Advancing a 'One Health' Approach to Promote Health at the Human-Animal-Environment Interface

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Abstract

A One Health approach (and related approaches such as veterinary public health, EcoHealth, and Planetary Health) recognizes the integral connections among humans, animals, and the environment in relation to people's health and well-being and promotes interdisciplinary collaborations to more holistically understand and more effectively act against public health threats. More than half of known human infectious disease pathogens have an animal source or origin and result in over a billion cases globally each year, often imposing high financial and societal costs. Pathogens from around the world threaten U.S. public health and national security, given the expanding ranges of some vector-borne and parasitic diseases as well as global connectivity. Human practices (e.g., changes in land use and how food is produced) are driving ecological and evolutionary conditions that facilitate disease spillover events and contribute to antimicrobial resistance. These changes are occurring rapidly on a widespread scale, both locally and globally, and are often tied to noncommunicable disease threats (e.g., food/nutrition and water insecurity, ecotoxicology). The pursuit of understanding human, veterinary, and environmental health issues separately leads to an incomplete understanding of disease risks and, therefore, missed opportunities for mitigating and adapting to these problems. One Health measures support primary prevention of such problems, or at least their earlier detection, enabling more timely and effective containment and response to public health threats at the human-animal-environment interface. In short, systematic and sustained One Health action is warranted to promote public health.

Relationship to Existing APHA Policy Statements

Topics relevant to a One Health approach are addressed in APHA Policy Statement 6512 (Studies in Comparative Medicine; now archived following its review in 2015), among others. Similarly, APHA Policy Statements 20164 (Compulsory Pasteurization of All Non-Human-Derived Animal Milk Products Intended for Human Consumption), 20163 (Reducing Human Exposure to Highly Fluorinated Chemicals to Protect Public Health), and 200712 (Toward a Healthy Sustainable Food System) all reference dimensions of human-animal-environment interconnectedness, and a proposed policy statement on Zika virus currently in development recognizes the importance of improving understanding of ecological determinants in vector-borne disease risk prediction and control measures. No specific policy refers to the approach itself or highlights key actions for its application.

Problem Statement

The term "One Health" was introduced in 2003 in the context of Ebola virus associated with the decline of great apes and then formalized via the Manhattan principles outlining connections among infectious diseases, the environment, human well-being, and economic development efforts.[1] There has since been growing high-level U.S. and global interest in and adoption of One Health approaches. One Health is defined as "a collaborative, multisectoral, and transdisciplinary approach—working at local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants and their shared environment."[2] While the human, animal, and environment domains can benefit from a One Health approach, there is compelling rationale for its application to a range of priority public health issues such as vector-borne and zoonotic diseases, food safety and security, and antimicrobial resistance, each of which may cause health emergencies or persistent public health burdens. It may also directly or indirectly relate to other public health themes (e.g., Zika virus and maternal and child health, physical activity and exposure to vectors).

More than half of the known pathogens infectious to humans are shared with animals ("zoonotic" diseases), either via recurring transmission (e.g., rabies or plague) or from an initial spillover event (as is suspected with HIV/AIDS, which genetic analyses suggest probably originally emerged from great apes through contact during hunting or butchering), and zoonotic disease emergence events are increasing.[3–5] Globally, more than 1 billion infections and 1 million deaths annually are attributable to zoonoses, and vector-borne diseases such as malaria, dengue, and tick-borne infections result in additional health and socioeconomic burdens.[6] Despite both endemic and emerging disease risks, upstream actions remain limited. For example, sentinel surveillance is generally underused, and when it does occur, its utility may be inhibited by poor between-agency coordination. Between 2004 and 2012, funding for West Nile virus surveillance decreased by 61% in the United States, with an associated decline in surveillance capacities for West Nile and other arboviruses.[7] Examples of broad public health topics with a One Health scope are presented below.

