboratory participating to the national surveillance sytem

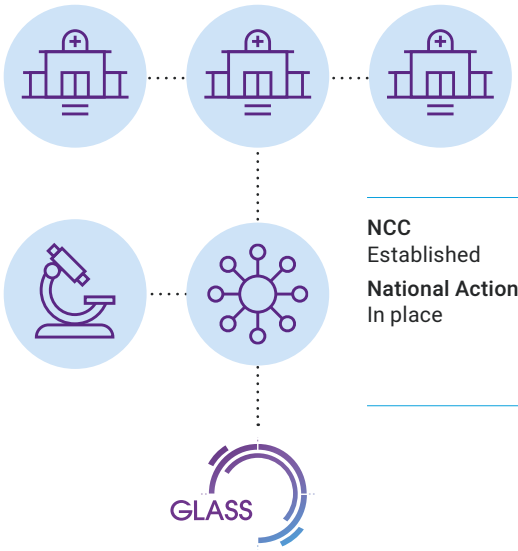
1 laboratory performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
8 surveillance sites providing data to GLASS (8 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	21

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Austria

Population 8.96 million

Austria (member state of European Union) takes part in EARS-Net (in 2018 142 hospitals/38 laboratories were included). In addition, SURV-Net (for non-invasive pathogens) and the CARBA-Net (carbapenemase producing pathogens) surveillance systems are in place.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

160 surveillance sites participating to the national surveillance sytem

153 hospitals

7 outpatient facilities

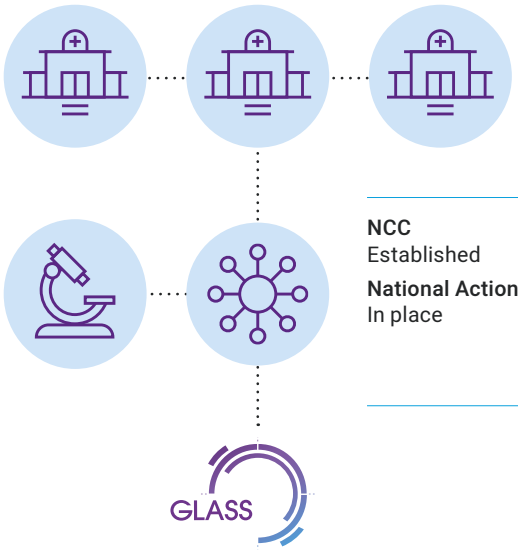
50 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
142 surveillance sites providing data to GLASS (142 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	17

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)[a]

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a Austria makes no warranties, express or implied, regarding the content, presentation, appearance, completeness of the data reported by GLASS

Bahrain

Population 1.64 million

Bahrain has a National Action Plan on AMR approved in 2016. The functioning national AMR surveillance system produces regular reports and covers about 80% of the population. Bahrain has been enrolled in GLASS since October 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

33 surveillance sites participating to the national surveillance sytem

5 hospitals

28 outpatient facilities

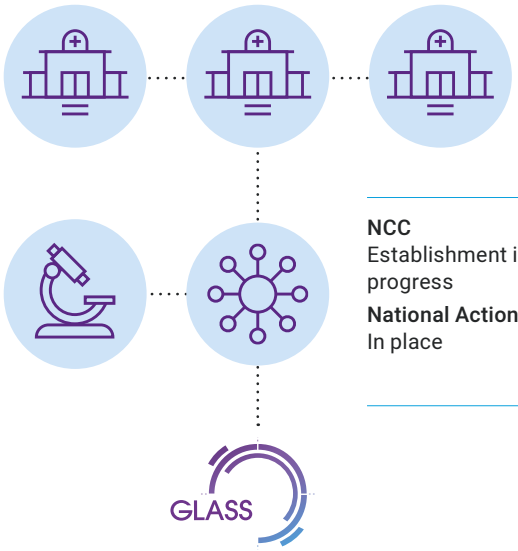
1 laboratory performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national sites reported to GLASS



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	6

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Bangladesh

Population 163.05 million

IEDCR is conducting AMR surveillance implemented as case-based surveillance of clinical syndromes.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

8
surveillance sites participating to the national surveillance sytem

8
inpatient and outpatient facilities

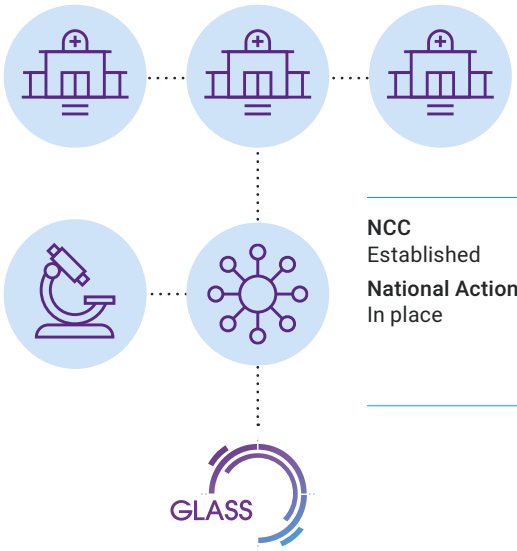
8 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS (8 in-out patient facilities)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2019
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Bhutan

Population 0.76 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

3 surveillance sites participating to the national surveillance sytem

3 inpatient and outpatient facilities

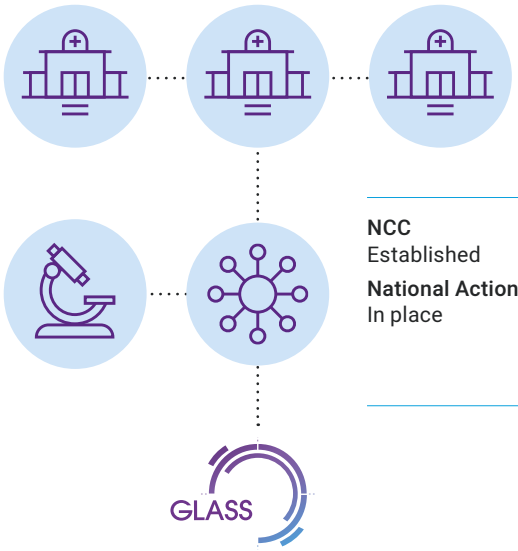
3 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Bosnia and Herzegovina

Population 3.30 million

AMR surveillance activities in Bosnia and Herzegovina are conducted by two networks; one in the Federation of Bosnia and Herzegovina and the other in Republika Srpska. The surveillance set-up for each network is normally described separately.

The Commission for Control of Resistance to Antimicrobial Medicines in Republika Srpska has developed and monitors implementation of the Program for Control of Resistance to Antimicrobial Medicines (2016–2020).

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS by Republica Srpska

1 surveillance site participating to the national surveillance sytem

1 hospital

0 outpatient facilities

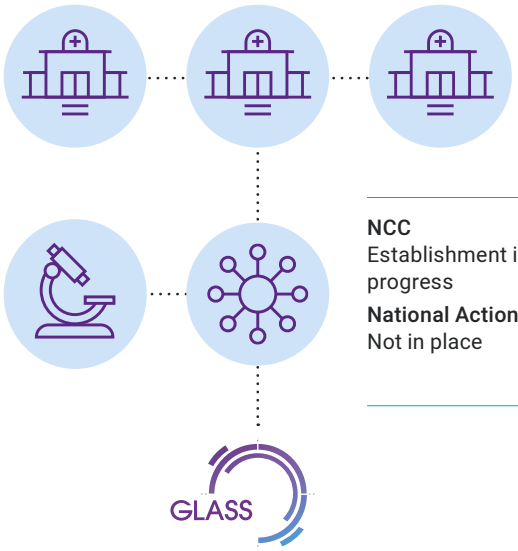
1 laboratory performing AST
EQA not provided

NRL
Not established

AST standard
EUCAST

EQA
not reported

in 2019 data call
all national surveillance sites reported to GLASS (1 hospital)



NCC
Establishment in progress

National Action Plan
Not in place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	17

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call) (Federation of Bosnia and Herzegovina and Republika Srpska)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Brazil

Population 211.05 million

The Ministry of Health begun its AMR Surveillance Program as a pilot project in 2018. The full AMR Surveillance Program providing data to GLASS will continue to evolve until 2022 when it is expected to reach at least 95 hospitals and seven outpatient clinics located in all 26 Brazilian states.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

18 surveillance sites participating to the national surveillance sytem

11 hospitals

7 outpatient facilities

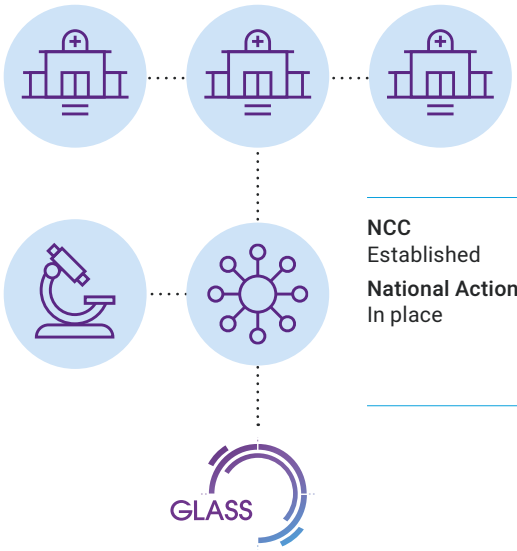
11 laboratories performing AST
EQA not provided

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
3 surveillance sites providing data to GLASS (3 hospitals)



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	2
Year of most recent survey	2014
Type of survey	pretreatment HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	Subnational
Year of most recent activity	2008
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Cambodia

Population 16.49 million

The Cambodian Ministry of Health endorsed and launched the Laboratory-Based Antimicrobial Surveillance Surveillance Standard Operation Procedure (SOP) in November 2019. The implementation of the SOP started in January 2018 in eight surveillance sites: three sites in the capital Phnom Penh and five in four other provinces.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

8 surveillance sites participating to the national surveillance sytem

8 hospitals

0 outpatient facilities

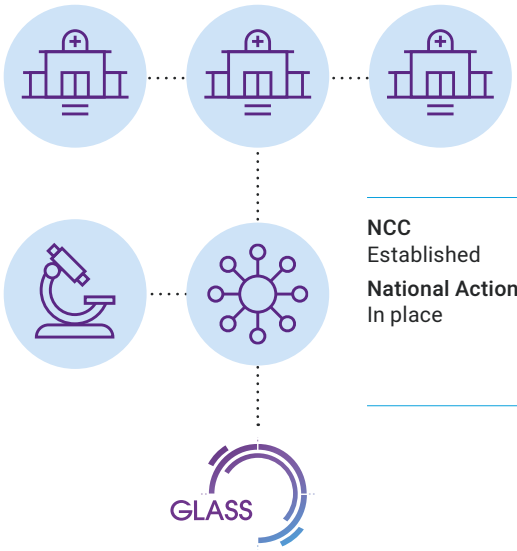
8 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS (8 hospitals)



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	2
Year of most recent survey	
Type of survey	

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	●
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	
	Shigella spp.	●	●	●	●	●
Urine	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	●
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Canada

Population 37.41 million

The Canadian Antimicrobial Resistance Surveillance System (CARSS) is a national system for surveillance of AMR and antimicrobial use. It integrates surveillance data from nine surveillance systems and laboratory reference services operated by the Public Health Agency of Canada. Federal Action Plan on AMR/AMU in Canada was published in 2015.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

70 surveillance sites participating to the national surveillance sytem

70 hospitals

0 outpatient facilities

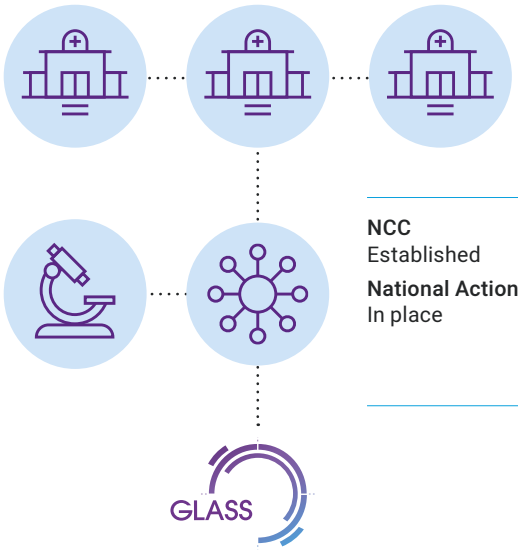
81 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
19 surveillance sites providing data to GLASS (19 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	22

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Côte d'Ivoire

Population 25.72 million

The integrated AMR surveillance system is based on 30 surveillance sites located in the laboratories of public secondary and tertiary hospitals (university hospital centers and regional hospital centers) and private human, animal and environmental health laboratories.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	✓
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

18 surveillance sites participating to the national surveillance sytem

18 hospitals

0 outpatient facilities

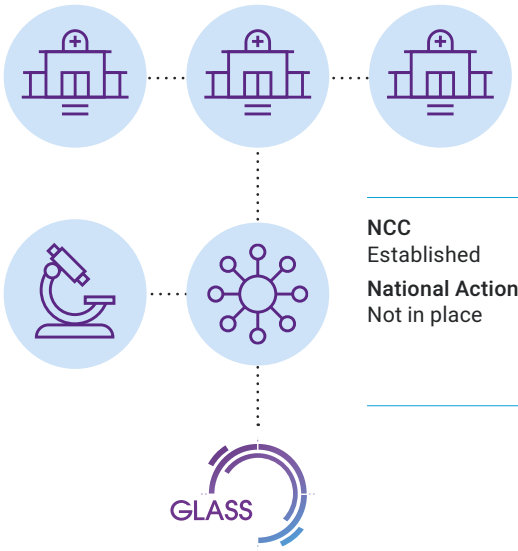
18 laboratories performing AST
EQA not provided

NRL
Established

AST standard
Not reported

EQA
Not reported

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
Not in place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2017
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Croatia

Population 4.13 million

Croatia has established a Committee for AMR (CCARS) that gathers heads of 37 microbiological laboratories and thus covers > 90% of Croatian population. The CCARS collaborates with the Reference Center for Antibiotic Resistance Surveillance that provides support for retesting alert organisms and conducting EQA.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

53 surveillance sites participating to the national surveillance sytem

32 hospitals

21 outpatient facilities

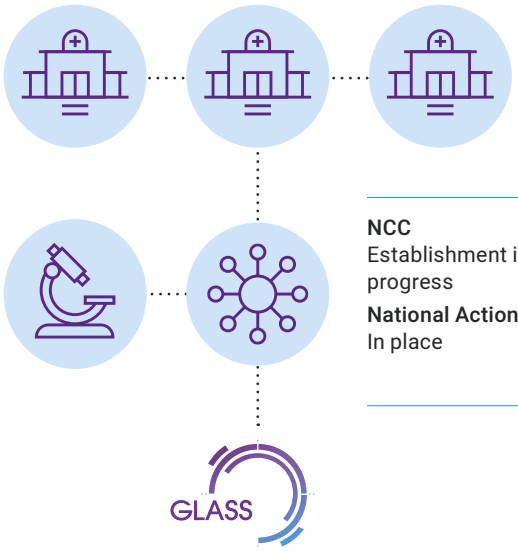
35 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS
(32 hospitals)
(21 outpatient facilities)



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	13

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Cyprus
Population 0.84 million

The National strategy of Cyprus against microbial resistance to antibiotics was published in 2012. The country participates in the EARS-Net and has been enrolled in GLASS since September 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

54 surveillance sites participating to the national surveillance sytem

5 hospitals

49 outpatient facilities

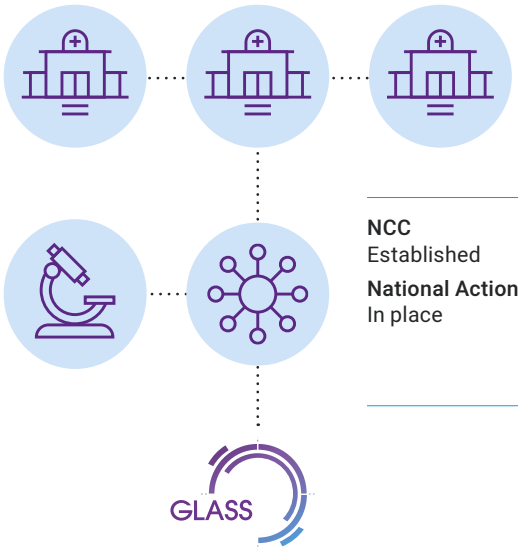
5 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
10 surveillance sites providing data to GLASS
(5 hospitals)
(5 outpatient facilities)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	12

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Czech Republic

Population 10.69 million

The Czech Republic participates in the EARS-Net and the national AMR surveillance network (CZ-EARS-Net) covers almost 80% of the Czech population. The country works on development of a new National Action Plan on AMR. The country has been enrolled in GLASS since December 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

77 surveillance sites participating to the national surveillance sytem

77 hospitals

0 outpatient facilities

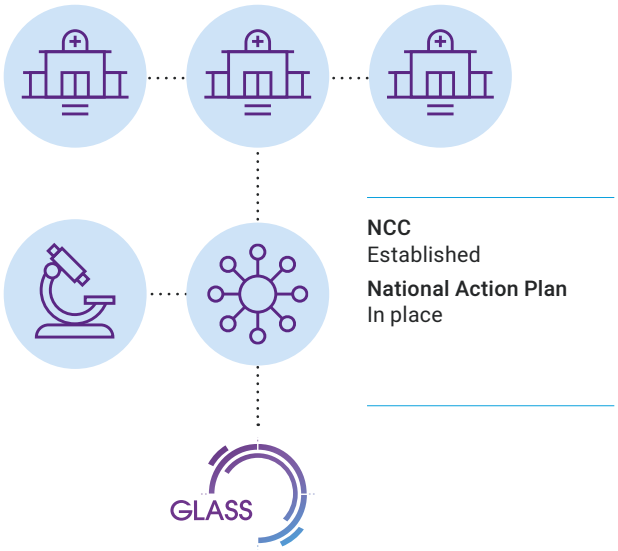
56 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS (77 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	18

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Democratic People's Republic of Korea

Population 25.67 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

18 surveillance sites participating to the national surveillance sytem

18 hospitals

0 outpatient facilities

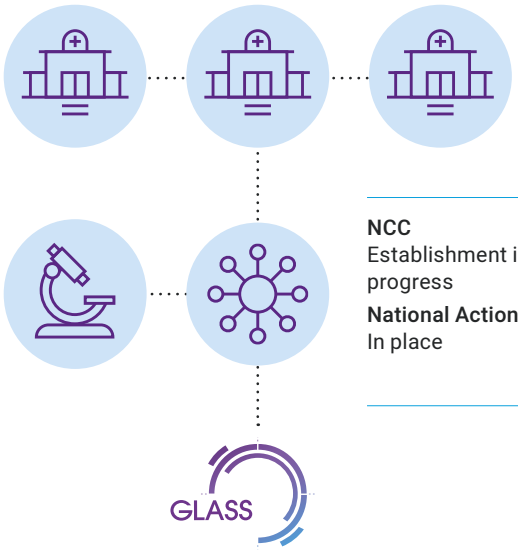
18 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
Other

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	Subnational
Year of most recent activity	2014
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Egypt

Population 100.39 million

Egypt is building its national AMR surveillance system. Phase one of the national AMR action plan (2017–2020) was drafted in 2017. Egypt has been enrolled in GLASS since May 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

39 surveillance sites participating to the national surveillance sytem

39 hospitals

0 outpatient facilities

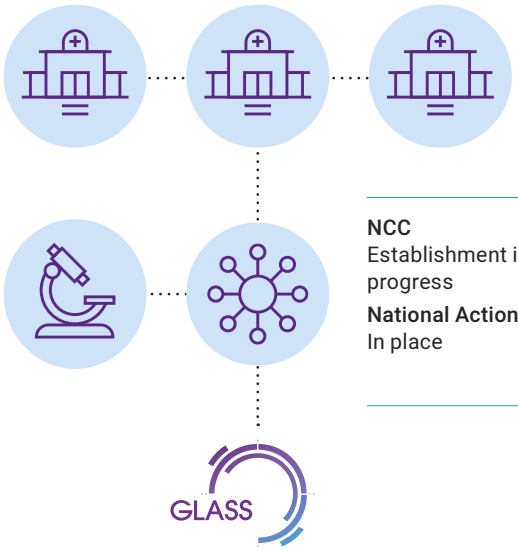
39 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
9 surveillance sites providing data to GLASS (9 hospitals)



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Ethiopia

Population 112.08 million

The AMR surveillance plan was developed and launched in August 2017. There are 16 hospitals and laboratories that have capacity for AMR testing reporting. The program was launched with a phase by phase approach. The first phase includes four surveillance sites, while the second phase since January 2019, five site.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

9 surveillance sites participating to the national surveillance sytem

7 hospitals

2 outpatient facilities

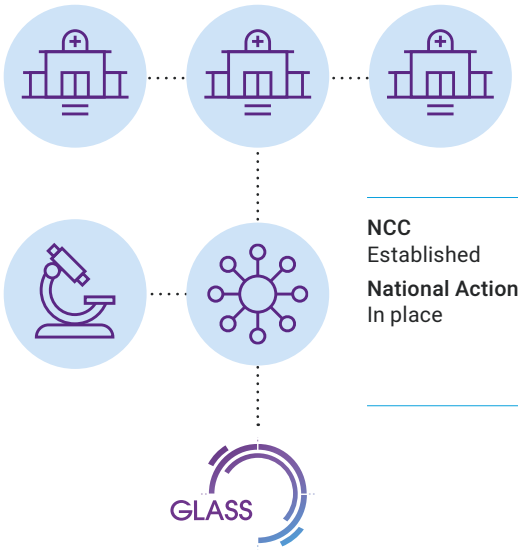
9 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
4 surveillance sites providing data to GLASS
(2 hospitals)
(2 outpatient facilities)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Finland

