Researchers identify genetic ‘fingerprint’ to predict drug resistance in bacteria

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The study identified a genetic signature in bacteria that, when present, indicates the likelihood of developing antibiotic resistance, said Kalen Hall, PhD, CEO and cofounder of Informuta who spearheaded the research before graduating from Tulane University School of Medicine in 2024.

Antibiotic resistance is a global public health crisis responsible for more than a million deaths annually. By 2050, the World Health Organization estimates it could surpass cancer and heart disease as the leading cause of death as more bacteria

develop defenses to the drugs designed to combat them.

Now researchers from Tulane University and Informuta, Inc. have identified a unique genetic signature in bacteria that can predict their likelihood of developing antibiotic resistance, according to a new study published in *Nature Communications*. The findings could help researchers more quickly identify precision-based treatments that are more effective against the deadly, treatment-resistant pathogens.

“If we see this pattern when we sequence its genome, we can expect it to become drug-resistant if you try to treat it,” said lead author Kalen Hall, PhD, CEO and cofounder of Informuta who spearheaded the research before graduating from Tulane University School of Medicine in 2024.

At the center of the study is *Pseudomonas aeruginosa*, a bacteria with a known history of multidrug resistance and a common cause of infection in hospitals. The bacteria are prone to deficiencies in a specific DNA repair pathway, a condition known to spur rapid mutations in bacteria, which increase the odds of drug resistance developing.

After analyzing the bacterial genomes for mutational signatures – a technique typically used in cancer research to map genetic changes in tumors – the team found a distinct pattern associated with these DNA repair deficiencies that accurately predicted bacteria’s potential to develop antibiotic resistance.

“It’s essentially a fingerprint that’s able to predict the presence of potential multidrug-resistant bacteria,” said Zac Pursell, PhD, associate professor of biochemistry and molecular biology at Tulane University School of Medicine.

Resistance can only be acquired when bacteria are treated with an antibiotic that fails to kill them, underscoring the need to identify the proper path of treatment. Making matters worse, the findings show that bacteria acquire resistance to drugs not involved in initial treatment.

“Over 50% of antibiotics prescribed are either unnecessary or the wrong treatment, and if you provide the wrong antibiotic, you’re promoting more and more resistance,” Hall said.

Importantly, the same DNA sequencing technology that can identify bacterial “fingerprints” can also identify points of attack for clinicians. The researchers found success identifying separate resistance pathways and administering specific combinations of antibiotics that target these pathways, preventing the bacteria from acquiring drug resistance.

Though the findings are still in their early stages, successful creation of a diagnostic tool could reduce the overuse of antibiotics and allow for more precise treatment of bacterial infections. Going forward, Hall’s biotech startup aims to develop a machine learning model that can scan bacteria samples and predict the development of antibiotic resistance.

“There’s absolutely nothing like this available right now, and it would be game changing for so many patient populations. Antibiotic resistance is getting worse year over year,” Hall said. “I believe proper antibiotic stewardship and accurate diagnostics are important pieces of the puzzle.”

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