Ethiopia Antimicrobial Resistance Surveillance

Annual Report

July 2017 – August 2018

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LETTER FROM THE DEPUTY DIRECTOR GENERAL OF THE ETHIOPIAN PUBLIC HEALTH INSTITUTE (EPHI)

Antimicrobial resistance (AMR) continues to be one of the most significant public health threats facing the world today. In Ethiopia, various reports indicated that there are wide practices of misuse of antimicrobials by health care providers, unskilled practitioners animal husbandry operation, and drug users.

In recognition of this problem, strengthening AMR surveillance system is one of the priority action by FMOH and Antimicrobial resistance (AMR) system strengthening is one of EPHI's flagship. In line with this, Ethiopia's AMR Surveillance Plan was developed and launched by the Ethiopian Public Health Institute (EPHI) under the Federal Ministry of Health (FMOH) with the support from international partners in 2017. The surveillance started in four sites with rapid plan of expansion to additional facilities.

This annual report presents progress made in the first year of implementation of Ethiopia's AMR surveillance system through August 2018. It provides information on the surveillance network coordination and organization, methods used, laboratory capacity building initiatives and how the system was monitored and evaluated during the reporting period. It also provides information on antimicrobial resistance pattern of antibiotic tested from surveillance site.

It is my hope that the findings of these report, conclusions and next priority actions will be taken into consideration by key stakeholders to design better implementation strategies on how to reduce the threat of antimicrobial resistance.

Finally, EPHI would like to acknowledge the support and contribution of the United States Centers for Disease Control and Prevention (CDC), the American Society for Microbiology (ASM), The OHIO State University (OSU), and the World Health Organization (WHO), to the establishment of Antimicrobial Resistance Surveillance in Ethiopia.

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ABOUT THIS REPORT

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EXECUTIVE SUMMARY

In the 2015 Strategy for the Prevention and Containment of Antimicrobial Resistance (AMR) for Ethiopia, the Ethiopian Government recognized the need for urgent action to combat the national and global threat posed by the growing resistance to antimicrobials. Adopted in early 2017, the Ethiopia Antimicrobial Resistance Surveillance Plan represents one of the first national efforts to strengthen the knowledge and evidence around resistance using coordinated and standardized clinical laboratory-based surveillance designed to capture isolate data from routine clinical laboratory practice. AMR Surveillance was officially launched in July 2017 at four sites (Phase 1), starting a phased implementation across the nation whereby sentinel surveillance sites submit data and isolates to the national reference laboratory at the Ethiopian Public Health Institute (EPHI).

This report presents data findings and describes progress made in the first year of implementation of Ethiopia's AMR Surveillance System through August 2018

This report describes progress made in the establishment of Ethiopia's AMR Surveillance System from July 2017 through August 2018, presents data findings, and reviews the successes and challenges encountered during the first year of AMR surveillance implementation to facilitate planning for system improvement and expansion.

Summary Achievements

1. Collected, collated, and analyzed AMR surveillance data from initial sentinel surveillance sites (Phase 1)
2. Trained and mentored all Phase 1 sentinel surveillance sites in microbiology, specimen collection, and data management
3. Built upon existing national isolate transport system to allow transport of bacterial isolates
4. Established infrastructure for data capture and information sharing from sentinel sites

Priorities for Coming Year

1. Ensure availability and uninterrupted access to quality microbiology supplies and equipment nationally
2. Improve quality of microbiology testing to support patient care and provide quality data for surveillance
3. Integrate AMR surveillance and associated laboratory networks into public health emergency response
4. Expand surveillance and laboratory mentorship to additional sites as capacity and resources allow

INTRODUCTION

Antimicrobial resistance (AMR) is a global health threat recognized in the 2016 United Nations General Assembly call for action. AMR can complicate the treatment of bacterial infections leading to increased mortality, morbidity, and healthcare costs. According to a review on AMR commissioned in 2014, an estimated 700,000 people die each year of antimicrobial resistant infections globally.

In 2009, concerned about the increasing prevalence of AMR globally, the Ethiopian Drug Administration and Control Authority (DACA), in collaboration with Management Sciences for Health/Strengthening Pharmaceutical System (MSH/SPS), conducted a formal situational analysis to understand the status of resistance and trends in the use of antimicrobial drugs in Ethiopia. This report concluded that while data were limited, evidence suggested a high level of antibacterial resistance and called for a national approach to prevent further AMR development and spread in Ethiopia. Subsequent work identified limited microbiology laboratory capacity and the lack of a systematic national AMR surveillance system to be principal limitations to effective AMR response in Ethiopia. In particular, laboratory-based surveillance that detects resistance patterns and monitors their spread was called for.

In 2015, the World Health Organization (WHO) released the Global Action Plan on Antimicrobial Resistance. That same year, the Federal Democratic Republic of Ethiopia released a Strategy for the Prevention and Containment of Antimicrobial Resistance for Ethiopia. This strategy details five objectives including "strengthening knowledge through surveillance."

In 2017, the Ethiopia AMR Surveillance Plan was developed and launched by the Ethiopian Public Health Institute (EPHI) under the Federal Ministry of Health (FMOH) with support from the Ethiopian Food Medicine and Health Care Administration and Control Authority (EFMHACA) and international partners including the WHO, the U.S. Centers for Disease Control and Prevention (CDC), the American Society for Microbiology (ASM), and The Ohio State University (OSU) Global One Health initiative.