Population 5.53 million

Communicable Diseases Act (1227/2016) requires comprehensive surveillance of AMR. Both the public and animal health sectors have well-established AMR surveillance and reporting systems. All clinical microbiology laboratories including private laboratories are participating in surveillance. Results are published yearly in the Finres report.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

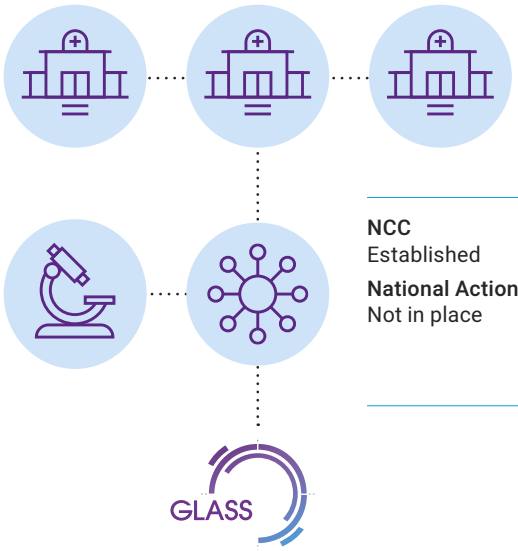
1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

23
laboratories participating to the national surveillance sytem[a]

23 laboratories performing AST
EQA not provided



NRL
Established

AST standard
EUCAST

EQA
Provided

NCC
Established

National Action Plan
Not in place

in 2019 data call
all national participating laboratories reported to GLASS
(23 laboratories)

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	21

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

France
Population 65.13 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

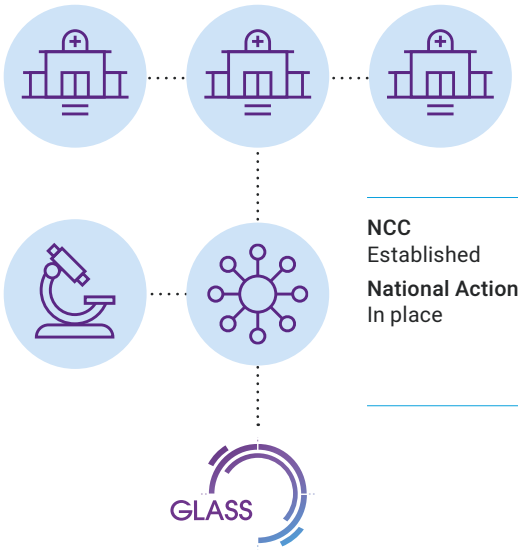
Indicators reported to GLASS

169
laboratories for *S. pneumoniae* and
54
laboratories for the other EARS-Net pathogens participating to the national surveillance sytem

173 laboratories performing AST
EQA provided to all labs for bacterial identification and AST

NRL
Established
AST standard
EUCAST/CLSI
EQA
Provided

in 2019 data call
169 for *S. pneumoniae* and 54 laboratories for the other EARS-Net pathogens reported to **GLASS**



NCC
Established
National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2014
Number of data points (1995-2019)[2]	14

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Gambia

Population 2.35 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1 surveillance site participating to the national surveillance sytem

1 hospital

0 outpatient facilities

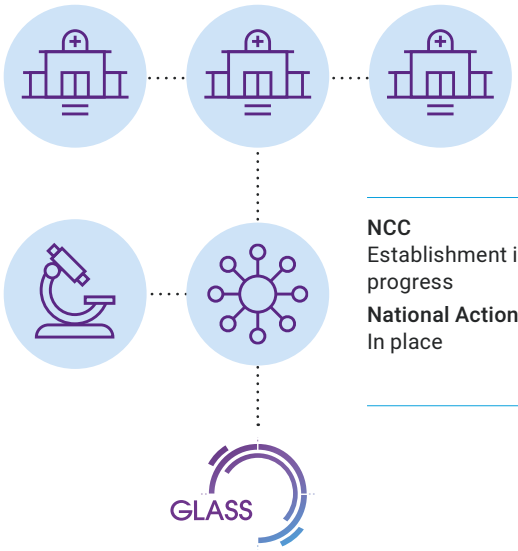
1 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2000
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Georgia
Population 4 million

The AMR National Strategy was approved in January 2017. AMR surveillance is included in the NAP. Georgia is building its national AMR surveillance system and participates in CAESAR. It has been enrolled in GLASS since April 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

152 surveillance sites participating to the national surveillance sytem

150 hospitals

2 outpatient facilities

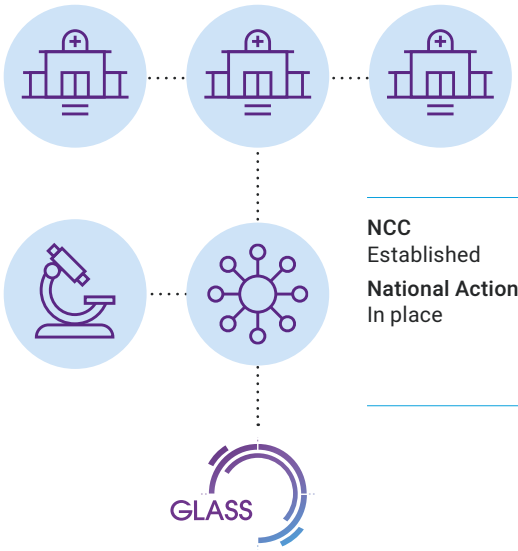
20 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
4 surveillance sites providing data to GLASS (4 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	11

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Germany

Population 83.52 million

The national surveillance of AMR is coordinated by the Robert Koch Institute, offering a publicly accessible interactive database for data of the AMR surveillance system (Antibiotika Resistenz Surveillance – ARS). The National action plan on prevention of AMR (DART 2020) was published in 2015.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

29571 surveillance sites participating to the national surveillance sytem

1163 hospitals

28408 outpatient facilities

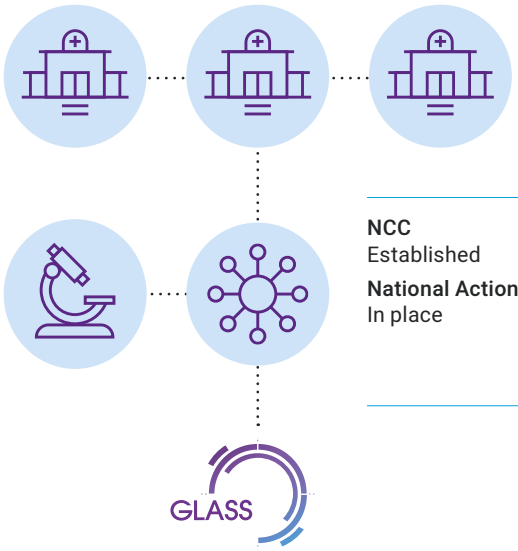
48 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
16429 surveillance sites providing data to GLASS
(602 hospitals)
(15827 outpatient facilities)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	19

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Greece

Population 10.47 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

55 surveillance sites participating to the national surveillance sytem

55 hospitals

0 outpatient facilities

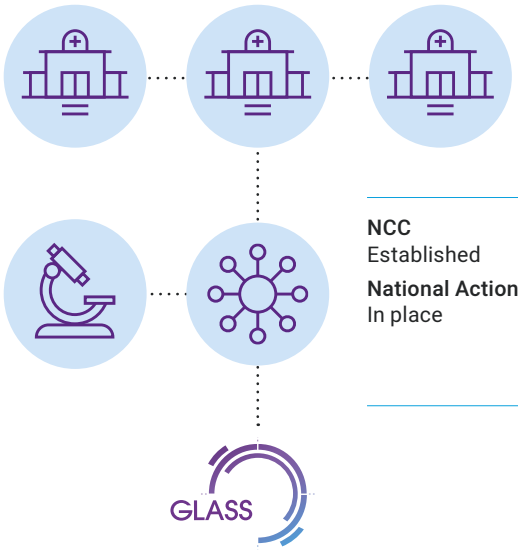
55 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Not established

AST standard
EUCAST/CLSI

EQA
Not reported

in 2019 data call
3 surveillance sites providing data to GLASS (34 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2010
Number of data points (1995-2019)[2]	4

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	🟢	🟡	🟡	🔴	🔴
	E. coli	🟢	🟡	🟡	🔴	
	K. pneumoniae	🟢	🟡	🟡	🔴	
	Salmonella spp.	🔴	🔴	🔴	🔴	
	S. aureus	🟢	🟡	🟡	🔴	
	S. pneumoniae	🔴	🔴	🔴	🔴	
Stool	Salmonella spp.	🔴	🔴	🔴	🔴	🔴
	Shigella spp.	🔴	🔴	🔴	🔴	
Urine	E. coli	🔴	🔴	🔴	🔴	🔴
	K. pneumoniae	🔴	🔴	🔴	🔴	
Genital	N. gonorrhoeae	🟢	🟢	🟢	🔴	🔴

🟢 70-100% data reported 🟡 <70% data reported 🔴 No data reported

India

Population 1.37 billion

There are 3 AMR surveillance networks participating in the National AMR Surveillance in the country. 1. National AMR Surveillance network, NCDC. 2. Antimicrobial Surveillance and Research network, ICMR; 3. Gonococcal Antimicrobial Resistance surveillance network, Safdarjung Hospital.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	✓
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

130 surveillance sites participating to the national surveillance sytem

65 hospitals

65 outpatient facilities

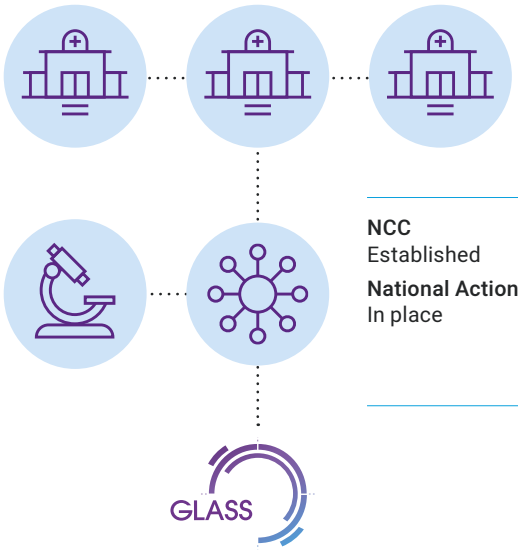
41 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
not provided

in 2019 data call
41 participating laboratories providing data to GLASS (41 laboratories)[a]



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2016
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system

India (continued)

AMR data submission to GLASS (2019 data call)						
Specimen type	**Pathogen**	**AST results**	**Age**	**Gender**	**Infection origin**	**Data on number of tested patient**
Blood[1]	Acinetobacter spp.	🟢	🟡	🟢	🟡	🟢
	E. coli	🟢	🟡	🟢	🟡	
	K. pneumoniae	🟢	🟡	🟡	🟡	
	Salmonella spp.	🟢	🟡	🟢	🟡	
	S. aureus	🟢	🟡	🟢	🟡	
	S. pneumoniae	🔴	🔴	🔴	🔴	
Urine[1]	E. coli	🟢	🟡	🟢	🟡	🟢
	K. pneumoniae	🟢	🟢	🟢	🟡	
Blood[2]	Acinetobacter spp.	🟢	🟢	🟢	🟡	🟢
	E. coli	🟢	🟢	🟢	🟡	
	K. pneumoniae	🟢	🟢	🟢	🟡	
	Salmonella spp.	🟢	🟢	🟢	🟡	
	S. aureus	🟢	🟢	🟢	🟡	
	S. pneumoniae	🔴	🔴	🔴	🔴	
Stool[2]	Salmonella spp.	🟢	🟢	🟢	🟡	🟢
	Shigella spp.	🔴	🔴	🔴	🔴	
Urine[2]	E. coli	🟢	🟢	🟢	🟡	🟢
	K. pneumoniae	🟢	🟢	🟢	🟡	
Genital[3]	N. gonorrhoeae	🟢	🟢	🟢	🟢	🟢

🟢 70-100% data reported 🟡 <70% data reported 🔴 No data reported

1 Data from the NDCD hospital surveillance network

2 Laboratories from part of ICRM network INC

3 Gonococcus network INC

Indonesia

Population 270.63 million

Indonesia enrolled to GLASS since 28 January 2019 and conducted a workshop and training on GLASS Implementation in March 2019, to designate the NCC, NRL, and surveillance sites (hospitals).

Indonesia also already have an AMR Control Committee (ARCC) under the MOH. The National and multisectoral ARCC is still on progress.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	✓
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

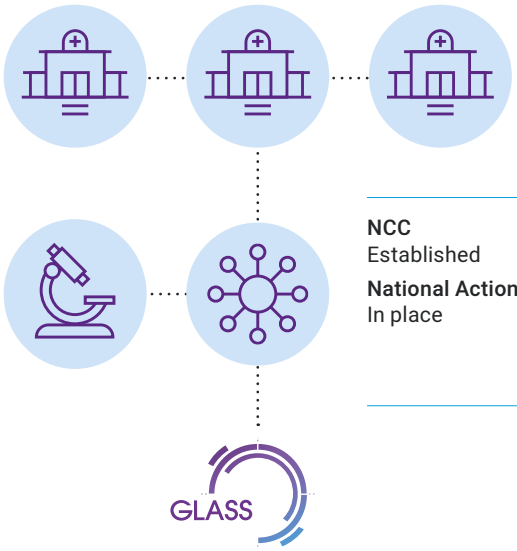
Indicators reported to GLASS

11 surveillance sites participating to the national surveillance sytem

11 hospitals

0 outpatient facilities

Number of laboratories performing AST not reported



NRL
Established

AST standard
CLSI

EQA
Provided

NCC
Established

National Action Plan
In place

in 2019 data call
9 surveillance sites providing data to GLASS (9 hospitals)

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Iran (Islamic Republic)

Population 82.91 million

Iran has developed its National Action Plan on AMR with promotion and development of AMR surveillance included in the NAP. The country has been enrolled in GLASS since May 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	✓
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

12 surveillance sites participating to the national surveillance sytem

6 hospitals

6 outpatient facilities

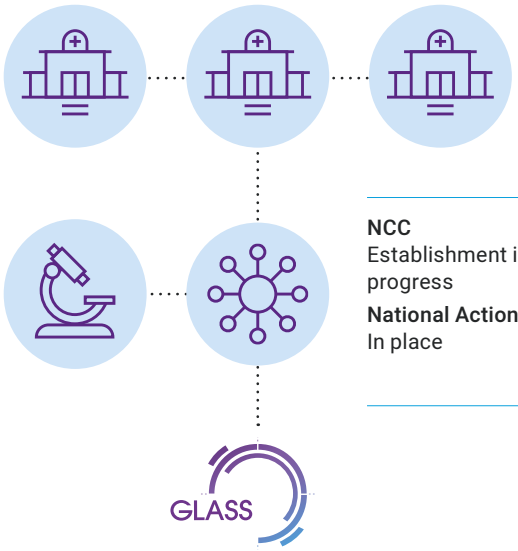
6 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
6 surveillance sites providing data to GLASS (6 hospitals)



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2014
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Iraq
Population 39.31 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	✓
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

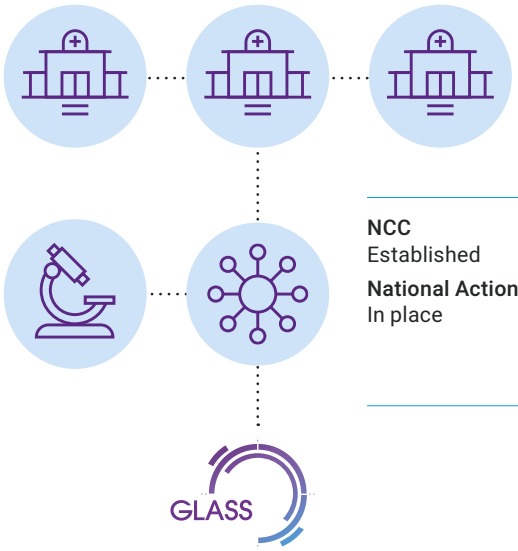
1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

Number of surveillance sites participating to the national surveillance sytem not reported

Number of laboratories performing AST not provided



NRL
Established

AST standard
CLSI

EQA
Provided

NCC
Established

National Action Plan
In place

in 2019 data call
No AMR data reported to GLASS

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2013
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Ireland

Population 4.88 million

Ireland AMR surveillance reaches 100% population coverage by 38 microbiology laboratories that report surveillance data on EARS-Net pathogens causing invasive infections.

CPE is a notifiable disease in Ireland (invasive since 2012). Outbreaks of colonisation or infection due to transmissible microorganisms are notifiable by law regardless of antimicrobial resistance patterns.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

59 surveillance sites participating to the national surveillance sytem

59 hospitals

0 outpatient facilities

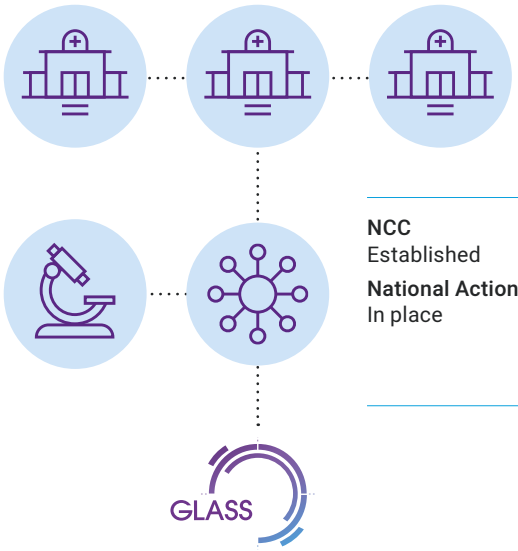
38 laboratories performing AST

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS (59 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	16

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Italy
Population 60.55 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

236 surveillance sites participating to the national surveillance sytem

56 hospitals

180 outpatient facilities

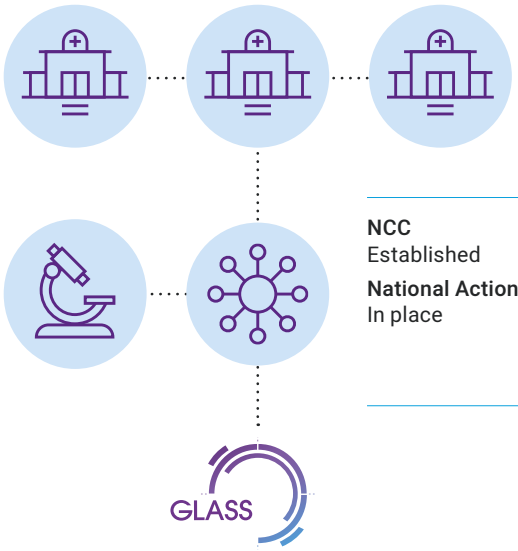
56 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
56 surveillance sites providing data to GLASS (56 laboratories)[a]



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2015
Number of data points (1995-2019)[2]	14

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system

Japan

Population 126.86 million

Please look at a review published in AMR control 2019: http://resistancecontrol.info/wp-content/uploads/2019/05/Yahara.pdf
Japan uses a different approach to deduplication than the one suggested by GLASS, but research has been conducted to assure that the outcome results are compatible.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1947
surveillance sites participating to the national surveillance sytem

1947
inpatient and outpatient facilities

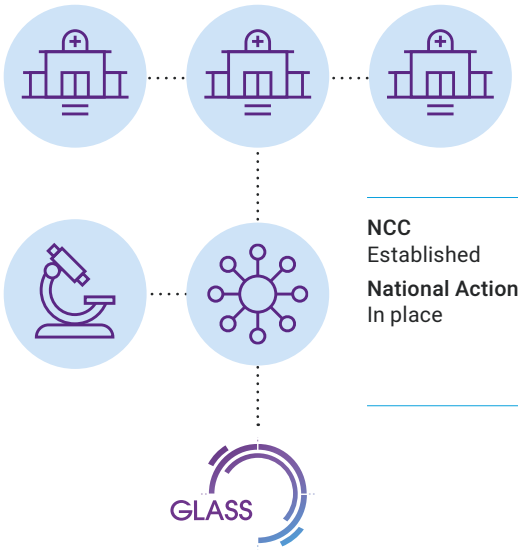
1947 laboratories performing AST
EQA provided to some labs for bacterial identification and AST

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
1947 surveillance sites providing data to GLASS (1947 in-out patient facilities)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2002
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Jordan

Population 10.1 million

Jordan initiated an AMR control response in 2017 by developing and endorsing the AMR NAP (2018 – 2022) and started the implementation of surveillance with the support of KOICA. The Jordanian National AMR Surveillance System (JARSS) has been developed, endorsed, and launched in July 2019 to be used as standardized national AMR surveillance system.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	✓
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	✓
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

8 surveillance sites participating to the national surveillance sytem

8 hospitals

0 outpatient facilities

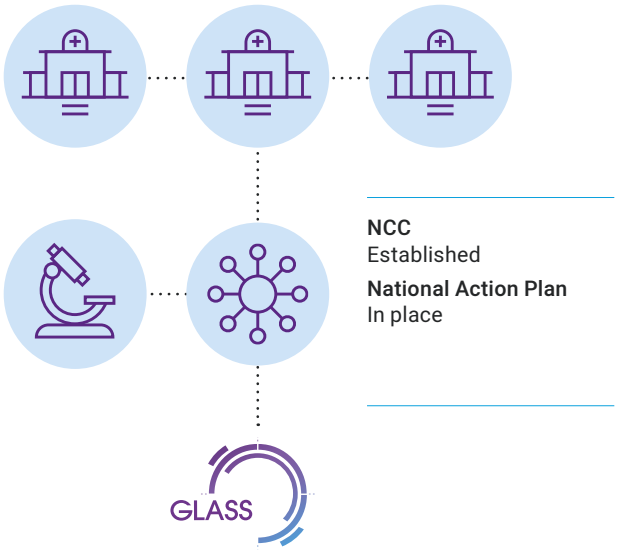
8 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS (8 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2009
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Kenya

