

Overcoming the Blind Spot: A One Health Vision to Enhance Human Medicine



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Are human healthcare clinicians fully considering the broader determinants of their patients' health, such as interactions with animals and access to clean water, air, and nature? Although these factors significantly impact individual health outcomes, they are often overlooked in clinical practice. Recognition of the interdependence of human, animal, and environmental health is central to One Health, a global initiative that supports collaboration between animal, environmental, and human health professionals. This transdisciplinary approach is critical for addressing today's most pressing human health challenges and urges immediate action for human health clinicians. The One Health approach considers human health through its interactions with biodiversity, climate change,

pollution, medical and industrial waste, microplastics, companion animals and wildlife, medications, agricultural systems, and local ecosystems with possible vector-borne diseases (Figure 1).



Figure 1. A One Health approach considers human health in its full ecological context. Authors created this figure with BioRender.com.

The One Health concept stems from centuries of collaborative thought and is guided by the ongoing need for transdisciplinary work. In ancient times, healers attended to both humans and animals. In the 1800s, physician Rudolf Virchow stated, "*Between animal and human medicine there is no dividing line—nor should there be*" [1]. In the 1960s, the term "One Medicine" emerged, followed in the 1990s by the term "Conservation Medicine," and more recently, terms such as "Planetary Health," "Zoonotic," "Zooecology," and "Interprofessional Education" [1]. Although there are different definitions and emphases, these approaches share a common foundation: recognition that the health of humans, animals, and ecosystems are interconnected and that addressing

contemporary health threats requires collaboration across disciplines and communities.

The current One Health conversation was strengthened in the early 1990s with the discovery that over 75% of emerging infectious diseases in humans are zoonotic [2]. Although rarely mentioned, the 1918 flu pandemic that killed 50-100 million people around the world is thought to have emerged from pigs at a U.S. Army base in Kansas (United States), and the human immunodeficiency virus (HIV) resulted from multiple cross-species transmissions of simian immunodeficiency virus [3,4]. The severe acute respiratory syndrome coronavirus 1 (SARS-CoV-1) epidemic in 2003-2004 increased awareness of the need for human and animal health professionals to work together, which has been further validated by the emergence of the Ebola virus, Middle East Respiratory Syndrome coronavirus, and Zika virus.

Why is this One Health way of thinking important to human health practitioners? Evidence shows that individual patient health may be significantly harmed by the effects of climate change, such as wildfire smoke and extreme heat, and environmental exposure to endocrine disruptors and forever chemicals. The loss of biodiversity, including potential "dilutional hosts" with low reservoir competence, can increase risk of mosquito- and tick-borne disease transmission to other hosts [5]. Conversely, fostering connections to nature improves mental and physical health outcomes for humans [6]. Ultimately, when human health clinicians take a One Health approach to patient care, they

are more likely to connect how animal and environmental health directly and indirectly impacts their patients' health. They are thus more aware of the effects of lifestyle (e.g., social determinants of health) and occupational risks (e.g., animal contact or outdoor work) and are better prepared to successfully advocate for, educate, diagnose, and treat their patients. The authors highlight the need for multidisciplinary collaborations in relevant areas, including zoonotic and vector-borne diseases, comparative medicine and translational research, nature-based solutions, access to healthcare, ecological interdependence, and current threats affecting human, animal, and ecosystem health (e.g., climate change, antimicrobial resistance, increased infectious disease prevalence).

Zoonotic and Vector-Borne Diseases

A One Health approach is urgently needed to address zoonotic and vector-borne diseases (VBDs), such as Lyme disease, malaria, babesiosis, and bartonellosis. Pathogen spillovers are growing more common and consequential as human populations encroach on wild places through urbanisation, habitat destruction, unsustainable agricultural and forestry practices, and climate change [4]. The coronavirus disease 2019 (COVID-19), thought to have originated in bats, has caused over seven million human deaths with millions more suffering from post-acute sequelae of COVID-19 and economic hardship [4]. Currently, highly pathogenic avian influenza (H5N1) is infecting species, including cows, cats, and humans, causing concerns about viral mutations that will enable person-to-person transmission and another pandemic [7].