Ethiopia AMR Prevention and Containment Strategy (2015)

Goal

To prevent, slow down, and contain the spread of AMR through the continuous availability of safe, effective, and quality-assured antimicrobials and their effective use

Second Strategic Objective

Strengthen the knowledge and evidence on antimicrobial use and resistance through One-Health surveillance and research

OVERVIEW OF ETHIOPIA AMR SURVEILLANCE

Surveillance Network

Ethiopia's AMR surveillance system is designed to connect sentinel surveillance sites to the National AMR Surveillance Coordinating Center. The National Reference Laboratory (NRL) at EPHI is the nation's only microbiology laboratory accredited by the International Standards Organization (ISO), and serves in the role of the National AMR Surveillance Coordinating Center. System roles and responsibilities include:

Sentinel Surveillance Sites	National Surveillance Coordinating Center
• Perform quality assured bacterial culture, and antibiotic susceptibility testing • Report AMR data as outlined in the AMR surveillance plan • Package and submit isolates as requested	• Coordinate surveillance and capacity building activities • Ensure data quality • Data management and analysis • Disseminate results and findings

To ensure data quality is maintained, roll-out of the AMR surveillance network is occurring in phases. Currently, the AMR surveillance system incorporates four laboratory sites serving multiple clinical sites:

EPHI: National reference laboratory providing clinical testing services to multiple healthcare facilities including St. Paul Hospital and AeBET Hospital

Tikur Anbessa Specialized Hospital: Federal specialized referral hospital serving patients from Addis Ababa and other regions

Amhara Public Health Institute: Regional reference laboratory based in Dessie serving healthcare facilities in the Amhara Region including Dessie Referral Hospital

Ayder Specialized Referral Hospital: Federal specialize referral hospital serving patients in Mekelle. In-house microbiology also conducts testing for Seame Clinic

Figure 1. Approximate location of Phase 1 surveillance sites (stars) — Ethiopia AMR Surveillance System 2017

Surveillance Goals

The stated goals of Ethiopia's AMR surveillance system are:

1. To asses and support building the laboratory capacity to provide actionable, quality assured, laboratory-based AMR surveillance data
2. Establish a nationwide surveillance network
3. Estimate the extent and burden of priority AMR pathogens
4. Analyze and report national data on a regular basis
5. Detect emerging resistance and characterize national spread
6. Generate evidence to inform the implementation of targeted prevention and control programs
7. Eventually transfer the AMR surveillance data to the national One Health system

Methods

Surveillance efforts are laboratory-based with the system designed to capture isolate data from routine laboratory clinical practice. Patient-level data (example: age, gender, in-patient location) are limited to data availability within laboratory information systems. Manual microbiology methods (example: plate culture and disc diffusion for antimicrobial susceptibility testing) are used at all sites.

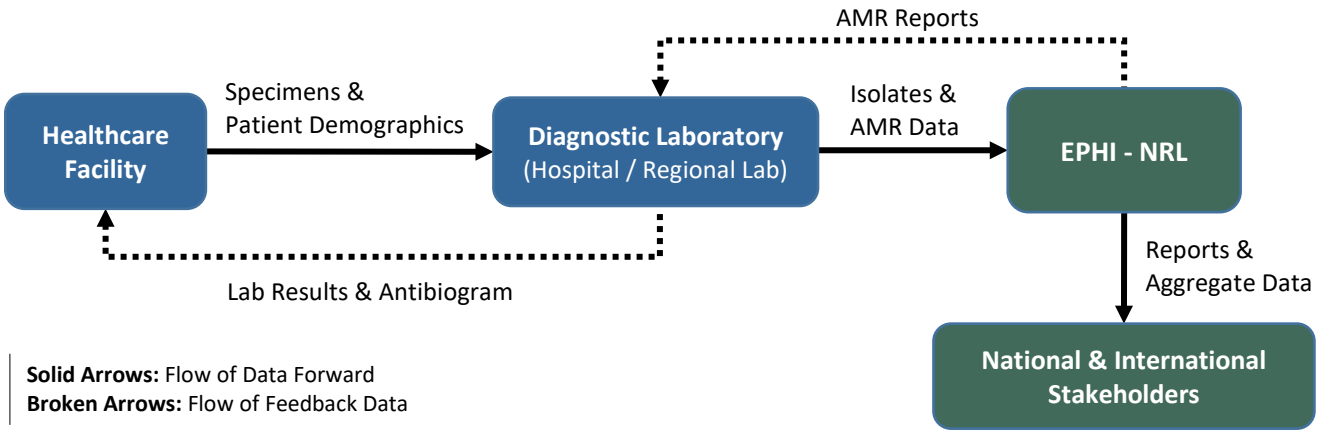
Laboratory data management at sentinel sites is primarily paper-based with AMR surveillance data entered into an electronic database adapted for this purpose. To limit the burden of data collection and focus laboratory capacity building, a limited set of AMR priority pathogens are targeted for surveillance reporting (Table 1).

Table 1. Priority surveillance pathogens by specimen for reporting to Ethiopia AMR surveillance

Specimen	Priority Surveillance Pathogens
Urine	• *Escherichia coli* • *Klebsiella pneumoniae*
Wound (Purulent Drainage)	• *Staphylococcus aureus*
All specimens	Carbapenem resistant: • *Acinetobacter* spp. • *Pseudomonas aeruginosa* • Enterobacteriaceae

An overview of the data and isolate flow throughout the AMR surveillance system is provided as Figure 2. In addition to standard laboratory quality control activities and external quality assurance testing, a proportion of recovered isolates are sent to EPHI for confirmation testing. Results from confirmation testing inform capacity building activities and further ensure data quality. Periodically, AMR reports are generated to inform infection prevention and control activities at hospitals and guide antibiotic stewardship policies and practices.

Figure 2. Ethiopian AMR Surveillance System Overview



ACHIEVEMENTS

Since the Ethiopia AMR Surveillance System was launched in July 2017 substantial progress has been made in building workforce capacity, establishing vital infrastructure and systems, integrating and coordinating laboratory data management, promoting communication across the laboratory network, and ensuring important gaps are identified and addressed. Specific achievements include:

Preparatory Activities

- Three-day key stakeholder sensitization workshop (August 2016) held to establish surveillance priorities and methods and develop work plans for surveillance implementation
- Performed standardized baseline assessments of microbiology laboratories nationwide to determine laboratory capacity and readiness to participate in surveillance activities. (Oct. 2016 - Feb 2017)
- Developed site specific work plans to build laboratory capacity and establish data management systems (February 2017)
- Finalized Ethiopia Antimicrobial Resistance Plan (March 2017)
- AMR surveillance launched (July 2017) through a one-day meeting attended by the Deputy Director General of EPHI, Regional Health Bureau representatives, the Ethiopian Society for Microbiology, the World Health Organization, the U.S. Centers for Disease Control and Prevention, and the American Society of Microbiology
- Re-assessments conducted on Phase 2 sites (April 2018) to determine readiness for expansion.

