THE NATIONAL ANTIMICROBIAL RESISTANCE MONITORING SYSTEM

STRATEGIC PLAN 2026–2030

INTRODUCTION

Antimicrobial resistance (AMR) remains one of the top national and global threats to public health. According to the CDC's *Antibiotic Resistance Threats in the United States, 2019* Report[1], more than 2.8 million antimicrobial-resistant infections occur each year and more than 35,000 people die as a result.

As part of the national strategy to combat AMR, the U.S. National Antimicrobial Resistance Monitoring System (NARMS) was established in 1996 as a collaboration of the U.S. Centers for Disease Control and Prevention (CDC), the U.S. Department of Agriculture (USDA), the U.S. Food and Drug Administration (FDA), and state and local health departments to track AMR in enteric bacteria from humans, meats, and food-producing animals using an integrated One Health approach.

This year marks the 30th anniversary of the NARMS program. Since its inception in 1996, NARMS has evolved from antibiotic susceptibility testing of human *Salmonella* isolates to a modern One Health integrated surveillance system utilizing whole genome sequencing. Today, NARMS equips stakeholders, partners, the scientific community, and the public with critical data and insights that drive coordinated action against antimicrobial resistance worldwide. As we close out the 2021–2025 NARMS Strategic Plan, we provide a summary of NARMS accomplishments at the end of this document.

In preparation for this strategic plan, a public call for input was made to solicit recommendations on the strategic direction of the program. The resulting 2026-2030 Strategic Plan reflects the collective insights of diverse stakeholders, federal priorities, and over 30 years of NARMS expertise. The new strategic plan is anchored in three themes:

1) **Strengthening Core Surveillance**: Reinforcing our commitment to rigorous, science-based monitoring of antimicrobial resistance trends;

2) **Expanding Collaborative Networks**: Deepening partnerships across public, private, and academic sectors to drive unified action;

[1] CDC. Antibiotic Resistance Threats in the United States, 2019. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2019. Available online: at www.cdc.gov/DrugResistance/Biggest-Threats.html. DOI: http://dx.doi.org/10.15620/cdc:82532.

3) **Embracing Innovation**: Actively exploring and integrating emerging technologies to stay ahead of evolving threats. Together, these focus areas will help NARMS to accomplish its mission to protect public health.

Vision: *A future free of illnesses and deaths from antimicrobial resistant bacteria*

Mission: *To conduct nationwide bacterial antimicrobial resistance monitoring in humans, food-producing animals, foods, and other sources, and to disseminate high quality data for timely actions to protect public health and monitor progress*

To accomplish its mission, NARMS currently conducts the following activities:

Monitors trends in antimicrobial resistance among enteric bacteria from humans, retail meats, animals at the time of slaughter, and other sources;

Disseminates timely information on resistance in pathogenic and commensal microorganisms to stakeholders in the United States and abroad to promote interventions that reduce AMR among foodborne bacteria;

Conducts in depth analyses and promotes extramural collaboration to better understand the emergence, persistence, and spread of AMR;

Contributes timely AMR data for outbreak investigations; and

Provides data to assist the FDA in making decisions to ensure the availability of safe and effective antimicrobial drugs.

STRATEGIC GOALS AND OBJECTIVES

GOAL 1: SUPPORT SUSTAINABLE AND INNOVATIVE APPROACHES FOR NATIONAL ANTIMICROBIAL RESISTANCE MONITORING IN FOODBORNE BACTERIA

NARMS will continue the existing collaborative and harmonized surveillance of AMR bacteria from human (CDC), animal (USDA, FDA) and food (USDA, FDA) sources, while exploring new approaches for measuring resistance trends. NARMS will iteratively review its data on other prioritized sources of resistance, including the role of environmental sources in perpetuating antimicrobial resistance.

Objective 1.1: Maintain and enhance routine AMR monitoring through antimicrobial susceptibility testing (AST) and whole genome sequencing (WGS) of enteric bacteria from humans, animals, foods, and other prioritized sources.

