

Underserved and Overexposed

AMR in Rural America



EXECUTIVE SUMMARY

Antimicrobial resistance (AMR) poses an escalating threat to the United States, with particularly severe implications for rural communities. While AMR, which refers to bacteria, fungus, and other pathogens that have evolved to be able to withstand current therapies including antibiotics, harms patients and undermines effective health care nationwide, rural Americans face unique structural, workforce, and environmental vulnerabilities that heighten both exposure and risk.

Rural health care systems already contend with acute shortages of infectious disease specialists, primary care providers, laboratory staff, and pharmacists. Nearly 80% of U.S. counties lack an infectious disease physician, and two-thirds of federally designated primary care shortage areas are rural. These deficits may hinder accurate diagnosis, timely treatment, and implementation of antibiotic stewardship practices—key defenses against AMR.

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The challenges are compounded by reliance on older, broad-spectrum antibiotics due to cost pressures, limited diagnostics, and lack of expertise. Rural children are disproportionately prescribed antibiotics, often inappropriately, while rural mothers face heightened infection risks during pregnancy and delivery amid declining obstetric services.

Occupational and environmental factors add further exposure. Agricultural practices, particularly the use of antibiotics in livestock production, contribute to the development of resistant pathogens that spread to farm workers, families, and surrounding communities. Rural residents are also vulnerable to hard-to-treat fungal infections linked to environmental exposures.

Despite the growing risk of AMR, innovation in antimicrobial drug and diagnostic development is woefully inadequate. The global pipeline for new antibiotics and antifungals is sparse, with few truly novel candidates and limited progress in rapid diagnostics—leaving clinicians reliant on aging therapies that are becoming increasingly ineffective.

The following white paper highlights real-world examples of what physicians, patients, and residents are up against in rural America and draws on a wide range of research to better understand the challenges AMR pose to rural health care.

Without sustained attention and investment, AMR will further erode the already fragile health infrastructure of rural America, with potentially profound consequences for hospitals, families, and local economies.

INTRODUCTION

In the winter of 2025, Dr. Christina Yen of Maine Medical Center met with a woman who had a type of blood cancer and was suffering from pain in her right knee. Yen is an infectious disease specialist but often works with cancer patients, as they are at an increased risk of developing life-threatening bacterial and fungal infections.

After Yen spoke with the patient and reviewed available medical records, she determined that the woman was likely suffering from an invasive fungal infection.¹ Of concern was that the patient had been prescribed a prophylactic antifungal as part of her cancer care that she took sporadically, increasing the likelihood that the infection had become resistant to first-line therapies. Also of concern was that the lab work required to get a definitive diagnosis would take up to 10 days, time that Yen did not want to waste for fear that the infection would worsen.

The patient had made it clear to Yen that she wanted to return home and not stay in the hospital for treatment. Hoping to honor this request, Yen suggested that the patient receive a Peripherally Inserted Central Catheter, more commonly known as a PICC line. PICC lines are typically inserted into a vein near the arm and enable medications to be delivered over an extended period, for weeks or sometimes even months. The patient nodded along in agreement with the strategy until Yen told her that she would not be able to lift anything over 5 pounds while the PICC line was in place.

“That’s a no-go for me,” the woman said, catching Yen off guard. “I live in a cabin and my only source of heat is a wood burning stove, and my ax is definitely heavier than 5 pounds. So, I’m either going to freeze to death or die from this infection.”



INTRODUCTION CONTINUED

Maine is one of the most rural states in the U.S. And while Maine Medical Center is based in Portland, it is a safety net hospital that serves patients from across the entire state, including deeply rural pockets where there are few physicians and limited health care infrastructure.

As Yen's story illustrates, patients in rural settings and the clinicians who care for them face distinct challenges when it comes to treating infections. Those challenges are becoming increasingly complex due to the rapid rise of antimicrobial resistance (AMR). AMR refers to when bacteria, fungus, and other pathogens evolve to be able to withstand the medications we use to fight them, most notably antibiotics. The infections these resistant pathogens cause cannot be treated with first-line antibiotics or antifungals; for some highly resistant infections, no effective treatments exist. AMR is a threat to all patients, and it is especially concerning for those in rural areas.

