Battling bacteria: Kean faculty, students on front line of researching antibiotic resistance

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Dr. Keith Bostian of Kean University's New Jersey Center for Science, Technology and Mathematics. - (AARON HOUSTON)

According to the **Center for Disease Control and Prevention**, at least 23,000 people in the U.S. die annually from multidrug resistance. About 2 million more don't respond to treatment, leading to increased severity of disease, time spent in the ICU, loss in quality of life and increased health care costs. Although this estimate has been called into question by some, a 2016 **Organization for Economic Cooperation and Development** report and others point toward the staggering possibility that the current annual global antimicrobial resistance death rate of 700,000 could grow substantially if action is not taken to combat the problem.

Dr. Keith Bostian, dean of **Kean University's New Jersey Center for Science, Technology and Mathematics**, is an expert on antibiotics resistance and is currently conducting cutting-edge research on the topic. Bostian recently met in Europe with the organization CARB-X (Combating Antibiotic Resistant Bacteria) to explain how the Institute of Life Science Entrepreneurship at Kean is helping advance its mission of identifying and developing new antibiotics to fight super bugs that no longer respond to current agents.

Diseases such as tuberculosis, malaria and pneumonia are treated with antibiotics, Bostian said, and these drugs are also critical to the care of patients suffering from a wide range of medical conditions. Even previously non-threatening infections such as chlamydia and gonorrhea “are now posing a much greater threat,” he added.

“Diseases are rapidly becoming resistant to existing antimicrobial drugs, and there are insufficient new drugs being developed to replace them. This makes antimicrobial resistance a critical risk for current and future generations,” Bostian said. He said prevention, rapid diagnostics, good stewardship and new drugs, collectively, are the solution to the problem. However, he stressed new antibiotics are critically important. “We are in a situation now where there are few new antibiotics in the development pipeline and more bacteria with few or no effective treatments. This will lead to dire consequences for modern medicine if left unchecked,” he said.

According to Bostian, a variety of antibiotic-resistant bacteria are found in every state, a few being the more dangerous multidrug-resistant strains. New Jersey is no exception. The CDC recently reported that over the past year New Jersey had at least seven cases of carbapenem-resistant Enterobacteriaceae, or CRE, known as the “nightmare bacteria” because this class of antibiotics is considered the last resort for treating these types of infections. According to the CDC, the bacteria kills up to 50 percent of those infected by it.

Another recent report, according to Bostian, was of a strain of Escherichia coli isolated in a New Jersey hospital in 2014 that possessed mobile genes, making it resistant to both broad-spectrum carbapenem antibiotics as well as colistin, an older antibiotic also increasingly used as a last resort for multidrug-resistant infections.

“These are just two notable examples at home of the global problem,” he said. “It is important to point out that these multidrug-resistant infections are found in a small subset of infected patients, that the patients mentioned here were all successfully treated with other antibiotics and that they did not cause major outbreaks of drug-resistant infections. It is a reminder, though, of the need for new treatments and the need to monitor and track multidrug-resistant organisms.”

Bostian stressed that the threat is global, and as such is increasing the spread of resistance, both in hospitals and communities.

New Jersey is doing its part in the fight against antibiotic resistance.

“We are encouraged by commitments at the state level through Gov. Murphy’s initiatives and the New Jersey Economic Development Authority to improve the innovative capacity in the state and the search for new drugs active against the resistant bacteria,” Bostian said. “Big pharma companies have exited the antibiotic discovery arena but have made some of their drug programs available to spinout companies.”

Bostian said Kean students and faculty are involved in many of these projects, from performing lab work to learning about how research is done in a relevant setting.

“They do this through internships, part-time jobs and some graduates of our growing biotechnology program have landed full-time positions with the companies,” he said. “The faculty also gets to contribute their expertise through an open and collaborative interaction with Institute of Life Science Entrepreneurship in incubated companies and benefit from real-world projects coming onto campus. It is an exciting dynamic for Kean and for the companies.”

ILSE is a nonprofit, regional life sciences institute located on the Kean campus in Union. It is an incubator and accelerator, supporting over 20 companies through its Entrepreneur Center and ATCC Center for Translational Microbiology. It is also a research institute with deep expertise in microbiology and antibiotic R&D. Kean students, interns and alumni (as employees) are also involved in ILSE's antibacterial research, conducting sponsored research for about a half-dozen biopharma companies locally and abroad, developing novel antibiotics active against MDR bacteria and microbiome approaches to disease. One such company incubated at ILSE is Prokaryotics Inc., a spinout of Merck & Co.'s antibacterial discovery programs.

Marshall Hayes, a full-time lecturer at New Jersey Center for Science, Technology and Mathematics, is the faculty leader of the Microbes and Microbiomes research stream within the Research First Initiative, an innovative curriculum that gives undergraduates the opportunity to engage in authentic research experiences early in their academic careers.

"In the RFI, the laboratory is our classroom," he said. "My students and I use both classical and molecular microbiological approaches to study microbial diversity and antimicrobial resistance.Students have isolated bacteria from various environments and have screened these isolates for resistance to antibiotics of clinical relevance." Undergraduate students have been involved in characterizing the function, activity and genetic bases of these molecules, with the goal of identifying novel bacterial products that may serve as future antibiotics, Hayes said.

Going forward, Bostian said he is hopeful the range of drug classes to fight off resistance will expand. "I am confident that technical solutions are at hand," he said. "I am pessimistic about the antibiotic marketplace and its failure, and the need to develop better business models with both push and pull incentives for the antibiotic developers. If we can find ways to improve the funding available to companies and commercial aspects of drug development, then we can address the massive problem of MDR."