Environmental determinants of disease risk: Changes in climate and other environmental conditions may permit species to expand their range and/or become established in new areas if introduced via trade or transit, as with the introduction and establishment of West Nile virus in the United States in 1999 and subsequent reports of the presence of the virus in all of the continental states.[7,8] Similarly, while historically most cases of Chagas disease documented in the country have been thought to be imported, recent detection of Trypanosoma cruzi infections in Texas suggests that autochthonous transmission may be underreported in at least some southern states.[9] Tick-borne disease is increasingly recognized as a growing public health threat in the United States, with a quadrupling incidence of tick-borne ehrlichiosis since 2000 and a steady expansion in the number of counties facing high rates of Lyme disease since 1993.[10,11] Although ecological determinants may play an important role in shaping the range of disease vectors (e.g., via climate, vegetation, soil, and other conditions that influence habitat suitability), attention to these dynamics with respect to current and potential future diseases remains limited even as wide-scale anthropogenic changes are rapidly occurring, fundamentally altering ecosystems and facilitating changing contact with other species in ways that may increase risk.[6,12,13] Socioeconomic determinants may reduce or increase environmental exposure risks, as seen with Chagas infections associated with poor housing conditions; domestic dogs may also serve as an intermediate host facilitating spread of disease to humans.[9]

Zoonotic and vector-borne disease risks: The United States has experienced both acute and sustained public health challenges from zoonotic and vector-borne diseases. As of January 2017, 728 human cases of hantavirus pulmonary syndrome had been diagnosed in the United States, traced to exposures in 36 states since the first detection of the rodent-borne disease in 1993; 36% of these cases were fatal.[14] Cases of hantavirus pulmonary syndrome have also occurred elsewhere in the Americas, with large outbreaks typically being linked to changes in environmental factors (e.g., land use changes, unusual weather).[14] Leading drivers of emerging zoonotic diseases include rapid international trade and travel, land conversion, changes in agricultural production systems without sufficient biosecurity, climate change, and more. Risk assessment and mitigation around these drivers are often not adequately emphasized in public health activities, resulting in reactive approaches.[6,15]

For example, the 2003 introduction of monkeypox into the United States resulted from importation of infected African rodents that transmitted the infection to pet prairie dogs, which then transmitted it to human pet owners and veterinary care providers.[16] While the import of African rodents was subsequently banned by the Centers for Disease Control and Prevention (CDC), limited pathogen screening and the lack of a consistent risk assessment framework for wildlife trade in the United States, along with continued illegal wildlife smuggling, represent a continued risk to public health and pose a threat to the conservation of biodiversity.[17,18] The U.S. Government Accountability Office has highlighted the disease risks of live animal importation, including fragmented authority and resulting gaps among federal agencies in protecting public health against risks from legal and illegal animal trade.[19]

Other settings and practices may also present heightened zoonotic disease exposure risks. More than 200 outbreaks associated with animal contact in public settings (e.g., petting zoos, agricultural fairs) were reported to the CDC between 1996 and 2012; infections ranged from enteric disease to rabies virus.[20] A recent review notes that prevalence studies at this interface remain limited and that some studies have revealed low rates of compliance with hand-washing practices in these settings.[21] Veterinary public health guidelines are available to help mitigate such risks and promote the emotional and educational benefits that such contact can offer, but awareness is needed to promote their adoption.

Antimicrobial resistance: Antimicrobials can provide critical benefits for sick humans and animals, but their use also can select for and help spread antimicrobial resistance. A global epidemic of resistance now poses a major challenge to our ability to treat infections throughout the world, including in the United States. Antimicrobial use in general is a driver of resistance; unnecessary or imprudent use can further hasten the spread of resistance. While improper human clinical use is an important source of resistance development, use in food production and the food chain can also play a role; resistance to the medically important antibiotic colistin was seen in humans after its use as a growth promoter for pig production in China.[22] Upwards of 80% of all antimicrobials used in the United States are employed for animal agriculture; up to an estimated 90% are excreted into manure, with the potential for widespread dispersion into the environment if proper waste management practices are not in place. Thus, judicious use is required in human clinical medicine as well as in the veterinary medicine and agriculture sectors.[22,23] Antimicrobial resistance (as well as other infectious diseases in animals) can also impose high costs and livestock losses in agricultural production, with potential implications for international trade, and may threaten food security.[24]

Non-zoonotic diseases in animals: Ecosystem degradation and effects on species composition may affect services naturally provided by "healthy" ecosystems (e.g., pollination, clean water provision, protection against erosion), many of which benefit public health.[13] Even non-zoonotic diseases in wildlife may threaten public health. For example, potential loss of agricultural pollination and pest control benefits provided by bats in North America (which are threatened by the fungal disease white nose syndrome) is projected at $3.7 billion to $53 billion per year, thereby potentially threatening food security and changing vector abundance.[25]