"AMR tends to really fester where there are cracks or weaknesses in our institutional structures, and the places in our society where we either lack resources or lack the ability to take care of our most vulnerable," Yen said.

Rural health care in the United States is under enormous strain. Workforce shortages, cost pressures, geographic barriers, and hospital and laboratory closures are among the factors that limit rural Americans' access to high-quality care. According to data from the United States Department of Agriculture's Economic Research Service,² urban areas have recorded declines in disease-related mortality rates for all age groups in the last 20 years while rural areas have seen increases in disease-related mortality rates for certain age groups, including 25-54-year-olds, the prime working-age population. As the report noted, this is potential indicator of "worsening population health, which could have negative implications for rural families, communities, employment, and the economy."



AMR could make matters much worse. Access to effective antibiotics, antifungals, and other antimicrobial drugs is essential to ensuring the health of everyone, including rural populations. Physicians rely on antibiotics to cure a wide range of infections from minor earaches and strep throat to life-threatening cases of sepsis and gangrene. Antibiotics also enable patients to receive chemotherapy, hip and knee replacements, organ transplants, and dozens of other procedures.

However, the emergence of AMR is eroding the effectiveness of our available antibiotics and undermining modern medicine as we know it. AMR is adversely impacting the health of Americans every day and driving up health care costs. The U.S. Centers for Disease Control and Prevention (CDC) reports that more than 2.8 million drug-resistant infections occur each year in the U.S., causing more than 30,000 deaths and adding \$4.6 billion³ in national healthcare costs.

