Antibiotic Resistance and Wastewater Effluent Chlorination

By Joan B. Rose, PhD

Does chlorination of sewage treatment plant (STP) effluent *reduce* or *promote* antibiotic resistant microorganisms? Recent research presented at the national meeting of the American Chemical Society provides evidence that this practice might give rise to trace levels of new, stronger antibiotics, which in turn could possibly foster antibiotic resistant microorganisms. University of North Carolina researcher Olya Keen, PhD, investigated the chemical products resulting from chlorinating the antibiotic doxycycline during disinfection of STP effluent. She found products with enhanced antibiotic activity, a clue that they might possibly give rise to other resistant bacteria.

Antibiotics enter wastewater when (a) they are excreted by people taking antibiotics and (b) they are flushed, unused, down the toilet. Chlorination, implemented to destroy microbial pathogens in wastewater, also destroys some pharmaceuticals, but incompletely. In the case of doxycycline, Dr. Keen found that chlorination resulted in trace levels of an antibiotic that appears even more potent than doxycycline. According to a March 22 EurekAlert! public release, the research "suggests that a re-evaluation of wastewater treatment and disinfection practices is needed." More research should be devoted to wastewater effluent disinfection, so let's tread carefully as we think about how to further the protection of public health.

What is Wastewater Effluent?

Wastewater effluent is the product of wastewater treatment after several steps, including sedimentation, flocculation, and anaerobic digestions, but prior to disinfection. As one of the last steps of wastewater treatment, effluent is disinfected (chlorinated by most treatment facilities to destroy pathogens), after which it is dechlorinated to avoid any negative impacts of chlorine in the environment.

Keep Antibiotics out of the Waste Stream

Responsible use and disposal of antibiotics will go a long way toward reducing the unintended consequences of their entering the waste stream. First, antibiotics should be taken exactly according to directions and not discontinued before the entire prescribed dose has been taken, unless otherwise instructed by a doctor. Pharmaceutical take-back programs are a good way to remove expired, unwanted or unused medicines from the home. According to the Food and Drug Administration (FDA),

these programs may be managed by community pharmacies or municipal trash and recycling services. The National Community Pharmacists Association, for example, has developed an online resource to help consumers locate medication disposal programs at local independent community pharmacies.

When a take-back program is unavailable, flushing certain medicines (FDA list) is still promoted by FDA to help prevent potential accidental ingestion that could be especially harmful to a child, pet or adult. For the majority of medications, however, if take-back programs are unavailable and flushing is not recommended by FDA for the particular drug being considered, medicines can be disposed of in household trash (providing there are no local ordinances to the contrary). Prescriptions should first be mixed with unpalatable matter such as kitty litter or coffee grounds in preparation for the journey to a landfill. This includes over-the-counter medications as well as prescriptions.

Wastewater Effluent Treatment Options

If allowed to proliferate, pathogenic bacteria could give rise to resistance through the process of gene exchange, which can occur when bacteria co-exist in close proximity. This is a concern, for example, in the sewage-contaminated Carioca River, which flows into Guanabara Bay in Rio de Janeiro, the venue for the 2016 Summer Olympics sailing and wind surfing events. A recent study presented evidence of antibiotic resistant bacteria in the river, raising concerns for the health of Olympic competitors. The Carioca River is heavily polluted with untreated sewage, representing a serious public health and environmental issue. STP effluent disinfection methods, traditionally chlorination, destroy pathogens that would otherwise be discharged into the environment. Here's where risk balancing comes into play: The very real public health risk posed by undisinfected effluent versus the possible risk of fostering the growth of antimicrobial-resistant microbes.

Ultraviolet radiation is another option for wastewater effluent disinfection, but research suggests UV should be combined with low levels of chlorine to avoid bacteria falling dormant, only to "wake up" and resume proliferating in what we've called a "Sleeping Beauty Effect." In fact, various disinfection technologies are often combined to achieve optimum results cost-effectively. Ozone and advanced oxidation are other disinfection tools in the wastewater effluent disinfection toolbox.

Sewage treatment plant effluent must be disinfected to avoid the discharge of pathogenic microorganisms into the aquatic environment—that's a well proven public health fact. More research is needed to ascertain the magnitude of the actual risk that disinfection of STP effluent contributes to fostering superbug development. Research can also shed light on how to use combinations of wastewater disinfection technologies to avoid or at least minimize the likelihood of superbug development.

Since its first use in 1908 in drinking water, chlorination has been one of our best allies in the war against infectious disease. We look forward to Dr. Keen's published study for a better understanding of her research and its implications for disinfection of sewage treatment plant effluent.

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