Population 52.57 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

8 surveillance sites participating to the national surveillance sytem

4 hospitals

4 outpatient facilities

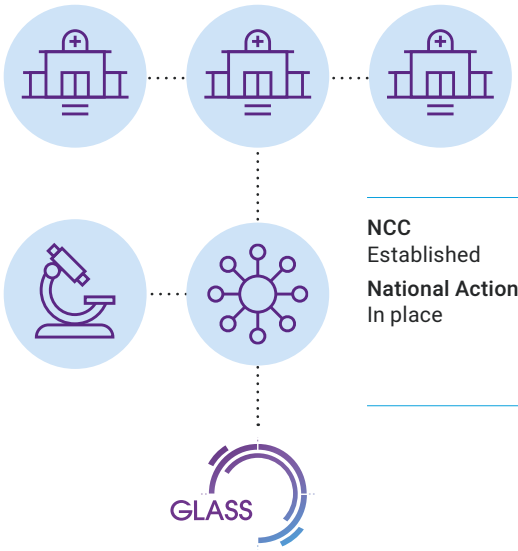
4 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogenes

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2014
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Kosovo[1]

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

24 surveillance sites participating to the national surveillance sytem

7 hospitals

0 outpatient facilities

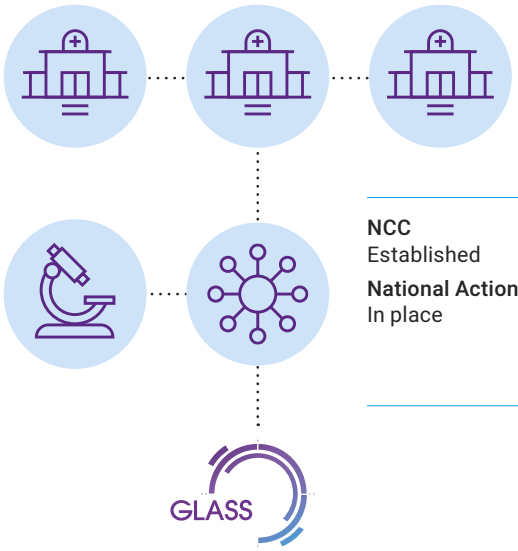
7 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

1 All references to Kosovo in this document should be understood to be in the context of United Nations Security Council resolution 1244 (1999)

Lao People's Democratic Republic

Population 7.17 million

The national AMR surveillance system in Lao PDR was formally established in 2018 with support from KOICA. A national AMR surveillance strategy and protocols were developed and are currently in the process of being endorsed by the MOH.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

2 surveillance sites participating to the national surveillance sytem

2 hospitals

0 outpatient facilities

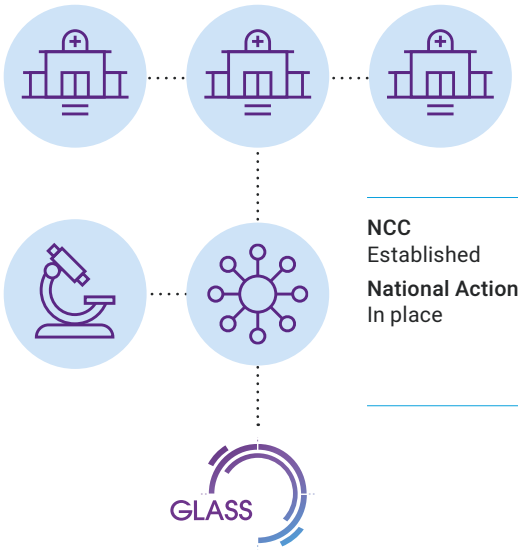
2 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
1 surveillance site providing data to GLASS (1 hospital)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Latvia

Population 1.91 million

The country participates in the EARS-Net and has been enrolled in GLASS since December 2016.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

11
laboratories participating to the national surveillance sytem[a]

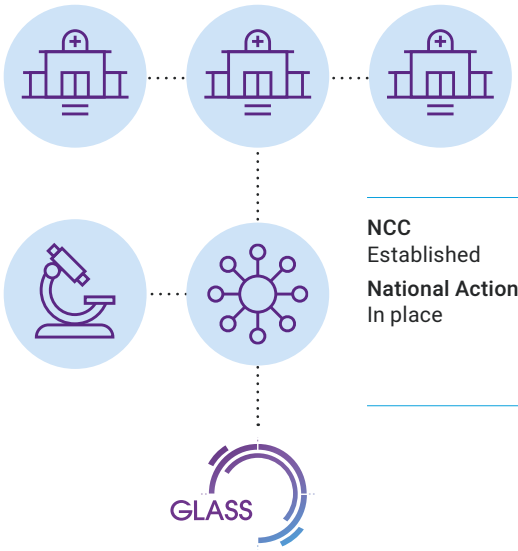
11 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
2 surveillance sites providing data to GLASS
(1 hospitals)
(1 outpatient facility)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2017
Number of data points (1995-2019)[2]	21

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

Lebanon

Population 6.86 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

30 surveillance sites participating to the national surveillance sytem

30 hospitals

0 outpatient facilities

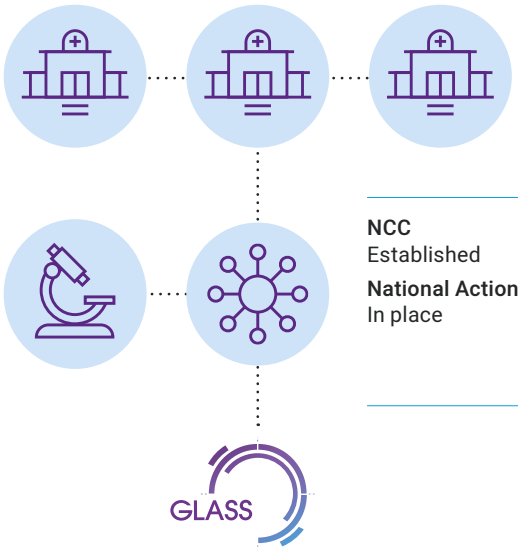
30 laboratories performing AST
EQA provided to some labs for bacterial identification and AST

NRL
Established

AST standard
EUCAST/CLSI

EQA
Not reported

in 2019 data call
8 surveillance sites providing data to GLASS (8 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	4

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Liberia

Population 4.94 million

Coordination with relevant sectors and partners regarding AMR surveillance is ongoing with stringent effort being made for AMR data collection and reporting to WHO GLASS.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

3
surveillance sites participating to the national surveillance sytem

3
hospitals

0
outpatient facilities

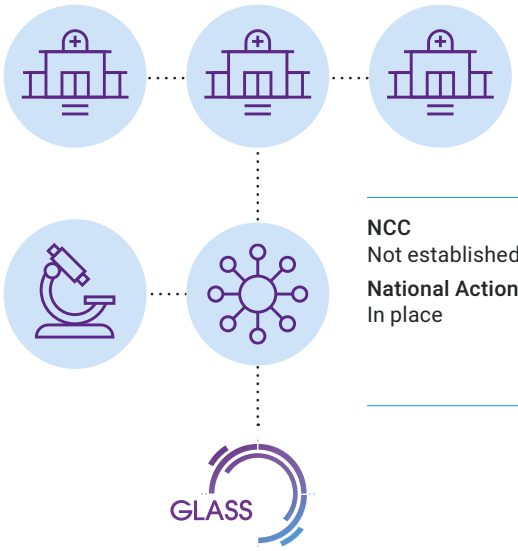
4 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Not established

National Action Plan
In place

Libya
Population 6.78 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

Number of surveillance sites participating to the national surveillance sytem
not reported

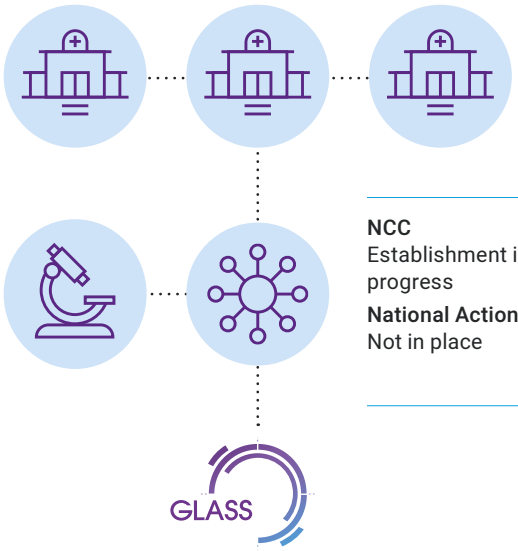
Number of laboratories performing AST not reported

NRL
Established

AST standard
Not reported

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Establishment in progress

National Action Plan
Not in place

Lithuania

Population 2.76 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

31 surveillance sites participating to the national surveillance sytem

6 hospitals

25 outpatient facilities

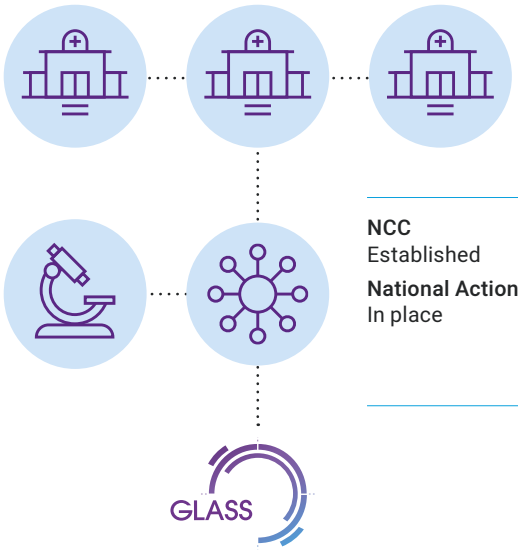
1 laboratory performing AST
EQA not provided

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	19

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Luxembourg
Population 0.62 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

9 surveillance sites participating to the national surveillance sytem

9 hospitals

0 outpatient facilities

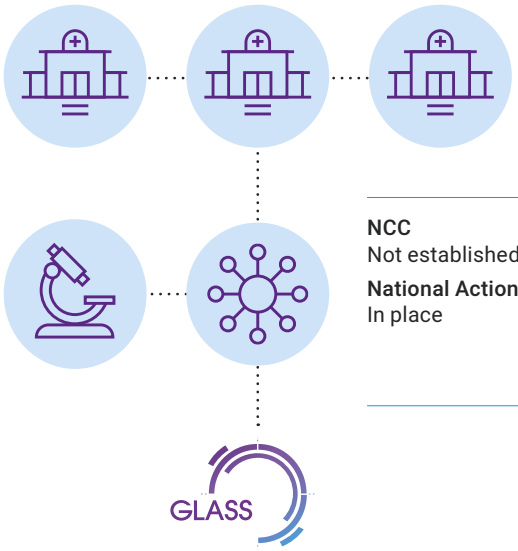
8 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
4 surveillance sites providing data to GLASS (4 hospitals)



NCC
Not established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2014
Number of data points (1995-2019)[2]	11

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Madagascar

Population 26.97 million

The AMR national action plan has been adopted at the government level. The plan developed is coherent with GAP and respect the "One Health" concept. The AMR surveillance system strategy is divided into two distinct but complementary parts: monitoring and laboratory.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	✓
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

7
laboratories participating to the national surveillance sytem[a]

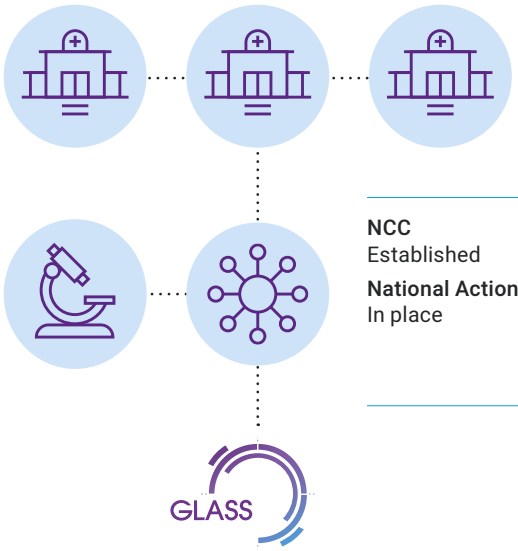
7 laboratories performing AST
EQA not provided

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national participating laboratories reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2007
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Malaysia
Population 31.95 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	✓
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

110 surveillance sites participating to the national surveillance sytem

42 hospitals

68 outpatient facilities

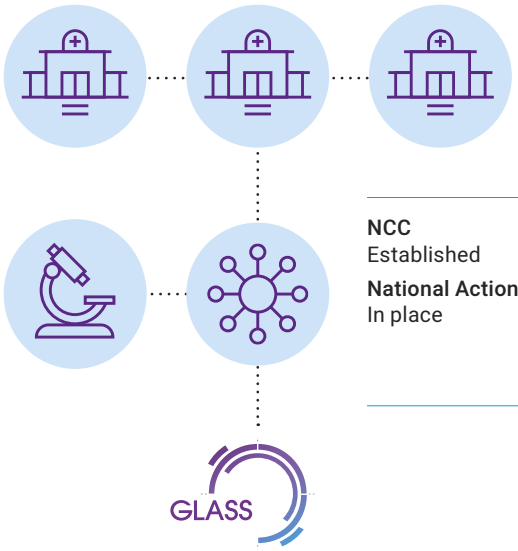
43 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2014
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	🟢	🟠	🟠	🟠	🟢
	E. coli	🟢	🟠	🟠	🟠	
	K. pneumoniae	🟢	🟠	🟠	🟠	
	Salmonella spp.	🟢	🟠	🟠	🟠	
	S. aureus	🟢	🟠	🟠	🟠	
	S. pneumoniae	🟢	🟠	🟠	🟠	
Stool	Salmonella spp.	🟢	🟠	🟠	🟠	🟢
	Shigella spp.	🟢	🟠	🟠	🔴	
Urine	E. coli	🟢	🟠	🟠	🟠	🟢
	K. pneumoniae	🟢	🟠	🟠	🟠	
Genital	N. gonorrhoeae	🟢	🟢	🟠	🟠	🟢

🟢 70-100% data reported 🟠 <70% data reported 🔴 No data reported

Maldives

Population 0.53 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

4 surveillance sites participating to the national surveillance sytem

2 hospitals

2 outpatient facilities

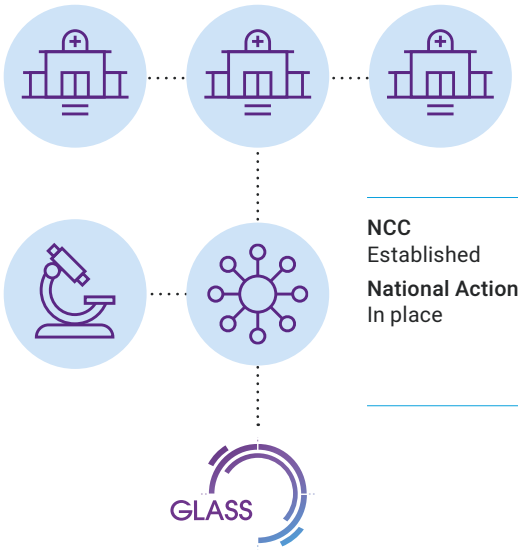
2 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2016
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Mali

Population 19.66 million

Mali has opted for a patient-based surveillance system. For this purpose, documents describing coordination mechanisms, surveillance site surveillance procedures, and data sharing were developed to build an effective surveillance system.The main components of the surveillance system have been put in place.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

5
laboratories participating to the national surveillance sytem[a]

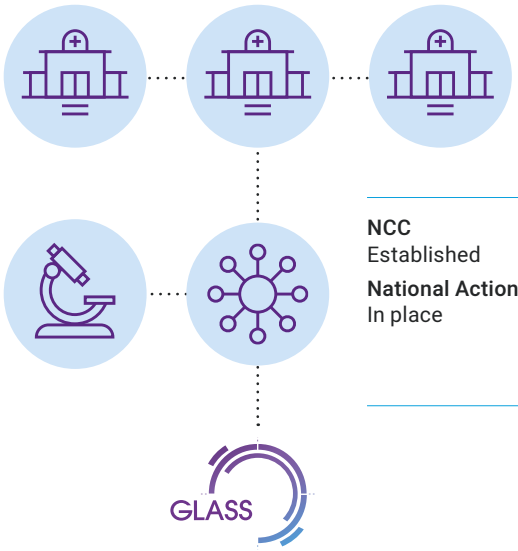
5 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
all national participating laboratories reported to GLASS



NCC
Established

National Action Plan
In place

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

Malta

Population 0.44 million

The microbiology laboratory at Mater Dei Hospital provides diagnostic services to all publicly provided primary, secondary and tertiary care. It is estimated that this covers more than 95% of inpatient care. Malta has just developed a National AMR Strategy and Action Plan which has been finalised and awaiting ministerial approval.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

14 surveillance sites participating to the national surveillance sytem

4 hospitals

10 outpatient facilities

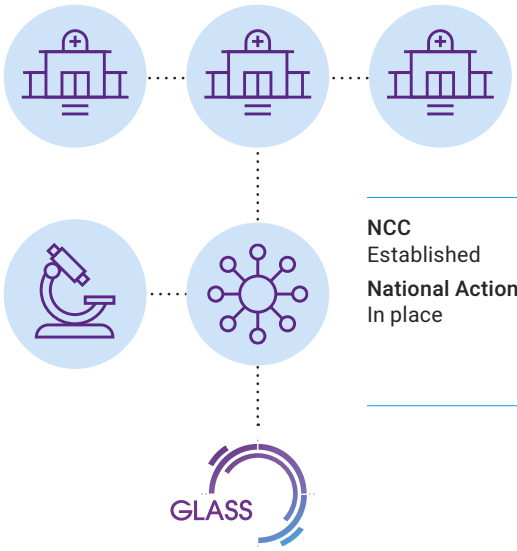
1 laboratory performing AST
EQA not provided

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2017
Number of data points (1995-2019)[2]	14

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Mauritius

Population 1.27 million

Mauritius has a free public health care system, comprising of 5 specialised hospitals, 5 regional hospitals and health centres as well as free laboratory test services. The Central Health laboratory at Victoria Hospital is the National Reference Laboratory where data on bacteria identification and AST is present in paper form.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1 surveillance site participating to the national surveillance sytem

1 hospital

0 outpatient facilities

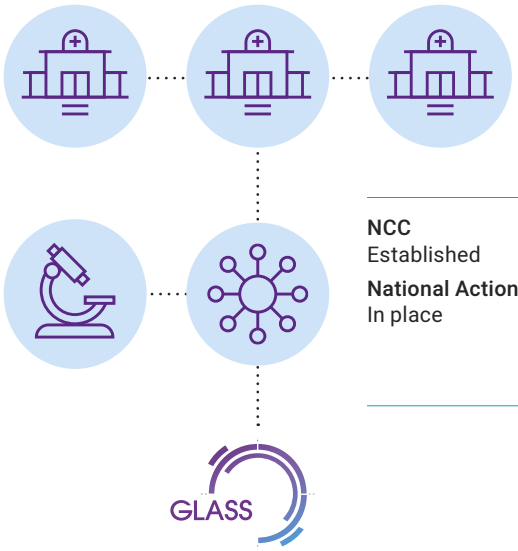
1 laboratory performing AST
EQA provided to some labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	9

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Mozambique

Population 30.37 million

Mozambique is in the implementation phase of AMR surveillance, focussing on BSI identified as part of routine patient care at a general hospital in the urban area of Maputo City. The surveillance is being carried out by the Instituto Nacional de Saúde of Mozambique (INS, the National Institute of Health).