**Each year in the U.S.
antibiotic-resistant infections
are responsible for:**

>2.8
MILLION

infections

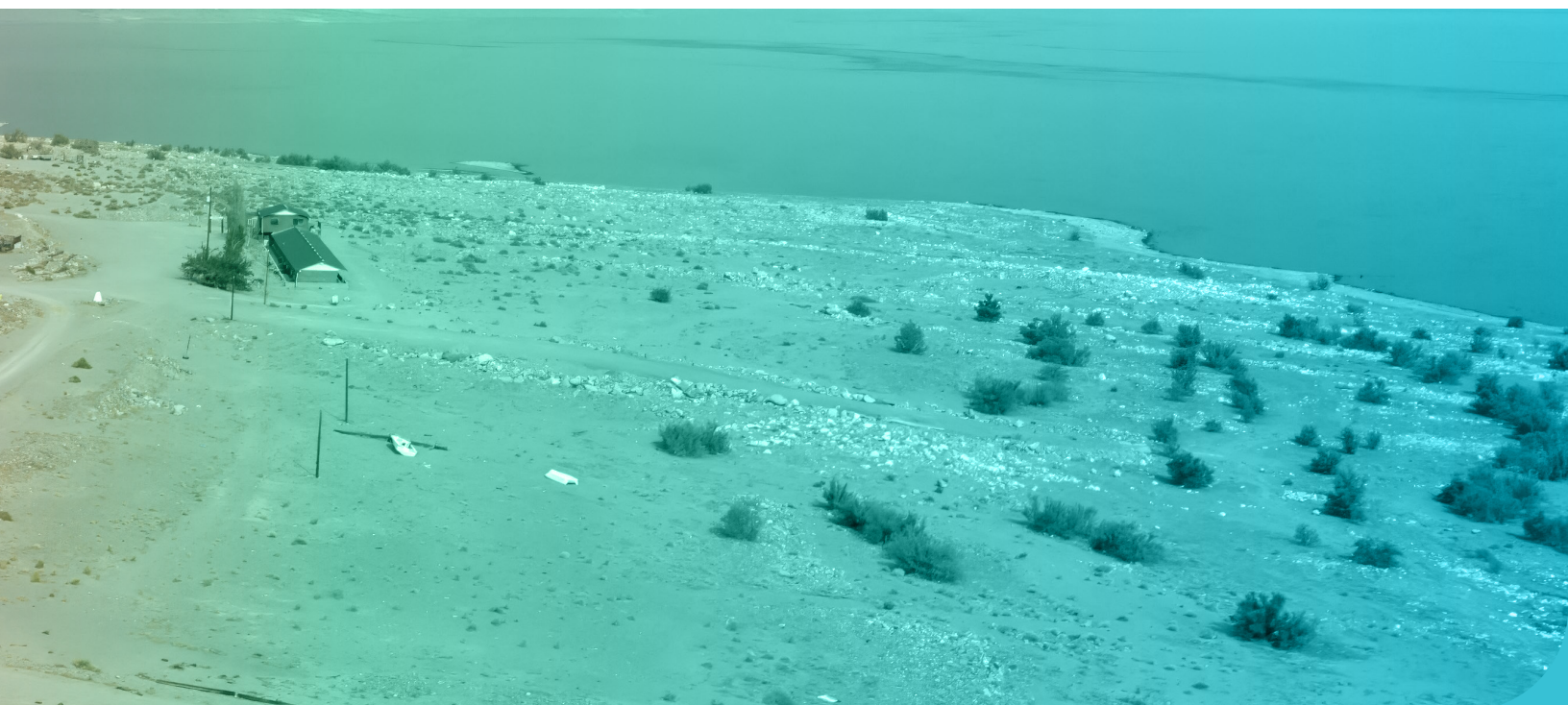
>\$4.6
BILLION

in healthcare costs

>30
THOUSAND

deaths

Given the baseline disadvantages rural Americans face in terms of accessing high-quality health care and the unique environmental risks associated with rurality, it is likely they will become increasingly prone to drug-resistant infections.





