SCCWRP Annual Report 2003-04

A review of technologies for rapid detection of bacteria in recreational waters

Rachel T. Noble[1] and Stephen B. Weisberg

[1]*University of North Carolina at Chapel Hill, Institute of Marine Sciences, Morehead City, NC*

ABSTRACT

Monitoring of recreational beaches for fecal indicator bacteria is currently performed using culture-based technology that can require more than a day for laboratory analysis, during which time swimmers are at risk. Here we review new methods that have the potential to reduce the measurement period to less than an hour. These methods generally involve two steps. The first is target capture, in which the microbial group of interest (or some molecular/chemical/ or biochemical signature of the group) is removed, tagged or amplified to differentiate it from the remaining material in the sample. We discuss three classes of capture methods: 1) Surface and whole-cell recognition methods, including immunoassay techniques and molecule-specific probes; 2) Nucleic acid methods, including polymerase chain reaction (PCR), quantitative PCR (Q-PCR), nucleic acid sequence based amplification (NASBA) and microarrays; and 3) Enzyme/substrate methods utilizing chromogenic or fluorogenic substrates. The second step is detection, in which optical, electrochemical or piezoelectric technologies are used to quantify the captured, tagged or amplified material. The biggest technological hurdle for all of these methods is sensitivity, as EPA's recommended bathing water standard is less than one cell per ml and most detection technologies measure sample volumes less than 1 ml. This challenge is being overcome through addition of preconcentration or enrichment steps, which have the potential to boost sensitivity without the need to develop new detector technology. The second hurdle is demonstrating a relationship to health risk, since most new methods are based on measuring cell structure without assessing viability and may not relate to current water quality standards that were developed in epidemiology studies using culture-based methods. Enzyme/substrate methods may be the first rapid methods adopted because they are based on the same capture technology as currently-approved EPA methods and their relationship to health risk can be established by demonstrating equivalency to existing procedures. Demonstration of equivalency may also be possible for some surface and whole-cell recognition methods that capture bacteria in a potentially viable state. Nucleic acid technologies are the most versatile, but measure nonviable structure and will require inclusion in an epidemiological study to link their measurement with health risk.

Full Text

ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/2003_04AnnualReport/ar26-noble_pg328-337.pdf