HANDLE ANTIBIOTICS WITH CARE

Slowing the Race

ADDRESSING ANTIBIOTIC

by Ramanan Laxminarayan, Ph.D., M.P.H.

In 1924, President Calvin Coolidge's 16-year-old son developed a blister on his foot after a game of tennis. A few days later, he died of a bacterial infection.

Most of us don't remember a time when a simple cut could be fatal. We grew up in a world with antibiotics. These drugs have saved millions of lives and transformed global health. Because of them, we rarely die of infections. We can have transplants; we can have surgeries that require the human body to be kept open for long periods of time without the risk of infection. They are really the basis on which modern medicine rests.

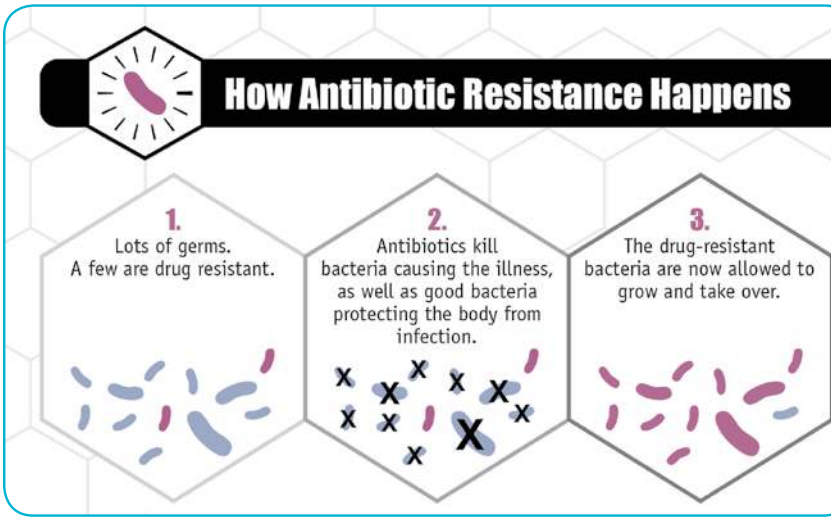
Antibiotics work by killing off bacteria that are susceptible to them. The bacteria that survive treatment are not susceptible to the drug or are "drug-resistant." It's a basic evolutionary phenomenon. Over time, as we've used these drugs, the populations of bacteria in our bodies and in the environment have become increasingly drug-resistant.

To make things worse, bacteria have the ability to share genetic material via DNA strands called plasmids. Completely unrelated bacteria can share plasmids. Thus, even bacteria that have not been exposed to an antibiotic can acquire resistance genes from other bacteria.

Antibiotic resistance occurs naturally, but our misuse of antibiotics in humans and animals has vastly accelerated the process. The CDC estimates that up to half of all human antibiotic use is unnecessary or inappropriate. This includes giving antibiotics inappropriately—for example, for treating a cold or flu, even though those are viral, not bacterial, infections and do not respond to antibiotics. It also includes the common practice of feeding antibiotics to livestock to make them grow more quickly, because bacteria that have developed drug resistance in animals can be transmitted to humans.

The massive use of antibiotics around the world has created antibiotic resistance that is a growing global public health problem. Fifteen years ago, 5–15% of bacteria were resistant to some or all antibiotics; today, it's 15–50%.

This evolutionary race we are in with bacteria is not a race we can win: Bacteria can evolve and reproduce much more quickly than we can develop new drugs. We have to find ways to slow the race.



A Problem of the Commons

Unfortunately, many economic forces encourage behaviors that drive the evolution of drug resistance. Doctors wanting to be responsive to their patients' wishes may prescribe antibiotics even when they are not warranted, such as in cases of the flu. Companies that sell antibiotics want to maximize profits, and this drives them to promote, not restrain, their drugs' use.

These things may be true about many drugs; however, there is something fundamentally different about antibiotics. My taking a drug to treat high blood pressure, for example, will not diminish its effectiveness for others. But my using an antibiotic contributes to the global population of antibiotic-resistant bacteria, and so can reduce the drug's effectiveness in the future, for me and for others.