Ixodes ticks carry Lyme disease as well as *Flaviviridae* viruses, and their range and incidence are spreading across Europe into Russia and across the United States and into Canada [8]. Similarly, the tick-borne diseases of ehrlichiosis and anaplasmosis are on the rise in dogs and cats, which could serve as sentinels for human disease [9]. Further, rising global temperatures are expanding the geographic range of VBDs by increasing vector distributions, prolonging seasonal activity, and extending disease transmission [2]. Although beyond the scope of this paper, climate change also impacts health directly through severe weather, sea-level rise, wildfires and poor air quality, food insecurity, and limited access to clean water, and indirectly through infectious disease spread [8,10].

Figure 2 demonstrates an example of the interconnectedness of ecosystems, such as how invasive plant species may further facilitate VBD transmission by changing the pathogen, vector, host, and environment epidemiology [11]. For instance, bush honeysuckle (*Lonicera maackii*) is among the most prolific invasive plants in North America and grows in thickets that are 18 times more dense than native vegetation. This protective cover is preferred by white-tailed deer (*Odocoileus virginianus*), which are tick hosts and serve as reservoirs for *Ehrlichia* bacteria. Within honeysuckle thickets, more ticks become infected with *Ehrlichia* spp. allowing the ticks to transmit that pathogen to humans and their companion animals (Figure 2, left side). Fortunately, removal of bush honeysuckle decreases the prevalence of *Ehrlichia* spp. in ticks, revealing a One Health-framed intervention that re-establishes native flora while decreasing ehrlichiosis incidence

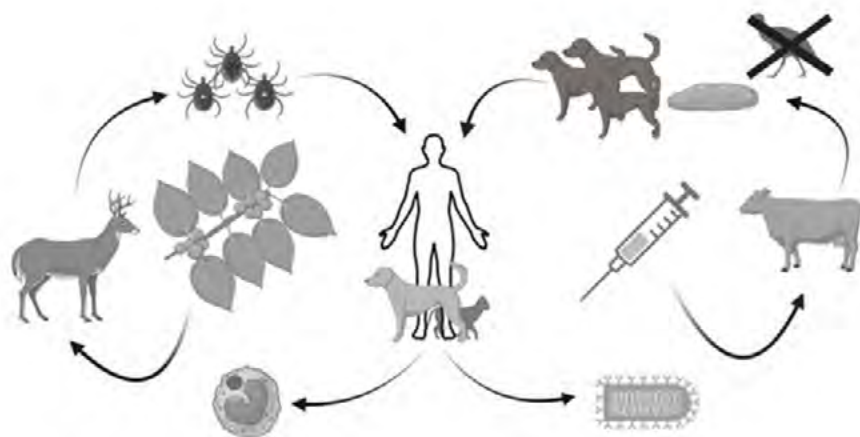


Figure 2. A One Health approach is needed to combat the many complex and inter-related causes for increased disease exposure, such as ehrlichiosis from ticks and rabies from feral dogs. Authors created this figure with BioRender.com.

in humans and other animals. Appropriate tick prevention in pets can also decrease human VBD exposure, and supporting biodiversity can increase the prevalence of both “dilutional hosts” and animals that ingest ticks [5]. In another example, increased use of non-steroidal anti-inflammatory drugs in aging cows in India caused renal failure in vulture populations that fed on their carcasses (Figure 2, right side) [12]. The loss of vultures led to more food for an increasing population of feral and rabid dogs and a subsequent increase in human rabies cases. These examples of zoonotic and VBDs highlight the benefits of collaboration between physicians, veterinarians, wildlife biologists, and ecologists.

Comparative Medicine and Translational Research

Combining human and animal disease surveillance may help mitigate the damage caused by outbreaks and environmental contaminants as pathogens may be detected in livestock, wild animal populations, or companion animals before being documented in humans. Maps depicting where dogs have Lyme borreliosis antibodies can be almost perfectly overlaid with the

U.S. Centers for Disease Control and Prevention’s maps of Lyme disease in humans [13]. Knowing disease patterns of companion animals in the community can inform the human health practitioners history taking and diagnostic testing.

