EVIDENCE OF Drug-Resistant Bacteria in Water

By Kelly A. Reynolds, MSPH, PhD

Recent media reports regarding the spread of the new and deadly carbapenem-resistant *Enterobacteriaceae* (CRE) bacteria in water has prompted a flurry of concern in the population. In recent decades, we have been warned of the overuse of antibiotics and the threat of emerging superbugs with broad-spectrum resistance to our best medical defense. If this threat has become our new reality, what defenses do we have and what role does the water treatment industry play?

Deadly CRE bacteria

Recently, the US Centers for Disease Control and Prevention (CDC) reported an increase of carbapenem-resistant *Enterobacteriaceae* infections in the US population. CRE is a serious public health concern due to two primary reasons: 1) the bacteria is resistant to some of our strongest antibiotic medications (i.e., carbapenems) and thus, can be difficult (if not impossible) to treat and 2) CRE infections have a very high mortality rate, with up to 50 percent of those infected dying from the disease.

CRE infections are primarily a concern in the healthcare setting, particularly with patients who are on extensive antibiotic treatments for other infections. Long-term care facilities are also associated with higher rates of CRE. Strains of the bacterium have been identified as being resistant to all available antibiotics; in other words, another feared superbug has emerged. Infections of CRE typically manifest as pneumonia but may also be in the form of urinary tract infections and blood or wound infections. Spread in hospitals, it is generally caused by person-to-person contact. The bacteria can be transmitted by wounds or stool of colonized individuals. As with many hospital-acquired infections (HAIs), CRE spread can be controlled by isolation of infected patients, effective handwashing, surface disinfecting and other safety precautions. The CDC has updated a 2009 report on the control of CRE infections in healthcare facilities.

Resistance mechanisms

Bacterial resistance to antibiotics occurs due to the production of enzymes that break down antibiotics, rendering them ineffective. An enzyme capable of breaking down carbapenems, known as *Klebsiella pneumonia* carbapenemase (KPC), was first identified in 2001. *Klebsiella* is a bacterial species that is part of the *Enterobacteriaceae* family. Another famous family member is *Escherichia coli (E. coli)*. Both are normal inhabitants of the human gut and commonly found in water and soil environments. Additionally, both can cause infections in humans. Other enzymes found in bacteria can inhibit antibiotic effectiveness, including NDM-1 (New Delhi metallo-β-lactamase), VIM (Verona integron-mediated metallo- β-lactamase) and IMP (impenem-resistant metallo-β-lactamase). These resistance mechanisms are not as common in the US but are common in other parts of the world and provide additional clues as to broader public health implications. For example, NDM-1 enzyme production has been identified in bacteria found in water. The potential for a waterborne route of CRE infection, therefore, is plausible. Although states are not required to report CRE infections to the CDC, the agency does track reported infections using two surveillance systems: the Emerging Infections Program and the National Healthcare Safety Network, which tracks healthcare-associated infections of more than 11,500 facilities across the nation. Nearly every state in the US has reported confirmed cases of CRE caused by the KPC enzyme. (see www.cdc.gov/hai/organisms/cre/trackingCRE.html#CREmap). In addition, as of September 2012, nine states have also reported CRE infections caused by the NDM enzyme.

Waterborne spread of untreatable bacterial infections

Many emerging pathogens originate in the healthcare environment but eventually emerge in the general population as well. Examples include Methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile*, originally associated with hospital infections and now widely spread in the general community. Waterborne HAIs are well documented. One of the most commonly identified bacteria transmitted in hospitals is *Legionella*. An estimated 8,000 to 18,000 cases of Legionnaires' Disease occur in the US each year, with a mortality rate of 10 to 15 percent. Exposure typically occurs due to inhalation of contaminated water aerosols from showers and faucets. In addition to *Legionella*, other similar bacteria are transmitted via the water supply and further have the ability to carry drug resistance (i.e., *Pseudomonas aeruginosa* and *Acinetobacter*). All are difficult to eliminate from the water system and cause significant infections in healthcare settings that are feared to worsen with developing antibiotic resistance factors.

In 2010, scientists reported finding a new antibiotic-resistance mechanism in patients from India, Pakistan and the UK. A year later, researchers isolated the NDM-1 containing bacteria in water samples in New Delhi. Poor control of medical wastes, where hospital wastewater is commonly discharged to the environment without adequate treatment and waste flows in open sewage ditches into urban areas, likely results in increased human exposures to drug-resistant pathogens. Wild animals, in particular birds, may also carry multidrug-resistant bacteria to human populations.

Exposure prevention

Microbial pathogens are a continuing threat in drinking and bathing waters. New emergence of multidrug-resistant strains in

tap waters and other environments remind us of the importance of preventing exposures rather than relying on post-infection treatments that may not be effective. Point-of-use treatment at the tap (drinking and showering faucets) is an important safeguard against harmful bacteria commonly present in distribution and premise plumbing.

References

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