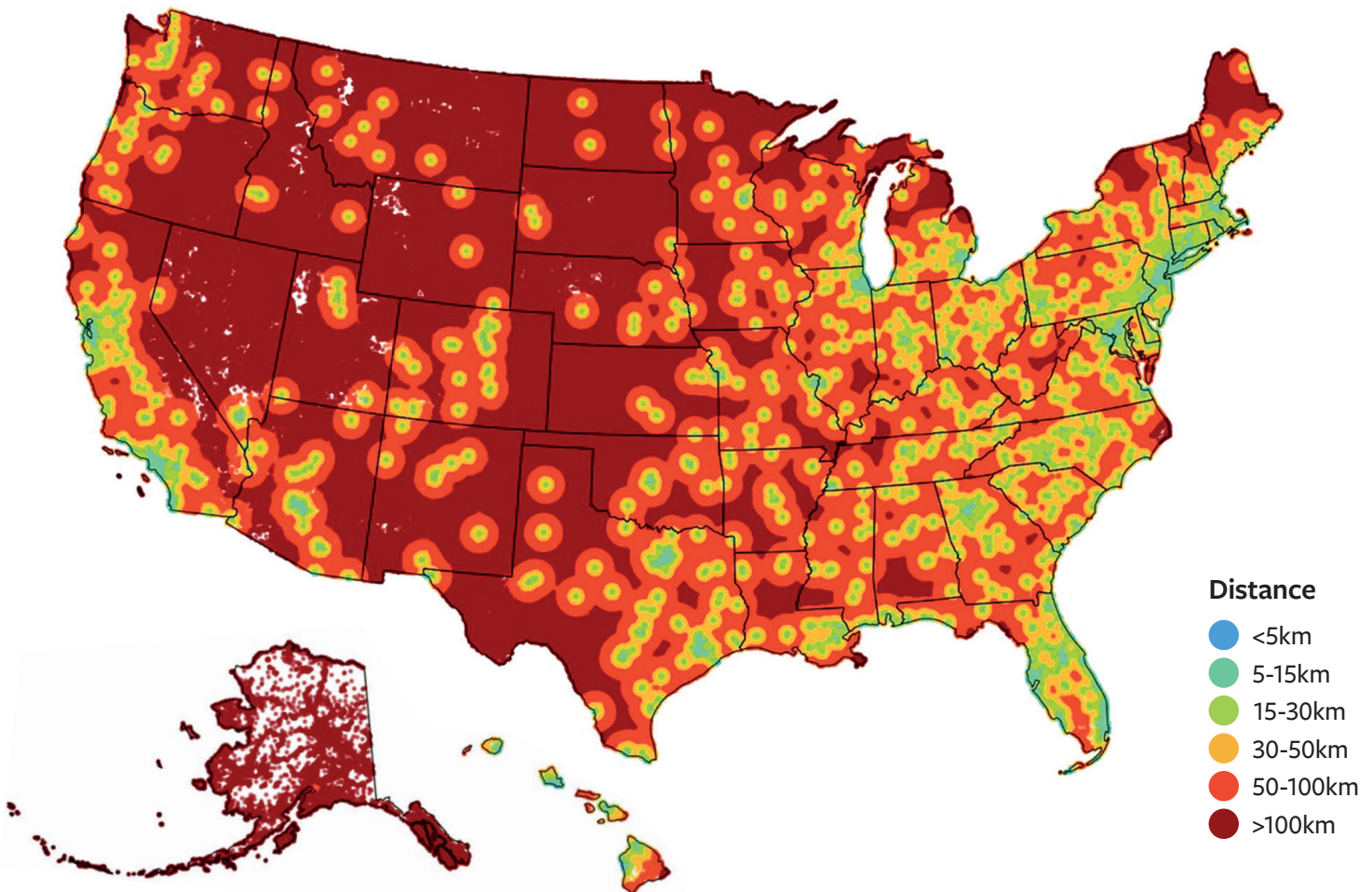
HEALTHCARE WORKFORCE SHORTAGES

One overarching challenge is that rural health care in the U.S. suffers from an acute shortage of infectious disease (ID) specialists. Nearly 80% of counties in the U.S. do not have an ID physician and a recent analysis showed that only 32% of individuals in rural America live within 20 kilometers from their nearest provider compared with 88% in urban counties.⁴

ID specialists play a critical role in treating and managing drug-resistant infections, with studies demonstrating that patients with Methicillin-resistant *Staphylococcus aureus* (MRSA) and other infections who consult with an ID specialist have better outcomes.⁵

Workforce shortages extend well beyond the field of ID specialists. According to data from the Department of Health and Human Services, more than 65% of all primary care health professional shortage areas are in rural America.⁶

Rural hospitals also struggle with shortages of laboratory staff and specialty pharmacists, which can impede the timely diagnosis and proper treatment of infections, fostering conditions in which AMR can flourish. Fewer specialists can also make it more difficult for hospitals to adhere to guidelines and policies intended to slow the spread of AMR, including antibiotic stewardship efforts.



Map of mean distance from each census block to an infectious disease physician.



STEWARDSHIP AND ACCESS CHALLENGES

Studies show that small and rural hospital have difficulty following antibiotic stewardship principles — that is, matching drugs and dosages to the diagnosed infection, rather than risking resistance by prescribing an antibiotic that is overly broad in coverage or taken for longer than the infection demands. Antibiotic stewardship is widely regarded as one of the most important defenses against the spread of AMR, both within hospital settings and within communities.

Physicians in rural areas are more likely to be generalists, and thus less familiar with the newest treatment guidelines.

There are numerous reasons why rural hospitals may struggle with antibiotic stewardship. They may lack their own lab services and providers may be inclined to prescribe older broad-spectrum drugs while they wait for tests to be processed in external laboratories. Rural providers could also favor older, inexpensive broad-spectrum antibiotics because, being less expensive, their use allows rural hospitals to spread federal reimbursement funds across an array of expenses. Or it may simply be that physicians in rural areas are more likely to be generalists, and thus less familiar with the newest infectious disease treatment guidelines.

The conditions and cost pressures of rural practice are additional factors that make it less likely that patients will be prescribed newer antimicrobials.⁷ This is due in part to the fact that academic centers tend to have more access to innovation across the board, irrespective of therapeutic area or disease states, and those academic centers tend to be clustered in urban areas.





