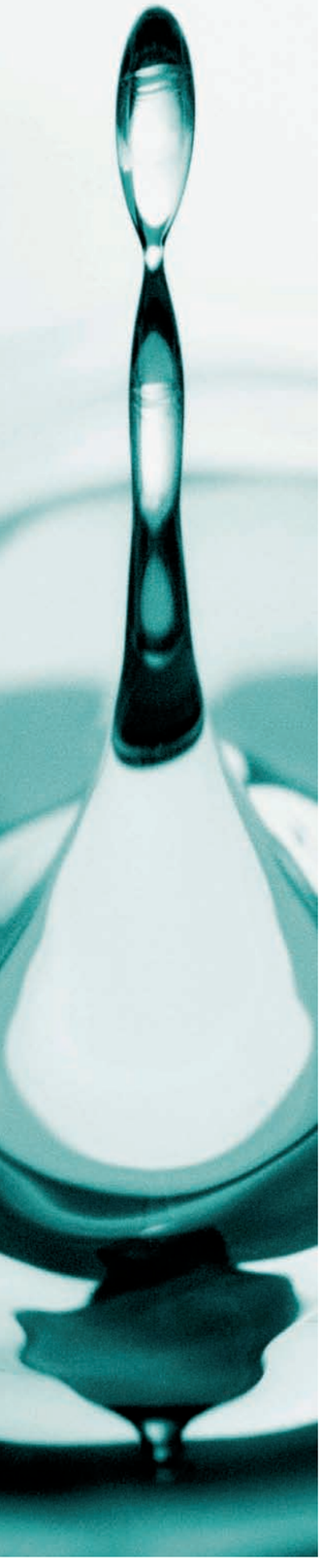

How can modern science help in the fight against the hidden microbial foes in our water supply? Water expert **Joan B. Rose** describes the issues and some of the solutions to the problem.

Science in the fight against water-borne disease

I am a water pollution microbiologist and I follow the microbes in faeces, from the septic tank to the beach, from the sewage to the river, from the manure to the well, from the irrigation waters to the vegetables, from the toilet to our hands. People and animals, even birds, deposit faecal microbes into the environment and many of them are infamous stealth agents, hidden and dangerous, secretly spreading disease through one of our most precious resources, water.

These microbes, bacteria, parasites and viruses, can be transmitted via contaminated water, food or through the surfaces we touch and our hands. They were designed to be excreted in high numbers by infected individuals, survive in the environment and be spread through ingestion. Table 1 provides a glimpse of some of these infamous water-borne pathogens. But new emerging microbes are also being discovered in sewage, including the ulcer-causing bacterium *Helicobacter* and cancer-causing polyomaviruses, and our investigations into their 'potential' for causing water-borne disease have just begun.

CSI for water (the case of the missing scientific data)

I heard once at a meeting that 'safe water' meant to a community what a 'safe blood supply' meant to medicine. Thus protecting the supply and vigilant monitoring are necessary to provide adequate life-saving water when and where we need it. Protection from disease-causing agents and pathogen discovery is one of the most important areas of study in the fight against water-borne disease. To really address how we can stop contamination and spread of disease to our communities through water we must first understand:

> the sources of these pathogens;
> their concentration in waste and water;
> their survival in the environment;
> their ability to be transported from the source to the exposure site;
> their ability to resist drinking water and wastewater treatment;
> their ability to cause harm.

Those of us undertaking such investigations have powerful new tools to assist in providing scientific data for each of the issues above. An example of such a tool is the polymerase chain reaction (PCR) – this can be used for source tracking, to identify virulence markers and to identify pathogens. By using these tools, the culprit can be found and the water-borne 'crime' can be solved. Yet investment in strategic/investigative monitoring is rarely made, thus we are left with many unsolved water-borne outbreaks and no scientific data to assist in preventing the next one.

Google water?

We have arrived, we made it to the 21st century. Information is plentiful, at the touch of a computer button we can gain access to all types of facts and figures. But, if you 'Google' *water*, you get 576,000,000 hits, including the US Environmental Protection Agency (EPA) website, the Power of Water, World Water Day, and Bottled Water. If you Google *water quality*, you get 167,000,000 hits; if you Google *water-borne disease*, you get 965,000 items, including the Centers for Disease Control (CDC) and World Heath Organization (WHO) websites. If you Google *water-borne disease maps* (you get one for US and one for Canada), you can find maps from the WHO from various countries: Zambia and cholera for example (www.reliefweb.int). Thus surveillance has improved – information is being formatted and disseminated. However, information is not necessarily knowledge. Our molecular tools have to be used within a framework which can aid decision-making, better strategic monitoring and communication.

The relationship between our health and water quality is also connected to quantity, precipitation, flooding, extreme events and land use. These interconnections must be thoroughly studied and tied into a risk-based framework which can be fed into Water Safety Plans (WSP) and Hazard Analysis and Critical Control Point (HACCP) strategies to protect the watershed and to address adequate treatment. Finally, we should all begin to think about our water ethics philosophy, from global agencies through government departments to local water authorities. Water-borne diseases are the plane crashes in a community and remain a significant threat to global health, particularly for the disadvantaged and our sensitive populations.

We have the scientific tools, and with the political support we could eradicate typhoid and cholera, those ancient diseases that still plague our world, and we can track down any newly emerging pathogen and learn what we need to do to both protect and respond to water contamination. In this century, those of us in the water pollution microbiology field can really begin to work toward stopping the faecal contamination of our waterways.

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Table 1. Ancient and modern infamous agents of water-borne disease

Microbe	Description	Famous for:	Current issues
Vibrio cholerae	Bacterium which causes cholera. No animals carry this bacterium but it can live in the marine environment.	Epidemics in London (Broad Street Pump); spread throughout the world with the first pandemic in 1817. Spread to every country in South America in one year, during 1990, the seventh pandemic.	Remains one of the most serious water-borne diseases in the world with a reported 100,000–250,000 cases per year with about 2,000–3,000 deaths (www.who.int/wer/2005/wer8031.pdf).
Salmonella typhi	Bacterium which causes typhoid. Comes from humans, highly tied to poor sanitation.	Plague of Athens. Epidemics during early settlements throughout history (London, India, Jamestown, Chicago).	The current disease burden of typhoid is estimated at 17 million cases per year and 600,000 deaths (www.who.int/vaccine_research/ diseases/typhoid/en/)
Escherichia coli O157:H7	Bacterium which causes haemolytic uraemic syndrome. Particularly associated with cattle and manure.	Outbreaks in swimming pools, during fairs from wells, from burgers and spinach. Famous for its ability to cause death in the young and old, affecting the kidney with some children needing kidney transplants.	Untreated animal manure and impact on untreated waters, including wells, irrigation water and recreational rivers and lakes.
Cryptosporidium hominus and *C. parvum*	Parasitic protozoa that cause severe diarrhoea; one type comes from humans, one from animals (e.g. cattle and sheep)	Causing the largest water park and drinking water outbreaks in recent times. Famous for being resistant to chlorine disinfection. Deadly to those with AIDS.	Widespread global pathogen, common in humans and animals. Increase in AIDS infections throughout the world suggests high vulnerability to disease with potential death.
Norovirus	Virus causing a rapid and violent vomiting and diarrhoeal illness. Comes from humans and survives on surfaces.	Cruise-ship vomiting disease. In the last year a new strain causing unprecedented outbreaks worldwide has appeared.	New strains developing rapidly; survives in water and on surfaces, and is difficult to clean up.