ON TAP

Emerging Infections

By Dr. Kelly Reynolds

People have been proffering doomsday predictions for eons. Lately, it seems the notion of new, killer viruses and bacterium running rampant throughout the world has captured the public's attention. Even Hollywood has jumped on the bandwagon with such movies as "Outbreak," the film in which Dustin Hoffman battles a killer virus. But what, if any, truth is there to these fictionalized accounts? As water treatment professionals, what do we need to be aware of?

The National Academy of Sciences Institute of Medicine in Washington, D.C., defines emerging infectious diseases as those whose incidence in humans has increased within the past two decades—or threatens to increase in the near future.

A new foe

While difficult to predict, most experts agree that new microbial diseases are certain to occur. In addition to newly discovered pathogens, emerging diseases may also be due to reemerging and drug-resistant microbes. According to the World Health Organization, 17.3 million individuals died of selected infectious diseases in 1995. Officials think these numbers are low because, many times, conditions such as cancer and diabetes can effectively mask the presence of an emerging infectious disease. Consequently, this is an area of great concern for health officials.

Still a long way to go

There are several ways by which an emerging pathogen can infect a person. Known as modes of transmission, these categories include: person-to-person, foodborne, waterborne and soilborne transmission. Foodborne, waterborne and soilborne transmission accounted for 22 percent of all deaths due to the selected infectious diseases. (See *On the Lookout*.)

Most disturbing for those in our industry is the fact that water may serve as an all too convenient medium for transport of microbial pathogens from one victim to another—owing to billions of waterborne infections each year. The following is a list of emerging pathogens known to be transmitted by the waterborne route:

1.) *E. coli 0157:H7*—An enterohem-orrhagic strain of *E. coli* capable of producing potent toxins that cause bloody diarrhea, kidney failure and death. Although more commonly associated with undercooked beef, waterborne outbreaks have occurred in 1989 and 1991, in Missouri and Oregon respectively. Unchlorinated well water and fecally contaminated recreational water were noted as contributing factors, respectively.

2.) *Cyanobacteria (blue green algae)*—Naturally occurring in fresh and brackish waters worldwide, algal blooms may be induced by high nutrient loads during agricultural or industrial runoff and produce a dangerous toxin. Acute health effects include gastroenteritis, liver or nervous system damage, pneumonia, sore throat, earache and irritation to the skin and eyes.

3.) *Cyclospora cayetanensis*—*Cyclospora* was identified as a new protozoan pathogen of humans in 1993. At 8-to-10 mm in diameter, it's larger than *Cryptosporidium* but smaller than *Giardia*. Contaminated water is most often the root cause of infection. Symptoms include watery diarrhea that may be prolonged in immunocompromised individuals.

4.) *Hepatitis E* virus—Tests have only recently been made available for this waterborne pathogen. Epidemics most often affect young adults and there is a high fatality rate in pregnant women—up to 30 percent. Inadequate chlorination and contaminated water appear to be the cause of large outbreaks in developing areas such as Africa, Asia and Mexico.

5.) *Group B Rotavirus*—Unlike group A rotaviruses, group B rotaviruses commonly infect adults causing a severe cholera-like illness. More than a million cases were reported in China between 1982 and 1983, and strong associations have been drawn to fecally contaminated water.

6.) *Vibrio cholerae 0139*—This new strain of V. cholerae is causing a new pandemic in Asia and is spreading to the Middle East, affecting persons of all ages. Fecally contaminated water and food appear to be the primary sources of infection.

7.) Other viruses, bacteria and protozoan suspected to cause waterborne disease are:

(1) Human astroviruses, enteric adenoviruses, caliciviruses, coronaviruses, toroviruses, pestiviruses, picobirnaviruses. These viruses cause a variety of gastrointestinal diseases and are suspected of waterborne transmission, but methods for their detection in water have not been developed.

(2) *Aeromonas species, Mycobacterium balnei, Helicobacter pylori* Bacteria of the Aeromonas species commonly are found in water and soil and may produce toxins capable

of causing gastroenteritis. *Mycobacterium balnei*, also common to the environment, may infect almost any site in the body, but are mostly associated with pulmonary disease and skin infections of the immunocompromised. *H. pylori* infections may result in peptic ulcers and gastric cancer.

(3) Microsporidia protozoa. These protozoa commonly are found in animals, may infect immunocompromised as well as healthy individuals, and cause persistent diarrhea.

For all of the progress the world has made battling infectious diseases, the death rate from this source has risen by more than 20 percent between 1980 and 1992 according to the World Health Organization. Outbreaks of *E. coli,* Hantavirus, and *Cryptosporidium* seemed to come from nowhere. In addition to these new adversaries, the reemergence of tuberculosis, cholera and malaria has caused us to reevaluate our true progress.

Where do they come from?

What causes the emergence of infectious diseases? The answer is not completely understood, but some of the major factors appear to be related to population dynamics, human behavior, geographical orientation, evolutionary mechanisms and ecological changes.