Network Coordination & Communication

- Hired a dedicated AMR Surveillance Coordinator and Data Manager
- Established regular calls with international AMR surveillance partners providing technical assistance
- Established ongoing formal and informal lines of communication with surveillance sites through assignment of dedicated focal persons, weekly calls with sites, and monthly supportive supervision site visits

Mentorship and Laboratory Capacity Building

- Provided sites with hands-on training in basic microbiology and antibiotic susceptibility testing methods.
- Developed site-specific work plans based on baseline assessment findings

- Initiated periodic onsite mentoring with four sentinel sites focused on basic microbiology, regular quality control activities, and antibiotic susceptibility testing
- Developed and provided sentinel sites with uniform and up-to-date microbiology standard operating procedures (SOP)
- Furnished sites with relevant quality control (QC) strains, licensed Clinical and Laboratory Standards Institute (CLSI) guidelines for results interpretation and reporting, and clinical microbiology reference materials
- Enrolled sites in an internationally recognized external quality assurance (EQA) program to help monitor and quantify improved capabilities over time

Microbiology Supplies and Equipment

- As resources allowed, provided needed essential bacteriology reagents and supplies to sentinel sites
- Assessed microbiology equipment at sites and, as resources allowed, repaired or replaced as needed
- Established methods to capture and document issues pertaining to the quality and availability of essential microbiologic supplies

Clinical Sensitization and Specimen Management

- Coordinated a 3-day workshop to finalize materials for standardizing clinical specimen collection training and instruction at the healthcare facility level
- Conducted site visits to each sentinel surveillance site to promote appropriate specimen collection practices and encourage communications between the clinical and laboratory departments

Isolate Transport

- Expanded the existing isolate transport program with the Ethiopian Postal Service Enterprise (EPSE) to allow transport of the bacterial isolates and clinical specimens for AMR surveillance and other programs
- Began using the Ethiopian Postal Service to transport AMR priority isolates to EPHI from non-Addis Ababa based sites for referral and confirmation testing (April 2018)

Isolate Repository and Quality Assurance Testing

- Established a repository at the NRL for all AMR priority isolates found at the surveillance sites

- Ongoing confirmatory testing is being performed monthly at the NRL on 10% of the isolates received from the surveillance sites with reports of findings shared with sites for quality assurance

Data Management and Analysis

- Provided sites with computers for data entry and initiated AMR data reporting and management using a freely available software, WHONET (5.6) customized to the needs of both the surveillance system and the surveillance sites
- Provided SOPs and trainings on surveillance reporting and WHONET data entry to ensure that AMR data is captured and processed in a standardized manner (February 2018)
- Capacitated EPHI data manager in WHONET data management, manipulation, and analysis

Virtual Case-Based Learning

- Piloting a virtual case-based learning platform to supplement ongoing laboratory capacity building activities
- Uses multipoint videoconferencing technology to connect international experts in microbiology with laboratory staff at surveillance sites
- Conducted initial training (June 2018) and provided video conferencing equipment to the 2 pilot sites

Monitoring & Evaluation

Monitoring Activities

- Instituted weekly calls with sites to collect dashboard indicators to track progress on AMR surveillance implementation
- Monthly site visits by EPHI NRL staff members were initiated (end of 2017) to measure progress on laboratory capacity building activities and work plans
- Established monthly meetings with all NRL staff involved in AMR surveillance implementation to share findings from monitoring visits and plan for quality improvement
- In May 2018, EPHI held a progress review meeting for partners and Phase 1 sites to review progress, share learning experiences, and plan for next steps

Early External Surveillance Evaluation

In November 2017, EPHI invited the CDC to conduct an external evaluation of the Ethiopian AMR surveillance system to review the surveillance plan and offer an early examination of how well the system was operating. Activities included:

- Interviews with facility administration, site laboratory staff, and system stakeholders
- Meeting with stakeholders to present findings and discuss next steps
- Observation of surveillance activities with activity and data flow mapping
- Review of data collection forms, tools, and databases
- Review and analysis of available surveillance data

Brief summary of external evaluation findings (system strengths and implementation challenges):

Strengths	Challenges
• Leadership and surveillance site staff are engaged and enthusiastic about AMR surveillance • System can be readily adapted to address implementation challenges • Laboratory capacity at the NRL and surveillance sites is increasing	• High staff turn-over and personnel shortages affecting quality of laboratory practices • Data quality needs to be further assured • Limited access to quality microbiology laboratory supplies • Representativeness of system output limited by location and number of samples that are collected

Based on recommendations provided by the CDC, improvements were made in the areas of data management, communication, and laboratory capacity building.

International Collaborations

- Ethiopia is one of just 10 countries in Africa enrolled to report progress on surveillance implementation and share data on AMR to the World Health Organization's Global Antimicrobial Resistance Surveillance System (WHO|GLASS)
- EPHI collaborates closely with international partners including CDC, ASM, OSU, and the WHO to further AMR surveillance initiatives in Ethiopia

FINDINGS

Preliminary Data Analysis

Data is currently being collected from all four Phase 1 AMR surveillance sites. Data entry efforts began in September 2017 with full optimization in February 2018 through the provision of customized, site-specific WHONET databases, SOPs, and trainings on electronic data entry. Data management and analyses are done using WHONET software and Microsoft Excel. Site-specific analyses, including hospital-level patterns of resistance and antibiograms, are completed and returned to surveillance sites as the number of tested isolates allows.

Between March and July 2018, approximately 1028 urine and 260 pus specimens from six clinical sites were submitted for processing at the four AMR surveillance laboratories. Figure 3 provides the number of urine specimens processed by month and stratified by submitting hospital. To date, Tikur Anbessa Specialized Hospital is processing the largest number of urine specimens. When possible, laboratory results prior to March 2018 were added to the system to allow additional analyses.