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1 surveillance site participating to the national surveillance sytem

1 hospital

0 outpatient facilities

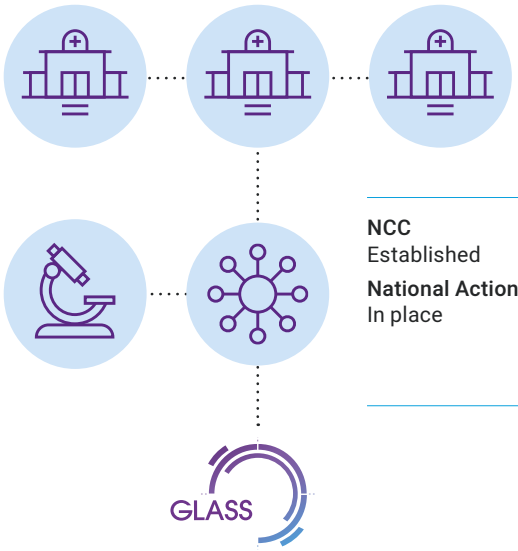
2 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	1
Year of most recent survey	2012
Type of survey	pretreatment HIV drug resistance (children)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2007
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Myanmar

Population 54.05 million

The National action plan for AMR has been established since 2017. The National Multi-Sectoral Steering Committee (NMSC) Combating AMR Myanmar was endorsed on the 22nd January 2018.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

7 surveillance sites participating to the national surveillance sytem

7 inpatient and outpatient facilities

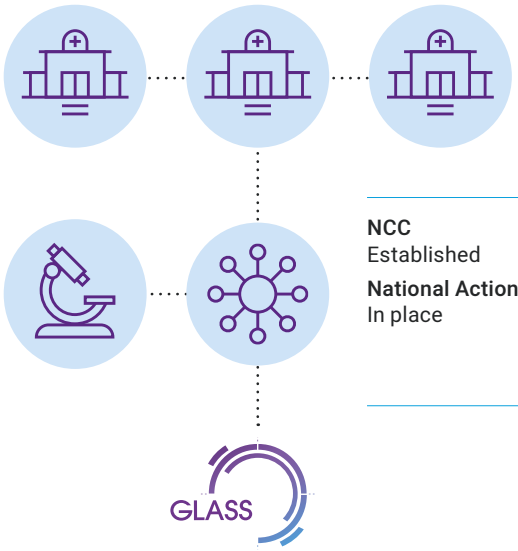
7 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	2
Year of most recent survey	2016
Type of survey	pretreatment HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	4

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Nepal

Population 28.61 million

Antimicrobial surveillance started in Nepal since 1999 with six participating laboratories/hospitals. The network has extended and includes twenty-one hospitals/ laboratories apart from National Public Health Laboratory (NPHL). NPHL has been designated as NCC and NRL for AMR surveillance in Nepal.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	✓
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

21 surveillance sites participating to the national surveillance sytem

21 inpatient and outpatient facilities

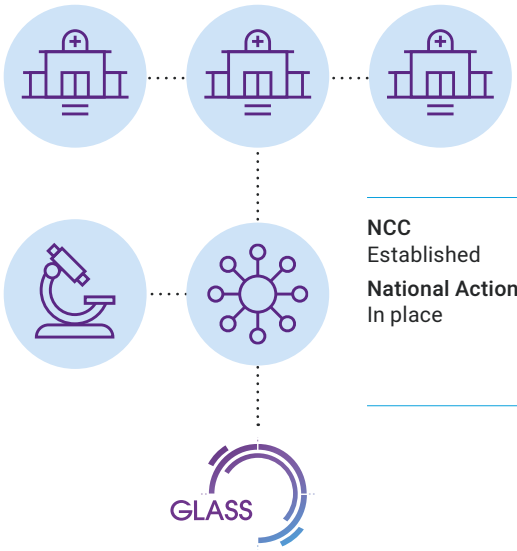
21 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	
Year of most recent survey	2016
Type of survey	pretreatment HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2011
Number of data points (1995-2019)[2]	5

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Netherlands

Population 17.10 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

160 surveillance sites participating to the national surveillance sytem

80 hospitals

80 outpatient facilities

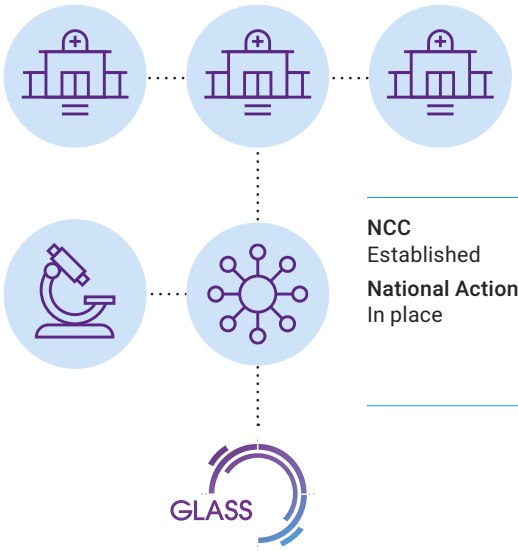
47 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
47 participating laboratories providing data to GLASS (47 laboratories)[a]



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	22

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Nigeria

Population 200.96 million

The surveillance system comprises of 2 National Reference Laboratories and 3 surveillance sites. Functions include supervision, capacity building, EQA support and reporting.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

29 surveillance sites participating to the national surveillance sytem

3 hospitals

26 outpatient facilities

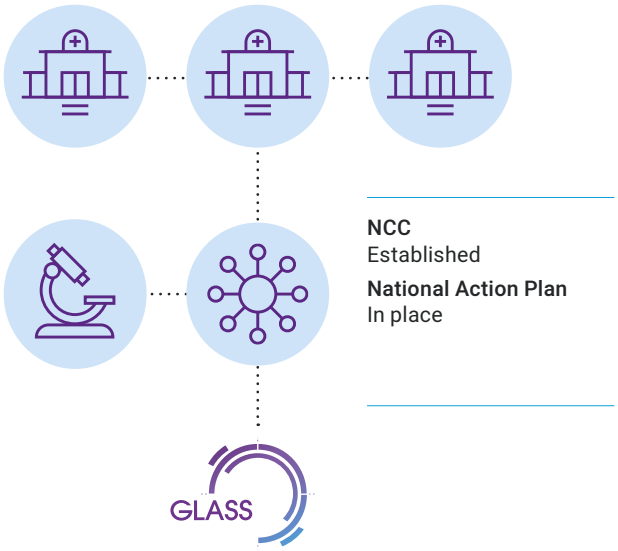
3 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	1
Year of most recent survey	2016
Type of survey	pretreatment HIV drug resistance (children)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2010
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

North Macedonia

Population 2.08 million

The Republic of North Macedonia is developing its national surveillance system with a network of laboratories covering about 79% of hospitals (2015). The country participates in CAESAR and has been enrolled in GLASS since May 2017.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

Number of surveillance sites participating to the national surveillance sytem not reported

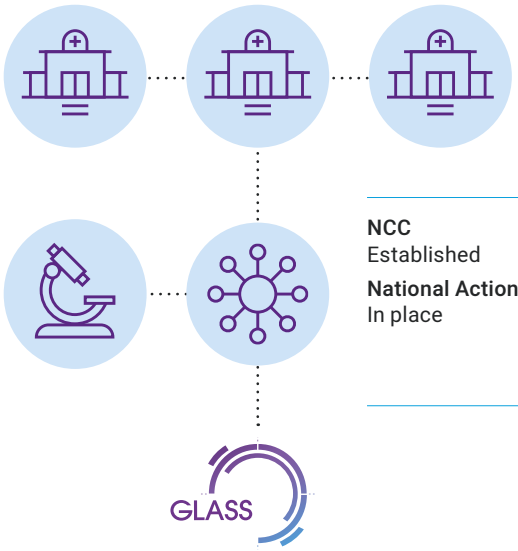
30 laboratory performing AST
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogens

NRL
Not established

AST standard
EUCAST

EQA
Not provided

in 2019 data call
37 surveillance sites providing data to GLASS (37 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	10

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Norway
Population 5.38 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

22
laboratories participating to the national surveillance sytem[a]

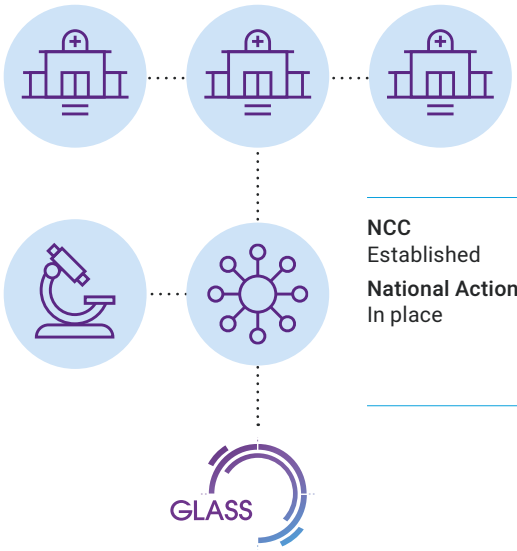
22 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
all national participating laboratories reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	20

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

Occupied Palestinian territory, including east Jerusalem

Population 4.98 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

Number of surveillance sites participating to the national surveillance sytem not reported

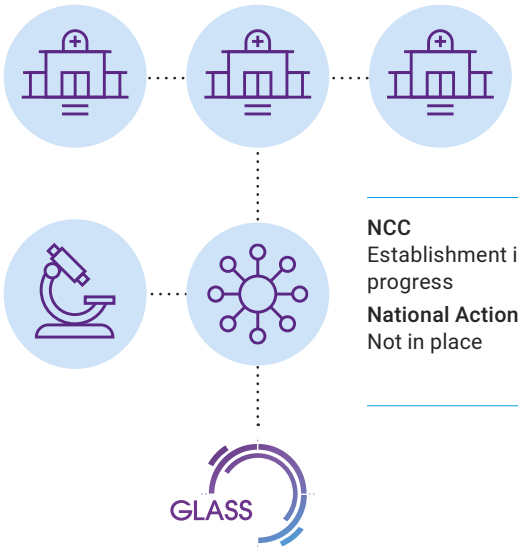
Number of laboratories performing AST not reported
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogens

NRL
Not established

AST standard
CLSI

EQA
Not provided

in 2019 data call
No AMR data submitted to GLASS



NCC
Establishment in progress

National Action Plan
Not in place

Oman

Population 4.97 million

GLASS reported data is derived from the national surveillance system for AMR (OMASS), which has expanded in 2018 to include 8 laboratories, after ensuring the quality of their testing and reporting. This system produces annual national report that includes MDRO, AMU, and antibiograms.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

32 surveillance sites participating to the national surveillance sytem

8 hospitals

24 outpatient facilities

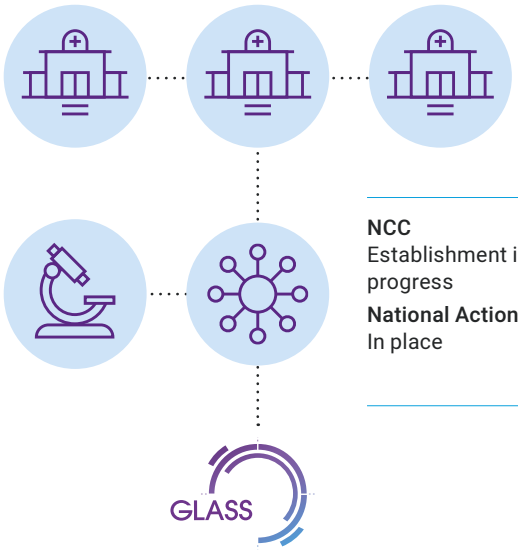
8 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	18

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Pakistan

Population 216.57 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

10 surveillance sites participating to the national surveillance sytem

8 hospitals

2 outpatient facilities

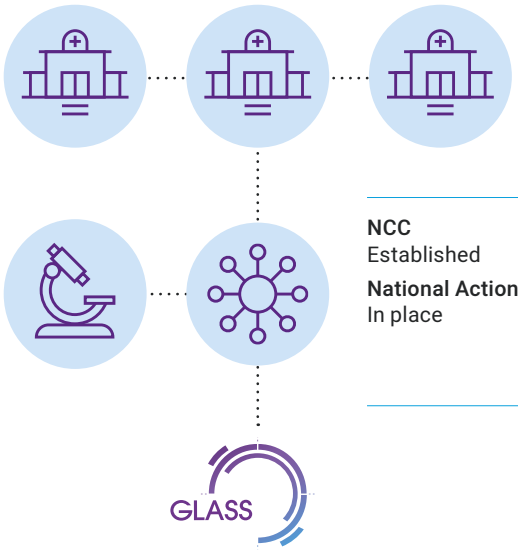
10 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2013
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	🟢	🟢	🟢	🟠	🔴
	E. coli	🟢	🟢	🟢	🟠	
	K. pneumoniae	🟢	🟢	🟢	🟠	
	Salmonella spp.	🟢	🟢	🟢	🟠	
	S. aureus	🟢	🟢	🟢	🟠	
	S. pneumoniae	🔴	🔴	🔴	🔴	
Stool	Salmonella spp.	🟢	🟢	🟢	🟠	🔴
	Shigella spp.	🟢	🟢	🟢	🔴	
Urine	E. coli	🟢	🟢	🟢	🟠	🔴
	K. pneumoniae	🟢	🟢	🟢	🟠	
Genital	N. gonorrhoeae	🟢	🟢	🟢	🔴	🔴

🟢 70-100% data reported 🟠 <70% data reported 🔴 No data reported

Philippines

Population 108.12 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	✓

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

26 surveillance sites participating to the national surveillance sytem

26 inpatient and outpatient facilities

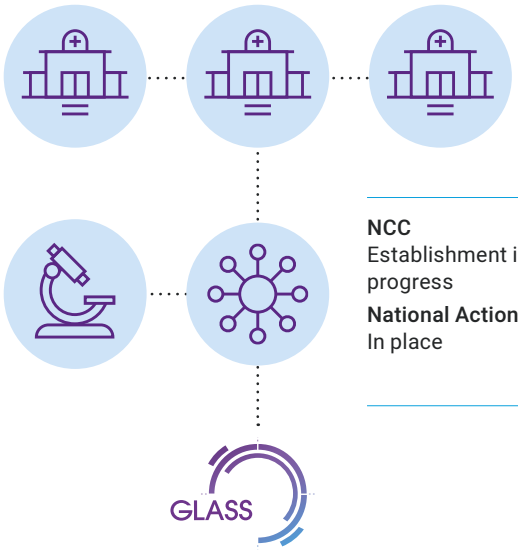
26 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2019
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Poland

Population 37.89 million

AMR surveillance is based on data obtained from laboratories and hospitals participating in EARS-Net. Those laboratories also send data on *Salmonella* spp. to EARS-Net coordination centre. On voluntary basis, laboratories send strains with important AMR mechanism to the NRCST for reference diagnostics. Once a year, hospitals investigate the presence of AMR alert pathogens and report to the District Sanitary Inspectorate.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

90 surveillance sites participating to the national surveillance sytem

90 hospitals

0 outpatient facilities

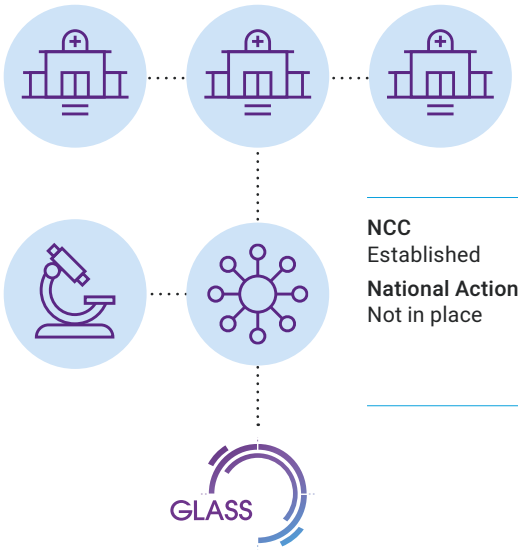
84 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
62 surveillance sites providing data to GLASS (62 hospitals)



NCC
Established

National Action Plan
Not in place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	12

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Republic of Korea

Population 51.23 million

The Republic of Korea, depending on the domestic situation, is adding pathogens to the GLASS list and examining resistant genes or virulence genes.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

8 surveillance sites participating to the national surveillance sytem

8 hospitals

0 outpatient facilities

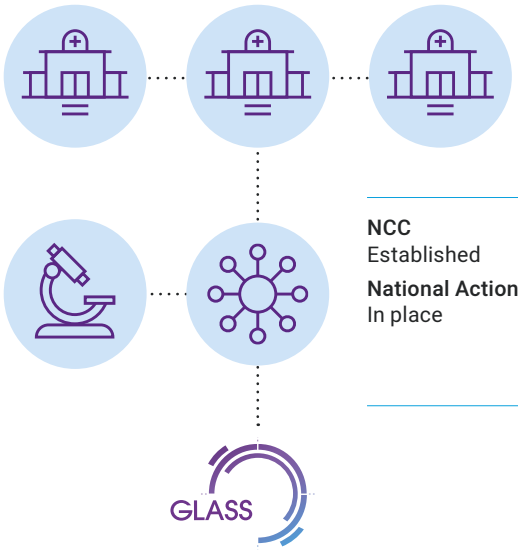
4 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	6

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Russian Federation

Population 145.87 million

The AMR surveillance network collects a maximum of 150 consecutive, non-duplicate isolates, from relevant clinical specimens identified by local laboratories, which are geographically spread throughout the Russia. This data is sent annually to the central laboratory together with basic epidemiological data. Organisms revealing rare resistance phenotypes or specific resistance of significance are further characterized using molecular methods.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

57 surveillance sites participating to the national surveillance sytem

49 hospitals

8 outpatient facilities

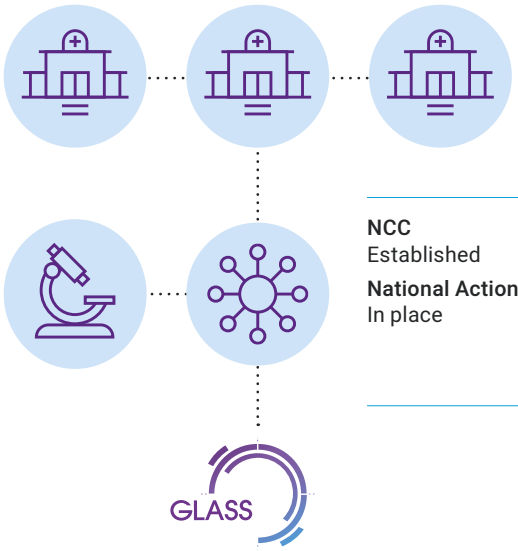
49 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
35 surveillance sites providing data to GLASS (35 hospitals)



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Saudi Arabia

Population 34.27 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

36 surveillance sites participating to the national surveillance sytem

36 hospitals

0 outpatient facilities

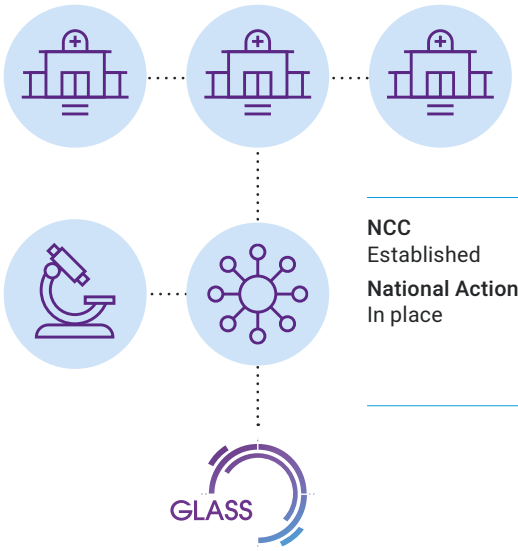
36 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2010
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	🟢	🟢	🟢	🟠	🔴
	E. coli	🟢	🟢	🟢	🟠	
	K. pneumoniae	🟢	🟢	🟢	🟠	
	Salmonella spp.	🟢	🟢	🟢	🟠	
	S. aureus	🟢	🟢	🟢	🟠	
	S. pneumoniae	🟢	🟢	🟢	🟠	
Stool	Salmonella spp.	🟢	🟢	🟢	🟠	🔴
	Shigella spp.	🟢	🟢	🟢	🟠	
Urine	E. coli	🟢	🟢	🟢	🟠	🔴
	K. pneumoniae	🟢	🟢	🟢	🟠	
Genital	N. gonorrhoeae	🔴	🔴	🔴	🟢	🔴

🟢 70-100% data reported 🟠 <70% data reported 🔴 No data reported

South Africa

Population 58.56 million

Under the NICD umbrella, GERMS-SA laboratory-based and aetiological surveillance, and the National AMR Surveillance report AMR data. GERMS-SA laboratory-based surveillance is for HIV-associated bacterial and fungal opportunistic infections, vaccine-preventable diseases and HAI BSI. It also includes syndromic surveillance and aetiological surveillance of STIs. The National AMR Surveillance collects data derived from blood culture from all public health facilities and the majority of private-sector laboratories.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

353 surveillance sites participating to the national surveillance sytem

350 hospitals

3 outpatient facilities

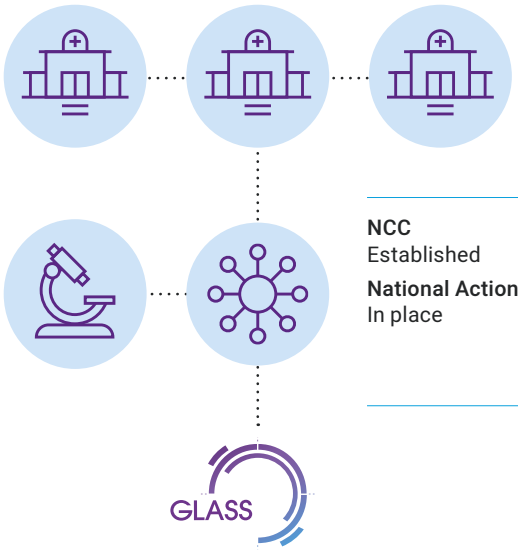
50 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST/CLSI

EQA
Provided

in 2019 data call
31 surveillance sites providing data to GLASS
(27 hospitals)
(4 outpatient facilities)



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	1
Year of most recent survey	2017
Type of survey	pretreatment HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2014
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Sri Lanka

Population 21.32 million

In 2017, the MOH, through the National Advisory Committee on AMR and with the support of WHO country office, established the National AMR Surveillance System for public as well as the private sectors. Each sector will develop their own surveillance system under One Health approach.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