Noncommunicable diseases: One Health can also aid in improving epidemiological understanding of noncommunicable diseases. Most directly, comparative medicine offers a long history of benefits to humans through development of therapeutics and scientific discoveries via animal models. Given technological advances, controversies regarding animal use, and sometimes inconsistent animal welfare policies in research settings, a shift in attention is needed toward advancing human and animal health through translational research, promoting adherence to best practices and standards, and pursuing possible alternatives. Signals for new or future One Health issues may be found by monitoring surveillance aspects of comparative medicine, in particular assessing multiple species within specific ecosystems for signs that suggest progressing resource limitations, new infections, or environmental toxicity. For example, genetic, lifestyle, and environmental risk factors for cancers in humans are highly resource and time intensive to elucidate; parallel studies in canines (e.g., the Golden Retriever Lifetime Study) may more rapidly inform cancer prevention and targeting in humans.[26] Exposures related to animals that also may be mediated via environmental media (e.g., allergens, endotoxins, microbial communities) have the potential for both beneficial and detrimental chronic disease effects (e.g., allergic asthma and other respiratory diseases).[13]

The human-animal bond offers mental and emotional health benefits, and an increasing body of research points to possible associations between pet ownership and cardiovascular disease risk reduction, likely tied to increased physical activity levels.[27] As pets may serve as vectors to infect people (and vice versa), risk reduction measures to promote safe and healthy outdoor places for animals and people to recreate and engage in physical activity may be important in facilitating healthy lifestyles.

One Health may also help elucidate toxin exposures at the human-animal-environment interface. For example, reduced eagle eggshell thickness caused by the pesticide dichloro-diphenyl-trichloroethane (DDT) was an early warning sign of risks to human health from persistent organic pollutant exposures. Some communities may be disproportionately at risk, including rural subsistence communities dependent on wildlife for food security, which potentially face heightened risks of exposure to pathogens and/or pollutants (e.g., heavy metals). A 2008 study conducted by the CDC detected heightened blood lead levels among hunters in North Dakota consuming wild game shot with lead bullets.[28] Other community members may also be exposed to lead through distribution of venison at food pantries given its importance as a protein source in that state.[28]

Moving from a reactive, typically resource-intensive approach to prevention and preparedness through One Health is thought to be highly cost effective by avoiding or reducing disease burdens, financial costs, and societal disruptions resulting from public health emergencies such as emerging infectious diseases and foodborne illnesses in the United States and abroad. Reactive approaches to disease threats at the human-animal-environment interface have resulted in high financial costs in addition to immediate and long-term public health burdens and wider societal effects, including losses of more than $30 billion globally from severe acute respiratory syndrome (SARS) (2003), $10 million in the United States from bovine spongiform encephalopathy (2003–2007), and $400 million in the United States from West Nile virus.[29]

Implementation of One Health still remains limited on the ground, facing ongoing barriers. Professional segregation and data separation in the animal and human health communities and evidence gaps that limit understanding of the relevance of animal and environmental health indicators to human health are thought to contribute to limited uptake of sentinel surveillance approaches.[30] Similarly, the need for a One Health approach has been demonstrated for the generally weak risk assessments and regulation of the possible environmental spread and persistence of substances (pharmaceuticals including antimicrobials, chemicals, pesticides, etc.) and the resulting potential short-term and longer term effects on human health and the environment.[13,31] Understanding the possible public health consequences of different use and waste management practices through integrated health impact assessments can help inform risk mitigation.

Partners involved in Rwanda's One Health strategic plan address challenges stemming from competition for resources, power and organizational structures, and lack of training, and they have identified a need for sustained government funding commitments to enable coordinated policies, evaluations, and infrastructure based on problem sets rather than sectoral mandates.[32] In 2010, the Stone Mountain Meeting on Operationalizing One Health articulated specific activities needed to advance One Health through culture change, increased visibility, political will/ financial support, and optimal coordination efforts. These activities include training and capacity building, proofs of concept and business plans to generate evidence and a rationale for adoption, country needs assessments for One Health programs, and global networks and information clearinghouses to share information and lessons learned.[33] The American Veterinary Medicine Association and the One Health Commission have reinforced the public health benefits for the United States of a One Health approach. According to the Council on Education for Public Health's 2016 revision of its accreditation criteria for schools of public health and public health programs, students must be able to "[e]xplain an ecological perspective on the connections among human health, animal health and ecosystem health (eg, One Health)" as a foundational knowledge requirement. The need for a more robust One Health policy is especially urgent given that many disease drivers occur outside of the direct public health sector, necessitating full engagement of other sectors to form synergies and solutions. This aligns with the United Nations Sustainable Development Goals, which demonstrate the interrelationships among health, environment, and social determinants and encourage partnerships to achieve the 17 global goals.

