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Combating AMR with Diagnostics

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Antimicrobial resistance (AMR) has been identified by the World Health Organisation (WHO) as one of the top ten global healthcare threats. Globally, mortality due to AMR is projected to reach 10 million deaths per year by 2050, of which 2 million deaths will be in India alone. Antimicrobial Resistance, as we know, is when disease (infection) causing pathogens or microbes, be they bacteria, fungi or virus, due to changes in their DNA, develop a resistance to antimicrobials or drugs used to treat the infection. In a short timeframe, these microbes develop resistance to multiple drugs and are called 'superbugs'. The rapid spread of superbugs make existing disease management and treatment regimens ineffective leading to prolonged leading to prolonged infections, increase in severity of disease, or high risk of death

The overuse of antibiotics in disease management and the misuse or unregulated use of antibiotics to treat medical conditions are primary drivers of AMR from a clinical standpoint. On the other hand, excessive use of antimicrobials to enhance productivity of livestock, aquaculture, crops, and the unregulated waste management of toxic chemicals in water bodies are other major reasons for the emergence of drug resistant microbes in the environment that is finding their way through food and water to cause serious threats to the health of humans, animals and plants. In 2010, India alone recorded a staggering 12.9 billion units of antibiotic consumption, the highest among all the countries! This figure indicates the gravity of continued drug use and its concomitant effects on the increasing case of AMR.

Diagnostics for effective management of AMR

Early diagnosis plays a significant role in effective management of AMR. Faster and accurate diagnostic tests enable identification and detection of microbes such that the patient can be treated with the most appropriate drug in time. This prevents misuse or overuse of antibiotics. Furthermore, diagnostics protocols can be effectively utilised in disease surveillance and occurrence of resistance patterns. This can play a vital role in timely interventions as well as prevention of further spread of the disease.

Emerging diagnostic technologies

Conventional methods like solid and liquid culture tests and staining techniques that have been the gold standards for the identification and characterisation of bacteria, were developed over 70 years back. These are time consuming and are limited in their use for rapid and timely clinical interventions. Molecular diagnostics, on the other hand, offer time efficiency and higher precision. High throughput, cost effective platforms, with high accuracy, high sensitivity and low turnaround time is the need of the hour.

Diagnostics for pathogen identification along with rapid and cost-effective antibiotic susceptibility testing (AST) at point of care can drive better treatment outcomes at scale. Technologies like mass spectroscopy, microfluidics, whole genome sequencing, artificial intelligence/machine learning (AI/ML) algorithms, single cell assays, radio-imaging and biosensor-based AST are promising technologies that can go a long way in effective prevention and for evidence-based treatment regimens against AMR.

Advancing innovations in AMR diagnostics

The Centre for Cellular and Molecular Platforms (C-CAMP) is one of India's most exciting Life Science entrepreneurial ecosystems and is an initiative supported by the Department of Biotechnology, Government of India. AMR is a key focus area and C-CAMP has funded, incubated and mentored many innovative start-ups in this domain. C-CAMP is also part of the CARB-X Global Accelerator Network. CARB-X is one of the largest not-for-profit partnerships, dedicated to accelerating the early development of antibacterial products. C-CAMP, in association with CARB-X, conducts an AMR Quest annually, to identify and support promising innovations that can combat AMR. The three month AMR Accelerator Program that follows the AMR Quest, supports innovators, start-ups and SMEs to validate and fast-track their solutions to the market.

C-CAMP's AMR portfolio in diagnostics includes Achira Labs that has developed Bug Check, a rapid molecular diagnostics platform for identification of microbial species and antimicrobial resistance genes in urinary tract infections; Module Innovations which is developing AST assays for UTI that has a rapid turnaround time of less than two hours, and WeInnovate Biosolutions' RAPID, is a device for fast and affordable solution for AST of various pathogens. T-CLINCH developed by ImmuGenix Biosciences, is a novel CRISPR-based point-of-care diagnostics (CRISPR-Dx) for AMR Adiuvo Diagnostics, has a rapid phenotypic device that uses autofluorescence and machine learning for AST, and Rapiddx is working on a microfluidics based rapid personalised antimicrobial susceptibility assay (r-PASA).

In line with its mandate, CARB-X is funding and supporting many cutting-edge innovations for AMR Diagnostics, including Module Innovations, with 11 innovative diagnostics projects currently progressing in the portfolio.Culture-free tests developed for use directly in patient samples include HelixBind's RaPID that characterizes microbes directly from the patient's sample, Proteus aims to identify the infecting bacteria within 60 seconds in human lungs using bacteria-specific Smart probes and fibre-based imaging and Day Zero Diagnostics uses machine learning algorithms for bacterial DNA analysis collected directly from a patient's sample. Single cell analysis is another emerging technology and Pattern Bioscience uses this technology in combination with deep learning to provide rapid identification and ID/AST to diagnose drug resistant microbes. Talis' innovation aims at developing high-performance, low-cost molecular diagnostic capability at the point-of-care (PoC) to identify Chlamydia and Gonorrhea directly from a patient's sample in less than 20 minutes, followed by antibiotic susceptibility within minutes, for the positive cases of Gonorrhea. T2 Biosystems' use of T2 Magnetic Resonance (T2MR®) technology detects microbes and resistance markers directly in whole blood and avoids the need for blood cultures. To improve efficiency of microbial culture-based assays, Avails Medical's 96 integrated sensors module does eAST directly in microbial cultures.

Collective endeavour

With such advancements in diagnostics in the last few years, we expect to see many of these exciting innovations reaching the market to create wider impact at scale. This can be further boosted by a collective effort among stakeholders, including product developers, policy makers, regulatory bodies, and health organisations. We strongly believe that this concerted effort can bring in the required policies for quality systems, supply-chain, incentivising the healthcare system, etc, for the deployment of these new-age diagnostics.

An editorial piece by Team C-CAMP (Centre for Cellular and Molecular Platforms)