PEDIATRIC PROBLEMS

Children often become sick with bacterial infections and are among the highest users of antibiotics. Ensuring that children are receiving the right antibiotic at the right dosage and frequency is essential, but difficult in practice, especially in rural settings.

A study in Tennessee, where more than half of the counties are considered rural,⁸ found in 2020 that pediatricians practicing in rural areas tended to prescribe antibiotics to children more frequently than urban ones did.⁹ And a separate study a year later also found that children in rural areas in Tennessee were specifically more likely to be prescribed antibiotics inappropriately, creating the conditions for antibiotic-resistant bacteria to emerge.¹⁰ In that second study, done by researchers at Vanderbilt University, the authors hypothesized that living in a rural area might be associated with lower income, less healthcare access, and more severe chronic illness.

Researchers across the border in Kentucky, which has the second-highest rate of pediatric antibiotic prescribing in the U.S. and more than half of its children living in rural areas, yielded similar findings.¹¹ Rural children had consistently higher rates of antibiotic prescriptions, receiving up to three courses of antibiotics per year. That study specifically noted that patients who were female, less than 2 years old, White, and living in a rural area had consistently higher rates of antibiotic prescriptions.

Similar patterns appeared in a 2024 analysis of antibiotic prescriptions written for children covered by Medicaid in North Carolina,¹² a state where 80 out of 100 counties classify as rural. In that study, White children living in rural areas had the highest rates of antibiotic prescriptions overall while Black children were more likely to receive inappropriate prescriptions that could not effect a cure.

Pediatricians practicing in rural areas tended to prescribe to children more frequently than urban ones did

Receiving the wrong antibiotics is an inherent risk of being in a rural location, according to Dr. Ganga Moorthy, an assistant professor of pediatrics at the Duke University School of Medicine and first author of that research, who studies antibiotic utilization in the U.S. and in East Africa.

“In rural areas, there are far fewer pediatricians,” Dr. Moorthy said.¹³ “Children are being taken care of by general practitioners, by adult physicians, by advanced practice personnel such as nurse practitioners or physician assistants, and all of those non-pediatricians are more likely to prescribe an inappropriate antimicrobial.



A RISK TO MOTHERS

Mothers—expectant, birthing, and postpartum—are likewise significantly disadvantaged in rural settings and may be at an increased risk of antibiotic-resistant infections. According to the National Advisory Committee on Rural Health and Human Services, women in rural settings had a nine percent greater probability of severe maternal morbidity and mortality, compared with urban residents.¹⁴ The same report noted that CDC Pregnancy Mortality Surveillance System data showed infection, including sepsis, is a leading cause of maternal mortality.

Mothers face myriad infectious risks throughout pregnancy and delivery. Kidney and urinary tract infections (UTIs) are common complications during pregnancy, and mothers and their unborn children are also at risk of chorioamnionitis, a bacterial infection that can affect the placenta and amniotic fluid, and endometritis, which inflames the tissue lining the uterus. Both chorioamnionitis and endometritis are associated with an increased risk of postpartum hemorrhage, a leading cause of maternal deaths.

Beyond treating these infections, antibiotics play a role in safeguarding mothers who are delivering their children via cesarean sections. The American College of Obstetricians and Gynecologists recommends prophylactically administering an antibiotic to nearly everyone undergoing a cesarean section to minimize the risk of surgical site infections.¹⁵ While this is good practice, it may contribute to the development of antibiotic-resistant bacteria on an individual level and raises concerns pertaining to antibiotic stewardship.





A RISK TO MOTHERS CONTINUED

The challenges mothers face are likely to get worse because, unfortunately, many of the overarching obstacles associated with rural care are amplified when it comes to labor and delivery, especially workforce shortages. Just like there is a shortage of infectious disease specialists in rural America, there is also a severe shortage of obstetric care providers in rural counties. Rural hospital closures have exacerbated the shortage of specialists, according to the National Rural Health Association, which noted in a recent report that 56% of rural counties are without access to obstetric care.