Evidence-Based Strategies to Address the Problem

At a global level, examples include the tripartite agreement signed by the World Health Organization (WHO), the Food and Agriculture Organization, and the World Organisation for Animal Health to address threats at the human-animal-ecosystem interface, with a focus on antimicrobial resistance, rabies, and zoonotic influenza, and the resolutions of the United Nations Convention on Biological Diversity acknowledging the value of One Health.[34,35] As part of WHO's post-Ebola efforts to strengthen preparedness capacity, a One Health approach is being promoted in multisectoral national action planning for health security. The Sendai Framework for Disaster Risk Reduction 2015–2030 recognizes biological hazards under its scope, creating momentum for upstream prevention to avoid health emergencies.

In the United States, several government agencies have acted to implement One Health in their operations, including through the CDC's One Health Office, the U.S. Department of Agriculture's One Health Coordination Center, the National Park Service's One Health Initiative, and the National Oceanic and Atmospheric Administration. One Health approaches are already applied for some diseases, perhaps most fully in domestic animal and wildlife vaccination for rabies control to prevent human cases.[36,37] Many stakeholders contribute to successful rabies prevention, detection, and control activities in the United States, including pet owners, veterinarians in private practice, vaccine producers, state wildlife authorities, public health officials, medical care providers, and diagnostic laboratories. While rabies is responsible for an estimated 50,000 human cases globally each year, the United States sees on average only one to three human cases.

Several professional organizations in the United States have also endorsed One Health. The American Veterinary Medical Association (AVMA) has approved position statements directly supporting One Health in recognition of the role of veterinarians in protecting and advancing human, public, and environmental health, including through disease reporting to local, state, and federal authorities.[38,39] The AVMA is a partner in the Healthy People Consortium, part of the U.S. Department of Health and Human Services Healthy People 2020 initiative.

Several regulatory and nonregulatory actions in the United States based on a One Health approach have proven effective. For example, an analysis of the U.S. Food and Drug Administration's ban on the sale of small turtles showed that the ban prevented an estimated 100,000 cases of associated salmonellosis among children yearly between 1976

and 1980.[40] Regulations remain fragmented and/or unenforced, however, and the persistence of this public health threat has reinforced One Health's relevance. Between 2006 and 2014, the CDC documented 15 multistate Salmonella outbreaks from contact with small turtles despite the ban.[41] In addition, a 2011 analysis of state laws related to keeping of reptiles and amphibians in day-care centers suggested inadequate regulations to protect children, a population at heightened risk for severe outcomes of infection with reptile- and amphibian-associated salmonellosis (RAAS) (for example, half of the centers did not require hand washing after handling of animals).[42] The true incidence of RAAS is thought to be systematically underreported.

Recent action on antimicrobial use in the United States also suggests the merits of taking a One Health approach. In 2015, the White House called for One Health surveillance efforts in its National Action Plan for Combating Antibiotic-Resistant Bacteria, noting the potential for resistance in humans, animals, and the environment. The same year, the Council on State and Territorial Epidemiologists (CSTE) released a position statement on antimicrobial stewardship that requested taking a One Health approach with improved oversight and judicious use in human and veterinary medicine as well as agriculture. CSTE recommended the promotion of multidisciplinary stewardship programs and the provision of educational resources to inform and reduce use by practitioners, food producers, and the public. In 2017, the U.S. Food and Drug Administration released a regulatory update for on-farm antibiotic administration under its Strategy on Antimicrobial Resistance, aiming to phase out medically-important antibiotics in animal production and shift oversight of therapeutic use to veterinarians.

To address variant influenzas and other zoonotic disease risks, the CDC has launched the Public Health Youth Agriculture Education Program jointly with the U.S. Department of Agriculture and CSTE to help educate young people—particularly those involved in 4H and Future Farmers of America—about risk prevention and mitigation. The program works closely with state health departments and local agricultural groups.[43] Similarly, the National Association of State Public Health Veterinarians compendia, including the rabies compendia, are a clear demonstration of how One Health collaborations can be successful in approaching a problem. Each compendium group is made up of a diverse group of representatives so as to capture different perspectives and reflect on the multisectoral nature of challenges and opportunities. The guidance provided serves as an authoritative framework; in some cases, the language in the compendia has even been absorbed into jurisdictions' regulations or laws.[37]