Figure 3. Number of Urine Specimens Processed by Month, All Healthcare Facilities - Ethiopia AMR Surveillance, March - July 2018

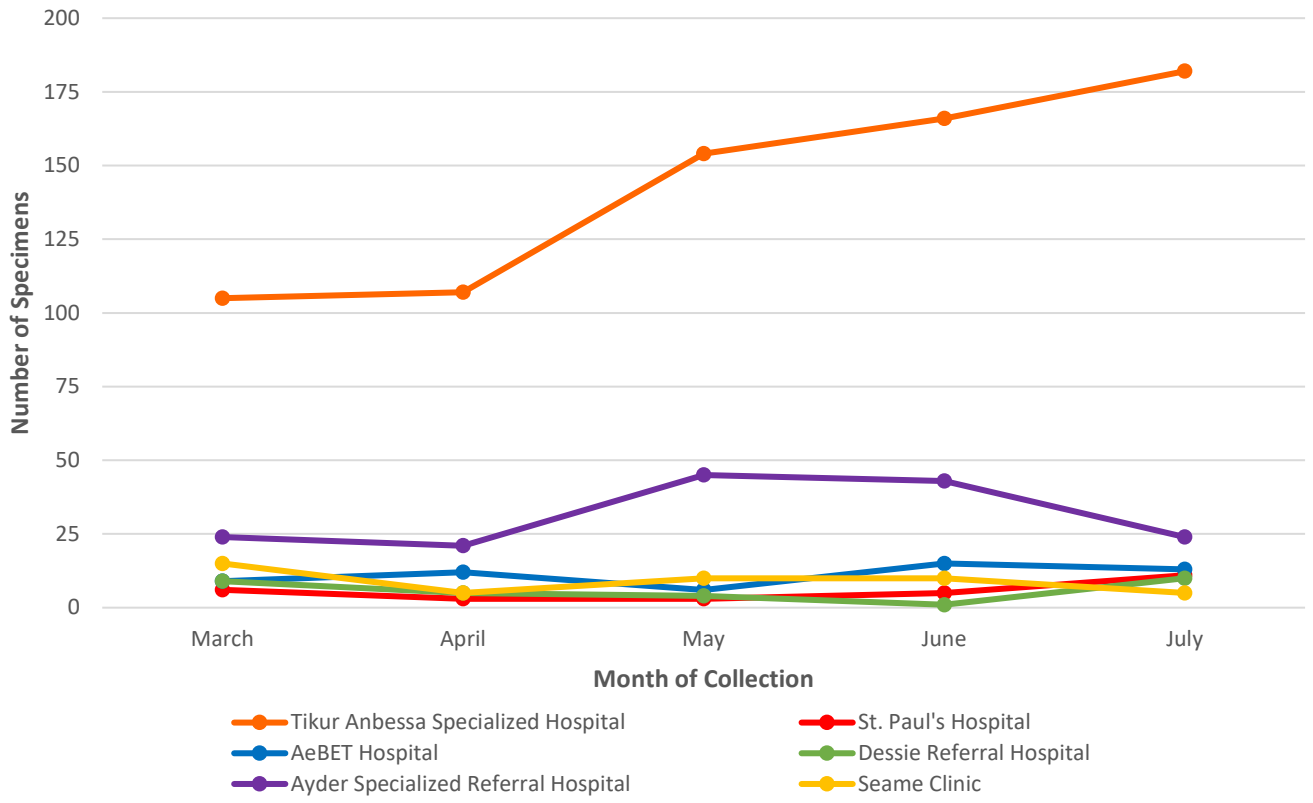
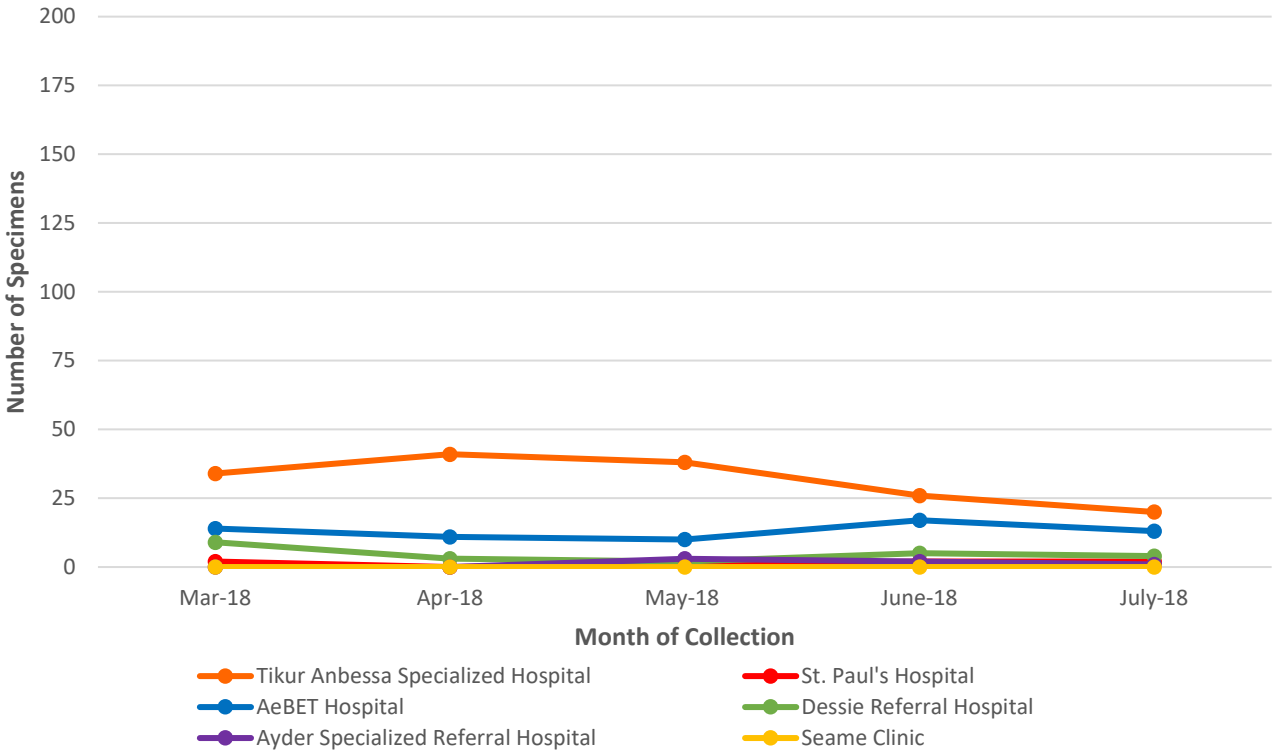


Figure 4 provides the total combined number of pus, abscess, and wound specimens processed by month and stratified by submitting hospital. Compared to the number of urine samples processed by month, the number of pus specimens is low and approximately equal across surveillance sites.