Beyond infectious disease, One Health also informs clinician understanding of disease models and development of new treatment modalities. Spontaneous companion animal models of disease can provide significant insight into the effects of environmental exposures as well as disease development, such as aging and cancer susceptibility, and novel treatments [14]. For example, the diagnosis of hyperthyroid cats in the late 1980s led to the realization that certain flame retardants were endocrine disruptors, and hence manufacturers stopped adding these compounds to children’s pajamas [14]. Additionally, cats with the highest serum concentrations of per- and polyfluoroalkyl substances (PFAS), the “forever chemicals” found in many household items, had the highest rates of obesity and indoor time, which may yield insight to causes of rising rates of human obesity [14].

Tap water contaminants and airborne environmental pollutants are associated with the risk of both urothelial carcinoma and lymphoma in dogs [15]. Thus, tap water filtration and more effective air pollution controls could decrease the overall incidence of these cancers in dogs, and potentially also humans, as companion animals often share the same air and water sources as their human caretakers. The higher incidence of osteosarcoma in dogs, combined with its biological and clinical similarities to the human disease, makes canine patients particularly valuable models for evaluating novel therapies. For example, a two-drug protocol tested in dogs with metastatic osteosarcoma led to a pediatric clinical trial at Children’s Hospital Colorado [16]. Because companion animals develop cancer naturally and often experience faster disease progression, comparative oncology can accelerate therapeutic discovery while benefiting both human and veterinary cancer patients.

Benefits of Nature

When human-built environments dominate daily lives, people may forget their reliance on the natural world for shelter, food, climate stability, medicine, and psychological health. Researchers have linked exposure to nature with a myriad of health benefits for people via increased physical activity, stress reduction, and attention restoration [17]. One study demonstrated that time in nature reduced blood pressure and anxiety and enhanced immune function and self-esteem [18]. Forest bathing (sensory experience upon immersion in the forest setting) has been shown to increase immune function and decrease levels of stress hormones [19]. The One

Health lens reminds people to actively seek and protect green spaces for physical and mental healing, restoration, and motivation.

The Human-Animal Bond

Approximately 86.9 million U.S. households (66%) own at least one pet, including 56.3 million with dogs and 43 million with cats [20]. The human-animal bond and its implications for health and well-being is closely linked to the benefits of the natural world. The concept of *biophilia*, first proposed by E.O. Wilson in 1984, describes people's innate affinity for living systems and tendency to seek connections with other organisms [21]. This bond spans relationships from companion animals in the home to highly trained service animals, therapy animals, emotional support animals, and attachment to wildlife. The health benefits of these relationships are substantial. Service animals provide physical and psychological support, reduce anxiety and stress across diverse settings, and can be trained to detect medical emergencies, such as hypoglycemia [22]. Beyond these specialised roles, companion animals in U.S. households provide important physical, emotional, and social benefits. Evidence links human-animal interaction with lower blood pressure, improved cardiovascular risk profiles, increased physical activity, and a greater sense of purpose [23]. During the COVID-19 pandemic, pets supported emotional well-being and reduced loneliness during a time of limited social interaction [24].

These benefits highlight the human-animal bond as a meaningful yet often overlooked social

determinant of health, shaping behaviors, emotional resilience, and healthcare utilisation. Public health frameworks recognise the human-animal bond as an intervention that can influence health outcomes, while studies highlight both its health benefits and structural barriers it can create to accessing housing, employment, and healthcare [6,25]. For example, individuals experiencing homelessness or domestic violence may delay seeking safety or healthcare due to concerns for their animals, while older adults may prioritise their pets' needs over their own, including refusing to be hospitalised if they do not have anyone to care for their pet. One Health clinics serving both humans and companion animals may help improve healthcare access [26]. Clinicians should routinely assess animal exposure as part of the comprehensive social and environmental history to identify both benefits and potential risks.

Antimicrobial Resistance

While awareness of antibiotic stewardship is increasing, agricultural antimicrobial use remains an important yet underappreciated contributor to resistance. Antimicrobials are frequently used prophylactically in feedlot animals, often at low doses over prolonged periods, with significant environmental exposure through antimicrobial residues in manure – conditions that maximise growth of resistant organisms [27]. In some countries, low-dose antimicrobials are used as growth promoters, although the benefit is modest (1–10%) and may disappear under sanitary conditions. Resistance genes can spread relatively easily through the environment, ultimately making infections more

difficult to treat across species.