17 surveillance sites participating to the national surveillance sytem

17 hospitals

0 outpatient facilities

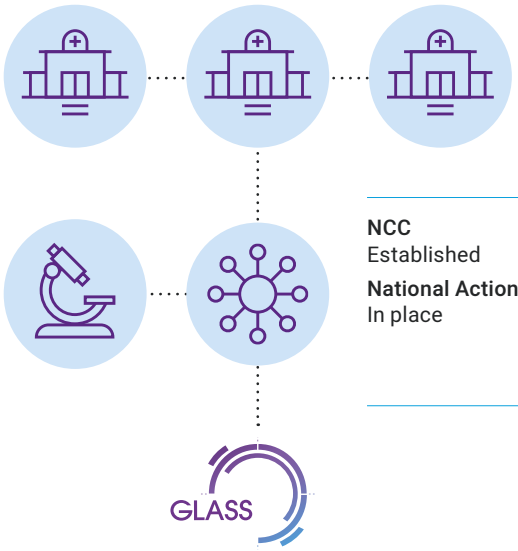
17 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Sudan

Population 42.81 million

NPHL (FMOH) is working with WHO-Sudan to develop and strengthen the AMR Surveillance structure. Data for 2018 were collected with WHO support from 4 hospitals in Khartoum, capital city of Sudan and one National Public Health Laboratory.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

24 surveillance sites participating to the national surveillance sytem

4 hospitals

20 outpatient facilities

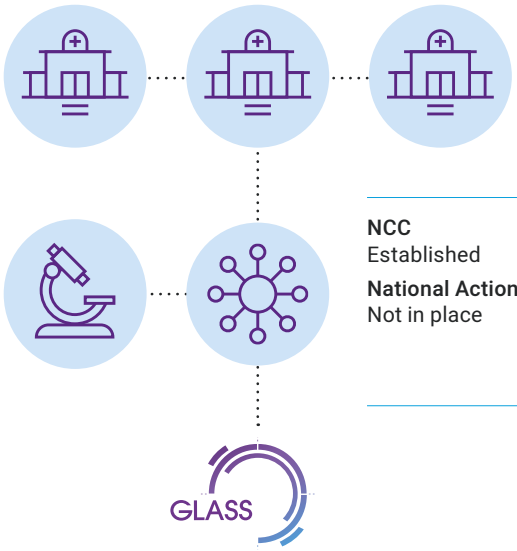
5 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
Not in place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2017
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	🟢	🟡	🟢	🔴	🔴
	E. coli	🟢	🟡	🟢	🟡	
	K. pneumoniae	🟢	🟡	🟢	🟡	
	Salmonella spp.	🟢	🟡	🟢	🔴	
	S. aureus	🟢	🟡	🟢	🟡	
	S. pneumoniae	🔴	🔴	🔴	🔴	
Stool	Salmonella spp.	🔴	🔴	🔴	🔴	🔴
	Shigella spp.	🔴	🔴	🔴	🔴	
Urine	E. coli	🟢	🟡	🟢	🟡	🔴
	K. pneumoniae	🟢	🟡	🟢	🟡	
Genital	N. gonorrhoeae	🔴	🔴	🔴	🔴	🔴

🟢 70-100% data reported 🟡 <70% data reported 🔴 No data reported

Sweden

Population 10.04 million

Sweden participates in EARS-Net since 1998. The Public Health Agency of Sweden and the National Veterinary Institute analyse and compile national data on antibiotic sales and resistance in an annual report, SWEDRES/SVARM. The Agency is coordinating four different systems: Res-Net, EARS-Net, SMI-Net and Svebar. National strategies on AMR were released in 2000, 2006 and 2016. In 2017 a new revised AMR NAP was developed.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

1229 surveillance sites participating to the national surveillance sytem

85 hospitals

1144 outpatient facilities

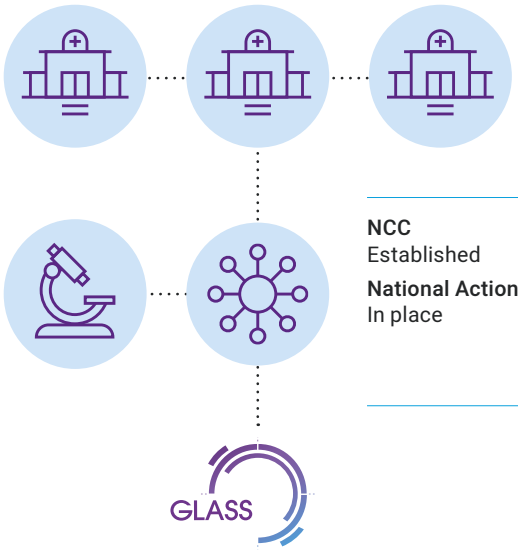
26 laboratories performing AST
EQA not provided

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
26 participating laboratories providing data to GLASS (26 laboratories)[a]



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	20

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

Switzerland

Population 8.59 million

Switzerland developed anresis.ch, a national surveillance system for AMR and AMC. It collects, and analyses AMR provided by a representative selection of 30 Swiss clinical microbiology laboratories. The collected data represent at least 80% of annual hospitalisation days and at least 30% of Swiss practitioners. The Swiss AMR Strategy (StAR) was adopted in 2015.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

30
laboratories participating to the national surveillance sytem[a]

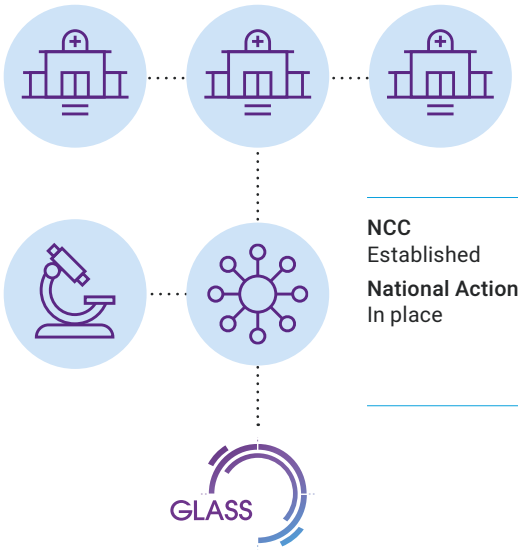
30 laboratories performing AST

NRL
Established

AST standard
EUCAST

EQA
Not reported

in 2019 data call
all national participating laboratories



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	19

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Syrian Arab Republic

Population 17.07 million

The country has selected 4 surveillance sites in Damascus, four hospitals and related microbiological laboratories.

Laboratory staff was trained to follow diagnostic protocol for AST and entering data in WHONET.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

4 surveillance sites participating to the national surveillance sytem

4 hospitals

0 outpatient facilities

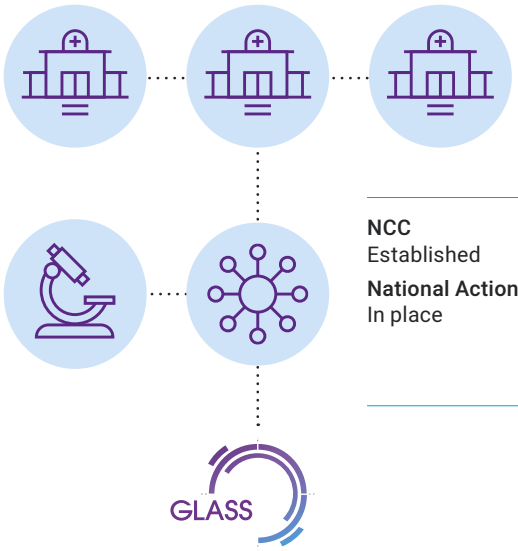
4 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Not provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2003
Number of data points (1995-2019)[2]	1

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Thailand

Population 69.63 million

At present, the National AMR surveillance system (NARST) consists of 97 sites. Data are collected quarterly and are analysed at national and regional level. This information is available on narst.dmsc.moph.go.th. To ensure quality of data, all sites receive National EQAs twice a year. All sites are required to submit unusual or suspected emerging AMR organisms to the NRL (NIH, MoPH), which send confirmation to the Bureau of Epidemiology for investigation.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

7 surveillance sites participating to the national surveillance sytem

6 hospitals

1 outpatient facilities

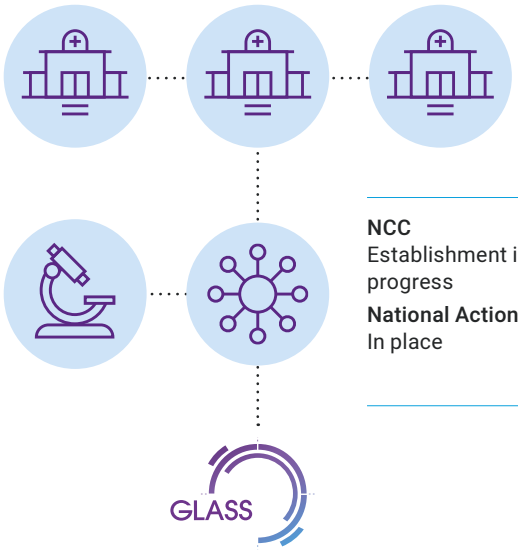
85 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	5

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Tunisia

Population 11.69 million

With the support of WHO EMRO office, the Tunisian project on AMR surveillance is progressing. The Tunisian NAP was recently approved and signed by the Minister of Health (25 June 2019). A NCC and a NRL have been proposed and their mission was defined, but their appointment is not yet official.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	✓
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

12 surveillance sites participating to the national surveillance sytem

12 hospitals

0 outpatient facilities

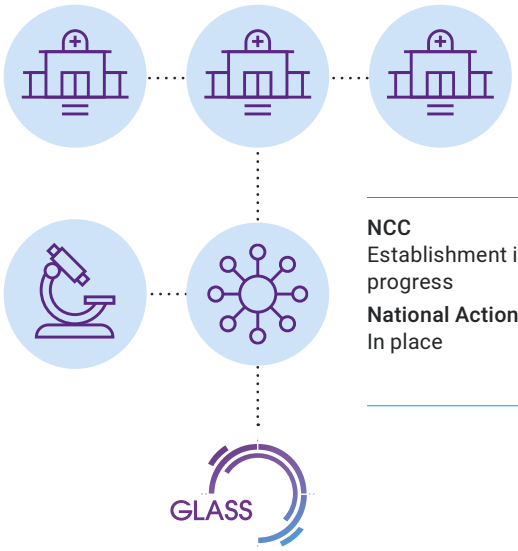
11 laboratory performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
EUCAST

EQA
Provided

in 2019 data call
11 surveillance sites providing data to GLASS (11 hospitals)



NCC
Establishment in progress

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	5

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	🟢	🟠	🟢	🟠	🔴
	E. coli	🟢	🟠	🟢	🟠	
	K. pneumoniae	🟢	🟠	🟢	🟠	
	Salmonella spp.	🟢	🟠	🟢	🟠	
	S. aureus	🟢	🟠	🟠	🟠	
	S. pneumoniae	🟢	🟠	🟠	🟠	
Stool	Salmonella spp.	🟢	🟠	🟠	🟠	🔴
	Shigella spp.	🟢	🟠	🟠	🟠	
Urine	E. coli	🔴	🔴	🔴	🔴	🔴
	K. pneumoniae	🟢	🟠	🟠	🟠	
Genital	N. gonorrhoeae	🟢	🟠	🟢	🟠	🔴

🟢 70-100% data reported 🟠 <70% data reported 🔴 No data reported

Uganda
Population 44.27 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

22 surveillance sites participating to the national surveillance sytem

6 hospitals

16 outpatient facilities

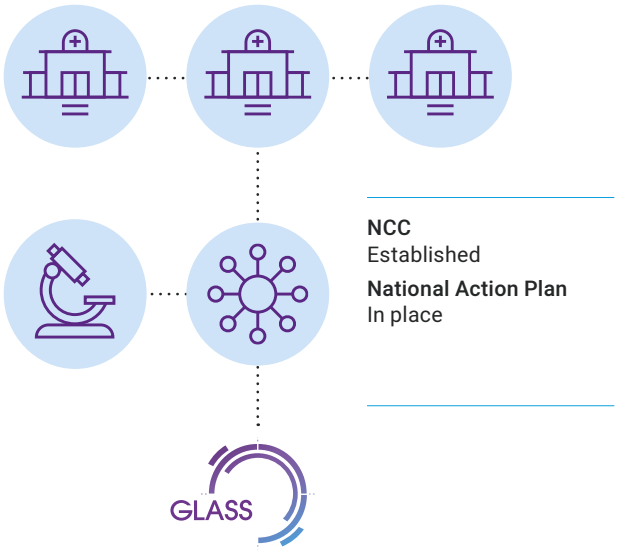
2 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
number of surevillance sites providing data to GLASS not reported



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance

Priority country for HIV: Tier[1]	1
Year of most recent survey	2017
Type of survey	acquired HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

United Arab Emirates

Population 9.77 million

The UAE has been conducting surveillance of AMR since 2010 when the Abu Dhabi Emirate - Antimicrobial Resistance Surveillance Program (AD ARS) was introduced; in 2015 it was expanded nationwide. The National Action Plan on AMR is under development. The UAE has been enrolled in GLASS since April 2017.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

191 surveillance sites participating to the national surveillance sytem

61 hospitals

130 outpatient facilities

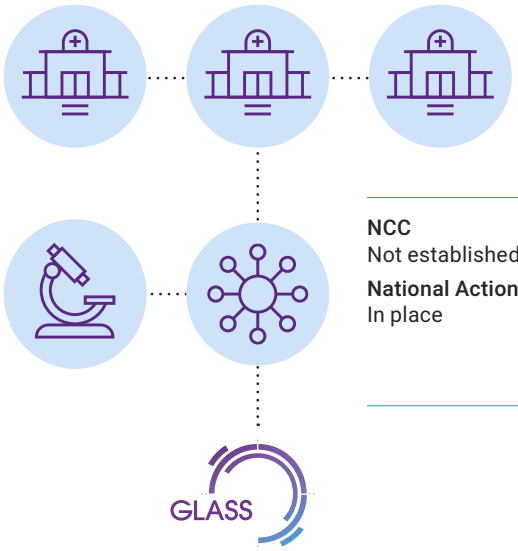
34 laboratory performing AST
EQA not provided

NRL
Not established

AST standard
CLSI

EQA
Not provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Not established

National Action Plan
In place

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

United Kingdom of Great Britain and Northern Ireland

Population 67.53 million

AMR surveillance is coordinated by Public Health England, Public Health Agency Northern Ireland, Health Protection Scotland and Public Health Wales. The UK has published a Five-Year National Action Plan (2019 to 2024) and a Twenty-Year Vision for AMR.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

159 laboratories participating to the national surveillance sytem[a]

107 laboratories for EARS-Net/blood specimens

149 laboratories for urine specimens

159 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

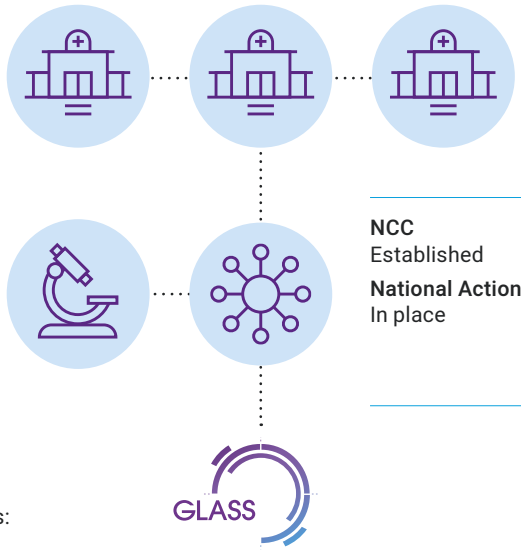
AST standard
EUCAST/CLSI

EQA
Provided

NCC
Established

National Action Plan
In place

in 2019 data call
All participating laboratories providing data to GLASS
(EARS-Net/blood specimens: 107 laboratories)
(Urine specimens: 149 laboratories)



Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	20

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

a The identification of the total number of surveillance sites submitting specimens to participating laboratories was not possible due to the set-up of the National surveillance system.

United Republic of Tanzania

Population 58.01 million

The country has started National AMR Surveillance in 2019, with participation of 6 laboratories including the National reference laboratory.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

Number of surveillance sites participating to the national surveillance sytem not reported

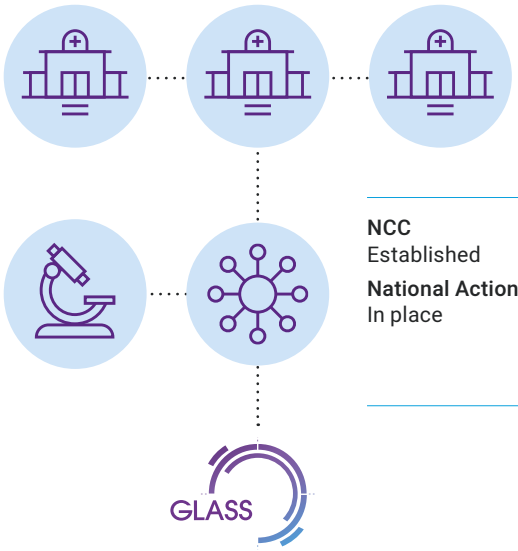
6 laboratories performing AST
EQA provided to some labs for bacterial identification and AST for some of GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance	
High burden country[1]	Yes
Source of data	Survey
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	2

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

United States of America

Population 329.06 million

AMR surveillance activities are coordinated by the Centers for Disease Control and Prevention (CDC) in conjunction with other federal, state and local public health agencies. Surveillance is directed by several national networks, including the National Healthcare Safety Network (NHSN), the Emerging Infections Program (EIP), the National AMR Monitoring System (NARMS), the National TB Surveillance System (NTSS), the AMR Laboratory Network (ARLN) and the Gonococcal Isolate Surveillance Project (GISP).

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	
DR TB[2]	✓
Malaria TES[3]	
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

44635 surveillance sites participating to the national surveillance sytem

4035 hospitals

40600 outpatient facilities

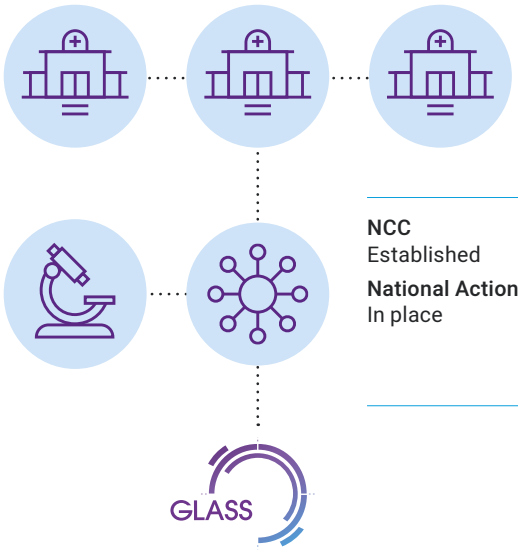
4035 laboratories performing AST
EQA provided to all labs for bacterial identification and AST for all GLASS pathogens

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
all national surveillance sites reported to GLASS



NCC
Established

National Action Plan
In place

Drug-resistant TB surveillance

High burden country[1]	No
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	26

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

AMR data submission to GLASS (2019 data call)

Specimen type	Pathogen	AST results	Age	Gender	Infection origin	Data on number of tested patient
Blood	Acinetobacter spp.	●	●	●	●	●
	E. coli	●	●	●	●	
	K. pneumoniae	●	●	●	●	
	Salmonella spp.	●	●	●	●	
	S. aureus	●	●	●	●	
	S. pneumoniae	●	●	●	●	
Stool	Salmonella spp.	●	●	●	●	●
	Shigella spp.	●	●	●	●	
Urine	E. coli	●	●	●	●	●
	K. pneumoniae	●	●	●	●	
Genital	N. gonorrhoeae	●	●	●	●	●

● 70-100% data reported ● <70% data reported ● No data reported

Zambia

Population 17.86 million

Currently, the country does not have an AMR surveillance system, but it is working towards its establishment. In 2017/2018, Zambia NCC conducted laboratory assessments for pathogen identification and AST in all country provinces. Three hospitals sites were identified and two are now able to generate data. In 2019, the NCC has begun to mentor three other sites in other regions.

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

6 surveillance sites participating to the national surveillance sytem

3 hospitals

3 outpatient facilities

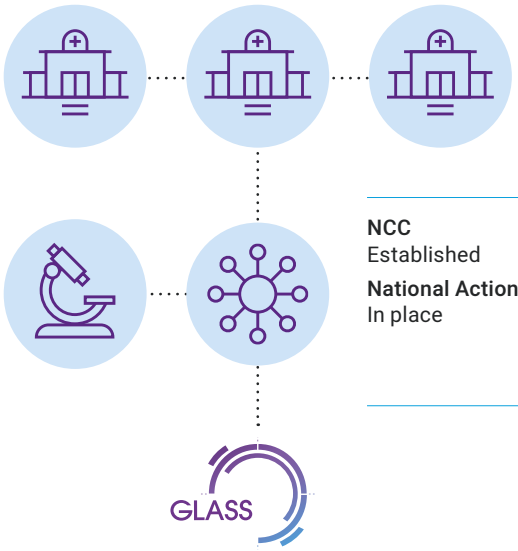
3 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance	
Priority country for HIV: Tier[1]	1
Year of most recent survey	2016
Type of survey	acquired HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance	
High burden country[1]	Yes
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019

Zimbabwe

Population 14.65 million

SURVEILLANCE ACTIVITIES	IMPLEMENTATION
GLASS-AMR	✓
GLASS-AMC	
HIV DR[1]	✓
DR TB[2]	✓
Malaria TES[3]	✓
Tricycle	
EGASP	

1. HIV Drug-Resistance
2. Drug-Resistant TB
3. Malaria Therapeutic Efficacy Studies

National AMR surveillance systems key indicators

Indicators reported to GLASS

2 surveillance sites participating to the national surveillance sytem

2 hospitals

0 outpatient facilities

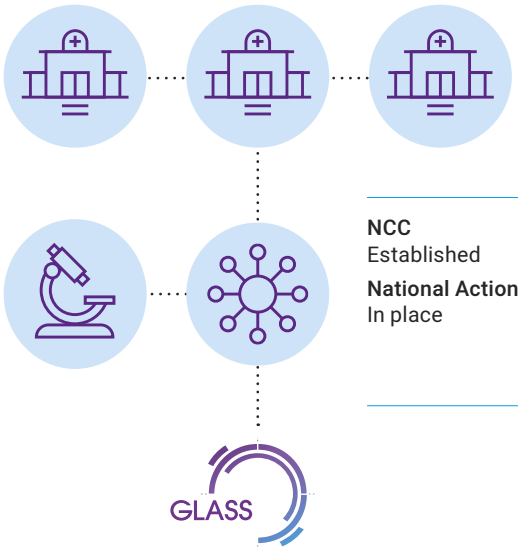
5 laboratories performing AST
EQA not provided

NRL
Established

AST standard
CLSI

EQA
Provided

in 2019 data call
No AMR data reported to GLASS



NCC
Established

National Action Plan
In place

HIV drug resistance surveillance	
Priority country for HIV: Tier[1]	1
Year of most recent survey	2015
Type of survey	pretreatment HIV drug resistance (adults)

1. Countries categorized in the Tier 1 (high priority country for HIV) are those comprising the 65% of global disease burden; countries categorized in the Tier 2 (medium priority country for HIV) contributes with an additional 15% of global disease burden.

