Probing Question: How does antibiotic resistance happen?

5 March 2009, By Alexa Stevenson, Research/Penn State

Before Alexander Fleming's discovery of penicillin in 1928, there were any number of unpleasant ways that bacteria could kill you. Countless women died from infection after childbirth, and a simple chest cold could turn into deadly pneumonia.

Need surgery? Not so fast—without antibiotics, the risk of sepsis was dangerously high. In fact, any injury that broke the skin was potentially fatal: Lord Carnarvon, the discoverer of King Tut's tomb, died in 1923 from an infected shaving cut. It's no wonder that penicillin—the name for a class of antibiotics developed from Penicillium fungi—was hailed as a miracle drug and earned Fleming a Nobel Prize.

Today, our ability to treat infection is threatened by the evolution of new strains of bacteria that have proven themselves resistant to antibiotics. As of 1994, strains have been identified that are resistant to all currently available antibiotic drugs. Are we headed back to the days of life-threatening shaving accidents?

Anne Buboltz, a postdoctoral fellow in veterinary and biomedical sciences at Penn State, explains that "antibiotic resistance is a natural result of evolutionary pressures." Just as animals evolve to evade predators or survive in harsh climates, bacteria evolve to withstand the things that threaten them—and these include antibiotics. "Bacteria with an antibiotic resistance gene can survive where nonresistant bacteria do not," says Buboltz. These survivors then reproduce, and the resistant strain becomes more common.

Have we unwittingly forced this natural process into overdrive? Buboltz believes so, noting, "The widespread use of antibiotic drugs creates a greater force of selection for bacteria with antibiotic-resistant genes." And that use is on the rise. Some of the increase is due to other miracles of modern medicine: many diseases that used to be deadly can now be treated with transplants or chemotherapy, and as ill patients live longer, they often require long and repeated courses of antibiotics.

A larger concern, however, is the unwarranted prescription of antibiotics, says Buboltz. Antibiotics work only on bacteria, not on viruses like the flu or the common cold. Yet some doctors prescribe them at the first sign of illness, and many patients have grown to expect a pill to cure whatever ails them. "In general, antibiotics are considered to be the greatest modern medical treatment," Buboltz says, "but reducing unnecessary antibiotic usage would decrease selection pressure for antibiotic resistance, which would likely cause a decreased rate of spread of antibiotic resistance." When antibiotics are necessary, she adds, it is important to take them as prescribed and to the end of their course.

In addition to cutting down on unnecessary antibiotic prescriptions, we can combat resistance by reducing transmission of bacteria in the first place, through simple practices like hand-washing. As with all bacteria, antibiotic-resistant strains spread through air and water, on clothing and other belongings. When you cough or shake hands, you may be passing resistant bacteria to others.

"Bacteria are incredibly inventive," observes Buboltz. "There is probably no way to eliminate them using antibiotics without also increasing the likelihood of resistance." She urges us to remember that many bacteria are beneficial to humans—such as those naturally occurring in our digestive tract. "The elimination of all bacteria would not be desirable," she notes. "We have a responsibility to educate the public about the spread of antibiotic resistance, and to take steps to reduce that spread."

Source: Alexa Stevenson, Research/Penn State