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EDITORIAL

The Biological Warfare of the Future

This is the second special issue on drug-resistant strains of bacteria, a menace of major proportions to the health of the world. For a period of time the "miracle drugs," of which penicillin is the best known, appeared to change irreversibly the seesaw battle between man and bacteria.

In a previous era pneumonia was the scourge of middle age in developed countries and many young people died of this dread disease. In the near past pneumonia and other infectious diseases were considered less important because a miracle antibiotic was available to cure them at the first-sniffle stage of the disease.

Unfortunately, the antibiotics were too good. Humans did not use them with discipline and they were spread around too widely and for too many uses, such as keeping cattle healthier during growth. Individuals with compromised immunity—such as organ transplant patients and AIDS sufferers—were also good incubators for drug-resistant strains. As a result the flexible bacteria modified DNA to produce drug-resistant strains, and now hospital stays pose dangers of infections as well as benefits.

The mechanisms of drug resistance are varied and are discussed in reference to how they occur and how they may be prevented. New enzymes that destroy the antibiotic more effectively can be selected and mutation at binding sites can diminish the effectiveness of the drug, as discussed by Spratt. Davies describes gene modification strategies that bacteria use to develop resistance: "A single base change can render useless a hundred million dollars of pharmaceutical research effort." An indication of strategies to come is the finding that such resistance occurs more often in antibiotics from nature, such as streptomycin, than de novo-designed antibiotics. Nikaido explores decreased drug accessibility to bacterial pathogens that results both from the less permeable membranes that prevent drug action and from the pumps that bacteria use to eliminate drugs. Berkelman, Bryan, Osterholm, LeDuc, and Hughes, in a policy forum, discuss the diminution (because of budget cuts at federal and state levels) of our surveillance system, the national Centers for Disease Control, and the complementary state agencies. Georgopadakou and Walsh discuss human fungi and their role in infection, an increasingly dangerous area. Gabay describes naturally occurring peptides that exhibit antibacterial or antifungal activity.

News articles by Culotta, Travis, Stone, Nowak, and Kingman illustrate the growing threat and the growing apprehension of drug-resistant strains. The penicillin-resistant pneumococci were found in 50 percent of the cases of pneumonia in Hungarian children and many of the bacteria were also resistant to many other antibiotics that are used as backup medicines. In Europe the spread of drug-resistant tuberculosis strains has been less than in the United States because the tuberculosis surveillance program has been better maintained in Europe. An overview of the drug resistance problem is given by Marx and Chin, the editors who coordinated this issue.

A particular worry is the possibility of vancomycin-resistant strains of staphylococci since that is the only drug available to stop the staphylococcal infections that are endemic in hospitals. That worry also illustrates the enormity of the problem since vancomycin-resistant enterococci already exist and are quite capable of sharing their DNA information with the staphylococci. These new findings also extend a warning to those health care plans that seem solely focused on costs of hospital stays and oblivious to the importance of new drugs and better understanding of our clever adversaries, the bacteria, fungi, and viruses. The cuts in funding for microbiological research and the surveillance systems generate illness and hospital stays that will cost far more than the money cut from the research budget. The frustrating search for sepsis-curing drugs illustrates the reason for the high cost of a drug and the need for basic research to understand more than one source of difficulty.

Humans should not confuse themselves. This is true biological warfare, in which new drugs designed by humans will become obsolete through bacterial mutations, only to be replaced by human drugs and new bacterial mutations in a seesaw battle. The days of soap and boiling water to fight bacteria are long gone (although soap and boiling water are still useful) and the days of miracle drugs and universal vaccines are going. A long struggle with a premium on basic research to improve our stratagems and applied research to develop new magic bullets is clearly the prognosis for the future.

Daniel E. Koshland Jr.