Figure 4. Number of Pus* Specimens Processed by Month, All Healthcare Facilities - Ethiopia AMR Surveillance, March - July 2018

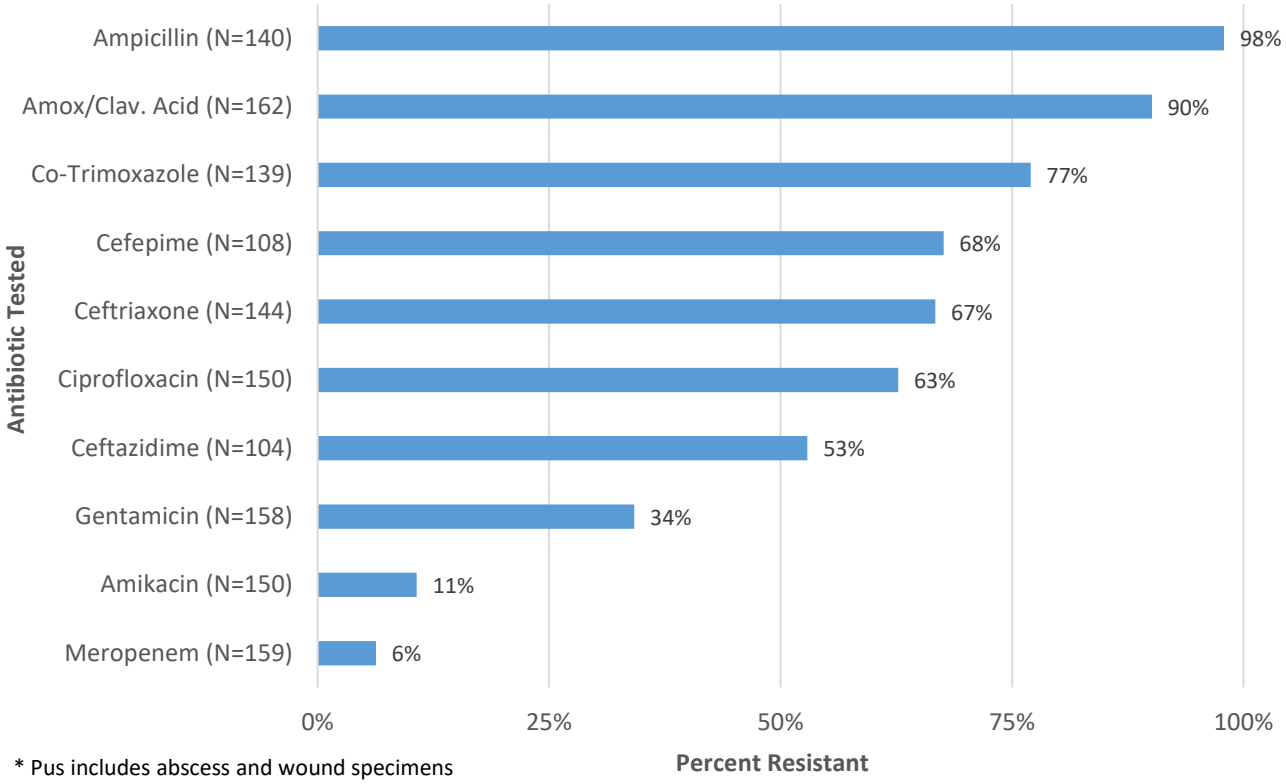


* Pus includes abscess and wound specimens

Due to the higher number specimens at Tikur Anbessa Specialized Hospital, data from the site were further analyzed. Overtime, as additional data is collected, these analyses can be run for the remaining clinical sites.

Between September 2017 and July 2018, approximately 1716 urine specimens and 323 pus, abscess, and wound specimens were processed at Tikur Anbessa Specialized Hospital. *Escherichia coli* was the most common pathogen isolated from urine, and the second most common pathogen in pus. Between September 2017 and July 2018 a total 184 patients at Tikur Anbessa Specialized Hospital were found to have *E. coli* isolated from urine and pus, abscess, and wound specimens. Figure 5 provides the proportion of these *E. coli* isolates that showed resistance by antibiotics tested. To prevent over reporting due to repeat cultures, only the first *E.coli* isolate from each patient was analyzed. The majority of the isolates showed resistance to broad-spectrum antibiotics with the highest resistance in Ampicillin (98%), Amoxicillin-clavulanate (90%), and Co-Trimoxazole [Trimethoprim-Sufamethoxazole] (77%).

