Combating Antimicrobial Resistance in the Face of Climate Change Requires a One Health Approach

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Background/Objectives. Antimicrobial resistance (AMR) is an emergent health problem that initially affects individuals in a community, but ultimately has implications for the health of global ecosystems. In light of ongoing climate changes, increases in severe weather are causing the uncharacteristic spread of microbes and warmer temperatures are leading to increased genetic mutations, gene transfer, and growth. Medical interventions, such as the administration of antibiotics, imposes evolutionary pressure on bacterial populations and ultimately leads to the emergence of AMR. The development of AMR occurs through either spontaneous mutation or genetic transfer and proliferates with misuse of antibiotics, improper sanitation, migration, run-off, and cross species interactions. In 2017 alone, resistant bacteria caused 4.8 billion dollars in human medical costs. Environmental changes, such as warmer temperatures, exacerbate the prevalence of AMR in ecosystems through accelerated pathogen growth leading to resistance gene mutations, transfer of resistance genes between organisms, and displacement of AMR pathogens. These resistant pathogens are increasing in prevalence across human, farm animal, and domestic animal populations. In this work, we highlight the need to use a one health approach to combat AMR and better understand the nuanced impacts of climate change and how its unmitigated effects are impacting global health.

Approach/Activities. To provide the best health outcomes for an individual, in view of the broader global ecosystem, a one health approach is needed to defend against the growing problem of AMR. The one health concept considers the wellbeing of the broader environment as well as humans, wildlife, agriculture, and companion animals. Natural (climate change, disease), intentional (weapons, attacks), and accidental events (chemical spills, resource exploitation) are all threats to our global one health. Threats, such as AMR and climate change, can present at the same time and location, giving rise to an even more complex crisis. For example, warmer climates can lead to individuals being more susceptible to AMR infections, and severe weather events can lead to wildlife migration resulting in new AMR bacterial infections. Developing a robust one health defense strategy includes broadly monitoring disparate data streams including medical records, veterinary data, environmental samples, and climate data, as well as scientific literature and news reports to provide a more complete depiction of the ecosystem and, therefore, more comprehensive preparedness against potential threats. PNNL has developed the capability for real-time monitoring of ecological threats and the capability to link these data to medical records, creating data driven insights into ecosystem health. To implement a one health approach to defend against AMR amplified by the effects of climate change, it is crucial that we engage in holistic research to develop a robust understanding about the implications of AMR within the broader global ecosystem.

Results/Lessons Learned. The complex underpinnings of the one health approach and threats affecting our ecosystem, such as AMR and climate change, are not easily understood in isolation. Understanding these phenomena is even more challenging when compounded by dynamic human behavior. The one health approach to defense preparedness crucially leverages real-time data streams to predict and develop actionable steps towards addressing the complex threat landscape of AMR in the face of a changing climate.