A good example of the unpredictability of infectious disease is the recent outbreak of the Hong Kong flu, which, until recently, only infected chickens. Researchers determined that it jumped to humans and that it is airborne, but were unable to learn much else, let alone how to contain the deadly disease. As a result, officials in China and Hong Kong shut down many markets and ordered the slaughter of every chicken. Most frightening is the fact that researchers don't know much about the disease or how to fight it. And this only serves to illustrate the problem researchers face with a multitude of emerging infections.

ON THE LOOKOUT

Of the nearly 52 million deaths in 1995 worldwide, 17.3 million occurred as a result of infectious disease. The top 10 list is:

1. Hepatitis B.....1.1 million
2. HIV/AIDS.....>1 million
3. Measles.....>1 million
4. Neonatal tetanus.....500,000
5. Whooping cough.....355,000
6. Roundworm and hookworm.....165,000
7. Acute respiratory infections.....4.4 million
8. Diarrhoeal diseases.....3.1 million
9. Tuberculosis.....3.1 million
10. Malaria.....2.1 million

These figures are referenced in the World Health Report 1996, WHO

Population dynamics

As the population of the world continues to grow at an explosive rate, resources cannot always keep up. The U.S. Census Bureau estimated there were 26 residents per square mile in the United States in 1900 compared to 83 in 1990. Many cities are overcrowded with poor or overstressed sanitation facilities and inadequate infrastructure. This presents a prime opportunity for pathogens to emerge.

FOR MORE INFORMATION

If you would like more information, I recommend the following article:

Moe, Christine L.,
"Waterborne transmission of infectious agents," *Manual of Environmental Microbology*, ASM Press, Washington, D.C., 1997.

Also, you can contact the respective health agencies for additional information:

The Institute of Medicine
2101 Constitution Avenue NW
Washington, DC 20418
(202) 334-2000

The Centers for Disease Control
1600 Clifton Road NE
Atlanta, GA 30333
(404) 639-3291

The World Health Organization
CH-1211 Geneva 27
Switzerland
+41 22 791 2111
email: postmaster@who.ch

Human behavior

Human behavior practices of intravenous drug abuse and unsafe sex provides additional routes of transmission for microbial pathogens. Even supposedly healthy behaviors may lead to infection as campers and hikers frequenting wooded or grassy areas are exposed to lyme disease-carrying ticks.

Furthermore, changing food industry practices and dietary choices may be responsible for an increase in the isolation rate of *Salmonella*. In addition, changes in water treatment, dispersal or disposal practices may create just enough of a niche for an emerging microbe to proliferate and initiate disease.

Geographical orientation

Our ability to bridge the geographical barriers via rapid airline travel has exposed countless individuals to new strains of organisms, against which they have no prior immunity. Such ease of travel also enables us to sample foods from distant parts of the world which may harbor new and deadly microbes.

Evolutionary mechanisms

While science and medicine have provided life-extending treatments, a new population of immunocompromised individuals has been born, providing a less defensive host for previously unrecognized pathogens to set up residence.

Perhaps one of the most frightening causes of pathogen emergence is the development of antibiotic resistance in known pathogens. Drug resistance occurs naturally in the life of microbes as their genetic make-up continually evolves with each generation, just as our own. Unfortunately, microbes may produce new generations in only a few hours, allowing for many genetic alterations to take place over a short period of time—and ultimately become drug resistant. For this same reason, vaccines effective against viruses one year also must be changed the next to accommodate

resistant strains. (This is why you must get a new shot in the arm each year to—hopefully—combat the flu). Enterococci is an intestinal bacteria known to pose an immediate danger due to drug-resistant infections. Although Vancomycin is still effective against this pathogen, history tells us that it's only a matter of time before resistance to this drug develops. As a result, such infections pose a real threat to hospital intensive care units.

Ecological changes

Acts of deforestation or reforestation also may cause an increase in exposure to vectors (carriers) of microbial pathogens, i.e., insects, animals or other environmental sources. The incidence of a number of diseases, previously thought to be under control, may be increasing due to changes in the ecology—such as an increase in mosquitoes and subsequently the incidence of malaria.

What can be done?

It is important to realize that no nation can afford to be complacent in regard to emerging pathogens. Significant resources must be allocated for development of new microbial treatments as stockpiles of effective drugs rapidly decrease. Increased surveillance is needed and resources must be in place to respond to outbreak situations where control of the spread of disease may be the most effective measure of immediate restraint.

In order to predict and possibly prevent future outbreaks, public health care workers must consider a variety of cross disciplines such as medicine, ecology, sociology and meteorology, just to name a few. And, nations throughout the world must communicate and cooperate in finding the most effective resolutions.

And last, but certainly not least, is the need for improved infrastructure, hygiene and education.

Conclusion

So, as an industry focused on water treatment, what can we do? First, let us recognize water as a major transmission route of enteric pathogens and continue to develop methods for detection and removal of pathogens from drinking and bathing water. Increased media coverage has helped to spread the word, now the water treatment industry must step up to offer solutions. The water industry plays a vital role in the chain of exposure prevention to these microbes. As such, we must continue to develop effective, reliable and affordable treatment devices to ensure widespread compliance and public health protection.

About the author

♦*Dr. Kelly A. Reynolds is a research scientist at the University of Arizona with a focus on the development of rapid methods for detecting human pathogenic viruses in drinking water. She also is a member of the WC&P Technical Review Committee.*