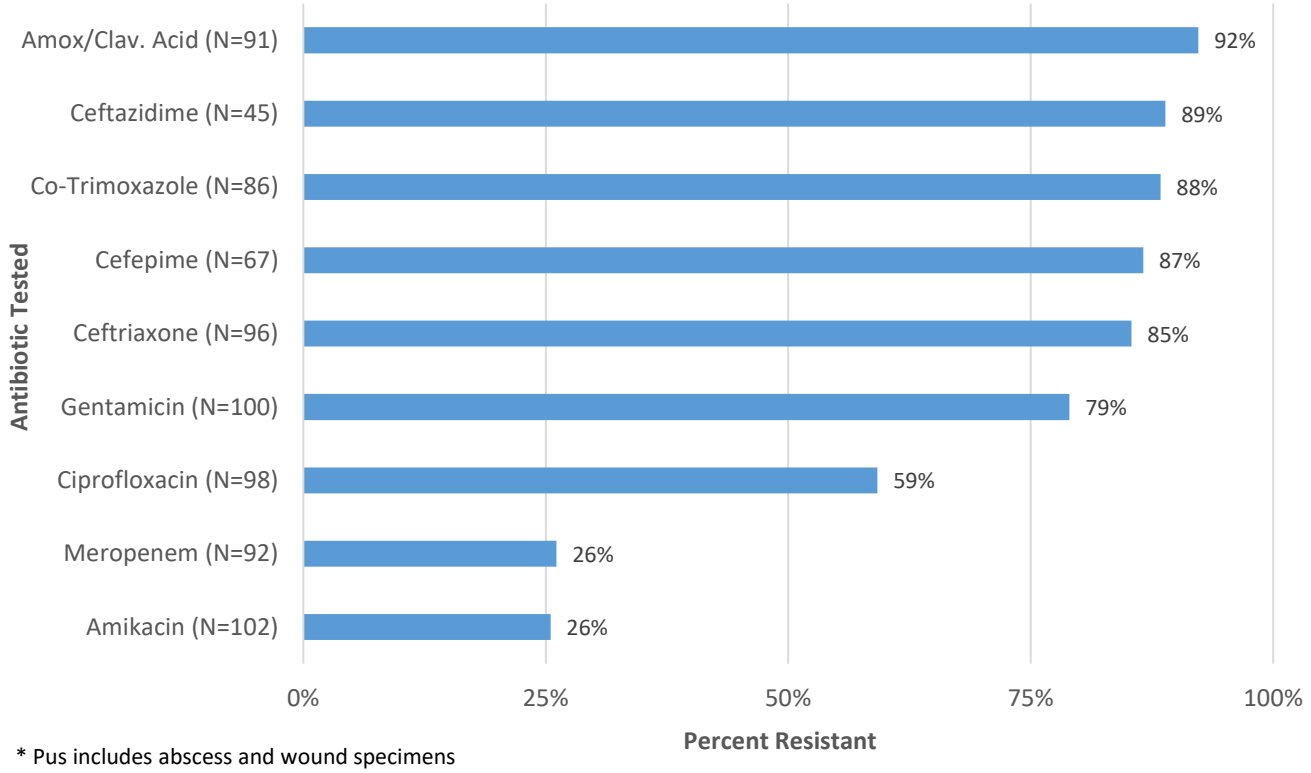
Figure 5. Proportion of *E. coli* Isolates (N=184) from Urine and Pus* Showing Resistance by Antibiotic Tested, Tikur Anbessa Specialized Hospital - Ethiopia AMR Surveillance, September 2017 - July 2018



* Pus includes abscess and wound specimens

Klebsiella pneumoniae was the second most common pathogen isolated from urine and pus. Between September 2017 and July 2018 a total 115 patients at Tikur Anbessa Specialized Hospital were found to have *Klebsiella pneumoniae* isolated from urine and pus, abscess, and wound specimens. Figure 6 provides the proportion of these *K. pneumoniae* isolates that showed resistance by antibiotics tested. The majority of the isolates showed resistance to broad-spectrum antibiotics with the highest resistance Amoxicillin-clavulanate (92%), and Co-Trimoxazole [Trimethoprim-Sufamethoxazole] (88%). High levels of resistance were also seen among the 3rd and 4th generation Cephalosporins, namely Ceftazidime (89%), Cefepime (87%), and Ceftriaxone (85%). Similar patterns of resistance were found between the *E. coli* (184) and *Klebsiella pneumoniae* isolates (115), however resistance to Gentamicin appears to be higher among the isolates of *Klebsiella pneumoniae* (79%) than the *E. coli* isolates (34%).

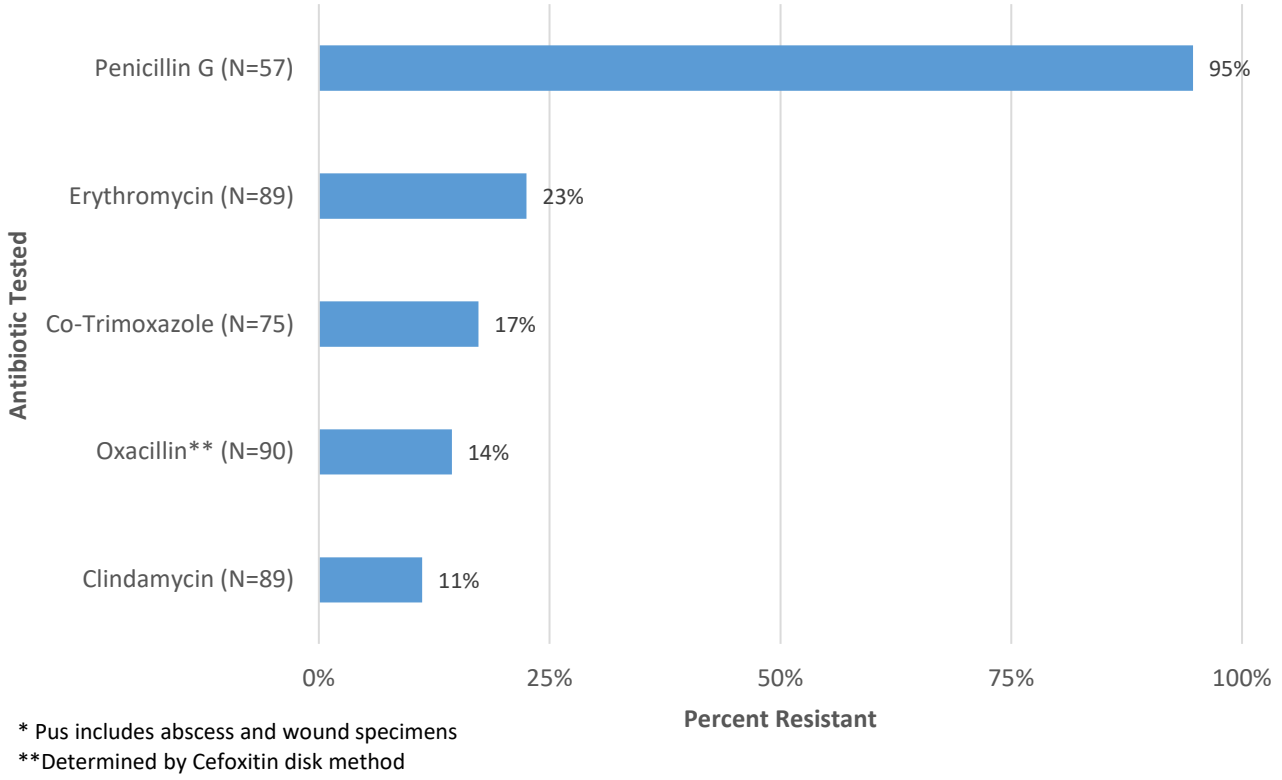
Figure 6. Proportion of *Klebsiella pneumoniae* Isolates (N=115) from Urine and Pus* Showing Resistance by Antibiotic Tested, Tikur Anbessa Specialized Hospital - Ethiopia AMR Surveillance, September 2017 - July 2018



