Need for Rapid Antimicrobial Susceptibility Testing Devices in Rural Areas

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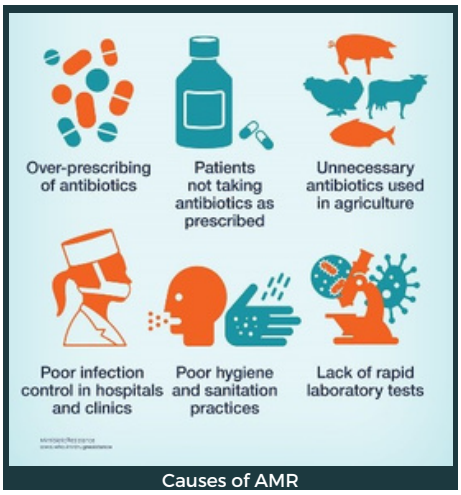
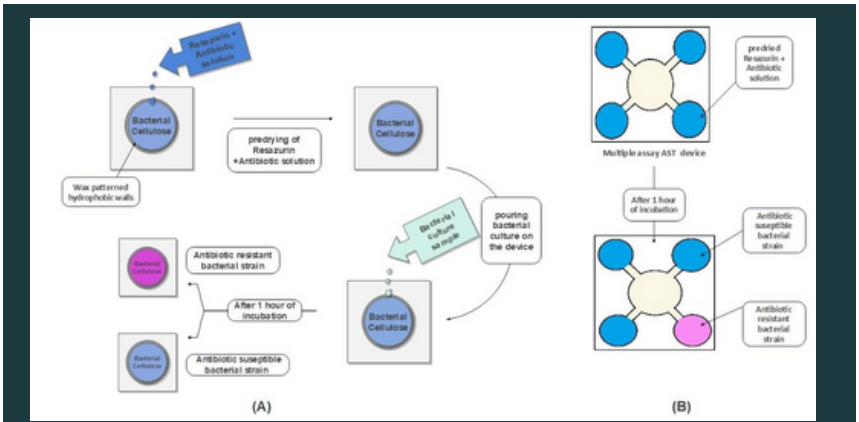
Antibiotic/antimicrobial resistance (AMR) is among the looming global health concerns. In 2014, estimates and actual data show that infections with AMR led to the loss of over 7 million lives every year, and that number has been predicted to rise to 10 million lives by 2050. To tackle the growing issue of AMR, antimicrobial stewardship strategies are being adopted in health systems all over the world, mainly in hospitals. These programs are not well established in this industry despite the importance of primary healthcare services in providing healthcare to communities, especially in rural and remote areas.



Causes of AMR

People in rural areas frequently face healthcare obstacles that restrict their capacity to get the care they need. Barriers to care include shortages of workers, health literacy, and stigma in remote regions. The risk of long-distance travel to obtain healthcare services is higher for rural people. In terms of travel time, expense, and lost productivity, this can be a heavy load.

Due to a lack of awareness of the misuse of antibiotics, restricted diagnostic facilities, self-medication, and unauthorized sale of antibiotics, rural residents are prone to the adverse effects of AMR. Even worse, some patients turn to traditional healers for their initial course of treatment, receiving herbal combinations for the management of illnesses. These chemicals, whose composition and potency are unclear, may improve pathogen fitness and aid in the emergence of resistance.



(A) Schematic of our method (B) Schematic of multiplexed AST assays

One of the intervention strategies to tackle AMR is to conduct Antimicrobial Susceptibility Testing (AST) rapidly to allow patients to follow the right therapy instructions. The conventional methods of broth dilution or disk diffusion are labor-intensive and expensive, requiring about 1-2 days to produce results. By then, the patient suffering a bacterial infection would be at risk of consuming broad-spectrum antibiotics.


(A) BC pellicle (B) FDBC (C) Device Fabrication

In the existing literature, filter paper-based microfluidic devices served the purpose of quicker detection. But these, too, have their own set of limitations, be it quick dry-up, low porosity, and poor water-holding capacity, which is not favorable for bacterial growth.

We (Micro Reaction Engineering Lab and Cellulose & Composites Group) were looking for a material/substrate that does not have these drawbacks. Bacterial Cellulose (BC), a biopolymer is known for its purity, high porosity, high retention, & water-holding capacity, & 3-D Nano fibrous network.

So, using Freeze-Dried Bacterial Cellulose (FDBC) as the substrate to carry out the visual detection assay seemed like an ideal solution. The fabricated device had FDBC as the substrate on which optimized volumes of antibiotics, resazurin dye, and a bacterial sample were added. Hydrophobic barriers are made with help of wax to control fluid flow on the devices. The color change due to pH-sensitive dye gives out the susceptibility results.

Moreover, this project aims to produce devices with aligned cellulose nanofibers which will expedite the detection. Hence, the developed device will be capable of detecting susceptibility quicker (less than 1 hour) with very low volumes of fluid. The assay packaging and ease of use will be focused on in order to optimize the design for multiplexed AST. This would help to improve the clinical viability of the device.

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