Bacterial Resistance and Antibiotic Overuse

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Less than 20 years after the discovery of penicillin in 1928, Alexander Fleming, the Scottish biologist and pharmacologist, began observing bacterial resistance to this "miracle" antibiotic. Fleming documented resistant strains of bacteria growing in his experimental petri dishes, despite the presence of penicillin, as early as 1945.[1] Thus were the beginning threads of knowledge that the use of antibiotics, while initially successful in treating bacterial infections, also creates selection pressures that promote the growth of resistant bacteria strains.

Even with this early research, it took until 2001 for the World Health Organization to launch a global strategy for combating antimicrobial (antibiotic) resistance.[2] Part of this resistance is due to the abundant use of antibiotics for nontherapeutic purposes in agricultural livestock. That is to say, outside of therapeutic uses of antibiotics to treat illness, antibiotics also seem to stimulate growth in animals and are used for this purpose. It wasn't until last year that the American Medical Association went on record at its annual meeting to oppose nontherapeutic antibiotic use in US livestock[3]—a full 7 years after the European Union banned nontherapeutic uses of "antibiotics useful for humans" in livestock.

Another part of the resistance stems from use of antibiotics in cleaning supplies. Antibiotics have become so prevalent that, recently, *Scientific America* ran an article where Allison Aiello, PhD, of the University of Michigan School of Public Health discussed finding significant environmental concentrations of triclosan and triclocarbon, 2 common antimicrobials used in household cleaners and soaps. These 2 bactericides have been identified in 60% of American waterways, likely from their significant concentrations in sewage sludge used as fertilizers.[4] Continued use of antimicrobials in human medicine, livestock, and the home will further propel significant selection pressure—which essentially means favoring antibiotic-resistant bacterial strains. Aiello's article concludes with a claim by a panel of experts from the US Food and Drug Administration (FDA) suggesting that there is little, if any, benefit from antibacterial additives in household cleaners.

What the Research Shows

Research resulting from a ban on certain uses of human antibiotics in European livestock offers us an important opportunity to measure the change in concentrations of certain bacteria in humans. For example, some 2 to 3 years after stopping the use of avoparcin in livestock, prevalence of vancomycin-resistant enterococci in human excrement was significantly lower. These are both glycopeptide antibiotics; avoparcin is used primarily as a feed additive, and vancomycin is often used as a last resort in gram-positive infections and so is an important human drug. On average, the prevalence of resistant bacteria in the 3 countries surveyed—Germany, the Netherlands, and Belgium—dropped in half within 2 to 3 years after removal of the avoparcin.[5] Several other studies reveal similar findings.[6,7] What we can see from this is that the use of antibiotics in livestock greatly impacts the type and quantities of bacteria in the environment as well as in the human gut.

Investigative research was reported in a book entitled *Hogging It* by M. Mellon, C. Benbrook, and K.L. Benbrook, published in 2001 by the Union for Concerned Scientists. The book revealed that tetracycline, penicillin, erythromycin, and other important antibiotics for human use are also used extensively for nontherapeutic purposes (as mentioned above) in US livestock production. Due to such use, the authors estimate that 24.6 million pounds of antimicrobials are ingested by agricultural livestock yearly in this country, of which 13.5 million pounds are prohibited from livestock use in Europe by the European Union.[8]

What is most significant is that use of antibiotics in livestock dwarves human consumption in the United States. In 2001, Americans consumed 3 million pounds of antibiotics. Simply put, we are feeding our livestock more than 4 times the

How to Minimize Antibiotics in the Environment: What You Can Do

- Wash your hands thoroughly between patient visits to reduce the risk of spreading infection and, thus, a need for antibiotics.
- Do not accede to patients' demands for unneeded antibiotics.
- Prescribe only the amount of medications you want a patient to take: ie, don't over prescribe.
- When possible, prescribe antibiotics that target only a narrow range of bacteria rather then broad-spectrum antibiotics.
- Stay current with state and local alerts about antibiotic resistance.
- Take back and properly dispose of any unused or expired medications. (For specific information on how to set this up, go to the *IMCJ* website and, under "Resources & Content," click on "Green Medicine." Then pull up the article entitled "Greener Pharmacy: Proper Medicine Disposal Protects the Environment.")
- Educate your patients on the benefits of consuming chicken, pork, and beef raised without antibiotics.
- Educate patients about the lack of evidence for use of antimicrobials in cleaning products.

For More Information

Related websites

- **Alliance for the Prudent Use of Antibiotics**: www.tufts.edu/med/apua
- **Center for Disease Control**: www.cdc.gov/drugresistance
- **Environmental Protection Agency (EPA) guidelines**: www.epa.gov/epawaste/index.htm
- **EPA, Health Services Industry Study, *Management and Disposal of Unused Pharmaceuticals (Interim Technical Report, EPA-821-R-08-013)***: www.epa.gov/guide/304m/2008/hsi-tech-study-200809.pdf
- **EPA, *Unused Pharmaceuticals in the Health Care Industry: Interim Report*** (August 2008): http://www.epa.gov/guide/304m/2008/hsi-PRELIM-study-200808.pdf
- **World Health Organization** (Type "pharmaceutical waste" into the search function on the website): www.who.int/en/

Resources

- Lappe M. *When Antibiotics Fail*. Berkeley, CA: North Atlantic Books; 1995.
- Levy S. *The Antibiotic Paradox*. Cambridge, MA: Perseus Publishing; 2002.

amount of valuable human medicines than we use ourselves. It does not seem farfetched to say this situation is a disaster waiting to develop.

Recently, data from the Teleosis Institute's Green Pharmacy Pharmaceutical Take-back Program in the Bay Area of California found that amoxicillin and cephalexin are among the top-10 drugs returned unused, following closely behind common analgesics. Assuming this is representative of the population as a whole, for all those who don't take them back, these antibiotics are dumped down the toilet or end up in landfill, contributing directly to environmental concentrations as mentioned above.

How to Make a Difference

You and I can do much to help alleviate this ever-growing catastrophe. As integrative health professionals, our responsibility is to be informed about risks to our environment from the use of any medications. Overuse of antibiotics is having significant impacts on both our food and water. In addition, if we are to have a healthcare system that will meet the demands of current and future generations, it is essential we limit use of antibacterials in our food and cleaning supplies as well as in personal care products.

All this means becoming more vigilant as to the prudent use of antibiotics therapeutically, while consuming and promoting meat consumption that is antibiotic free and not using bactericidal cleaners in the home and office—as previously mentioned, the FDA found little evidence of benefit from using these cleaners for general cleanliness. It also means, of course, educating our patients about this topic.

In this regard, essential to a sustainable clinic is closed-loop product stewardship: Any prescribed medication or supplement should be taken back when unused or expired. Patients best learn how to properly dispose of medicines from our own example. I have been taking medications back from my patients for more than 2 years. The costs are minimal, and the value to my patients as well as the environment is worth the expense. Expanding the program to take back all conventional medication from your patients is easily done and supports the message that we care about the effects of healthcare on the environment (for more information, see the sidebar "How to Minimize Antibiotics in the Environment: What You Can Do").

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