Of particular concern is the agricultural use of critically important antimicrobials, including fluoroquinolones, cephalosporins, macrolides, and colistin [27]. In areas where these medications have been used extensively for prophylaxis, resistance among human populations has increased, including vancomycin-resistant enterococci following agricultural use of avoparcin, a compound structurally similar to vancomycin. Consequently, the World Health Organization has called for the end of these practices. Environmental contamination can further drive resistance through human and animal sewage laden with antimicrobials, their metabolites, and resistant bacteria, and from industrial pharmaceutical waste [27]. Rising antibiotic resistance threatens treatment of infections and medical interventions that depend on effective antimicrobials, such as invasive surgeries, cancer chemotherapy, organ transplantation, and immunomodulatory treatments [28]. These hurdles and potential consequences affect both human and animal patients.

Ecological Interdependence

One Health takes an ecological approach that moves from the individual patient to the broader community and environment, revealing how actions in one part of the system can have consequences across species and ecosystems. For instance, exposure to endocrine disruptor chemicals found in consumer products (e.g., beauty products, pesticides, flame retardants, industrial by-products, pollutants, and plastics) has been linked to

cancer, obesity, diabetes, infertility, osteoporosis, and reproductive disorders, including early onset of puberty and menopause [29]. As global plastic production, which is already exceeding tens of billions of tons annually, is projected to triple over the next 30 years, these health risks are likely to become more prevalent [29]. Human health clinicians will increasingly need to think about environmental contaminants as they relate to patient care and advocate for practices that prioritise patient safety.

Conclusion

All professionals, living creatures, and ecosystems can benefit from adopting a One Health approach that encourages us to overcome existing blind spots and develop more effective, collaborative solutions (Table 1). Human health clinicians play a critical leadership role in breaking down professional silos and fostering transdisciplinary collaborations to support a more inclusive practice of medicine. They can also promote the interconnected health of people, animals, and the planet, understanding that their patients' health depends on healthy and biodiverse environments and that animal, environmental, and occupational exposures impact patient outcomes.

What can you do today to implement One Health in your life and clinical practice?

- Walk outside on your break to boost your immune system and health
- Recommend time in nature to improve mood and help treat depression
- Ask patients about pets and environmental exposures, which can impact health
- Grow plants in your workspace and pollinator-friendly plants outside
- Practice and encourage antibiotic stewardship
- Collaborate with One Health-related professionals
- Minimise plastic use
- Advocate for improved waste management and environmental protections

Table 1. Recommendations on incorporating One Health principles into your daily life.

Author Contribution Statement

All authors contributed to the design and preparation of the original manuscript draft. TLW created the figures using BioRender.com. All authors critically reviewed and revised the manuscript and approved the final version for publication.

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References

1. Deem SL. Veterinary medicine and One Health. In: Marshall K, (ed). Diversity, equity, and inclusion in veterinary medicine. Hoboken: Wiley; 2025. p. 163-9.
2. Taylor LH, Latham SM, Woolhouse ME. Risk factors for human disease emergence. Philos Trans R Soc Lond B Biol Sci. 2001;356(1411):983-9.
3. Barry JM. The site of origin of the 1918 influenza pandemic and its public health implications. J Transl Med. 2004;2(1):3.
4. Plowright RK, Parrish CR, McCallum H, Hudson PJ, Ko AI, Graham AL, et al. Pathways to zoonotic spillover. Nat Rev Microbiol. 2017;15(8):502-10.
5. LoGiudice K, Ostfeld RS, Schmidt KA, Keesing F. The ecology of infectious disease: Effects of host diversity and community composition on Lyme disease risk. Proc Natl Acad Sci U S A. 2003;100(2):567-71.
6. Hoy-Gerlach J, Townsend L. Reimagining healthcare: human-animal bond support as a primary, secondary, and tertiary public health intervention. Int J Environ Res Public Health. 2023;20(7):5272.
7. Runstadler JA, Puryear WB. The virus is out of the barn: the emergence of HPAI as a pathogen of avian and mammalian wildlife around the globe. Am J Vet Res. 2024;85(5):ajvr.24.01.0018.
8. Caminade C, McIntyre KM, Jones AE. Impact of recent and future climate change on vector-borne diseases. Ann N Y Acad Sci. 2019;1436(1):157-73.