Objective 1.2: Serve as a source of phenotypic and genotypic AMR data, bacterial isolates and applicable metadata to support scientific innovation and foster collaborations.

Objective 1.3: As needed, conduct periodic testing and implement pilot projects to explore AMR in minor species of food-producing animals, additional food products, imported foods and other possible sources of AMR.

GOAL 2: ENRICH OUR UNDERSTANDING OF AMR BY USING CURRENT AND EMERGING TECHNOLOGIES TO INFORM DEVELOPMENT OF OPTIMAL INTERVENTIONS

Effective strategies to control and reduce resistance require details about the molecular mechanisms responsible for its emergence, evolution and spread. Genomic technologies provide such detailed information (*e.g.*, resistance genes, phylogenetic relatedness, serotype, virulence, *etc*.) and will continue to be used to characterize bacteria under surveillance. Artificial intelligence (AI) offers unprecedented power to analyze complex and heterogenous kinds of data (structured and unstructured, spatial, temporal, social, genomic etc.). Together with the traditional approach, advanced genomics and AI opens new opportunities for NARMS to understand the dynamics of resistance and to recommend better prevention and control actions.

Objective 2.1: Fully harness WGS and apply predictive AMR analytics, plasmid tracking tools, and other bioinformatics processes to identify sources of AMR and to elucidate and predict the mechanisms by which resistance develops, spreads, and persists.

Objective 2.2: Evaluate the best uses of metagenomics for its ability to augment AMR monitoring and provide a broader perspective on the complex microbiome of biological samples from humans, animals, and foods.

Objective 2.3: Increase interoperability and meaningful integration of One Health monitoring data systems, as appropriate, to increase the efficiency of data (and metadata) analysis and deploy advanced methods to interpret complex findings.

Objective 2.4: Explore advanced technologies to foster discovery, inform predictive models, track genes, support learning, share findings, and improve judicious antimicrobial use.

GOAL 3: STRENGTHEN COLLABORATION, COMMUNICATION, AND TIMELY SHARING OF NARMS DATA

Given that AMR is common and may readily enter or spread within the United States, federal NARMS partners and collaborators are committed to the open sharing of relevant information for timely public health response and to improve and scale up data-driven prevention efforts.

Objective 3.1: Routinely deposit monitoring results into public databases and post web-based updates that describe emergent resistance phenomena for timely responses.

Objective 3.2: Identify communication gaps and improve information sharing tools for practitioners, educators, and others working to control AMR.

Objective 3.3: Explore innovative communication strategies for timelier and effective presentation of complex data to a broad range of audiences for informed decision making.

Objective 3.4: Increase collaboration with stakeholders and partners to foster bidirectional information sharing improving human and animal health and limiting antimicrobial resistance.

GOAL 4: ASSESS THE EFFECTIVENESS AND IMPACT OF AMR PREVENTION AND STEWARDSHIP PRACTICES

A One Health approach to combatting antimicrobial resistance requires sustained participatory and investigative investment from the sectors engaged with and impacted by AMR: human, veterinary, and the environment. For example, NARMS data can be used by CDC to assess risk factors for human AMR infections and help elucidate conditions driving resistance in clinical settings. NARMS data are used by USDA as a reference for food-animal studies looking at pre- and post-harvest actions. FDA has used NARMS data to measure the impact of policies to

inform judicious use. NARMS continues to engage with stakeholders and partners and to fund work for these purposes.

Objective 4.1: Conduct collaborative studies with partners to analyze surveillance data to assess the burden of resistance on human and animal health and determine risk factors for these zoonotic infections.

Objective 4.2: Partner with USDA Agricultural Research Services (ARS) and others to conduct focused research and develop data-driven solutions as a component of prevention and control of resistant pathogens.

Objective 4.3: In coordination with One Health partners, identify, implement, and evaluate antimicrobial stewardship (AMS) practices to preserve antibiotic effectiveness while minimizing the emergence of resistance.

Objective 4.4: Support the implementation of mechanisms for sustainably generating antimicrobial use (AMU) data in animals.

