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Development of Rapid and Sensitive Bacteria Test For Environmental Water Without Sample Processing

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Abstract

Climate change and population growth continue to threaten the availability of potable water around the globe. In order to move toward a sustainable water future, it is necessary to maximize use of current water resources. Water reuse therefore has become an integral part of many water agencies' strategic planning. In particular, potable reuse can greatly supplement conventional drinking water sources and is attracting increased attention. Essential to potable reuse is public health protection, which in turn relies on effective treatment and monitoring. While redundant treatment elements can be effective, real-time monitoring tools to characterize microbial contamination is critical for assessing treatment efficiency and protecting public health. However, current microbial testing relies solely on culture-based methods that require a day or longer to produce a result. This delay prevents timely operational and managerial responses to microbial contamination events that could compromise the drinking water supply. Newer molecular methods such as quantitative polymerase chain reaction (qPCR) are faster, but expensive, and require multiple steps (filtration, nucleic acid extraction followed by qPCR) that still take several hours to produce results. Here we describe a rapid and sensitive microbial testing method based on Integrated Comprehensive Droplet Digital Detection (IC 3D). Our benchtop IC 3D system is capable of single-cell sensitivity with minimal processing in a culture-free step within 1 hour. The high sensitivity and simple workflow makes IC 3D a suitable candidate for real time monitoring for microbial contaminants in potable water systems. We are currently developing and validating our portable IC 3D system to perform rapid on site or real-time continuous microbial testing of source and finished water.