New Science for More Accurate and Timely Swimming Advisories

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Nothing can spoil your day at the beach more than finding it posted with an "Advisory" notice for swimming. Ontario's Health Units require a swimming advisory when samples show that the E. coli content is higher than Ministry of Health guidelines for recreational water quality. The advisory sign normally remains posted at the beach until subsequent testing shows the risk to swimmers is once again within acceptable limits.

There are two types of posting: an advisory and a beach closure. An advisory is a warning that the water may contain levels of bacteria that may cause an increased risk of developing minor skin, eye, ear, nose and throat infections and stomach disorders. A rare beach closure occurs following catastrophic events, such as sewage spills, that present an immediate risk to health from contact with the water.

Health risks in swimming water arise from pathogens: harmful bacteria, viruses or protozoa from fecal sources, whether human, agricultural or wildlife. Unfortunately, it is difficult and costly to measure such pathogens directly. Therefore, E. coli is used as a surrogate, or "microbial indicator", for fecal pathogens because it can be readily measured with relatively inexpensive tests. The presence of E. coli indicates contamination from human or animal fecal wastes and possible occurrence of human-associated pathogens.

Current assessment methods

But how does a health unit currently go from sampling the water to deciding on its quality? The standard methods to grow and count the E. coli require 18-24 hours. Adding the time to collect water samples from several beaches, transport them to a laboratory, and decide whether or not the beach should be posted can take 2 to 3 days! But E. coli numbers in lake water can change significantly over much shorter times, and thus a beach posting reflects water quality 1 to 3 days ago, and not necessarily conditions on the day of the posting!

To provide more timely results, scientists have been working on two different methods to improve the timeliness of the assessments and the accuracy of beach postings. These are Rapid Analytical Methods and Predictive/Forecast Models.

Rapid Analytical Methods

Current methods for assessing E. coli in lake water are simple and inexpensive but have limitations noted above. Also, due to the manner in which the E. coli is cultured, current methods may give a false positive (overestimate the E. coli count) by culturing other bacteria, or a false negative (underestimate the E. coli count) because some E. coli in the sample won't grow in the lab. An alternative method that avoids the limitations of the current method is a DNA-based technique known as polymerase chain reaction (or simply PCR). From a single copy of the DNA of target bacteria, PCR can generate billions of copies of the DNA in a few hours, enabling rapid identification of presence of all of the specific bacteria, such as E. coli, in a sample of lake water. However, PCR does not provide a precise count of the number of bacteria in the sample.

Now an improved PCR technique, called Quantitative PCR (Q-PCR), will provide both an accurate count of the number of a specific bacteria, including E. coli, in the sample, and undertake the analysis much faster than PCR. Hence Q-PCR could be useful for a health unit that collects 80-90 lake water samples from several beaches in the morning, and in a few hours provide results to determine if beach postings are needed.

The Q-PCR technique provides both a more accurate assessment of E. coli numbers and a very rapid count of E. coli versus the current methods. The drawbacks of the Q-PCR method are higher cost of equipment and supplies, and the higher degree of skill required to operate the equipment and interpret results. Nevertheless, the U.S. Environmental Protection Agency is currently considering switching to Q-PCR for rapid and accurate assessment of E. coli in recreational waters.

Predictive/Forecast Modeling

It is well known that environmental conditions affect pollution in nearshore water. For example, rainwater runoff from fields can transport E. coli to a creek, which then discharges at a beach. Thus, just by observing conditions at a beach, we can make an educated guess as to whether or not we should expect elevated levels of E. coli today.