Fighting antibiotic resistance

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From farm to fork -- how engineers are helping fight antibiotic resistance

Scientists have recognized the threat of antibiotic-resistant pathogens for a long time, but more recently the call for action has arrived on the doorsteps of government and academia. Among the professionals joining in the worldwide battle are engineers.

Earlier this month, MSU hosted the Fourth International Symposium on the Environmental Dimension of Antibiotic Resistance (EDAR) for 250 participants from 30 countries.

Conference convener James Tiedje, University Distinguished Professor in the Department of Plant, Soil and Microbial Sciences, noted that engineers like Edwin Willits Professor Syed Hashsham and Research Assistant Professor Robert Stedtfeld, both from the MSU Department of Civil and Environmental Engineering, are already working on ways to evaluate the antibiotic resistance implications for human health.

Stedtfeld and Hashsham have developed tools for simple and low-cost field surveillance.

“Such platforms are expected to have a large impact on high-risk populations, such as those in Southeast Asia,” Stedtfeld explained. “In an attempt to bridge gaps between environmental occurrence and health, we have also developed an occurrence database called the Antibiotic Resistance Dashboard Application. This mapping tool can be used to further enhance international efforts and potentially allow for timely analysis of antimicrobial dissemination.”

Stedtfeld said the overall goal is to help sick people get more therapeutic utility out of antibiotics. That can be done by reducing selective pressures of antibiotic resistance and diminish potential transmission to human pathogens.

“While ambitious, the highly integrated and multidisciplinary tasks are strengthened by conferences such as EDAR,” he added.
A number of internationally known experts were among those featured at the EDAR conference, including Ed Topp, principal research scientist at the London, Ontario, Research and Development Centre for Agriculture and Agri-Food Canada; Amy Pruden, the W. Thomas Rice Professor at Virginia Tech’s Department of Civil & Environmental Engineering; and Tong Zhang, from the Environmental Biotechnology Laboratory in the Department of Civil Engineering at the University of Hong Kong.

Topp has led several national studies to better manage the risks that food production practices pose for environmental quality and human health.

Pruden thinks bringing engineers into the research framework is “hitting the nail on the head.” She is currently leading projects to identify critical control points for the spread of antibiotic resistance from farm to fork and in sustainable water systems.

Zhang said engineers can contribute through sanitation and water treatment of the different sources, including wastewater treatment plants, pharmaceutical industries, hospitals, and by managing livestock.

“Being an engineer, we may start with wastewater from pharmaceutical industries and hospitals, using membrane filtration to remove pharmaceutical and resistant bacteria together and apply incineration to destroy them completely. For domestic wastewater treatment plants, advanced treatment should be applied, including membrane filtration or ozonation, to further reduce the discharge to the environment.”

Jade Mitchell, assistant professor in the Department of Biosystems and Agricultural Engineering at MSU, has also joined the antimicrobial resistance fight.
“My work is focused on understanding the human health risk associated with using antibiotics in agricultural settings,” she said. “My research group is currently collecting data through experiments to estimate the potential for antimicrobial resistant genes to spread to non-resistant bacteria in the gut and the environment.

“Ultimately, our goal is to build a computational exposure model that includes the expected increases in antimicrobial resistance in natural and man-made systems. That will help us estimate human exposures and health risks,” she explained. “This effort brings research efforts from many of these fields.”

Hashsham emphasized that “it is critical that experts from many fields including engineering and basic sciences come together to establish principles related to spread of antimicrobial resistance and develop tools for global surveillance both in the environment and in clinical settings because antimicrobial resistance is inevitable. Resistance invariably emerges within five to eight years of the introduction of a new antibiotic.”

The EDAR conference was supported, in part, by the USDA National Institute of Food and Agriculture, Zoetis, MSU’s Office of the Vice President for Research and Graduate Studies, and the four colleges with expertise central to the problem: Agriculture and Natural Resources, Engineering, Natural Science, and Veterinary Medicine.