NEW DEVELOPMENTS IN RAPID DIAGNOSTIC TECHNOLOGY FOR ANTIMICROBIAL RESISTANCE

E.C. Alocilja¹, M.K. Vashe², B. Etchebarne², Z. Li²

¹Department of Biosystems and Agricultural Engineering, ²College of Osteopathic Medicine
Michigan State University

*Corresponding author, Tel.: (+1-517) 432-8672; Email: alocilja@msu.edu

Antimicrobial resistance (AMR) is a complex interconnected problem that affects all sectors of society. It undermines efforts for effective prevention and treatment of infections. Increasing levels of resistance have important economic implications as second and third-line regimens are many times more expensive than first-line drugs. A recent World Bank report indicated that by 2050, AMR would cause low-income countries to lose more than 5% of their GDP and push up to 28 million people into poverty, the volume of global real exports would shrink by 1.1–3.8%, global healthcare costs may range from USD300 billion to more than USD1 trillion per year, and the decline in livestock production could range from 2.6% to 7.5% per year⁷. Presently, there are disturbing cases of drug resistance to last-resort antibiotics, such as Klebsiella pneumoniae showing resistance to carbapenem; Escherichia coli to fluoroquinolone; and gonorrhea to cephalosporin. Carbapenem-resistant Enterobacteriaceae have shown resistance to colistin. Multidrug-resistant tuberculosis (TB), extensively drug-resistant TB, and drug-resistant malaria are on the rise. If AMR is unchecked, many infectious diseases will again be untreatable, reversing progress in public health. Coordinated action is required to minimise the emergence and spread of AMR. Greater innovation and investment are required in research and development of new antimicrobial medicines, vaccines, and diagnostic tools. Unless addressed swiftly and seriously and on a sustained basis—the growing global problem of antibiotic resistance will be disastrous for human and animal health, food production and global economies⁸.

To address this global problem, AMR mitigation strategies must aim to reduce antibiotic use. Rapid diagnostics will play a critical role in ensuring that antibiotics are prescribed only when they are appropriate. To support the decision to prescribe appropriate antibiotics, the detection technology must be able to provide near-real time results, automatic alerts, rapid report, affordable, accessible, and simple to use. Furthermore, rapid determination of antimicrobial susceptibility is crucial for the optimal antimicrobial therapy of infected patients. Rapid testing is also required to monitor the spread of resistant organisms throughout the community. Recent developments in rapid diagnostic technologies for AMR include molecular tests and pyrosequencing assays⁵. However, phenotypic methods will continue to have an advantage when resistance to the same antimicrobial agent may be due to several different mechanisms. The diversity of genetic mechanisms may exceed the capabilities of current molecular technology⁷. While genotypic assays have the ability to detect resistance, they cannot detect susceptibility. And although results can be obtained rapidly, many molecular methods are labour-intensive, expensive, lack standardisation, prone to false-positive results due to potential contamination, requires a laboratory infrastructure, and needs skilled personnel to perform the assay.

This paper will present an innovative cell phone-enabled technology that combines a phenotypic-based assay for quick disease screening and a molecular assay for disease confirmation that addresses many of the weaknesses of existing methods. Phenotypic screening is completed in <10 minutes for <USD0.05 per test and the molecular confirmation is completed in <2 hours for <USD2 per test; report is generated in real time; diagnosis and symptoms are corroborated; historical data of the diagnosis are retrievable; data are stored in a central location; and geographical distribution and trend analysis of the infection are available. The technology is field-operable, universally accessible, and simple to use; it requires no equipment, no electricity, and no refrigeration; and it facilitates data sharing across locations.

References