Sentinel surveillance can provide an "early warning" benefit to public health. Such surveillance has been employed to monitor a range of public health threats, including West Nile virus in crows (which are highly susceptible to infections), mosquitos, and equids to determine human exposure risks[7]; cyanotoxin exposures in animals from harmful algal blooms[44]; and hunter surveillance for wildlife deaths that may precede human cases of Ebola virus in Central Africa.[13] Pathogens discovered in other species may offer information about potential human diseases. For example, while Zika virus did not gain global attention until 2015, it was first detected in monkeys in Uganda in 1947. To promote early detection of novel diseases, the United States Agency for International Development's Emerging Pandemic Threats PREDICT-2 project includes coordinated pathogen and behavioral risk surveillance for viral circulation in humans and wildlife in 31 countries that are "hot spots" for emerging diseases to improve understanding of viral circulation among animals and humans and the factors driving spillover risks. Coordinated surveillance and communication between PREDICT country partners have led to faster deployment of multisectoral investigation teams (e.g., from human health, veterinary services, wildlife, and environment departments) and mobilization of response efforts.[45] Data from satellite monitoring may also have value for public health; for example, prediction of rainfall patterns can inform Rift Valley fever risks in certain regions, which may allow for preventative vaccination campaigns in livestock.[46]

The high health, financial, and societal disruption costs from reactionary approaches to public health emergencies can potentially be reduced or prevented through One Health approaches that advance prevention and preparedness. An analysis of a One Health approach emphasizing pandemic risk mitigation via strengthening of human health and veterinary service capacity projected a high return on investment through cost avoidance, with estimates upwards of $30 billion in benefits per year relative to business-as-usual approaches.[29] Including public health effects and their anticipated economic consequences in cost-benefit analyses in other sectors (e.g., the environment and animal health practices) may provide more complete information for decision making. In addition, efficiency gains might be seen from coordinated activities (e.g., transport, laboratories) in instances in which resource sharing can occur.[29] The overall economic argument serves as a strong motivator for investments in global health security to improve prevention, detection, and response capacity.

Opposing Arguments/Evidence

Funding and the political willpower for granting it are currently largely mobilized around disease emergencies. It is much more difficult to build support for primary prevention of a problem (disease emergence, toxin exposures, foodborne illnesses, etc.) without being able to point to concrete evidence that a future emergency will, in fact, occur. Similarly, even with greater predictive capacities, it is unlikely that One Health approaches can prevent all public health threats on the horizon; single-sector efforts will still play an important role in responding to them. Yet, the high costs of health emergencies and the much lower costs of disease prevention suggest the value of risk reduction or at least early warning to avoid or reduce potential public health and economic damage.[24,29]

Recent reviews have noted the overall limited evidence base for One Health–driven outcomes.[47] The scope of One Health issues, the varying relevance of sectors by situation, and the lack of prescriptive approaches make consistent implementation and evaluation strategies challenging. In addition, there is not a widely accepted strategy for determining instances in which One Health applications can be value-added; however, they are unlikely to be needed, for example, when a clear effective, affordable, and widely used strategy for disease control can be implemented by a single sector without negative implications for other sectors. Enabling cross-disciplinary collaborations may also require resources up front or on a continual basis. Depending on the topic, certain sectors may see greater benefits (whether immediate or long term) than others from such collaborations.

Bureaucratic challenges present significant barriers to concrete and sustained implementation of One Health. Authority across public agencies is often fragmented, state and federal jurisdictions may be unclear, and leaders of one agency may perceive cooperation with another public agency to undercut their ability to "win" more resources in what is seen as a zero-sum struggle for limited public resources. Entrenched structures and processes are not easily overcome; incentives for disciplines to work together remain limited, and there may be a lack of political buy-in without perceived value of the relevance of other disciplines to their work.[48] One Health is intended not to replace or diminish the importance of specific disciplines but, rather, to bring together information from different disciplines to anticipate and address relevant issues more effectively through inclusion of their input. There may also be disincentives in terms of externalities from other sectors. For example, nontherapeutic use of antimicrobials (e.g., for growth promotion) may have financially profited feed manufacturers, animal producers, and the pharmaceutical industry; however, it may impose longer term public health risks via its contribution to the emergence and spread of antimicrobial resistance.