AMR complexifies other aspects of women's health outside of pregnancy, including the treatment and management of UTIs. Women have a lifetime risk of 53% of experiencing UTI and the risk increases with age.¹⁶ Cases of, and hospitalizations for, complicated UTI (cUTI) are on the rise; one study used data from nearly 150,000 patients in a large California health system and found that 57% of UTIs were caused by bacteria resistant to at least one antibiotic class, while 13% were resistant to three or more classes.¹⁷ In rural settings, women may face numerous challenges associated with accessing timely care for UTIs, which could increase the likelihood that it leads to more complicated infections, bacteremia, or life-threatening sepsis.



OCCUPATIONAL AND COMMUNITY RISKS

Rural areas also are places where farmers and other agricultural workers are likely to be exposed occupationally to antibiotics and antifungal compounds and placed at risk of developing resistant infections as a result.

In projects running for more than a decade, environmental-health researchers at the Johns Hopkins Bloomberg School of Public Health have demonstrated that routine antibiotic use in chicken and hog production, intended to protect animals against diseases of crowding, contributes to the emergence of antibiotic-resistant bacteria in the animals and on farm properties.

One type of resistant bacteria, a strain of MRSA with a genetic signature that distinguishes it from both the hospital-associated and the community-onset variety, lurks in manure dust on farms, which is breathed in by farmworkers and settles on their clothing.¹⁸ Repeat studies have shown that the bacteria linger in farmworkers' nasal passages and pass to their children and household members, and that farmworkers have higher rates of MRSA skin infections.¹⁹ Slaughterhouse workers are also at risk if they accidentally cut themselves with contaminated knives or breathe in mist from high-pressure hoses used to clean areas in processing plants.





OCCUPATIONAL AND COMMUNITY RISKS CONTINUED

These risks can extend to the residents of the surrounding communities. Studies have shown that people in rural communities who live close to large-scale livestock operations are more likely to carry antibiotic-resistant bacteria traceable to farms even if they do not work there, and that members of communities where swine manure is applied on fields are at higher risk of MRSA infection.²⁰

“The whole construct of exposure is quite complex, and it doesn’t necessarily follow a bull’s-eye distribution,” explained Meghan Davis, an associate professor of environmental health and engineering at the Bloomberg school and co-author on multiple papers.²¹ “It’s going to be based on prevailing winds, weather patterns, time of year.”

There are additional environmental factors contributing to the spread of AMR among rural residents that have nothing to do with farms. In California, for instance, coccidioidomycosis, or Valley fever — an environmental pathogen that poses a hard-to-treat infection risk when dry soil is stirred up by winds — has infected film crews on location²² and laborers installing solar panels.²³

Other fungi endemic to different parts of the United States have been pinpointed as risks for wildland firefighters, forestry personnel, paper-mill operators, landscapers and construction workers. A 2022 analysis of hospital discharge data found that incidence of fungal infections is closely linked to socioeconomic factors as well as environmental exposures.²⁴



LIMITED INNOVATION

Despite the growing burden of AMR in the U.S. and globally, investment into antibiotic and antifungal R&D is lagging and the pipeline of new antibiotics and antifungals is insufficient for the problem at hand. Globally, only 32 antibiotics are in development to address priority bacterial pathogens identified by the U.S. CDC and the World Health Organization (WHO).²⁵ In a recent assessment, the WHO noted that, “Not only are there too few antibacterials in the pipeline, given how long is needed for R&D and the likelihood of failure, there is also not enough innovation.”²⁶ Of the 32 antibiotics currently in development, only 12 can be considered innovative, and most of those candidates will fail in clinical testing.

Not only are there too few antibacterials in the pipeline, given how long is needed for R&D and the likelihood of failure, there is also not enough innovation

Antifungal R&D is not faring any better. Only four new antifungals were approved during the last 10 years, according to the WHO, and only nine agents are currently in clinical development against priority fungal pathogens.²⁷

Further complicating matters is the lack of rapid diagnostics and drug susceptibility testing. In the absence of a definitive diagnosis and without clear information on what antibiotic or antifungal will be effective, physicians are forced to treat empirically, relying on old broad-spectrum therapies that can be associated with numerous side effects. The persistent use of broad-spectrum therapies also breeds resistance among patients.