* Pus includes abscess and wound specimens

At Tikur Anbessa Specialized Hospital, *Staphylococcus aureus* was the most common pathogen isolated from pus. Between September 2017 and July 2018 a total 95 patients were found to have *S. aureus* isolated from urine and pus. As shown in Figure 7, the majority of the *S. aureus* isolates showed resistance to Penicillin G (95%). An indicator of methicillin-resistant *Staphylococcus aureus* (MRSA), resistance to Oxacillin (14%) was found to be low among the isolates tested.

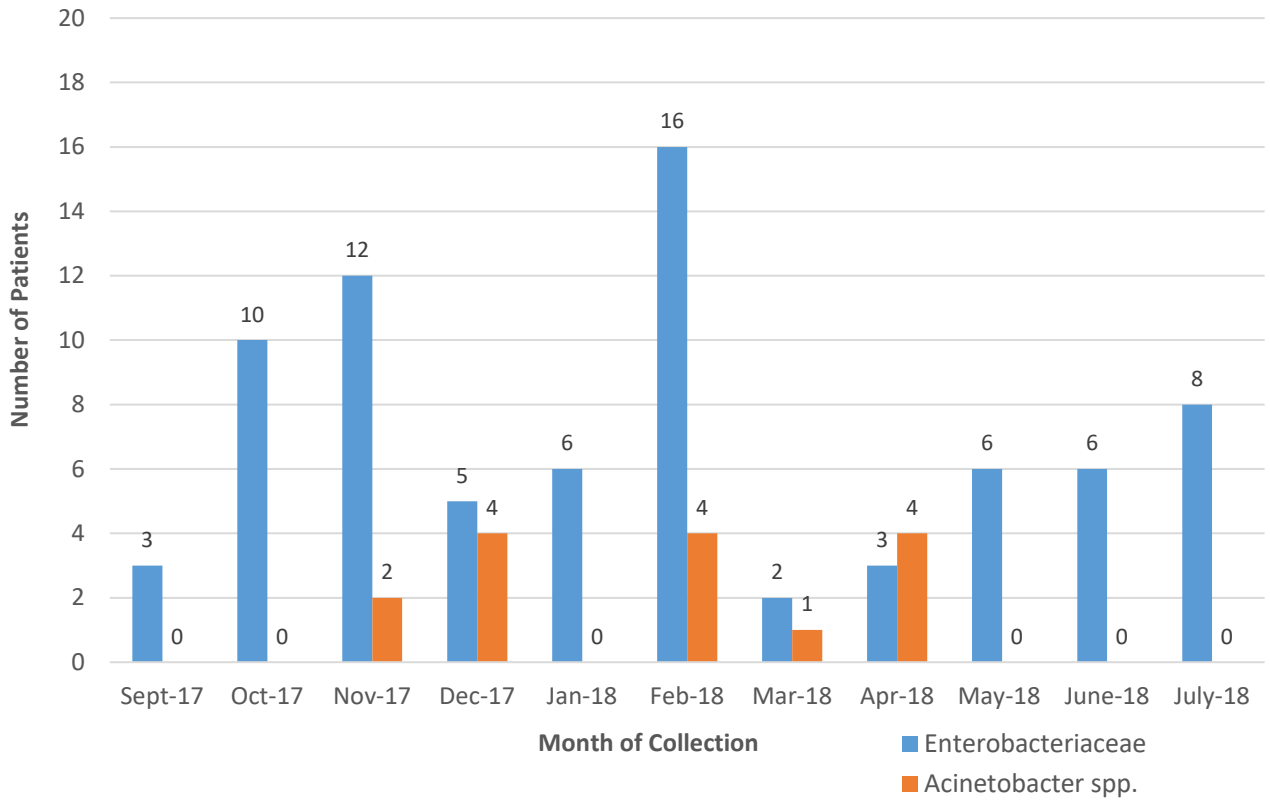
Figure 7. Proportion of *Staphylococcus aureus* Isolates (N=95) from Urine and Pus* Showing Resistance by Antibiotic Tested, Tikur Anbessa Specialized Hospital - Ethiopia AMR Surveillance, September 2017 - July 2018



* Pus includes abscess and wound specimens
**Determined by Cefoxitin disk method

Data from Tikur Anbessa Specialized Hospital were analyzed for all specimens from which carbapenem-resistant Enterobacteriaceae, *Acinetobacter* species, or *Pseudomonas aeruginosa* were isolated. Figure 8 presents the number of carbapenem-resistant isolates found between September 2017 and July 2018. To prevent over reporting due to repeat cultures, only the first isolate from each patient was analyzed. Carbapenem-resistant Enterobacteriaceae was isolated from 81 patients, and 15 patients were found to have carbapenem-resistant *Acinetobacter* species. No carbapenem-resistant *Pseudomoas aeruginosa* were isolated during the time frame. It is expected that these numbers are under-reported due to limited supplies for testing carbapenem resistance. It is important to note that the total number of Enterobacteriaceae, Acinetobacter, Pseudomonas aeruginosa isolated was not captured in the data.