Drug-resistant TB surveillance	
High burden country[1]	Yes
Source of data	Surveillance
Surevillance coverage	National
Year of most recent activity	2018
Number of data points (1995-2019)[2]	3

1. This indicates whether the country has been defined by WHO for the period of 2016-2020 as having a high burden of TB and/or multidrug-resistant TB (MDR-TB)
2. Number of years from which data are available between 1995 and 2019


SECTION
04

4. Global AMR surveillance in other pathogens and Regional activities

4.1 Global AMR surveillance in other pathogens

4.1.1 Surveillance of HIV drug resistance

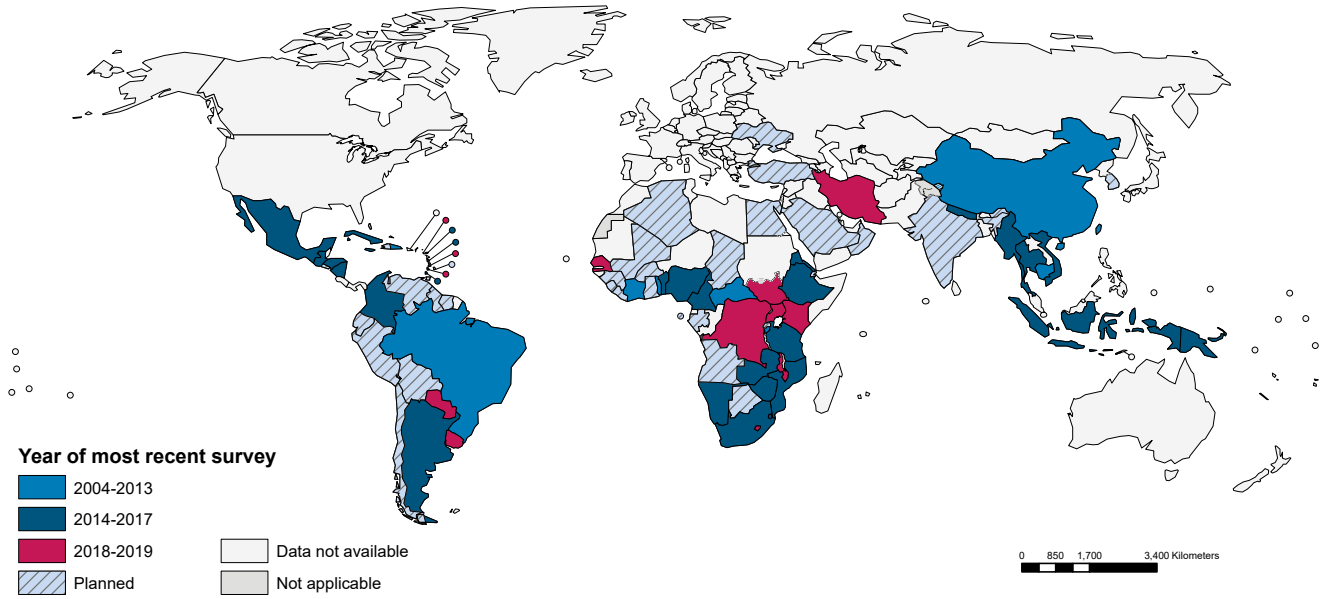
The emergence and transmission of some level of HIV drug resistance is inevitable, even when appropriate regimens are prescribed and adherence to treatment is optimal. To address this challenge, WHO issued in 2004 a global strategy for the surveillance and monitoring of resistance to these drugs, which was revised in 2015. The revised strategy is included in the Global Action Plan on HIV Drug Resistance 2017–2021 [27].

The strategy for surveillance and monitoring of resistance to HIV drugs recommends four activities:

- annual monitoring of indicators of resistance to HIV drugs associated with the quality of care in all antiretroviral therapy clinics in a country;
- surveillance of pre-treatment resistance to HIV drugs among adults initiating first-line antiretroviral therapy;
- surveillance of resistance to HIV drugs among children < 18 months with a new diagnosis of HIV infection; and
- surveillance of acquired resistance to HIV drugs in adults and children receiving treatment;

Surveillance data were received from sentinel clinics between 2004 and 2014; since 2014, nationally representative methods have been recommended and used. The data on resistance to HIV drugs are representative of entire populations of individuals with HIV who are initiating or receiving HIV treatment. Between 2004 and 2018, 49 countries conducted surveys of resistance to HIV drugs with the WHO-recommended standard methods, which allow comparison of data within and among countries over time. A further 35 countries plan to conduct surveys (Fig. 4.1).

Fig. 4.1. Surveys of resistance to HIV drugs conducted with WHO-recommended standard methods

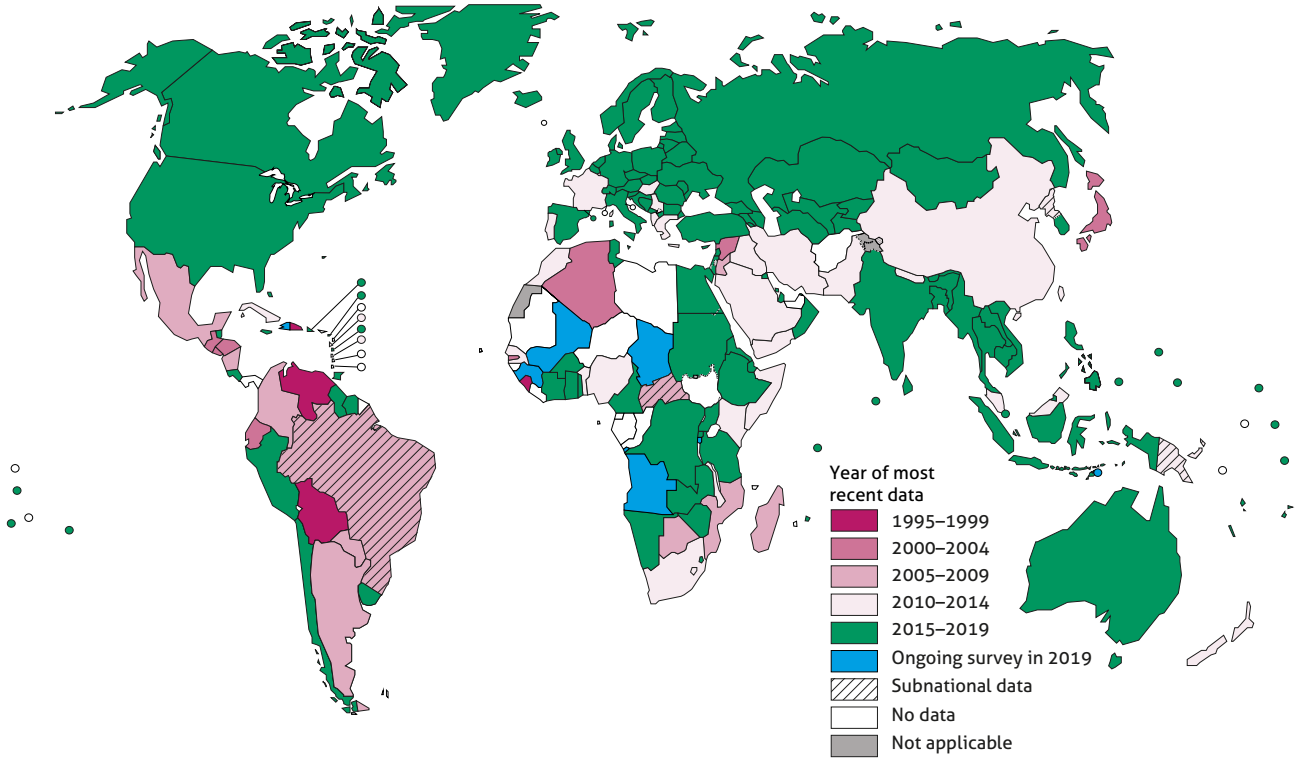


The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Information Evidence and Research (IER)
World Health Organization

Quality assurance and dissemination of data on resistance to HIV drugs are core WHO activities, and survey results have been used to inform policies and treatment guidelines at national and global levels. Data from surveillance of resistance to HIV drugs are entered and stored in a dedicated WHO database, for three main purposes: (1) for countries and genotyping laboratories in quality assurance of epidemiological and sequence data for high-quality country reports; (2) to ensure standardized interpretation of resistance by linkage to the most recent algorithm for interpreting these data; and (3) to provide a long-term, secure repository for data on resistance to HIV drugs [9]. A global network of WHO-designated laboratories for resistance to HIV drugs provides reliable, quality-assured genotypic data.

Fig. 4.2. Most recent year of data on rifampicin resistance among new cases, 1995 - 2019



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Data Source: World Health Organization
Map Production: Information Evidence and Research (IER)
World Health Organization

World Health Organization

4.1.2 Surveillance of resistance to tuberculosis drugs

The Global Project on Anti-TB Drug Resistance Surveillance, hosted by WHO, is the oldest and largest AMR surveillance project in the world. Since its launch in 1994, data on drug resistance among TB patients have been collected and analysed systematically from 164 countries, collectively accounting for more than 99% of the world's population and of TB patients (Fig 4.2).

The countries comprise 105 that have continuous surveillance systems based on routine testing of susceptibility to drugs in at least 80% of patients with bacteriologically confirmed TB and 59 countries that rely on periodic epidemiological surveys of nationally representative samples of TB patients. Of the 30 countries defined by WHO as having a high burden of TB in 2016–2020, 20 still rely on periodic surveys, and 3 have no data [9].

The Global Project is supported by various technical partners and the WHO Supranational Reference Laboratory Network for TB, which comprises 32 laboratories. The objective is to strengthen the capacity of national TB reference laboratories to diagnose TB and resistance to the medicines commonly used to treat TB. Standardized laboratory methods and survey design allow comparisons of data within and among countries over time. The advent of rapid molecular techniques has improved coverage of routine drug susceptibility testing in many countries. Furthermore, increasing integration of next-generation sequencing into surveillance overcomes limitations associated with conventional phenotypic testing and allows additional insights into molecular epidemiology [9].

The country territories and areas profiles include the following information:

- year, source (continuous surveillance or survey) and coverage (national or sub-national) from the most recent data available on the prevalence of resistance to rifampicin, one of the critical first-line medicines used to treat TB;
- number of data points available since 1995; and
- whether the country has been defined by WHO as having a high burden of TB and/or multidrug-resistant TB in the period 2016–2020.

4.1.3 Surveillance of antimalarial drug efficacy

Antimalarial drug resistance is a major public health problem and limits control of malaria. A summary of worldwide data on antimalarial drug efficacy and drug resistance is available on the website of the Global Malaria Programme (https://www.who.int/malaria/areas/drug_resistance/drug_efficacy_database/en/).

WHO has prepared protocols for assessing antimalarial drug resistance in all transmission areas and also for monitoring the efficacy of antimalarial medicines against *Plasmodium vivax* malaria. The protocols are designed to provide essential information for monitoring the therapeutic efficacy of a range of antimalarial drugs against uncomplicated falciparum malaria and to ensure a sufficient evidence base for use by ministries of health to establish informed treatment policies and guidelines. The use of a standardized protocol allows comparison of results in and among countries in the same region. Routine monitoring of the therapeutic efficacy of artemisinin-based combination therapy is essential for timely changes to treatment policy and can help to detect early changes in the sensitivity of *P. falciparum* to these drugs. WHO currently recommends monitoring of the efficacy of first- and second-line artemisinin-based combination therapy every 2 years at all sentinel sites and changing the antimalarial treatment policy when the treatment failure rate in a 28- or 42-day follow-up study (depending on the medicine) exceeds 10%. The proportion of patients who are parasitaemic on day 3 is currently the best indicator for use in routine monitoring of the sensitivity of *P. falciparum* to artemisinins. WHO has issued guidelines for the use of in-vitro tests, molecular analysis and measurement of drug concentrations to define and detect drug resistance in cases of treatment failure. Molecular markers are early signals of the emergence of resistance, can be used to confirm that treatment failures are due to resistance and can be useful for policy decision and change. The protocols and tools are available on the Global Malaria Programme website (https://www.who.int/malaria/areas/drug_resistance/efficacy-monitoring-tools/en/).

WHO has set up a global database to respond to the emergence of resistance to antimalarial drugs, which consists of published and unpublished studies of therapeutic efficacy and surveys of molecular markers of antimalarial drug resistance conducted by national partners. The database is the source for WHO's online "malaria threats" map, the *World malaria report* and updated on-line reports on antimalarial drug efficacy and drug resistance.

WHO has provided support in creating sub-regional networks for monitoring antimalarial resistance. The Mekong network; the Red Amazónica para la Vigilancia de la Resistencia a las Drogas Antimaláricas; the Pacific network; the Bangladesh, Bhutan, India, Nepal and Sri Lanka network; the Horn of Africa Network for Monitoring Antimalarial Treatment; and the Pakistan, Islamic Republic of Iran and Afghanistan monitoring network have increased surveillance of drug efficacy in their regions and provided the data for updating national treatment policies. Through these networks, WHO offers training in implementing protocols, microscopy, analysing and validating data and preparing reports and publications to improve the quality of the data.

4.1.4 Environmental surveillance of antimicrobial resistance

Environmental reservoirs such as wastewater discharges from communities, health facilities and antimicrobial manufacturing sites and their downstream water bodies are known to contribute to the emergence and spread of AMR. The global action plans on AMR of both WHO and FAO recommend development of techniques for environmental surveillance of AMR [28].

Since 2015, several new environmental surveillance approaches have been proposed and pilot-tested. GLASS is monitoring and assessing the usefulness of each approach with a view to including environment surveillance techniques in GLASS to complement established surveillance of AMU and of AMR in bacteria from humans and animals. Technical input was provided by the Dutch National Institute for Public Health and the Environment to the environmental component of the ESBL *E. coli* Tricycle project, with analysis of wastewater samples for a panel of antimicrobial residues in the first round. Levels of residues that are stable in the environment might be used to estimate antimicrobial use in a community if data on consumption are not available or are unreliable. Further work should be undertaken to define the most appropriate analysis, analytical methods and approaches for normalization and validation of results.

Aside from Tricycle, WHO is involved in other environment AMR surveillance initiatives. Metagenomic sequencing of wastewater (sewage) has been tested in 79 sites in 60 countries [29]. Although the technique is not pathogen-specific, it detects AMR in a wide range of community pathogens and could therefore complement microbiological testing of individual patients. The epidemiological and public health value of data on human sewage data should be defined before expanding the technique to the global level.

FAO, one of WHO's tripartite partners, and the International Atomic Energy Agency have jointly investigated use of the nuclear technique commonly known as "isotope fingerprinting" to complement conventional methods of environmental monitoring [30]. The approach can be used to trace and identify the sources and conditions of dissemination of antibiotics in water bodies due to agricultural runoff. The technique is suitable for local investigation rather than global surveillance.

4.2 Regional activities to promote AMR surveillance in common bacterial pathogens

4.2.1 African Region

The WHO Regional Office for Africa continues to support Member States in developing and implementing their national action plans with the One Health approach and strengthening partnerships with FAO, OIE and other partners for more coordinated, efficient AMR surveillance in the Region, which will facilitate integration into GLASS. The national action plans of 33 countries have been approved by national authorities. IHR joint external evaluations, which provide information on the status of surveillance of AMR, have been conducted in 46 of the 47 countries.

The Regional Office also encourages countries to enrol in GLASS as part of AMR activities. Five countries enrolled in GLASS by the end of 2019 (Chad, Côte d'Ivoire, Gabon, Ghana and United Republic of Tanzania) and one in February 2020 (Burundi). As of March 2020, 21 of the 47 countries in the Region had completed enrolment, and 49 laboratories in 28 countries are participating in WHO EQA for AST.

Support is being provided to countries. in developing a national surveillance system by strengthening national laboratory capacity and the workforce for surveillance of AMR. Since December 2017, specific support for the establishment of a national surveillance system has been provided in Mali, resulting in AMR surveillance operational at five surveillance sites and capacities built for the monitoring of antimicrobial use. The Tricycle Project is being promoted in the Region, with support provided to Ghana and Madagascar. Ghana was further supported with refresher training in the methods of the Tricycle protocol. Zambia and Zimbabwe received technical guidance and orientation on the Tricycle protocol for its inclusion in projects funded by the WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance. In February 2020, Zambia launched an integrated AMR surveillance framework, providing a mechanism for systematic, coordinated generation, collection and analysis of data on AMR.

The Regional Office has trained national professionals from 35 countries in monitoring AMU to support rational use of antimicrobials. In the annual self-assessment for the tripartite in 2018–2019, 19% of responding countries reported a national monitoring system for consumption and rational use of antimicrobials in human health, and 74% reported laws or regulations on the prescription and sale of antimicrobials for human use.

4.2.2 Region of the Americas

The WHO Regional Office for the Americas/Pan American Health Organization (AMRO/PAHO) supports AMR surveillance and containment in the Region in a special programme to encourage new and extend existing initiatives and platforms. The Regional Office works with countries and various partners in the Region to ensure standardized, good-quality laboratory and epidemiological surveillance data. The goal is to improve understanding of the effects of AMR in the Region for patient care, policies and interventions in order to combat AMR locally, nationally, regionally and globally. The Regional Office has therefore launched an initiative to enhance surveillance of AMR in isolates by extending the long-standing ReLAVRA network of 19 Caribbean and Latin American countries [12]. The new initiative will combine data on patients with those from laboratory and epidemiological surveillance.

The first phase of a protocol for enhanced surveillance of AMR in isolates, which will address bloodstream infections is to be implemented in 13 countries participating in early implementation (Argentina, Belize, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Mexico, Paraguay, Peru, Trinidad and Tobago and Uruguay). The protocol includes practical guidance and technical support for countries. As the level of national AMR surveillance varies by country, the protocol will include further strengthening of national AMR surveillance systems and also guidance in establishing AMR surveillance for those that do not yet have such a system.

The Regional Office and Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Guatemala, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuela have been involved in preparation of the GLASS early implementation protocol for inclusion of *Candida* spp. and are leading its implementation. For countries that use WHONET, a standard configuration for data collection integrates enhanced AMR surveillance and *Candida* spp. The AMR surveillance protocol ensures that countries use one standard configuration for both initiatives.

EQA is conducted in the Region by the "Latin American Quality Control Program for Bacteriology and AMR" in the National Institute of Infectious Diseases, Malbrán, Argentina. During 2019, NRLs in 20 countries (17 in Latin America and 3 in the Caribbean) participated in the EQA programme. EQA for mycology diagnosis was provided to the countries participating in GLASS-Fungi.

To ensure access and use of data on AMR collected by ReLAVRA, the Regional Office developed several dashboards, which provide regional maps and general trends in antibiotic susceptibility for selected combinations of priority pathogens and drugs for the period 2000–2016 [31].

4.2.3 Eastern Mediterranean Region

The WHO Regional Office for the Eastern Mediterranean continues to establish and improve national AMR surveillance systems and support to strategies to tackle AMR in the Region.

Several activities to increase laboratory capacity were conducted in 2019. National laboratory capacity for detection of AMR continues to be mapped, and technical assessment of AMR NRLs was undertaken in Bahrain, Egypt and the Islamic Republic of Iran. Technical support was provided to AMR NRLs in Jordan, Pakistan and Tunisia to increase their capacity to establish laboratory quality management systems according to international standards. A tool for assessing the capacity of NRLs for molecular detection and confirmation of emerging AMR, which was pilot-tested in Jordan and Tunisia.

Integrated global surveillance of ESBL-producing *E. coli* with the One Health approach (the Tricycle Project) was started in Pakistan in 2018, and a training workshop was held in January 2019 in Jordan to extend implementation of the protocol to Egypt, the Islamic Republic of Iran, Jordan, Morocco and Sudan. Implementation in those countries is at various levels.

National teams from Afghanistan, Egypt, the Islamic Republic of Iran, Jordan, Lebanon, Oman, Pakistan and Sudan were trained in the WHO method for collecting data on AMC. Subsequently, data submitted by the Islamic Republic of Iran, Jordan and Sudan were included in the global AMC report released in 2018. In 2019, national teams from Morocco and Tunisia were trained in the collection of national AMC data. The Tunisian AMC team collected data for 2014–2016 and will submit data for 2018–2019 on the GLASS AMC platform in 2020.