Related terms have recently gained traction in human medical and ecological communities (Planetary Health and EcoHealth, respectively). While the terms may have some nuanced differences, they share common goals. One Health promotes inclusivity by acknowledging human, animal, and environmental components. While infectious diseases were the main starting point for One Health efforts and have frequently involved veterinary public health experts, opportunities for wider applications, including expanding environmental components (e.g., ecotoxicology, land use changes, and climate change) and addressing food and nutrition security threats, are well articulated.[49,50] Not all public health issues warrant a One Health approach; entry points for its value-added application depend on the specific topic and context. However, the relevance of sectors is not always readily determined. Associations may be missed without including inputs from animal and environment sectors in public health risk assessments.

Alternative Strategies

The current, highly reactive approach to public health emergencies with environmental or animal determinants relies on effective response. Funding mobilization for Ebola virus in West Africa (2014) and the Zika epidemic in the Americas (2016) proved challenging, with federal emergency response requiring funding approval from Congress and reallocation of funds for Ebola virus recovery to Zika virus response.[51] Trace-back to the source of epidemics often remains limited and highly resource intensive, resulting in missed opportunities for prevention of future outbreaks (e.g., as seen with foodborne disease outbreaks). This ad hoc strategy leaves public health authorities unprepared for future epidemics of known and novel diseases and represents an inefficient use of already-limited public health resources.

Action Steps

APHA recommends that:

1. Federal, state, and local public health departments communicate and collaborate with agricultural, entomological, veterinary, and environmental authorities and other relevant partners and experts (e.g., universities) in both routine and emergency situations, potentially through the use of data-sharing systems, routine meetings, working groups, and communication channels with relevant networks (e.g., local veterinarians), to build

capacity and facilitate interagency and interdisciplinary coordination and sharing of expertise, including in joint planning, surveillance, and analysis exercises to prevent, detect, respond to, and recover from outbreaks and other health emergencies.

2. Regulatory agencies conduct integrated human, animal, and environmental health impact assessments to explore short-and long-term public health effects and externalities in decision making (e.g., veterinary drug licensing, wildlife trade policies, land planning), paired with economic analyses to inform budgeting processes. These analyses should include potential avoided costs to other sectors (e.g., trade, tourism) through preventive or management strategies that mitigate or control disease risks (e.g., via animal vaccination, biosecurity measures, and regulations).

3. Public health authorities employ tools to monitor and detect changing risks to human, animal, and environmental health, including via use of geographic information systems for mapping species and/or pathogen distributions, sentinel surveillance systems, and remote sensing (e.g., of climate and weather, vegetation), as a means of tracking and, ideally, predicting disease risks to inform effective prevention, preparedness, and response measures (including use of existing information that, to date, is not routinely employed for public health purposes but may support states in risk modeling, assessments, and prioritization that incorporate knowledge from multiple disciplines).

4. Public health schools and programs provide training opportunities for interdisciplinary understanding and collaboration on human health, animal health, and ecosystem health by offering projects or courses with faculty or students from other relevant fields (e.g., veterinary medicine, ecology).

5. Public health employers provide access to interdisciplinary training opportunities with veterinary and environment experts as part of professional development and continuing education activities.

6. Public health authorities partner with stakeholders in both the public and private sectors to develop solutions to promote human, animal, and environmental health. Biosecurity and waste management, judicious use of antimicrobials, surveillance and reporting, and consumer awareness represent key needs that could benefit from these partnerships, including through voluntary reporting and changes in industry standards. Particularly relevant sectors include agricultural production, extractive industries, pharmaceutical and chemical production and marketing, and trade and travel, as well as the public sector (e.g., in reporting of unusual animal die-offs that could signal human disease risks).

7. Public health authorities and technical organizations share findings, consider lessons learned, and identify ways to operationalize One Health via events and initiatives during National Public Health Week, international One Health Day (November 3), the International Day for Disaster Risk Reduction, World Rabies Day, and/or other forums, seeking collaborations with their veterinary and environment counterparts.

8. Public health funding agencies favor interdisciplinary projects and outputs to incentivize collaboration on topics at the human-animal-environment interface, including through joint agency requests for proposals.

9. Public health authorities engage relevant expert organizations (such as the National Association of State Public Health Veterinarians) and coordinate with disaster risk reduction managers to jointly promote evidence-based disease prevention and control measures.

10. Public health authorities and technical organizations disseminate information to both public health professionals and the general public about human-animal-environment connections, including the links between ecosystem degradation and public health, such as threats to food and water safety and security, the emergence and spread of zoonotic and vector-borne diseases, the health consequences of natural and biological disasters, ecotoxicology, and other critical and growing dangers to health.

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