# Monitoring wildlife may shed light on spread of antibiotic resistance in humans

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Sarah Jobbins, left, and Kathleen Alexander tested for resistance to 10 antibiotics among cattle and 18 wildlife species in Chobe, Botswana. Credit: Virginia Tech

Antibiotics are a blessing but may also be an empty promise of health when microbes develop resistance to our pharmacological arsenal.

Globally, the emergence of antibiotic resistance is an important threat to both human and animal health.

The lifestyle differences among species can provide critical insight into the mechanisms of antibiotic resistance spread and the potential for improved monitoring and control, Virginia Tech scientists reported today (July 29) in the online first preprint of the *Journal of Wildlife Diseases*. Kathleen Alexander, an associate professor of wildlife in the College of Natural Resources and Environment at Virginia Tech, and Sarah Jobbins, a former postdoctoral associate in wildlife now studying veterinary medicine at the University of Sydney, used the common intestinal bacteria Escherichia coli to evaluate the spread of antibiotic resistance among humans, domestic animals, and wildlife in the Chobe district of northern Botswana.

The researchers tested for resistance to 10 antibiotics among cattle and 18 wildlife species to explore key attributes and behaviors that may increase exposure and allow resistance to move among humans, animals, and ecosystems.

Results were compared with 193 human samples from healthy and clinically ill patients at the local hospital and 12 environmental sources of human fecal waste.

Among 150 wildlife fecal samples, 41 percent contained E. coli isolates that were resistant to at least one or two of the 10 antibiotics tested, while 13 percent were resistant to three or more antibiotics. E. coli from wildlife, human clinical, and environmental samples were resistant to a similar spectrum of antibiotics.

Multidrug resistance was found across land types, from areas of human habitation to protected areas such as Chobe National Park.

"Resistance was widespread but not ubiquitous," Jobbins said.

Multidrug resistance was significantly higher in water-associated species, such as hippopotamus, crocodile, waterbuck, and otter.

"Surface water is a critical shared resource for humans and animals, particularly in dry regions of the world such as Botswana," Jobbins said. "It can also act as a powerful exposure medium for the introduction of resistance into populations never previously exposed to antibiotics."

Multidrug resistance was significantly higher in carnivore species, animals that might have greater exposure to antibiotic resistance through diet.

"Resistance may accumulate up the food chain," Jobbins said, "making apex predators such as crocodile, leopard, and hyena important ecosystem sentinels."

Species inhabiting urban areas, such as mongoose, baboon, and warthog, harbored significant levels of multidrug resistance.

"Isolates from wildlife demonstrated similar patterns of resistance to human E. coli from environmental and clinical sources in the study area, including several front-line antimicrobials," Jobbins said. "Importantly, these individuals connect human populations with other species, providing a mechanism by which resistant microbes are distributed throughout the ecosystem."

Jobbins and Alexander's study examines antimicrobial resistance in a broad range of hosts, both in absolute numbers and breadth of species, in their natural environment.

"This novel approach may be applied to other ecosystems, facilitating

early detection of antimicrobial resistance accumulation in the environment," said Alexander, who is an affiliate of Virginia Tech's Fralin Life Science Institute.

The researchers conclude that capitalizing on the role of wildlife as potential sentinels of aquatic and terrestrial ecosystems through long-term monitoring of antimicrobial resistance among top predators and water- and human-associated species may support improved surveillance, detection, and control of the spread of antimicrobial resistance across the landscape.

"Wildlife communities provide a unique opportunity for us to begin to understand how antimicrobial resistance moves across landscapes," Alexander said. "Each species occupies a particular niche and interacts with the environment in different and specific ways, dependent on key life history strategy elements. Wildlife communities may then act as sentinels for ecosystem health, providing clues to points where humans, animals, and natural systems are coupled and transmission of antimicrobial resistance is occurring.

"The presence of antibiotic resistance across land uses in this system is of grave concern. This is an emerging problem of global proportions, resulting in failed treatments and deaths," she pointed out.

With one of the highest rates of HIV/AIDS in the world, Botswana is extremely vulnerable to infectious disease. "Alarmingly, our research identifies widespread resistance in wildlife to several first-line antimicrobials used in human medicine," Alexander said.

"There is a need to be much more aggressive about controlling the spread of antibiotic resistance," she continued. "We can harness life history diversity in wildlife communities to identify where contact with resistant microbes might occur in the environment. Right now, our data

suggest that surface water may be a critical exposure medium. In an environment where there are no commercial agriculture or livestock production activities, our next step is to establish why we are seeing these patterns."

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