Figure 8. Number of Carbapenem Resistant Isolates Received by Month Tikur Anbessa Specialized Hospital - Ethiopia AMR Surveillance, September 2017 - July 2018



Measures of Data Quality

Data quality is important for ensuring that both individual patient care and national policies are informed by the most accurate and reliable information possible. Components of data quality include the quality of data produced (i.e., laboratory results) and the quality of the data captured (i.e., data entry). In the context of AMR surveillance, the quality of the data produced is affected by:

- Quality of the specimens sent to the laboratory
- Quality of the microbiology laboratory practices
- Quality and availability of laboratory supplies
- Quality and maintenance of laboratory equipment

The quality of the data captured was affected by human error and lack of complete source data, resulting in occasional incorrect data entry, missing data, and entry of duplicates. Following the provision of fully customized site-specific WHONET databases, SOPs, and trainings on data entry, data submitted was found to have increased completeness, particularly data on “healthcare institution,” which increased in completeness from 0% to 98% following the introduction of fully customized WHONET databases.

In order to monitor the quality of the antibiotic susceptibility testing data produced at the sentinel surveillance sites and reported to AMR surveillance, the EPHI NRL conducts monthly confirmatory testing on 10% of the priority AMR isolates collected from the participating surveillance sites. Between July 2017 and August 2018, confirmatory testing was conducted on 26 isolates. Among these, 15 (58%) had at least one discordant antibiotic susceptibility testing result compared to the NRL. Among all isolates tested, *Klebsiella pneumoniae* had the highest proportion of isolates with discordant antibiotic results. Among all isolates tested, ciprofloxacin and amoxicillin-clavulanate were the two antibiotics with most frequently discordant results. Antibiotics with discordant antibiotic susceptibility testing results were typically reported with higher levels of resistance by the surveillance site than were found during confirmatory testing at the NRL. The low level (42%) of result accordance reveals the need for ongoing support and activities to improve the quality of the data produced at the sites.

Surveillance Limitations

With every surveillance system, limitations should be recognized for their impact on the information the system is able to produce, and how the data can be interpreted and used. The data findings presented above should be considered in light of the following limitations:

Limitation 1: Reliance on existing clinical specimen collection practices

The existing surveillance system captures data from clinical specimens sent, at the discretion of physicians, for routine laboratory diagnostics. To the extent that microbiology services are underutilized and/or empiric antibiotic therapy is provided prior to collection of specimens, patients that have failed first-line antibiotic therapy will be over represented. This situation will tend to overestimate resistant infections.

EPHI is collaborating with clinical experts to develop and roll-out a training curriculum to encourage unbiased specimen submission and train providers on proper specimen collection.

Limitation 2: Reliance on patients presenting to sentinel sites

The system currently captures data on patients presenting to the existing sentinel laboratory sites, the majority of which serve larger public tertiary referral hospitals. Patients attending private facilities or smaller healthcare facilities will not be represented in the data. When interpreting findings, this limited patient population should be considered.

When possible, alternative approaches to including healthcare facility and/or private clinical networks (e.g., accessing private laboratory network data and/or isolate-based surveillance where isolates are centrally processed at the NRL) should be considered.

CONCLUSIONS & NEXT STEPS

Ethiopia's National AMR Surveillance System represents one of its first national efforts to strengthen the knowledge and evidence around antimicrobial resistance. Implementing a coordinated and standardized surveillance approach, the Ethiopian Public Health Institute has increased the nation's understanding of this most important public health threat. Multi-sectoral leadership and stakeholder engagement were key elements that ensured the early success of this program.

With success have come challenges; the availability of quality microbiology testing to support patient care and provide data for surveillance remains a substantial challenge. Government support for the establishment and enhancement of quality microbiology throughout the country will serve to improve patient outcomes and microbiology-dependent surveillance programs.

Ethiopia's AMR surveillance system has provided the foundation needed for an integrated One-Health AMR approach. Ultimately, the benefits of implementing AMR surveillance may extend beyond surveillance activities improving Ethiopia's ability to detect and respond to a future public health threats.

Upcoming Activities & Next Steps

A number of activities are planned for the coming year:

- An intergovernmental/multi-sectoral AMR technical working group will be established
- In-lab surveillance site mentorship will expand to additional sites if capacity and resources allow
- An innovative laboratory specimen collection training of trainers curriculum for improved knowledge and practices among front-line healthcare workers will be launched
- Virtual case-based learning will be piloted as a cost-effective approach to increase laboratory capacity
- The National AMR Surveillance Plan will be revised to account for lessons learned, improved methodologies, and updated timelines
- Additional surveillance sites will be included based on site readiness, existing capacity, and the availability of human and material resources to support expansion

Needs and Priorities to Ensure Success

The following needs have been identified as key priorities for government support and stakeholder engagement to ensure the continued success of the AMR surveillance program:

Designate clinical microbiology as a funded priority for national health and emergency response

- Ensure retention of experienced clinical microbiologists at facility level
- Promote the appropriate use of microbiology in patient care
- Establish a pathway and incentives for accreditation of microbiology laboratories

Ensure the availability and access to quality microbiology supplies and equipment nationwide

- Define a standard set of microbiology supplies required for a functioning clinical laboratory
- Establish robust systems to provide the standard set of microbiology supplies to all clinical laboratories
- Work at a policy-level to remove barriers to the rapid procurement and importation of microbiology supplies into Ethiopia
- Establish systems to monitor the quality of microbiology supplies imported and used across Ethiopia

Integrate AMR surveillance and associated laboratory networks into public health emergency response

- Prioritize laboratory confirmation of suspected outbreak case patients using specimen/isolate transport systems and centralized NRL for processing and results dissemination
- Include AMR surveillance system leadership in outbreak investigations and responses involving pathogens amenable to microbiologic analysis.

Support enhancement and adoption of laboratory information management systems (LIMS) for microbiology

- Set national standards for LIMS architecture especially as it applies to microbiology
- Fund incentives for LIMS implementation