Objective 4.5: Advance the understanding of AMR across One Health by strengthening partnerships with FDA's Veterinary Laboratory Investigation and Response Network (Vet-LIRN), the CDC's Food Safety Centers of Excellence (FS CoE), the USDA–APHIS National Animal Health Laboratory Network (NAHLN) and the ARS Emerging Foodborne Pathogens initiatives to provide objective research results and data-driven solutions to AMR.

CHALLENGES AND OPPORTUNITIES

The *NARMS Strategic Plan* is a dynamic roadmap that outlines the program's commitment to providing scientifically sound data on AMR in enteric pathogens through sustained monitoring, data sharing, and collaboration.

Programmatic challenges to the continued success of NARMS include:

- Sufficient expertise and uninterrupted resources in the face of competing animal and human health priorities;
- Reduced availability of bacterial cultures resulting from the growing use of culture-independent diagnostic tests (CIDTs), which impedes AMR monitoring and requires new and flexible surveillance methods;
- Limited and incomplete AMU information from human and veterinary medicine hinders understanding of the drivers of resistance and risks associated with specific practices.

- Inadequate information on geographic distribution of AMR exposure to effectively guide AMR-related public health activities. This makes it difficult to quantify short- and long-term AMR outcomes, define success metrics, and assess return on investment.

Opportunities to further enhance NARMS include:

- Linking to other national and international infectious disease and AMR surveillance systems to better predict and track the trajectory of AMR and assess the impact of AMS efforts;
- Identifying ways to clarify outcomes while reducing data noise and more clearly showcase NARMS' programmatic successes;
- Increasing use of wastewater surveillance to provide additional opportunities to identify best-fit data applications and interpretation of AMR trends;
- Expanding the use of molecular diagnostics can improve timeliness and efficiency in data acquisition; and
- Enhancing public-private cooperation and information sharing on the drivers of AMU, their effectiveness in different situations, and possible alternative approaches that enhance judicious use.

OVERVIEW OF ACCOMPLISHMENTS: 2021–2025

As we close out the 2021–2025 NARMS Strategic Plan, a brief summary of program accomplishments is described below, organized by the previous strategic plan's goals:

Enhance Sampling for Foodborne Pathogens Within a One Health Framework

Impact: NARMS expanded its One Health data collection to develop a more robust and representative national picture of AMR across people, animals, and the environment. The data are available for universal access on the National Antimicrobial Resistance Monitoring System page of the FDA website.

1. Documented and communicated AMR prevalence data on more than 430,000 human clinical isolates, 210,000 food-producing animal isolates, and enteric bacteria isolated from over 170,000 retail meat samples.

2. Continued tracking of AMR in outbreaks of *Salmonella,* Shiga toxin-producing *E. coli*, *Campylobacter*, and *Shigella* infections.

3. Increased representativeness of population exposure through an improved retail food monitoring design.

4. Evaluated the status of AMR in new sources across One Health through targeted pilot surveys:
    a. Conducted comprehensive studies of AMR in the cecal contents of sheep, lamb, and goats at slaughter, and their meat products collected from retail outlets.
    b. Conducted surveys of AMR in the cecal contents of veal at slaughter, and AMR in *Salmonella* isolated from the mesenteric lymph nodes of cattle.
    c. Conducted bacterial AMR testing in Siluriformes fish and added routine testing of shrimp, salmon, and tilapia to NARMS.
    d. Completed sample collection and laboratory phases of a national pilot survey of surface waters for AMR bacteria and genes.

Employ Advanced Technologies to Better Understand the Evolution and Spread of AMR Among Foodborne Pathogens

Impact: Improved resolution, efficiency and accuracy of AMR detection and tracking, directly informing prevention and response capacities and identifying potential research opportunities.

1. Established AMR reference libraries and resolved complex genomic structures to improve understanding of the context for chromosomal and plasmid-based AMR by moving from short-read sequencing to developing complete and high-quality chromosome and plasmid assemblies through routine long-read sequencing.

2. Integrated CDC's PulseNet WGS data into NARMS bioinformatics workflow resulting in timelier identification and reporting of human AMR isolates.

