Researchers develop highly accurate sensor for E. coli risk detection

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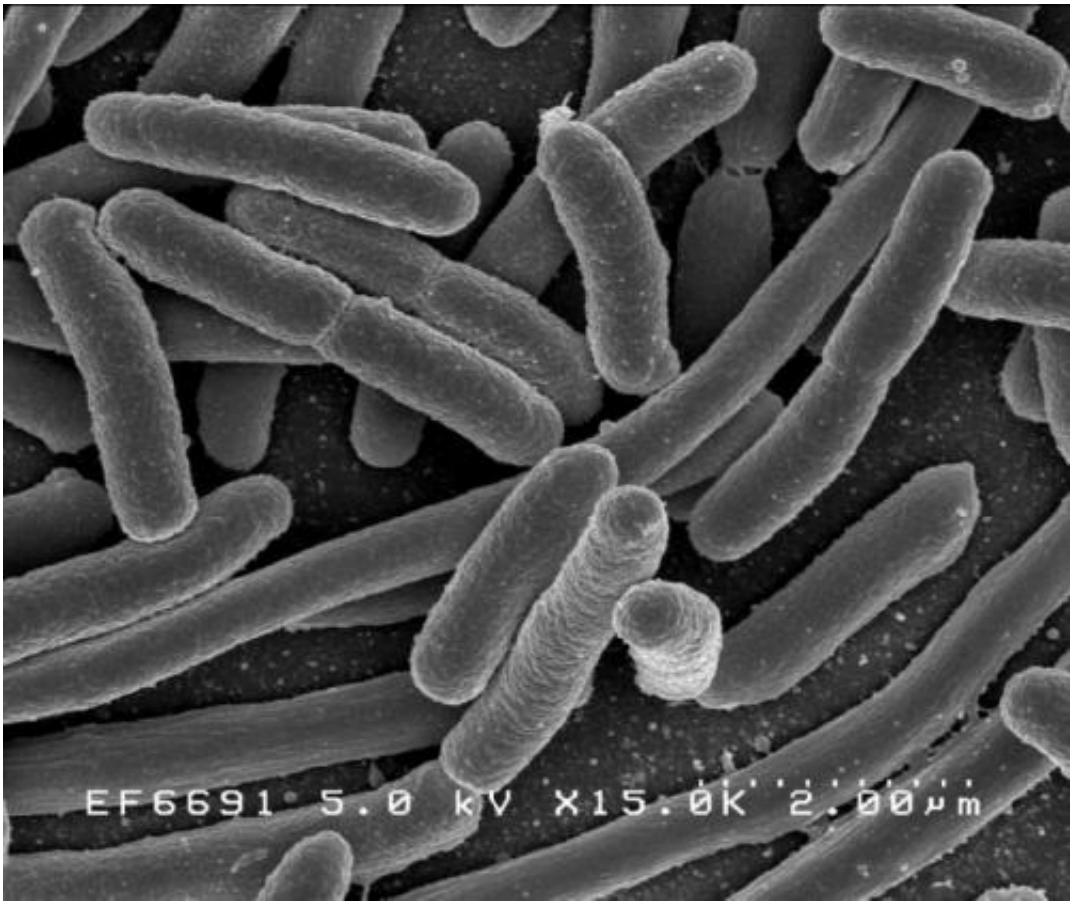

Escherichia coli. Credit: Rocky Mountain Laboratories, NIAID, NIH

Researchers at CU Boulder have developed and validated a new sensor for E. coli risk detection that features an impressive 83% accuracy rate when detecting contamination in surface waters.

The findings were recently published in *Water Research* and could improve detection of a variety of contaminants quickly and effectively in water systems around the globe and in America.

Emily Bedell (Ph.D.EnvEngr'22) is the lead author on the paper from the Mortenson Center in Global Engineering. She said about two billion people worldwide use a drinking water source that has some level of fecal matter in it and can cause health issues ranging from diarrhea to stunted growth—especially in young children.

"About 60% of all diarrheal deaths are related to water quality, globally," she said. "This is a real problem, but current methods for finding poop in drinking water are expensive, have high barriers to entry like extensive training requirements or can take about 24 hours to provide results. We have invented a sensor combined with a machine learning model that uses fluorescence to show fecal contamination spikes in real-time."

Both the sensor and machine learning model combination have been approved for a patent by the U.S. Patent Office.

Bedell said fluorescence works by shining a UV LED light source on a water sample and measuring the amount of light that is absorbed and re-emitted at a higher wavelength. That information can quickly show potential contamination, but it is sensitive to many environmental and physical factors such as sample temperature, which cause noise in the data and make it difficult to interpret.

"We use machine learning techniques to cut through that noise to better detect anomalies," Bedell said.

Fast and accurate assessment of water quality is a growing need—not only in low-income countries, but in situations like the Flint, Michigan water crisis where citizens were exposed to dangerous levels of lead

from poor government policies.

Professor Evan Thomas, director of the Mortenson Center, is a co-author on the paper. He said climate change is also a factor in this discussion as more frequent power outages may impact treatment facility operations and severe weather could contaminate critical water sources.

"We are going to need more data on water quality, and we need it to be widely available," he said. "Taking measurements once a day will not be enough to ensure we are receiving water that doesn't have either biological or chemical contaminants that can harm us in both the short and long term."

Bedell is now employed as an engineer for Virridy in Boulder and is working on advancing the technology further. Ideally it will function in partnership with a larger home treatment system for those utilizing a private well—where water quality is not regulated by the EPA—for their drinking water.

"That sensor will be a miniaturized version of the design built in this paper and will be installed on a house's main water line coming from the well," she said. "The sensor's data will be sent through the user's WiFi to an online database where the machine learning model will be applied to predict risk level and send the information to a mobile app that will alert the user if contamination is detected."

Bedell said she has always been interested in the intersections of engineering, the environment and social equity and this research project really brought those aspects together during her time with the Mortenson Center.

"Water quality research hits on all those points in so many ways. With more data we can explicitly point out how and when communities are

being harmed through environmental injustices so that the policies and practices put in place that caused the harm can be addressed," she said.

More information: Emily Bedell et al, A continuous, in-situ, near-time fluorescence sensor coupled with a machine learning model for detection of fecal contamination risk in drinking water: Design, characterization and field validation, *Water Research* (2022). DOI: 10.1016/j.watres.2022.118644

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