



Role of AI in AMR Surveillance

*Ambika Paul and Sarjna Meena

Post Graduate Institute of Veterinary Education and Research, Jamdoli, Jaipur,
302031, Rajasthan University of Veterinary and Animal Sciences, Jobner, Jaipur

*Corresponding Author's email: ambika.paul96@gmail.com

Antimicrobial resistance (AMR) is one of the 21st century's most pressing global health crises. When bacteria and other microbes evolve to withstand antibiotics and other drugs, common infections become harder to treat, leading to prolonged illness, higher medical costs, and thousands of deaths worldwide each year. To stay ahead of this fast-moving threat, scientists and health authorities are forming alliances with Artificial Intelligence (AI). Recent advances in machine learning and data science are helping researchers and clinicians not only track resistant pathogens more effectively but also forecast resistance patterns, identify emerging threats earlier, and support smarter antibiotic use. By combining computational power with health data, AI is reshaping how we detect, track, and predict antimicrobial resistance.

Significance of AMR Surveillance

Surveillance is the backbone of AMR control. It involves collecting and analyzing data on resistant infections from hospitals, labs, and community settings to understand how resistance is spreading. Traditional surveillance systems, however, often struggle with fragmented data, delays in reporting, and limited analytical capacity. As resistance evolves rapidly, delays in detection can have serious consequences. AI offers a way to modernize surveillance, making it faster, more comprehensive, and more predictive.

Transforming data overload into clear signals

Modern healthcare generates vast amounts of data from microbiology lab reports and hospital records to antibiotic prescription data. AI systems excel at handling this complexity. Machine learning algorithms can integrate multiple data streams, clean inconsistencies, and detect resistance patterns across regions and time periods. Studies show how AI can convert routine clinical data into real-time surveillance insights, improving situational awareness for public health authorities. This enables real-time or near real-time tracking of resistance trends and provides public health authorities of emerging resistant strains.

Early Warning Strategies for Emerging Resistance

This enables real-time or near real-time tracking of resistance trends and provides public health authorities a clearer picture of where resistant strains are emerging. By learning from historical trends, AI models can identify subtle shifts in resistance patterns that may signal an emerging outbreak or a newly resistant strain. Research in Scientific Reports demonstrates that machine learning models can accurately predict antibiotic resistance phenotypes from surveillance datasets, often earlier than conventional analytical methods.

Predicting Resistance Before It Spreads

Beyond simply detecting resistance, AI can help predict how resistance may evolve in the future. Using advanced algorithms, researchers have developed models that forecast resistance patterns based on historical surveillance data, antibiotic use, and other clinical

variables. For example, machine learning models like XGBoost have shown high accuracy in predicting bacterial resistance phenotypes from large surveillance datasets, suggesting that AI could support proactive public health planning.

Enhancing Genomic Surveillance

AI also plays a key role in analyzing genomic data from pathogens. Whole-genome sequencing generates detailed “blueprints” of microbial DNA, but interpreting this data quickly and accurately is challenging. Machine learning tools help identify genes associated with resistance, track how resistant strains spread geographically and temporally, and enable faster surveillance than traditional laboratory methods.

Supporting One Health Surveillance

AMR doesn’t only affect humans—it arises and spreads across animals, food systems, and the environment. A recent scoping review highlights that AI can integrate datasets across these multiple domains, enhancing “One Health” surveillance that connects human health with veterinary and environmental information. This integrated approach is essential for understanding how resistance moves between species and ecosystems.

Strengthening Clinical Decision-Making

In addition to population-level surveillance, AI can help clinicians make better treatment choices. AI-driven clinical decision support systems analyze patient data in real time to recommend the most effective antibiotics based on local resistance patterns. This helps reduce inappropriate antibiotic use—a major driver of AMR—and supports precision therapy.

Challenges and Ethical Considerations

Despite the promise of AI, obstacles remain. Many AI models require high-quality, standardized data, which is lacking in some regions. Data privacy, model transparency, and integration into existing health systems are ongoing challenges. Experts emphasize that achieving the full benefits of AI will require investment in infrastructure, data standards, and ethical frameworks.

Conclusion

AI is not a magic bullet, but it is rapidly becoming a crucial tool in the global AMR response. By combining powerful data analysis with real-world surveillance needs, AI can help detect resistance earlier, predict future threats, support smarter treatment decisions, and ultimately strengthen public health systems. As technology and data capacity grow, AI-enabled AMR surveillance may offer one of our best defenses against the rise of superbugs.

References

1. Hanna A et al. How AI can help us beat antimicrobial resistance. *npj Antimicrobials and Resistance*, 2025.
2. Mutisya et al. Prediction of antibiotic resistance using machine learning on global surveillance data. *Scientific Reports*, 2025.
3. Scoping review on AI, One Health, and AMR surveillance. PubMed-indexed review, 2025.
4. AI and clinical decision support for AMR. PubMed-indexed article, 2024–2025.