9. Diniz PPVP, Moura de Aguiar D. Ehrlichiosis and anaplasmosis: an update. *Vet Clin North Am Small Anim Pract.* 2022;52(6):1225-66.
10. Zinsstag J, Crump L, Schelling E, Hattendorf J, Maidane YO, Ali KO, et al. Climate change and One Health. *FEMS Microbiol Lett.* 2018;365(11).
11. Allan BF, Dutra HP, Goessling LS, Barnett K, Chase JM, Marquis RJ, et al. Invasive honeysuckle eradication reduces tick-borne disease risk by altering host dynamics. *Proc Natl Acad Sci U S A.* 2010;107(43):18523-7.
12. Richards N, Gilbert M, Taggart M, Naidoo V. A cautionary tale: diclofenac and its profound impact on vultures. In: *Encyclopedia of the anthropocene.* New York: Elsevier; 2018.
13. Companion Animal Parasite Council. Parasite prevalence maps [Internet]. 2026 [cited 2026 Aug 25]. Available from: <https://capcvet.org/articles/parasite-prevalence-maps/>
14. National Academies of Sciences, Engineering, and Medicine. Companion animals as sentinels for predicting environmental exposure effects on aging and cancer susceptibility in humans: proceedings of a workshop. Washington, DC: National Academies Press; 2022. Available from: <https://www.nationalacademies.org/projects/HMD-HCS-20-07/publication/26547>
15. Smith N, Luethcke KR, Craun K, Trepanier L. Risk of bladder cancer and lymphoma in dogs is associated with pollution indices by county of residence. *Vet Comp Oncol.* 2022;20(1):246-55.
16. Yager R, Regan D, Outcalt C. Cancer therapy successfully used with dogs meets safety checkpoints in human trial. *Am J Vet Res.* 2026;87(8):ajvr.26.06.0243.
17. Jimenez MP, DeVille NV, Elliott EG, Schiff JE, Wilt GE, Hart JE, et al. Associations between nature exposure and health: a review of the evidence. *Int J Environ Res Public Health.* 2021;18(9):4790.
18. Sundermann M, Chielli D, Spell S. Nature as medicine: the 7th (unofficial) pillar of lifestyle medicine. *Am J Lifestyle Med.* 2023;17(5):717-29.
19. Li Q. Effects of forest environment (shinrin-yoku/forest bathing) on health promotion and disease prevention - the establishment of 'forest medicine'. *Environ Health Prev Med.* 2022;27:43.
20. American Veterinary Medical Association. U.S. pet ownership statistics [Internet]. 2025 [cited 2026 Aug 25]. Available from: <https://www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics>
21. Wilson E. Biophilia: the human bond with other species. Cambridge: Harvard University Press; 1984.
22. Hardin DS, Anderson W, Cattet J. Dogs can be successfully trained to alert to hypoglycemia samples from patients with type 1 diabetes. *Diabetes Ther.* 2015;6(4):509-17.
23. Johnson RA. Promoting One Health: the University of Missouri Research Center for human/animal interaction. *Mo Med.* 2013;110(3):197-200.
24. Martin F, Bachert KE, Snow L, Tu HW, Belahbib J, Lyn SA. Depression, anxiety, and happiness in dog owners and potential dog owners during the COVID-19 pandemic in the United States. *PLoS One.* 2021;16(12):e0260676.
25. Kerman N, Gran-Ruaz S, Lem M. Pet ownership and homelessness: a scoping review. *J Soc Distress Homeless.* 2019;28:1-9.
26. Jankowski K, Aguirre Siliezar K, Knuchell JA, Duenas-Ramirez A, Edwards JJ, Dear JD. One Health clinic challenges and evolution: increasing access to care for people and pets in a rural community in Northern California. *Front Vet Sci.* 2025;12:1599422.
27. McEwen SA, Collignon PJ. Antimicrobial resistance: a One Health perspective. *Microbiol Spectr.* 2018;6(2).
28. Huemer M, Mairpady Shambat S, Brugger SD, Zinkernagel AS. Antibiotic resistance and persistence: Implications for human health and treatment perspectives. *EMBO Rep.* 2020;21(12):e51034.
29. Deem S, Holliday D. Impacts from endocrine disrupting chemicals on wildlife health. In: *Fowler's zoo and wild animal medicine.* Saint Louis: Saunders Elsevier; 2023. p. 131-6.

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