Infection Control Today - 12/2001: Microbial Resistance and Disinfectant Use

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CLEANING AND DISINFECTING

Microbial Resistance and Disinfectant Use

By Rodney Stine

Overuse... this word rings out a warning. Too much of a good thing can be a bad thing. Some types of overuse only affect our personal lives. For instance, overuse of words renders them ineffective. Overuse of objects causes them to wear out. However, overuse of pesticides, antibiotics, or disinfectants is not so easily dismissed. The mode of action of each of these antimicrobials is different; therefore the outcome of overuse is unique to each. These substances, and the microbes resistant to them, work in distinct ways. The concern is that we do not overuse these agents and create a new generation of mutated microbes so that we are limited in our ability to combat them.

Not much has been published about overuse of surface disinfectants and their microbial resistance. Reports discussing these products are concerned with general safety for the healthcare worker (HCW) using them. Here we look at microbial resistance to surface disinfectants as compared with antibiotics and pesticides.

Antibiotics and Resistance

Antibiotics work specifically against bacteria, and are one of the great discoveries of the 20th century. Antibiotics, namely penicillin, became available in limited use during the early 1940s. We often think of bacteria as evil, but in truth, they're not all inherently bad. Many are common residents in the nose, throat, and intestines. The bacteria will only cause trouble if they somehow get perturbed, or if they find a way to spread to the lungs or blood stream. Why they do this is not yet understood.

When one of these things happens, the bacteria go into reproductive overdrive and infection starts. Antibiotics go after the bacteria and either break down the cell walls or interfere with reproduction by blocking different biochemical pathways. Scientists have known that bacteria could "learn" to combat the mechanisms of antibiotics. In any colony of bacteria, there are going to be a few cells that are exceptionally strong. The vulnerable cells are attacked and not allowed to divide, but the few strong mutant cells are left to reproduce. The result is a new generation of stronger "bugs" that are not affected by the antibiotic. As a counter punch, we have continued to develop stronger antibiotics, increased the dosage, or combine the two to overcome infection.

The trouble is that with each additional treatment, bacteria are given another chance to build up their resistance against different drugs. Antibiotics are prescribed more often than in the past and more routinely for treating upper respiratory infections. S. Michael Marcy, MD, clinical professor of pediatrics at the University of Southern California and the University of California at Los Angeles, says, "Most upper respiratory infections are viral, and antibiotics simply have no effect on them. Their structure and reproductive activities are completely different." What treating a virus with an antibiotic does is create more resistance among the normal bacteria in your body. Thus, overuse of antibiotics can cause the resistant bacteria to outnumber the susceptible bacteria, creating a super strain. When these normal bacteria become infectious, they are resistant to treatment.

Surface Disinfectants and Microbial Activity

Disinfectants, specifically surface disinfectants, work environmentally and in a totally different way than antibiotics and many pesticides. Disinfectants work by absorbing onto any microbial cell. According to research by Stedman, Kravitz, and King, such absorption increases the permeability of the cell membrane, ultimately leading to rupture and leakage of the contents of the cell. The cell dies. There is no chance for mutation.

What are the best disinfectants? It is well known that the long-chain quaternary compounds, which posess the greatest antimicrobial activity, are those with at least one radical, with C8 to C18 length carbon chain. (Domagk, Deutsch Med and Wochschr 61/829) General characteristics of disinfectants provided by the Mississippi State Extension Service list six categories of surface disinfectants:

- Alcohols. These are not recommended for surface use due to evaporation.
- Halogens (iodines). These are broad spectrum but are corrosive. They have few reactions but are unstable at high temperatures.
- Quaternary ammonium compounds. These have good germicidal range, are non-corrosive and non-sporocidal, are low in toxicity and are effective against vegetative bacteria, fungi, and viruses. They may, however, be deactivated by hard water.
- Phenolics (single or multiple). These have a wide germicidal range, are very effective in the presence of organic matter, and have low toxicity. They do, however, degrade certain plastics over time and are difficult to rinse, therefore encouraging film accumulation.
- Coal tar distillates (creason and cresylic acid). These have wide germicidal activity and are highly efficient in the presence of organic matter. They are corrosive and toxic at high concentrations.
- Aldehydes (glutaraldehye). These have wide germicidal activity, and are sporicidal and fungicidal. They are moderately toxic and also have a strong, unpleasant odor.

Surface Disinfectants and Resistance

Concerns have been raised by the resistance of microbes to use of disinfectants.[1] This research relates exclusively to high-level disinfection, such as hospital theater standards, and are unlikely to be of concern in other environmental situations. Additionally, the disinfectants concerned were based on single active ingredients.

Traditionally, surface disinfection has been considered less important and less significant than instrument processing or waterline sanitation. However, surface areas are a prime source for indirect or secondary transmission of infectious diseases for both medical personnel and patients. Constant contact of surfaces and other environmental elements by HCWs providing medical care create opportunistic chances of cross contamination and infection. The recommended procedure for using disinfectants is to thoroughly clean the surface first and then apply the disinfectant.

If microbes escape and live after a disinfectant is used, it is not because the pathogen is a mutant. Because disinfectants are non-selective, they kill the microbes on contact. It is possible to miss microbes with disinfectants. The microbes live and continue to multiply and contaminate. The only way microbes could escape death after coming in contact with the disinfectant is if they somehow could armor themselves so as not to have their cell membrane permeated. This is unlikely. If we are worried about the development of super, mutant bacteria, we aren't going to find the problem in the overuse of disinfectants or many pesticides. We will find the problem in the overuse of antibiotics, some pesticides, and antibacterial products made for the use of the general public.

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