This is a case of what economists call a problem of the commons. There are resources that we all use ("commons"), like the air and the oceans. When we use one of these resources, our actions can have consequences for others. The problem is that those using a common resource according to their own self-interest may deplete or pollute that common resource, and so act in a way that is contrary to the best interests of all.

Antibiotic effectiveness is such a resource. It's not a typical resource, because it's not the *supply* of antibiotics that will run out—it's their *effectiveness*. But it is a resource we all benefit from, and one that can be used up.

RESISTANCE

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Going forward, we need to rethink how we use this valuable resource. The challenge is to create incentives—for patients, doctors, hospitals, drug companies—to act in ways that slow its depletion.

Change Incentives, Change Behavior

Antibiotic resistance is a complex problem that will require multidimensional solutions. One component must be public education about the issue. Educating doctors and patients on the negative consequences of antibiotic use will encourage more judicious use. Patients may not be aware that using antibiotics increases their chance of developing drug-resistant infections. Informed self-interest can be a powerful incentive.

Another is the cost of novel antibiotics. Most antibiotics today are very inexpensive because they are generics. That's good in that it increases access to antibiotics, but low cost also encourages overuse or inappropriate use in many instances. In contrast, the cost of finding and developing new antibiotics is high. In recent years, a single treatment course of a novel antibiotic, Cubicin, has been about $1,500–$2,000, compared to about $10 for older antibiotics. Doctors knew it was available as a last resort if all other antibiotics failed, but its price was high enough that no one would think of using it as a first-line drug. Higher prices for novel antibiotics do limit access to them, but that limits their use, and that slows the development of resistance to them. And indeed, resistance to Cubicin is under 1%, whereas other, less expensive antibiotics that were introduced after Cubicin have resistance levels of 5–7%. As we face high prices for new antibiotics, maybe we'll be more careful about how we use the ones we have.

Over time, increasing resistance will also force us to pay greater attention to infection control, vaccines, and other means of preventing infectious diseases.

Taking Action

One fortunate thing about antibiotic resistance is that there are both local and global effects. Even though we talk about it as being a global issue, it doesn't work the same way as, say, atmospheric CO_2, where a ton of carbon emitted in the U.S. is the same as a ton of carbon emitted in China. If you do things right in your country, resistance can be low within your country. Look at Sweden. They use antibiotics appropriately, and they have much lower levels of antibiotic resistance than the U.S. If we change our ways, we too can have lower levels of resistance, instead of having one of the highest levels of resistance in the developed world.

In the past two years, world leaders have finally started taking this on as an issue that requires international cooperation. Last year, President Obama released a National Action Plan for Combating Antibiotic-Resistant Bacteria, which includes efforts to foster appropriate use of antibiotics in humans and to reduce the use of medically important antibiotics in animals in factory farming. The President has also established an advisory council to guide federal actions to improve how antibiotics are used in the U.S.

There is not yet a grassroots organization to educate people about antibiotics, like a Mothers Against Drunk Driving, but it's coming. I think the time will come when people know that antibiotics are powerful drugs that are not to be misused. What's the alternative? A return to a day when a simple cut could be fatal. ■

Economist **Dr. Ramanan Laxminarayan** is a member of the President's Advisory Council on Combating Antibiotic-Resistant Bacteria. Director of the Center for Disease Dynamics, Economics & Policy, he is an expert in the economic dimension of the problem of antibiotic drug resistance.

Further Reading and Viewing

Dr. Laxminarayan's TED Talk
"The Coming Crisis in Antibiotics"
www.ted.com/speakers/ramanan_laxminarayan

***Imagine* interview with Dr. Laxminarayan**
cogito.cty.jhu.edu/14508

World Antibiotic Awareness Week
www.who.int/drugresistance

CDC Get Smart about Antibiotics
www.cdc.gov/getsmart

Frontline: Hunting the Nightmare Bacteria
www.pbs.org/wgbh/frontline/film/hunting-the-nightmare-bacteria