As AMR evolves and spreads, particularly in rural settings, clinicians will need access to more targeted therapies and rapid diagnostics. This will not only improve outcomes among patients, but it will also enable clinical teams to be better stewards of these important medicines.

CONCLUSION AND RECOMMENDATIONS

Rural Americans face distinct challenges when it comes to treating infections and AMR is exacerbating these challenges. A confluence of factors, including workforce shortages, social and occupational risks among residents, and a lack of innovative antibiotics in development could accelerate the spread of AMR in rural settings.

Rural health systems are poorly prepared to respond to this growing crisis, but there are steps to be taken that can better equip clinicians and patients to address AMR.

They include:



Support incentives and policies that enhance recruiting efforts aimed at attracting and retaining infectious disease specialists and pediatricians to work in rural settings.



Enhance support for antimicrobial stewardship programs in rural settings to ensure appropriate use of existing therapies.



Improve access to and uptake of new antibiotics and diagnostics in rural settings.



Strengthen the antimicrobial pipeline through policies that encourage private investment and reward the successful development of innovative antimicrobials.



Increase public awareness of AMR, especially among at-risk occupations such as farm workers.

Endnotes

- 1 Interview with Dr. Christina Yen, May 2025
- 2 Thomas, K. L., Dobis, E. A., & McGranahan, D. (2024). *The nature of the rural-urban mortality gap* (Report No. EIB-265). U.S. Department of Agriculture, Economic Research Service.
- 3 CDC. Antibiotic Resistance Threats in the United States, 2019. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2019
- 4 Maamari, J., Chen, Z., Motairek, I., Al-Kindi, S., & Fleisher, J. (2024, May). Mapping Proximity to Infectious Disease Physicians Across the United States. *Open Forum Infectious Diseases*, 11(5)
- 5 Turner, R. B., Valcarlos, E., Won, R., Chang, E., & Schwartz, J. (2016). Impact of Infectious Diseases Consultation on Clinical Outcomes of Patients with Staphylococcus aureus Bacteremia in a Community Health System. *Antimicrobial Agents and Chemotherapy*, 60. 10.1128/aac.00439-16
- 6 Bureau of Health Workforce Health Resources and Services Administration (HRSA) U.S. Department of Health & Human Services. (2025). *Designated Health Professional Shortage Areas Statistics: Second Quarter of Fiscal Year 2025 Designated HPSA Quarterly Summary*.
- 7 Interview with Christine Miller, November 2024
- 8 Data USA. (n.d.). *Tennessee*. Data USA. Retrieved June 30, 2025, from <https://datausa.io/profile/geo/tennessee>
- 9 Katz, S. E., Staub, M., Ouedraogo, Y., Evans, C. D., Kainer, M. A., Griffin, M. R., & Banerjee, R. (2020). Population-based assessment of patient and provider characteristics influencing pediatric outpatient antibiotic use in a high antibiotic-prescribing state. *Infection Control & Hospital Epidemiology*, 41(3).
- 10 Dantuluri, K. L., Bruce, J., Edwards, K. M., Banerjee, R., Griffith, H., Howard, L. M., & Grijalva, C. G. (2021). Rurality of Residence and Inappropriate Antibiotic Use for Acute Respiratory Infections Among Young Tennessee Children. *Open Forum Infectious Diseases*, 8(1).
- 11 Wattles, B. A., Vidwan, N. K., Feygin, Y., Jawad, K. S., Creel, L. M., & Smith, M. J. (2021, May). Antibiotic prescribing to Kentucky Medicaid children, 2012-2017: Prescribing is higher in rural areas. *The Journal of Rural Health*, 38(2).