As of March 2020, 19 countries in the Region were enrolled in GLASS, and the Regional Office supported 15 (83%) of these countries in submitting data during the latest GLASS data call.

Capacity-building workshops were conducted on generation of good-quality, evidence-based AMR surveillance data, consisting of a workshop on GLASS and WHONET for GLASS-enrolled countries in Tunisia in January 2019; sub-regional training in establishing national AMR surveillance plans in Morocco in February 2019; training in laboratory quality management for GLASS-enrolled countries in February 2019; and training in the basics of bacteriological identification and AST for staff of the Central Public Health Laboratories in Afghanistan at Ras Al Khaimah University, United Arab Emirates, in September 2019.

4.2.4 European Region

Surveillance data on nosocomial infections, AMC and AMR have been collected for almost two decades in countries of the European Union and the European Economic Area through networks initially funded by the European Commission. The data collected in these networks have provided trends and signal priorities to policy-makers [32, 33].

When the European Strategic Action Plan was adopted in 2011, only a few countries within the European region, but not part of the EU/EEA systematically collected and shared data on AMC and AMR. Therefore, the WHO Regional Office for Europe, together partners institutions[6], established the AMC network for monitoring antimicrobials consumption and the CAESAR network for surveillance of antimicrobial resistance to assist these countries and areas in the European Region in setting up or strengthening surveillance systems.

Since its establishment in 2011, the 19-member countries and areas of the AMC Network have been collecting AMC data annually. The Regional Office supports the Network by building capacity for data collection, analysis, dissemination of findings and a further intervention to improve use of antibiotics in practice. The second report of the AMC Network included an analysis of AMC data for 2011–2017 in 16 of the participating countries and areas for measuring antibacterial consumption [34]. The annual meeting of the AMC Network in 2019 focussed on topics around antibiotic use in primary care and methods for measuring use and consumption in the community.

The CAESAR Network, established in 2012, provides technical assistance to improve the quality of laboratory test results and the collection, management, analysis and reporting of data on resistance. Currently, 19 countries and areas are engaged in the network, of which 11 submit AMR surveillance data (Armenia, Belarus, Bosnia and Herzegovina, Georgia, Montenegro, North Macedonia, the Russian Federation, Serbia, Switzerland, Turkey and Ukraine and Kosovo[7]). Annual meetings have been organized since 2013 in conjunction with the European Congress of Clinical Microbiology and Infectious Diseases, except in 2018, when ECDC and the WHO Regional Office for Europe organized the first joint meeting of networks for AMR, AMC and healthcare associated infections (HAI), which was attended by about 300 delegates from 47 European Member States. CAESAR member countries are supported in organizing national meetings to strengthen their surveillance networks and discuss their data, the results of annual CAESAR EQAs and priorities for further technical support.

Currently, 25 countries and areas in the European Region are enrolled in GLASS. The Regional Office will support the extension of the enrolment in GLASS to more countries and areas in the European region. In addition, the Regional Office will consider carrying out ad hoc interventions in those countries that do not have yet a national AMR surveillance network. In particular, the implementation of "proof-of-principle" projects for introducing the systematic use of antibiotic susceptibility testing, by stimulating the utilization of blood culture diagnostics, has generated encouraging results. So far, two of these projects have been successfully completed – in Georgia in 2016 and in Armenia in 2018 – and other two are currently ongoing – in Tajikistan and Uzbekistan.

6 Most notably, for AMC, the University of Antwerp, Belgium; and for CAESAR, the Dutch National Institute for Public Health and the Environment and the European Society of Clinical Microbiology and Infectious Diseases

7 All references to Kosovo in this document should be understood to be in the context of the United Nations Security Council resolution 1244 (1999).

4.2.5 South-East Asia Region

The Regional Office for South-East Asia conducted a situation analysis in 2016 as a first step in AMR prevention and containment in the Region. In 2018, two meetings were held in Bangkok, Thailand, to assess progress and identify gaps and challenges in implementation of national action plans and to make actionable recommendations. The analysis of AMR prevention and containment programmes focussed on seven areas: national action plans aligned with the Global Action Plan on governance of AMR; awareness-raising; national AMR surveillance systems; rational use of antimicrobials and surveillance of use and sales; infection prevention and control and AMR stewardship; research and innovation; and engagement in One Health. An eighth focus area of overarching coordination mechanisms for One Health was added. Progress in 30 indicators for the eight focus areas was assessed as a proxy for strategic interventions or programmes, and 10 additional indicators were introduced. The situational analysis in 2018 revealed significant progress in identifying focus areas and indicators in national action plans of Member States in the preceding 2 years.

In 2019 a Regional Office taskforce on AMR has been formed, consisting of 12 experts, to make observations and recommendations for strengthening surveillance and translating surveillance data into policy and practice.

All 11 Member States in the Region participate in GLASS. Regional EQA is conducted in NRLs and in 50% of surveillance sites in Maldives and 100% of those in Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Sri Lanka and Thailand. Results on the antibiotic susceptibility of > 100 isolates were provided by six countries: Indonesia, India, Maldives, Myanmar, Sri Lanka and Thailand.

Technical support is provided for pilot-testing the Tricycle project in India, Indonesia and Nepal, with training and inception workshops conducted in October and November 2018 in Nepal.

The Ministry of Health of Indonesia organized a training course on GLASS concepts and methods on 26–29 March 2019 in Surabaya, with facilitators from WHO headquarters, the Regional Office, the WHO Country Office and the WHO collaborating centres at the Public Health Agency of Sweden and at Hong Kong University. Training was preceded by a workshop for multi-sector stakeholders in AMR, including the ministries of Agriculture, Environment and Forestry and Marine and Fishery, the National Agency on Drugs and Food Control, the Ministry of Research Technology and Higher Education, hospitals and regional laboratories, WHO and FAO. Each sector described progress in implementing national AMR surveillance, and WHO and FAO reported on regional and global AMR surveillance and steps taken for integrated AMR surveillance among sectors. The aim of the training was to support hospitals, NRLs and national coordinating centres in applying the main concepts of GLASS and in developing national AMR surveillance systems, including steps in establishing them and in applying the methods taught to generate, validate and upload aggregated AMR data files to the GLASS IT platform.

4.2.6 Western Pacific Region

Countries in the Region have progressed in work on AMR at varying speeds over the past two decades. The Action Agenda for Antimicrobial Resistance in the Western Pacific Region, approved in 2015, provides guidance on priorities, including development and strengthening of implementation of national plans and raising awareness in various sectors, improving surveillance of AMR, monitoring AMU and strengthening health system capacity to contain AMR. Its approval triggered commitment and action globally and in the Region.

In 2019, a vision For the Future: Towards the Healthiest and Safest Region was adopted by Member States to guide the work of WHO in the Region in the coming years. Member States also endorsed the Framework for Accelerating Action to Fight Antimicrobial Resistance in the Western Pacific Region, which sets out new ways of slowing the emergence and spread of AMR and addressing its impact on health and economies in the Region. It provides sustained, forward-looking solutions with the participation of all sectors of society.

Between 2018 and 2019, Australia, Japan, Malaysia, New Zealand, the Philippines, the Republic of Korea and Singapore strengthened or established AMR surveillance systems, and several countries participated in specialized surveillance efforts. The Philippines is one of two countries in which the GLASS-EGASP method was pilot-tested, while Malaysia is participating in the Tricycle project. Several countries provide surveillance data on *N. gonorrhoeae*.

The Regional Office has provided training and support in adopting the WHO method for monitoring AMC to Brunei Darussalam, Cambodia, the Lao People's Democratic Republic, Mongolia, the Philippines and Viet Nam. Seven countries – Australia, Brunei Darussalam, Japan, Mongolia, New Zealand, the Philippines and the Republic of Korea – submitted data for global monitoring of AMC in 2018, and, in line with the new regional framework, the Regional Office is establishing an AMC surveillance system to monitor AMC and AMU throughout the Region, thereby increasing multi-stakeholder accountability, strengthening stewardship of antimicrobials and improving health outcomes. The system will capture and synthesize information on AMC and AMU in all sectors and countries. In 2019, 12 countries, areas and territories in the Region agreed to participate in the system.

As of March 2020, nine counties have enrolled in GLASS. The Regional Office will continue to provide technical support to Member States in establishing or strengthening national AMR surveillance by issuing simple step-by-step guidance on ensuring the core capacity of a national AMR surveillance system, particularly in lower–middle-income countries, and by establishing an informal regional expert consultation group on AMR surveillance. The Regional Office will also support AMR surveillance by establishing a network of AMR reference laboratories and formalizing a regional network of institutions to support capacity-building on AMR and provide broader support for health systems, including stewardship, AMC monitoring and Infection Prevention and Control).


SECTION
05

5. Conclusion

While still in its early implementation phase, GLASS already provides the largest source of information of AMR in common infections in both the community and in hospitals. This third GLASS report presents the frequency of AMR in 2,164,568 patients with laboratory-confirmed infections in 66 countries, territories and areas (Table 2.1) in 2018. The majority of the infections reported were urinary tract infections (79%), followed by bloodstream infections (20%).

High rates of resistance among antimicrobials frequently used to treat common bacterial infections have been observed. The rate of resistance to ciprofloxacin, an antimicrobial medicine commonly used to treat urinary tract infections, varied from 8.4% to 92.9% for *E. coli* and from 4.1% to 79.4% for *K. pneumoniae* in 33 and 34 reporting countries, territories and areas, respectively, after application of GLASS cut-off values[8].

The new AMR indicators in the Sustainable Development Goal monitoring framework, the frequency of bloodstream infections due to methicillin-resistant *S. aureus* and *E. coli* resistant to third-generation cephalosporins, were reported by 25 and 49 countries, territories and areas, respectively. While the data are still not nationally representative, the median rate observed for methicillin-resistant *S. aureus* was 12.11% (IQR 6.4–26.4) and that for *E. coli* resistant to third-generation cephalosporins was 36.0% (IQR 15.2–63.0).

The range of frequency of infections due to resistant strains of bacteria varied widely among countries, territories and areas, with higher rates in 8 low-income and 15 lower–middle-income countries than in 13 upper–middle-income and 29 high-income countries. The differences may reflect selection bias, fewer surveillance sites and fewer patients enrolled in national surveillance systems and other limitations (see Annex 1, section A.1). Nevertheless, the high rates of AMR should be investigated further to guide actions in each country.

The report summarizes implementation of the core components of AMR surveillance and shows that the progress is remarkable, particularly in low- and lower–middle-income countries, clearly demonstrating political will to monitor and tackle AMR. Although some countries, territories and areas still face major challenges in building national surveillance systems, and improvements are urgently needed, participation in GLASS and the amount of information generated by the system have increased substantially.

Countries, territories and areas have welcomed the shift in approaches to surveillance promoted by GLASS, from those based solely on laboratory data on isolates to systems that include epidemiological, clinical and population-level data. An increasing number of countries, territories and areas provided more complete data. In this third data call, 28 out of 66 (42%) countries, territories and areas submitted not only information on pathogen-specific sites of infection, the age and gender of tested patients and the origin of infection, but also data on the number of sampled patients for each type of infection, allowing for calculating the frequency of AMR in tested populations.

GLASS is evolving continuously. New technical documents and IT tools have been developed to facilitate AMR and AMC surveillance and data management, analysis and sharing. New modules have been developed, such as for AMC surveillance, focussed surveillance (e.g. emerging AMR in *Candida* spp. and *N. gonorrhoeae*) and surveys (e.g. One Health AMR, point prevalence survey, mortality attributable to AMR).

Some emerging AMR events may represent significant international public health risks. GLASS-EAR allows timely detection, reporting, risk assessment and monitoring of emerging resistance and provides support with new tools and capacity-building. Newly detected AMR includes phenotypes that have not previously been reported or are very rare and novel genotypes associated with mechanisms of resistance that could have a high public health impact (i.e. high potential for spread and effects on health) or pose serious challenges for laboratory detection and surveillance.

TB, HIV and malaria programmes have been working for many years to address the challenge of AMR by supporting national and global surveillance networks, strengthening laboratory networks, optimizing diagnostic testing and treatment, raising awareness of the dangers of AMR and working with stakeholders

8 AMR data for < 10 patients and for pathogen–antibiotic combinations for which there are < 10 AST results and/or > 30% unknown results are not included in the analysis

to innovate products and service delivery [9]. The lessons learnt and experience of good practices in preventing and managing AMR in these programmes have inspired GLASS development and can be adapted and used to strengthen surveillance in other settings and coordinated action to tackle AMR broadly.

5.1 The way forward

While GLASS has made notable achievements in promoting national AMR surveillance systems and sharing data according to global standards, the limitations and gaps of systems must be identified and addressed. Technical limitations are summarized in detail in Annex 1 and in previous GLASS reports [35, 36]. Lessons from the early implementation phase of GLASS (2015–2019) are being used to identify methods to ensure better quality, robustness and representativeness of the data collected and the results.

There is still wide variation in the types of data submitted and their completeness and representativeness. The flexibility built into GLASS allows data to be collected from countries, territories and areas with surveillance system at different stages of development; however, the results must be interpreted carefully. Improvements are required to ensure more accurate assessment of the threat and drivers of AMR globally.

Advocacy and communication are essential to engage and support countries, territories and areas, as is collaboration with partners in AMR surveillance and capacity-building. GLASS benefits from the expertise of the GLASS AMR Collaborative Platform, which comprises the WHO AMR Surveillance and Quality Assessment Collaborating Centres Network and partner technical institutions [15]. These groups collaborate in further development of AMR surveillance systems.

The regional AMR surveillance networks play a key role in promoting peer support for capacity building, identification of ways to overcome difficulties, and represent an important pillar for advancing AMR surveillance globally. GLASS will continue to liaise with and learn from the regional networks experience for further development of the global system.

A central feature of GLASS continues to be the full ownership of data by countries, territories and areas and their active participation in ensuring development of national AMR surveillance systems to meet national public health needs. Several features of GLASS, including the method for data collection and reporting, will be presented at the third High-level Technical Consultation and Meeting on Surveillance of Antimicrobial Resistance and Use for Concerted Actions co-sponsored by Sweden and Republic of Korea. Representatives from countries, territories and areas enrolled in GLASS will be invited to discuss technical issues and advise the next steps in GLASS development.

GLASS has become an essential system for monitoring global trends in AMR and for identifying drivers of AMR. WHO seeks the consolidation of this system to improve the knowledge and evidence base to inform effective, sustainable control strategies to tackle the AMR threat.

REFERENCES

References

1. **WHO report on surveillance of antibiotic consumption:2016-2018 early implementation.** [http://www.who.int/medicines/areas/rational_use/who-amr-amc-report-20181109.pdf?ua=1]
2. O'Neill J: **Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations.** In: *Review on Antimicrobial Resistance.* UK Government and Wellcome Trust; 2014.
3. Naylor NR, Atun R, Zhu N, Kulasabanathan K, Silva S, Chatterjee A, Knight GM, Robotham JV: **Estimating the burden of antimicrobial resistance: a systematic literature review.** *Antimicrob Resist Infect Control* 2018, 7:58.
4. **Antimicrobial resistance factsheet** [http://www.who.int/mediacentre/factsheets/fs194/en/]
5. WHO: **Global Action Plan on Antimicrobial Resistance.** In.; 2015. https://apps.who.int/iris/bitstream/handle/10665/193736/9789241509763_eng.pdf?sequence=1
6. **Thirteenth General Programme of Work, 2019–2023** [https://apps.who.int/iris/bitstream/handle/10665/324775/WHO-PRP-18.1-eng.pdf]
7. **Report of Secretary General** [https://undocs.org/en/A/73/869]
8. **MONITORING AND EVALUATION OF THE GLOBAL ACTION PLAN ON ANTIMICROBIAL RESISTANCE Framework and recommended indicators** [https://apps.who.int/iris/bitstream/handle/10665/325006/9789241515665-eng.pdf?ua=1]
9. **Tuberculosis, HIV, malaria and neglected tropical diseases. Strengthening collaboration to prevent and manage antimicrobial resistance** [https://apps.who.int/iris/bitstream/handle/10665/311689/9789241515450-eng.pdf?ua=1]
10. **Centre for Disease Prevention and Control European Antimicrobial Resistance Surveillance Network (EARS-Net)** [https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/ears-net]
11. **Central Asian and Eastern European Surveillance of Antimicrobial Resistance (CAESAR)** [http://www.euro.who.int/en/health-topics/disease-prevention/antimicrobial-resistance/about-amr/central-asian-and-eastern-european-surveillance-of-antimicrobial-resistance-caesar]
12. **ReLavra: Rede Latinoamericana de Vigilancia de la Resistencia a los Antimicrobianos** [https://www.paho.org/hq/index.php?option=com_content&view=article&id=13682:relavra-home&Itemid=42427[=en]
13. World Health Assembly: **Resolution WHA68.7 Antimicrobial Resistance.** In.; 2015. https://apps.who.int/gb/ebwha/pdf_files/WHA68-REC1/A68_R1_REC1-en.pdf
14. **GLASS Manual for Early Implementation** [http://apps.who.int/iris/bitstream/10665/188783/1/9789241549400_eng.pdf]
15. **WHO AMR Surveillance and Quality Assessment Collaborating Centres Network** [https://www.who.int/glass/collaborating-centres-network/en/]
16. **GLASS-EAR: Guide for emerging AMR event sharing** [https://apps.who.int/iris/bitstream/handle/10665/274957/9789241514583-eng.pdf?ua=1]
17. **GLASS Early implementation protocol for inclusion of *Candida* spp.** [https://apps.who.int/iris/bitstream/handle/10665/326926/WHO-WSI-AMR-2019.4-eng.pdf?ua=1]
18. Webb BJ, Ferraro JP, Rea S, Kaufusi S, Goodman BE, Spalding J: **Epidemiology and Clinical Features of Invasive Fungal Infection in a US Health Care Network.** *Open Forum Infect Dis* 2018, 5(8):ofy187.
19. Sarma S, Upadhyay S: **Current perspective on emergence, diagnosis and drug resistance in.** *Infect Drug Resist* 2017, **10:**155-165.
20. Weston E SM, Lertpruek S ,: **The enhanced gonococcal antimicrobial surveillance program (EGASP) in thailand, 2015–2016.** *Sex Transm Infect* 2017(93):A116-A117.
21. AMR Control: **The ESBL tricycle AMR surveillance project: a simple, one health approach to global surveillance.** In.; 2017. http://resistancecontrol.info/2017/the-esbl-tricycle-amr-surveillance-project-a-simple-one-health-approach-to-global-surveillance/
22. **World Bank Country and Lending Groups** [https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups]
23. EUCAST: **EUCAST guidelines for detection of resistance mechanisms and specific resistances of clinical and/or epidemiological importance.** In.; 2013.
24. CLSI: **M100 Performance Standards for Antimicrobial Susceptibility Testing.** In., 27th edn; 2017.
25. **World Population Prospects: The 2019 Revision** [https://population.un.org/wpp/]
26. **Global action plan on HIV drug resistance 2017–2021** [https://apps.who.int/iris/bitstream/handle/10665/44863/9789241503501_eng.pdf?sequence=1]
27. **The FAO Action Plan on Antimicrobial Resistance 2016-2020** [http://www.fao.org/3/a-i5996e.pdf]
28. Aarestrup FM, Woolhouse MEJ: **Using sewage for surveillance of antimicrobial resistance.** *Science* 2020, **367**(6478):630-632.
29. **Antimicrobial movement from agricultural areas to the environment: The missing link. A role for nuclear techniques** [http://www.fao.org/3/ca5386en/CA5386EN.pdf]
30. AMR/PAHO W: **ReLAVRA Data Visualization Dashboards.** In.; 2019.
31. AMR/PAHO W: **ReLAVRA Data Visualization Dashboards**. In.; 2019. https://www.paho.org/hq/index.php?option=com_content&view=article&id=15341:relavra-visualization-1&Itemid=40388&lang=en
32. **Antimicrobial consumption in the EU/EEA** [https://www.ecdc.europa.eu/sites/default/files/documents/Antimicrobial-consumption-EU-EEA.pdf]

33. **Antimicrobial Medicines Consumption (AMC) Network** [file:///C:/Users/tornimbeneb/Downloads/9789289054744-eng.pdf]
34. **Global Antimicrobial Resistance Surveillance System (GLASS) Report: early implementation 2016-2017** [http://www.who.int/glass/resources/publications/early-implementation-report/en/]
35. WHO: **Global Antimicrobial Resistance Surveillance System (GLASS) Report: early implementation 2017-2018.** In.; 2019.
36. Public Health Agency of Sweden: **Surveillance of Antimicrobial Resistance for Local and Global Action.** In.; 2014.
37. Hindler JF, Stelling J: **Analysis and presentation of cumulative antibiograms: a new consensus guideline from the Clinical and Laboratory Standards Institute.** *Clin Infect Dis* 2007, 44(6):867-873.
38. Heginbothom ML, Magee JT, Bell JL, Dunstan FD, Howard AJ, Hillier SL, Palmer SR, Mason BW, Group WAS: **Laboratory testing policies and their effects on routine surveillance of community antimicrobial resistance.** *J Antimicrob Chemother* 2004, 53(6):1010-1017.
39. Public Heath England: **English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) Report.** In.; 2017.

ANNEXES

Annex 1. Readers' guide to GLASS-AMR results

GLASS collects information on the status of national AMR surveillance systems from the answers to a short questionnaire sent annually to AMR national focal points. The questionnaire addresses overall coordination, the surveillance system and quality control [37], with a set of indicators (Table A.1) to measure development and strengthening of national AMR surveillance. The indicators allow basic understanding of the structure of the surveillance systems that collect the AMR results reported to GLASS and help in identifying both the strengths and capacity of enrolled countries, territories and areas and any challenges and limitations for making representative estimates of AMR.

