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FROM THE EDITOR

What Is Ethically Important About Antimicrobial Resistance?

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There were approximately 2 billion people living on our planet when Alexander Fleming discovered penicillin in the late 1920s.[1] Nearly a century later, there are over 4 times that number.[1] But as humans shape their environment through forces like agriculture, industrialization, globalization, and technology, that environment pushes back. Smoke from raging wildfires is visible from the International Space Station[2]; little spotted lanternflies bedeck and blight mid-Atlantic hardwoods[3]; and, far smaller still, microorganisms evolve and evade our arsenal of infection-fighting medicines. Antimicrobial resistance (AMR) is the phenomenon of adaptive change in bacteria, fungi, viruses, and parasites that renders these potential agents of disease and ecological change less susceptible to treatments designed to control them. In 2019, the World Health Organization (WHO) in 2019 named AMR one of the top 10 threats to global health, alongside viral pandemics and climate change.[4] These topics, and others on the WHO's list, have been explored in past theme issues of the *AMA Journal of Ethics*,[5,6,7,8] but this will be the first in-depth issue to explore the threat of AMR.

AMR is not only a technological or medical challenge but also an ethical challenge affecting individuals, communities, societies, and even ecosystems. In the most straightforward example, a patient with an infection may face longer, more invasive, and more costly treatment; diminished quality of life; or even death as a consequence of AMR. But the same patient might also face stigma, isolation, and uncertainty. Isolated patients are visited less frequently by health professionals wearing added layers of personal protective equipment and are alerted to the dangers of spreading resistant microbes to other patients by signage and special handling but offered little or no advice for protecting their loved ones when they go home.[9,10] Even in the absence of illness, patients who carry antimicrobial-resistant microbes may be treated differently during elective surgery or cancer treatment or denied a life-saving organ transplant because of the microbes they carry within them.[11]

The human body provides an environment for trillions of microorganisms. While human cells are *not* outnumbered 10:1 (the true ratio is roughly 1:1), we carry with us a large and diverse microbiome whose members play a surprising role in health and disease.[12] As vital as the microbiome is to the healthy functioning of the human body, many human infections arise from overgrowth, invasion, or translocation by members of this community: urinary tract infections are often caused by bacteria from the

gastrointestinal tract; pneumonias are often caused by bacteria from the mouth and throat; boils and abscesses are often caused by bacteria that live, usually unnoticed, on the skin. A person's microbiome might include antimicrobial-resistant organisms, which often prove tenacious members of the ever-changing microbial community.[13] When a person and their microbiome are seen separately, AMR is simply a coincidental feature of microorganisms in the individual. But when a person and their inseparable microbiome are seen as an entire unit, AMR becomes a contingent feature of the individual.

Who experiences this coincidence or carries this "trait" of AMR? The most commonly cited driver of AMR is antimicrobial use, often called out as "overuse." (*Use* is a descriptive claim, *overuse* a normative one that requires framing.) However, the burdens of AMR are not borne primarily by the most privileged patients. People with limited access to health care, in developing countries, living in poverty; members of marginalized communities like Black Americans or men who have sex with men; and young children are disproportionately affected by AMR.[14] Individual antimicrobial use as well as community antimicrobial use, agricultural and environmental use, wastewater management and sanitation, crowding, and other structural forces that affect human health and susceptibility to disease all shape who carries and suffers from antimicrobial-resistant organisms.[15]

Although microbes play crucial roles in ecosystems, including in soil health, nutrient cycling, and water purification, the spread of AMR threatens these delicate balances, with cascading implications for ecological sustainability.[16] Like other sustainability challenges, the threat of AMR reaches across time. Today's patterns of AMR reflect past antimicrobial use; today's antimicrobial use further shapes the patterns of AMR that will test future generations. But unlike weather patterns or deforestation, AMR isn't simply a consequence of human actions manifest in the environment; it is a consequence of human actions manifest in ourselves. Even if climate change drives colder temperatures in some places, rising sea levels drive us to higher ground, or giant leaps for mankind carry us beyond Earth itself, wherever we go, AMR is something that we will carry with us and within us.

In this issue of the *AMA Journal of Ethics*, contributors explore the topic of AMR as a multimodal phenomenon—as both a trait and an experience, a cause and a consequence, an individual burden and an ecological challenge. Their work sets the stage for the next issue of the journal, "Antimicrobial Stewardship," the interventional tool kit that health professionals and organizations use to promote an array of aims, chief among them changing the future of AMR.

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