- 12 Moorthy, G. S., Young, R. R., Raman, S. R., & Smith, M. J. (2024, January). Variations in antibiotic prescribing among children enrolled in North Carolina Medicaid, 2013-2019. *The Journal of Rural Health*, 40(3).
- 13 Interview with Dr. Ganga Moorthy, October 2024
- 14 National Advisory Committee on Rural Health and Human Services. (2020, May). *Maternal and Obstetric Care Challenges in Rural America: Policy Brief*. HRSA.gov. <https://www.hrsa.gov/sites/default/files/hrsa/advisory-committees/rural/2020-maternal-obstetric-care-challenges.pdf>
- 15 American College of Obstetricians and Gynecologists. (2018). *Practice Bulletin: Use of Prophylactic Antibiotics in Labor and Delivery*. ACOG.org. <https://www.acog.org/clinical/clinical-guidance/practice-bulletin/articles/2018/09/use-of-prophylactic-antibiotics-in-labor-and-delivery>
- 16 Infectious Diseases Society of America. (2025). *Complicated Urinary Tract Infections (cUTI): Clinical Guidelines for Treatment and Management*. IDsociety.org. <https://www.idsociety.org/practice-guideline/complicated-urinary-tract-infections/>
- 17 Ku, J. H., Tartof, S. Y., Contreras, R., Ackerson, B. K., Chen, L. H., Reyes, I. A., Pellegrini, M., Schmidt, J. E., & Bruxvoort, K. J. (2024). Antibiotic Resistance of Urinary Tract Infection Recurrences in a Large Integrated US Healthcare System. *The Journal of Infectious Diseases*, 230(6), 1344-1354.
- 18 Rinsky, J. L., Nadimpalli, M., Wing, S., Hall, D., Baron, D., Price, L. B., Larsen, J., Stegger, M., Stewart, J., & Heaney, C. D. (2013, July 2). Livestock-Associated Methicillin and Multidrug Resistant Staphylococcus aureus Is Present among Industrial, Not Antibiotic-Free Livestock Operation Workers in North Carolina. *PLoS One*.
- 19 Nadimpalli, M., Rinsky, J. L., Wing, S., Hall, D., Stewart, J., Larsen, J., Nachman, K. E., Love, D. C., Pierce, E., Pisanic, N., Strelitz, J., Harduar-Morano, L., & Heaney, C. D. (2014, September). Persistence of livestock-associated antibiotic-resistant Staphylococcus aureus among industrial hog operation workers in North Carolina over 14 days. *Occupational and Environmental Medicine*, 90(9). Cite
- 20 Carrel, M., Schweizer, M. L., Vaughan Sarrazin, M., Smith, T. C., & Perencevich, E. N. (2016). Residential Proximity to Large Numbers of Swine in Feeding Operations Is Associated with Increased Risk of Methicillin-Resistant Staphylococcus aureus Colonization at Time of Hospital Admission in Rural Iowa Veterans. *Infection Control & Hospital Epidemiology*, 35(2).
- 21 Interview with Meghan Davis, October 2024
- 22 Wilken, J. A., Marquez, P., Terashita, D., McNary, J., Windham, G., & Materna, B. (2014, April). Coccidioidomycosis Among Cast and Crew Members at an Outdoor Television Filming Event — California, 2012. *CDC Morbidity and Mortality Weekly Report*, 63(15).
- 23 Wilken, J. A., Sondermeyer, G., Shusterman, D., McNary, J., Vugia, D., McDowell, A., Borenstein, P., Gilliss, D., Ancock, B., Prudhomme, J., Gold, D., Windham, G. C., Lee, L., & Materna, B. L. (2015). CDC Morbidity and Mortality Weekly Report. *Coccidioidomycosis among Workers Constructing Solar Power Farms, California, USA, 2011–2014*, 21(11).
- 24 Rayens, E., Kay Rayens, M., & Norris, K. A. (2022). Demographic and Socioeconomic Factors Associated with Fungal Infection Risk, United States, 2019. *Emerging Infectious Diseases*, 28(10).
- 25 World Health Organization. (2024). *2023 Antibacterial agents in clinical and preclinical development: an overview and analysis*.
- 26 World Health Organization. (2024, June 14). *WHO releases report on state of development of antibacterials*.
- 27 World Health Organization. (2025, April 1). *Antifungal agents in clinical and preclinical development: overview and analysis*.



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