Vanishing Cure: Preserving Antibiotics in a World of Rising Resistance

In Toronto, a previously healthy three-month-old boy developed what initially appeared to be a routine respiratory infection. Despite intensive care, his condition deteriorated rapidly. After 44 days, life support was withdrawn. The case, reported in 2005, was Canada's first documented fatal infection caused by methicillin-resistant *Staphylococcus aureus* (MRSA)—a strain of bacteria resistant to many antibiotics. Antimicrobial resistance (AMR) contributes to an estimated 4.95 million deaths globally each year. Without urgent action, this number could rise to 10 million by 2050. AMR already places an enormous strain on healthcare systems by increasing the number of patients admitted to hospitals with prolonged stays. Intensive care and isolation are often required, escalating the cost of treatment.

The history of MRSA illustrates the profound irony of antibiotic resistance. In the early 20th century, bacterial infections were a major cause of death worldwide until Alexander Fleming discovered that *Penicillium* mold could inhibit the growth of *Staphylococcus aureus,* the very bacterium that inspired the development of humanity's first antibiotic.

By the 1940s, penicillin was widely deployed. That ushered in a golden age of medicine when millions of lives were saved. Yet bacteria fought back, proving to be remarkably adaptable. They evolved to survive the very drugs meant to kill them. Scientists call this process antimicrobial resistance, or AMR. The more antibiotics are used, the faster resistance develops, as drug exposure gives survival advantages to resistant strains. By the 1960s, shortly after methicillin was introduced to fight penicillin-resistant strains, MRSA had already emerged. MRSA is still with us today and remains among the most persistent antibiotic-resistant pathogens. Scientists fear that we may return to a pre-antibiotic era, when infections easily cured during the golden age turn deadly again.

Antibiotics, once hailed as miracle drugs, are now losing their effectiveness. They are no longer seen solely as medical treatments, and are increasingly recognized as a "global common." However, antibiotics are vulnerable to overuse and depletion—a dynamic described by economist Garrett Hardin in his concept of the "Tragedy of the Commons." While individual antibiotic use may appear rational—whether in human medicine, animal husbandry, or agriculture—the cumulative effect threatens the global pool of antibiotic effectiveness. Resistant bacteria circulate through international travel, trade, and the environment. Antibiotic residues in wastewater, runoff from farms, and improper disposal practices contribute to bacterial evolution in soil and water ecosystems, further eroding the collective antibiotic efficacy.

AMR's diffuse origins and cross-sectoral impact make it one of the most complex public health challenges. This complexity has led to consensus that single-sector efforts are insufficient. The "One Health" approach has gained traction, recognizing the interconnections between human, animal, plant, and environmental health. The framework seeks to bring together healthcare providers, veterinarians, environmental

scientists, and policymakers to develop coordinated strategies to preserve antibiotics as a shared vital resource.

Within the One Health framework, stewardship of existing antibiotics is promoted as a key strategy to slow resistance. Proposals include improving hygiene and infection prevention in hospitals, reducing or eliminating the use of antibiotics as growth promoters in agriculture, promoting accurate diagnostics to avoid unnecessary prescriptions, and raising public awareness about responsible antibiotic use. These efforts could help extend the lifespan of current drugs—though they may not keep pace with resistance.

Health professionals point to one significant concern: the innovation gap. It's been more than 30 years since any new antibiotic featuring a novel chemical class has been approved for clinical use. Gram-negative pathogens, identified as highly prone to antibiotic resistance, have not seen a truly novel class of antibiotics in over 50 years. Health officials worry this could increase vulnerability to untreatable infections. Several countries are making promising advances. Researchers at McMaster University in Canada are taking advantage of the country's rich biodiversity to find unique drug discovery opportunities. In 2025, they identified lariocidin—the first new antibiotic class in nearly three decades. In the UK, CRISPR-Cas9 gene editing technology is improving antibiotic properties. In the US, AI-driven platforms enable labs at MIT to identify promising antibiotic compounds in days rather than years.

Despite breakthroughs, translating discoveries into treatments remains challenging. Following the discovery of penicillin in the 1940s, many new antibiotic classes were developed. Since the 1980s, investment in antibiotic development has declined. Major pharmaceutical companies have withdrawn because antibiotics do not contribute to sustainable economic returns. Unlike chronic disease drugs taken for years, antibiotics are prescribed for short courses. The most powerful antibiotics are reserved as "last-resort" treatments, generating minimal revenue. This market condition has driven most large firms from antibiotic development, with numbers falling from 18 in the 1980s to just a handful today.

Several governments are experimenting with incentive structures. One approach is push incentives, which support early-stage research by reducing innovation costs. CARB-X (Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator), funded by governments and private foundations, helps promising antibiotic candidates advance through preclinical development. However, data shows discoveries often stall before clinical trials due to limited commercial viability as a key barrier, suggesting that push funding alone may not address all challenges.

Another approach involves pull incentives, rewarding drugs that reach the market and prove effective. These models attempt to decouple profits from sales volume, offering developers reliable returns even when new antibiotics are used sparingly. The UK became the first to implement a subscription-style model in 2019, where pharmaceutical

companies receive a fixed annual payment in exchange for making effective antibiotics available to the nation, regardless of usage.

Some analysts argue pull incentives may face limitations without cross-country cooperation and sufficient collective financial incentives. This debate has prompted the EU to explore a framework that coordinates with the existing UK initiative while engaging with parallel efforts underway in the United States, Canada, and Japan.

Policymakers also grapple with questions of equitable distribution. Antibiotic resistance is inherently global. Drug-resistant bacteria can emerge anywhere and spread worldwide. This creates what researchers describe as a paradox: while high-income countries like the UK work to limit overuse domestically and expand access to new treatments, many low- and middle-income countries struggle to obtain even basic antibiotics. When people rely on outdated drugs, treatments are prolonged and resistance potentially grows. Health experts argue that domestic policies in high-income countries face inherent limitations if global access inequalities remain unaddressed. They note that drug-resistant pathogens emerging in low- and middle-income countries may one day present a direct threat to high-income ones. These concerns have led to discussions about mechanisms to improve access to both new and existing antimicrobials in low- and middle-income countries.

Recent initiatives like SECURE, backed by multinational partners, represent early efforts to bridge this gap, aiming to promote appropriate use while expanding access to essential antibiotics in low- and middle-income countries—what some describe as an integral piece of the One Health puzzle.