Table A.1 GLASS indicators of national surveillance

AREA	INDICATOR	OUTCOME
Coordination	Existence of a plan for a functioning national AMR surveillance	Exists, with budget/Exists without budget/Does not exist/Unknown
	Establishment of a national coordinating centre	Established/Not established/ Unknown
	Nomination of an NRL	Established/Not established/ Unknown
Surveillance system	Total number of AMR surveillance sites (hospital and outpatient facilities) that send data to GLASS	Numerical
	Number of local clinical laboratories that perform AST and send data to GLASS	Numerical
Quality assessment	EQA provided for NRL	Provided/Not provided/Unknown
	Type of AST standards followed by countries, territories and areas	CLSI, EUCAST, other
	EQA provided to local laboratories that perform AST for national AMR surveillance sites	To all laboratories/Some laboratories/ Not provided/ Unknown

CLSI, Clinical and Laboratory Standards Institute; EUCAST, European Committee on Antimicrobial Susceptibility Testing

Indicators of the implementation of surveillance indicators are summarized for each country, by WHO region, in section 2.2.2, and national results are presented as infographics in the country profiles. The indicators are monitored annually to assess countries, territories and areas' progress.

AMR data for eight pathogens that cause common infections in humans are collected through a case-finding surveillance system, which collates results from susceptibility testing of specimens from blood, urine, stool, as well as cervical and urethral specimens, that have been sent routinely to diagnostic laboratories for clinical purposes [14]. The list of pathogen-antimicrobial combinations under GLASS surveillance are shown in Table A.2. The population from which AMR data are collected is the population of patients seeking care in healthcare facilities (HCFs).

Table A.2 Pathogen-antimicrobial combinations under GLASS surveillance

PATHOGEN	ANTIBACTERIAL CLASS	ANTIBACTERIAL AGENTS THAT MAY BE USED FOR AST[a,b]
Escherichia coli	Sulfonamides and trimethoprim	Co-trimoxazole
	Fluoroquinolones	Ciprofloxacin or levofloxacin
	Third-generation cephalosporins	Ceftriaxone, cefotaxime, or ceftazidime
	Fourth-generation cephalosporins	Cefepime
	Carbapenems[c]	Imipenem, meropenem, ertapenem, or doripenem
	Polymyxins	Colistin
	Penicillins	Ampicillin
Klebsiella pneumoniae	Sulfonamides and trimethoprim	Co-trimoxazole
	Fluoroquinolones	Ciprofloxacin or levofloxacin
	Third-generation cephalosporins	Ceftriaxone, cefotaxime, or ceftazidime
	Fourth-generation cephalosporins	Cefepime
	Carbapenems[c]	Imipenem, meropenem, ertapenem, or doripenem
	Polymyxins	Colistin
Acinetobacter spp.	Tetracyclines	Tigecycline or minocycline
	Aminoglycosides	Gentamicin and amikacin
	Carbapenems[c]	Imipenem, meropenem, or doripenem
	Polymyxins	Colistin
Staphylococcus aureus	Penicillinase-stable beta-lactams	Cefoxitin[d]
	Penicillins	Oxacillin
Streptococcus pneumoniae	Penicillins	Oxacillin[e]
	Penicillins	Penicillin G
	Sulfonamides and trimethoprim	Co-trimoxazole
	Third-generation cephalosporins	Ceftriaxone or cefotaxime
Salmonella spp.	Fluoroquinolones	Ciprofloxacin or levofloxacin
	Third-generation cephalosporins	Ceftriaxone, cefotaxime or ceftazidime
	Carbapenems[c]	Imipenem, meropenem, ertapenem, or doripenem
Shigella spp.	Fluoroquinolones	Ciprofloxacin or levofloxacin
	Third-generation cephalosporins	Ceftriaxone, cefotaxime, or ceftazidime
	Macrolides	Azithromycin
Neisseria gonorrhoeae	Third-generation cephalosporins	Cefixime
	Third-generation cephalosporins	Ceftriaxone
	Macrolides	Azithromycin
	Aminocyclitols	Spectinomycin
	Fluoroquinolones	Ciprofloxacin
	Aminoglycosides	Gentamicin

a The listed substances are priorities for surveillance of resistance in each pathogen, although they may not be first-line options for treatment. One or more of the drugs listed may be tested.

b One or more of the drugs listed may be tested in countries. R, I, S and nominator and denominator data for each shall be reported separately.

c Imipenem or meropenem is preferred to represent the group when available.

d Cefoxitin is a surrogate for testing susceptibility to oxacillin (methicillin, nafcillin); the AST report to clinicians should state susceptibility or resistance to oxacillin.

e Oxacillin is a surrogate for testing reduced susceptibility or resistance to penicillin; the AST report to clinicians should state reduced susceptibility or resistance to penicillin.

GLASS is based on the rationale that the growth of a pathogen in selected specimens is a proxy of infection in the associated anatomical sites (bloodstream, urinary tract, gastro-enteric, genital). Reliable data should represent a single episode of illness in a patient. For microbiological data, only the first positive culture from a patient is reported for each disease episode for surveillance purposes, even if several positive cultures are obtained or resistance emerges during treatment. Therefore, after removal of duplicates and on the assumption that routine microbiological testing is done systematically, the number of isolates for which laboratory AST results can be used represents the number of patients infected with targeted susceptible or resistant bacteria at a specific anatomical site [35]. GLASS uses this information to generate the proportions of infected patients with growth of non-susceptible strains for each specimen type, pathogen and antibiotic under surveillance.

Countries, territories and areas are asked to report epidemiological variables such as age, gender and origin of infection for tested patients. The origin of infection is used as a proxy of where the infection was contracted (hospital or community) [35]. Population data are also collected for all samples taken for microbiological testing, GLASS records the numbers of patients with positive and negative samples (no microbial growth), which is used as a denominator to generate two additional metrics for each specimen type, pathogen and antibiotic under surveillance in the population of tested patients: frequency of infection and frequency of infection due to non-susceptible strains [35].

GLASS receives submissions of AMR rates not only directly but also through CAESAR and EARS-Net, which are established, official AMR surveillance networks. Both networks collect information on AMR rates in blood specimens for *Acinetobacter* spp., *K. pneumoniae, E. coli, S. aureus and S. pneumoniae*. In order to avoid duplication of data submitted, the countries, territories and areas participating in these networks and enrolled in GLASS may authorize the ECDC for EARS-Net or the WHO Regional Office for Europe for CAESAR to transfer the data to GLASS. These countries, territories and areas also send additional data directly to GLASS.

GLASS accepts submissions of AST results for both single antibiotics and sub-groups of antimicrobials. Results reported by countries, territories and areas to EARS-Net are submitted to GLASS aggregated by antimicrobial class. According to the method for AMR data preparation and analysis used by ECDC, if AST results are reported for more than one antibiotic belonging to the same antimicrobial class (or group) in the same patient, results for only one of the antibiotics are considered [32]. Class susceptibility is calculated after final interpretation of the AST results for each antibiotic [32]: if a pathogen is reported to be resistant to at least one antibiotic, it is considered to be resistant to the whole class; if the result for at least one antibiotic is reported to be in susceptibility category "I", and no resistance is reported to any of the other antibiotics, the whole class is considered to be in category "I"; if the pathogen is reported to be susceptible to all the antibiotics, it is considered to be susceptible to the whole class.

Limitations in interpretation of results

While the methods currently used in GLASS have been approved internationally, surveillance is complex system [38]. The limitations of any research or surveillance system are the characteristics of its design or method that influence interpretation of the data collected. They are a by-product of the ways in which surveillance systems are initially designed and a direct consequence of all the constraints in data collection, such as those due to national policies and agendas, difficult logistics, lack of resources, sampling bias, poor diagnostic capacity, measurement errors and problems of data management. The limitations of the method used in generating GLASS results must be considered in interpreting them in order to assess the extent to which the outcomes truly reflect the status of surveillance systems reported by enrolled countries, territories and areas, their AMR epidemiological profiles and the extent to which the results can be used as a basis for future development. The limitations identified are listed below.

Reporting capacity

Many health care and public health professionals are involved in the various steps of data generation, and commitment and training are required at all levels to ensure high-quality data. Differences in capability and resources among countries, territories and areas and limiting conditions outside the direct control of the national AMR surveillance system affect data collection and its validity. GLASS support for the development and strengthening of national systems should narrow the gaps in the future.

The number of surveillance sites in each country depends on the structure of the national surveillance system, financial and technical capability and the size of the country and its geographical limits.

Regions include different numbers of countries, territories and areas that submit rates of AMR and different capacity for generating representative, accurate data, even between neighbouring countries, territories and areas. The data must therefore be interpreted and used with consideration of the limits and constraints to their reliability. The report shows, however, the potential added value of harmonizing data collection, which, in the future, will allow not only generation of reliable regional and global AMR estimates but also identification of trends and gaps in the responses of regions and countries, territories and areas.

Data structure, quality and representativeness

Because of problems inherent in the quality of the data and therefore potential bias, no statistical analysis was performed of associations among infection types, of the proportion of resistance in a specific pathogen or to identify risk factors linked to age, gender or the source of infection.

Data aggregation is a major limitation, as it considerably limits options for epidemiological characterization, obviating the detection and validation of data from countries, territories and areas with unusual antimicrobial patterns. Furthermore, antibiotics could not be grouped into classes to identify patterns, as AST results are not line-listed, and the merging of outcomes for different antibiotics would result in overestimation of resistance.

Lack of a sampling strategy results in selection bias, which may affect the representativeness and interpretation of results.

Cases are found and tested only in the population that seeks medical care. Frequency can therefore be calculated only for this population. The completeness of data, particularly for population variables such as age, gender and origin of infection, could not be assured for all reporting countries, territories and areas.

Most data are still generated in laboratories, with no epidemiological insight.

Some of the isolates identified might represent cases of contamination or colonization. As the data are aggregated, each country was considered responsible for assessing the clinical significance of positive cultures, and those reported are considered a proxy of infection. Moreover, while the distinction between infection, contamination and colonization is relevant for estimating disease incidence, it is less relevant for estimating the proportion of resistance.

The frequency of infection in tested patients may actually represent the frequency of positive cultures, in low- and medium-resource settings because of low rates of culture and in all settings with high rates of empirical treatment or with diagnosis by molecular methods and not culture. Both situations can result in significant underestimates of frequency of infection.

Although the CLSI recommendation is to show results only when a minimum of 30 isolates are reported, GLASS chose a cut-off of 10 patients in order to present data from countries, territories and areas with limited resources or very recent surveillance systems.

Discrepancies were found in reporting negative results and antibiotics that were “not tested”. Although countries, territories and areas may select “no AST” or “unknown breakpoints” for unknown AST results, if certain pathogen–antimicrobial combinations were not reported in the RIS file, it was not always possible to determine whether no isolates of the organism were identified or whether some isolates were identified but not tested for susceptibility to antimicrobials. In addition, the degree of uncertainty in the AMR rates generated could be very high when the data indicated a high percentage of unknown AST results for certain antibiotics. Therefore, 30% unknown AST results was chosen as the cut-off for graphical representation of outcomes to ensure a reasonable balance in terms of inclusion of results and the proportion of isolates for which data were available [40, 41]. To avoid this limitation, countries, territories and areas should always report negative AST results for isolates that were not tested.

Evaluation

A small set of progress indicators is used to evaluate implementation of the surveillance system in each participating country. Information from countries, territories and areas is derived primarily by self-assessment, as the national focal point fills in the implementation questionnaire, and there is still no method for determining the amount and validity of reported data according to the functionality of their systems. The information collected in the third round, however, allowed a first overview of country activities and provides the baseline for further development. More indicators will be integrated in the next phase of GLASS-AMR implementation.

Annex 2. Reporting activities of antimicrobial resistance, by region, specimen and pathogen

WHO REGION AND SPECIMEN	PATHOGEN							
(number of countries territories or areas)[9]	*Acinetobacter* spp.	*E. coli*	*K. pneumoniae*	*N. gonorrhoeae*	*Salmonella* spp.	*Shigella* spp.	*S. aureus*	*S. pneumoniae*
African (n=7)								
Blood	7	7	7	×	5	×	7	5
Genital	×	×	×	3	×	×	×	×
Stool	×	×	×	×	3	4	×	×
Urine	×	4	4	×	×	×	×	×
Americas (n=4)								
Blood	2	2	2	×	3	×	2	1
Genital	×	×	×	1	×	×	×	×
Stool	×	×	×	×	3	2	×	×
Urine	×	2	2	×	×	×	×	×
Eastern Mediterranean (n=15)								
Blood	13	14	12	×	9	×	14	8
Genital	×	×	×	5	×	×	×	×
Stool	×	×	×	×	10	10	×	×
Urine	×	15	12	×	×	×	×	×
European (n=25)10								
Blood	25	25	25	×	5	×	25	23
Genital	×	×	×	19	×	×	×	×
Stool	×	×	×	×	5	3	×	×
Urine	×	8	8	×	×	×	×	×
South-East Asian (n=8)								
Blood	8	8	8	×	8	×	6	6
Genital	×	×	×	3	×	×	×	×
Stool	×	×	×	×	6	3	×	×
Urine	×	8	8	×	×	×	×	×
Western Pacific (n=7)								
Blood	6	6	6	×	6	×	6	6
Genital	×	×	×	6	×	×	×	×
Stool	×	×	×	×	5	5	×	×
Urine	×	5	5	×	×	×	×	×
Total	**61**	**104**	**99**	**37**	**68**	**27**	**60**	**49**

9 Kosovo included in accordance with Security Council resolution 1244 (1999).

Annex 3. Analysis and interpretation of data on antimicrobial resistance

Reported Data

GLASS requests submission of two types of AMR data files generated from the same source database which are outlined as follows [14]

The resistant, intermediate, susceptible "RIS" **file** with susceptibility testing *results*. These are data (aggregated from all participating national surveillance sites submissions) on the number of patients with positive cultures per specimen type, and AST results for each GLASS pathogen–antibiotic combination, interpreted according to EUCAST, CLSI, or other national definitions [24, 25]. Data includes numbers of patients with susceptible, Intermediate, and resistant isolates, as well as numbers of isolates with unknown susceptibility. Two different types of unknown results are recorded: "Unknown_no_AST" representing the number of isolates with AST results not reported (or not performed) for a specific antibiotic, and "Unknown_no_breakpoints" representing the number of isolates with AST performed but no interpretation of results available for a specific antibiotic. The AST data is stratified according to core patient variables [14]:

- Age: age-groups defined as per the WHO Global Health Observatory (less than 1 year, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, over 85 years), or as unknown.
- Gender: female, male, unknown.
- Infection origin: hospital, community, unknown. Countries, territories and areas were advised to use the following definition: "Hospital" origin is selected for patients admitted for >2 calendar days when the specimen was taken or admitted to the health care facility for ≤2 calendar days but transferred from another health-care facility where he or she was admitted for ≥2 calendar days. "Community" origin is selected for patients cared for at outpatient clinics, or patients in hospital for ≤2 calendar days when the specimen was taken. Countries, territories and areas using a different classification method were nevertheless invited to report infection origin data in the GLASS format.

SAMPLE ***file with the numbers of patients seeking care at surveillance sites***. In hospital and community facilities from which specimens for bacterial isolation were taken over a defined period, stratified by the same variables as in the RIS file.

Data preparation

GLASS requires input data to be de-duplicated, so that one isolate will represent one patient. This minimises bias associated with reporting of repeated cultures. Thus, when several cultures are collected from one patient, repeat isolates of a given species from the same patient are excluded. Only the first isolate per patient, per pathogen, per reporting period, and per stratification level is included. Note that for national and local surveillance, it is important to collect consecutive isolates of the same pathogen in order to monitor clinical episode characteristics. De-duplication and data quality assurance should be performed either at surveillance sites before submission to the NCC, or by the NCC. If deduplication is done locally, the NCC should also conduct new checks for duplicates and data quality. Finally, it is the task of the designated NFP to upload the datasets, including aggregated data at national level, onto the GLASS IT platform (GLASS guide to uploading aggregated AMR data [42]). The GLASS data management team offers direct support to countries, territories and areas both for de-duplication and aggregation of the data, and quality checks are run during the data validation process.

GLASS requires countries, territories and areas to include a dataset batch identification number – for example, "Data set 1", "Data set 2" – in order to distinguish subsets of national aggregated data. This approach is used when countries, territories and areas are not able to aggregate national data in a single data set, or when dividing the national data set has an important added value, for example by regions [14].

AMR data validation and analysis

Countries, territories and areas are responsible for ensuring the validity, consistency, and completeness of AMR data submitted to GLASS. A second validation step is performed during the AMR uploading process thanks to a series of automatic checks built in to the GLASS platform, which identify issues related to the integrity of the dataset (e.g. variables, codes), and the consistency of the data provided (for example, specimen-pathogen-antibiotic combinations, and validity of the AST results provided). Summary tables are also generated allowing the NFP to verify that the uploaded data reflect what was prepared. Data uploading can be finalised only after all the validation steps are completed. Once uploaded, the last validation step is performed by the GLASS team. Data are exported into STATA 14 (StataCorp LP, Texas, USA) and summarised to identify unexpected distribution of age, gender, infection origin, and AST results for each specimen-pathogen-antibacterial combination. Communication with countries, territories and areas is maintained during this stage in order to resolve possible data issues or clarify existing gaps in data submission. In case of errors, countries, territories and areas are asked to correct and resubmit their data. Validated data are then analysed using STATA 14 and R Software.

AMR data are summarised by country, territories and areas, and main results are represented graphically and compiled into tables in the report electronic supplementary material [add hyperlink when defined]). AST results are categorized as follows, based on the EUCAST change in the definitions of the **S, I** and **R** susceptibility categories where **I** is defined as "susceptible, increased exposure", while CLSI keeps the **I** as "intermediate": **S** (susceptible), **I, R** (resistant + nonsusceptible), and unknown (unknown_no_AST + unkown_no_breakpoints). GLASS does not anymore merge categories (neither **S+I** nor **I+R**) when reporting surveillance data, presenting **S, I** and **R** separately.

Data are described by the following approaches

1. **Pathogen non-susceptibility overview:** For each specimen type, pathogen and antibiotic under surveillance, the proportions of patients with growth of non-susceptible, I and susceptible strains are calculated from the following formula and described graphically:

Number of patients with growth of non-susceptible (or I or susceptible) strains of bacteria species under surveillance (per specimen type and antibiotic) /

Total number of patients with growth of bacteria species under surveillance with AST results (per specimen type and antibiotic)

Overall AST results, the proportion of samples with unknown AST and AST results stratified by specimen type, age, gender and origin of infection are provided electronically in the supplementary material (add hyperlink when defined).

Further analysis is performed for data based on samples. As countries, territories and areas territories and areas are asked to provide only clinically significant results, reported positive cultures are considered proxies of infection. In addition, data de-duplication allows reporting only of new cases. Therefore, the frequency of infection with the pathogens under surveillance and the frequency of infection with pathogens that are not susceptible to specific antibiotics are calculated for the population at risk, defined as the total number of symptomatic patients who sought medical care and from whom a specimen was taken.

2. **Non-susceptible pathogen–antimicrobial combination frequency:** For each specimen type, origin of infection and pathogen, the frequency of patients with infections is calculated per 100 000 tested patients from the following formula and presented graphically:

Cases of infection in the population tested during the reporting period (per specimen type, pathogen and origin of infection) /

Population tested during the reporting period (per specimen type and origin of infection)

Subsequently, for each specimen type, origin of infection, pathogen and antibiotic under surveillance, the frequency of patients with growth of non-susceptible strains is calculated per 100 000 tested patients from the following formula and presented graphically:

Cases of AMR in the population tested during the reporting period (per specimen type, pathogen, origin of infection and antibiotic) /

Population tested during the reporting period (per specimen type and origin of infection)

The two charts are aligned to show the relation between the size of the contribution of each pathogen to infection at a specific anatomical site and the frequency of infections caused by pathogens resistant to specific antibiotics. The frequencies of AMR are also provided electronically in the supplementary material (add hyperlink when defined).

3. Meropenem was chosen to illustrate resistance to carbapenems. As indicated by the European Committee on Antimicrobial Susceptibility Testing, meropenem offers the best compromise between sensitivity and specificity in terms of detecting carbapenemase producers. Carbapenem resistance is one of the types of resistance of greatest concern worldwide, and several carbapenem-resistant pathogens are included as critical priorities on the WHO list of priority pathogens (43). When meropenem is not tested, imipenem may be tested instead.

For each specimen type, pathogen and origin of infection, the frequency of strains non-susceptible to carbapenem is calculated per 100 000 tested patients, stratified by gender and age, from the following formula, and presented graphically:

Cases of AMR due to strains non-susceptible to carbapenem in the tested population during the reporting period (per specimen type, pathogen, origin of infection, age and gender) /

Tested population during the reporting period (per specimen type, origin of infection, age and gender)

Results stratified by age, gender and origin of infection for all reported antibiotics are provided in the electronic supplementary material (add hyperlink when defined).

Pathogens isolated in specimens from < 10 patients are excluded from the analysis. The proportions and frequencies of AMR are not shown for pathogen–antibiotic combinations that are not reported, for which there are < 10 AST results or for which 100% of AST results are unknown. If the unknown AST results are more than 30%, in the pathogen non-susceptibility overview graphs the bars are not coloured and in the non-susceptible pathogen – antimicrobial combination frequency graphs only the antibiotics names are shown, without any graphical representation of the outcomes. If the proportion of provided information on infection origin and or gender is below 70%, results are not stratified.

Confidence intervals (CIs) are calculated using the Wilson method to address limitations due to small sample sizes or zero values [44].

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