3. Defined recurring, emerging, or persisting (REP) strains of enteric bacteria with AMR and established routine monitoring for REP strains via PulseNet.

4. Advanced methodologies for tracking AMR spread such as the Lociq[2] tool for characterizing and tracking plasmids carrying AMR.

5. Identified key genetic factors influencing AMR, and potential targets for better tracking, by using a new pangenome approach to study the emergence and evolution of AMR in *Salmonella*.

6. Developed a more comprehensive picture of AMR and the microbiome through metagenomic studies of animals, foods, and environmental surface waters.

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[2] Harrison L, Zhao S, Li C, McDermott PF, Tyson GH, Strain E. Lociq provides a loci-seeking approach for enhanced plasmid subtyping and structural characterization. Commun Biol. 2023 Jun 2;6(1):595. doi: 10.1038/s42003-023-04981-1.

Improve Data Sharing, Communication, and Collaboration

Impact: Significant improvements in data sharing, including user friendly data formats and interactive data interfaces - along with other NARMS communication and engagements - stakeholders were informed of emergent AMR findings in a timelier and accessible manner for prevention and response efforts.

1. Increased accessibility of NARMS Now and Resistome Tracker dashboards with seamless integrations of WGS and AST data.

2. Elevated trend visualization of outbreak-associated isolates that have clinically important AMR by updating BEAM (Bacteria, Enterics, Amoeba, and Mycotics) Dashboard with NARMS data.

3. Enhanced communication of NARMS findings through multiple avenues including publication of Integrated Reports, interim NARMS updates to highlight emergent trends, issuance of Health Advisories and/or Travel Notices/Watches, and focused commodity group meetings.

4. Advanced clinical medicine by collaborating with Sanford Guide (via Sanford Guide's Spectra of Activity tool) to broaden access to the latest *Salmonella, Shigella*, and *Campylobacter* AMR data enabling clinicians to make better informed healthcare decisions.

5. Expanded data accessibility by initiating annual publication of sample and isolate-level AMR data and metadata from food-producing animal ceca and food products.

6. Improved communication of findings by collecting and communicating data on risk factors, clinical outcomes, and genetic mechanisms of AMR to the scientific community through publications in scientific journals and presentations at scientific meetings.

Assess the Sources and Impact of AMR and the Effectiveness of Prevention Practices for Foodborne Pathogens

Impact: NARMS was used to advance in-depth collaborative AMR research and to guide actions to further strengthen public health, including the advancement of clinical medicine through better treatment guidelines.

1. Facilitated easier interpretation of AST data for key enteric pathogens through updated guidance. These include the Clinical and Laboratory Standards Institute clinical guidance for *Campylobacter, Shigella*, and *Vibrio*, as well as *Vibrio* guidance provided by the European Committee on Antimicrobial Susceptibility Testing.

2. Updated clinical treatment guidelines to support optimal patient outcomes such as the Red Book, Yellow Book, and UpToDate, through collaboration with academic and society organizations.

3. Identified genomic features associated with animal sources by implementing routine bioinformatics analyses.

4. Promoted advancements in veterinary AMS and use monitoring, through the FDA Vet-LIRN, the USDA NAHLN and CDC Food Safety Center of Excellence partner collaborations, in which veterinary diagnostic laboratories were incorporated into the nation's AMR monitoring activities.

LINKS TO ADDITIONAL INFORMATION

Additional information about NARMS can be found on the FDA, CDC, and USDA websites listed below. The FDA website also includes NARMS Executive Reports, which summarize data from all three agencies.

FDA:

https://www.fda.gov/animal-veterinary/antimicrobial-resistance/national-antimicrobial-resistance-monitoring-system

CDC:

https://www.cdc.gov/narms/index.html

USDA:

https://www.fsis.usda.gov/science-data/national-antimicrobial-resistance-monitoring-system-narms

USDA:

https://www.aphis.usda.gov/labs/nahln

https://www.aphis.usda.gov/labs/nahln/approved-labs/amr