The Impacts of Climate Change on Nonhuman Patients and the Need for Attention to Its Consequences

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Companion animals (CA), such as dogs and cats, are part of our daily lives. They share our surroundings and environment, including environmental stresses and lifestyle. Therefore, they are directly exposed to the same environmental risks as we are and, just like us, are susceptible to the same risk factors for illnesses or diseases derived from climate change (CC).

CA are also animal patients with the greatest availability of high-level medical care services, which supports the diagnosis and management of diseases based on scientific evidence. Their relationship with human owners represents an opportunity to observe the consequences of CC in advance, as sometimes disease processes go faster in nonhuman bodies. But do we really pay enough attention to how climate change affects these species, and the special importance of observing its impact on them? For this work, I will focus on dog and cat patients, the most common companion animal patients (CAP).

This paper critiques the little consideration given to the impact of climate change (CC) on animal patients. We need to engage CAP in climate change research and policymaking to achieve CC resilience and maximize benefits in a shared way.

The question I address in this work is the following: Does the scientific community have an ethical duty to incorporate animal patients into the research and epidemiology of the effects of climate change? I answer yes.

CC impacts the health of CAP. The Pan American Health Organization (PAHO) declares CC as the greatest threat to health in the 21st century,[1] however, veterinarians do not engage enough with CC on an individual or societal level.

Due to the direct suffering that CC causes in CAP, I consider it imperative to establish the necessary preventive measures against its effects, expand climate change research involving CAP such as epidemiological surveillance of global warming effects on CAP and its impact on public health, as well as promote the development of skills of animal health professionals to both participate in research and communicate with the owners of these animals.

CAP's inclusion in CC research would generate information from a comprehensive perspective and the results obtained could produce benefits shared between humans, and other animals. Because CAPs have a shorter life span than humans, the effects of environmental conditions manifest more immediately, and the effects of CC on them can serve as evidence of future impact on human health. The One Health approach to ethics and policy reinforces this proposal for the resolution of shared problems.

It is important to mention that this work does not seek to include animal patients in clinical trials, but in epidemiological studies; however, the former may be a future proposal defended using a similar approach.

Moral Responsibility towards Companion Species

The term companion animal refers to animals that are in close relationship with humans, but that also share the environment, surroundings, and living space daily. There is a great deal of discussion about which animals are considered in this category. As for animal patients, the most common are dogs and cats, so, for this work I focus on them in the arguments raised.

Animals have the status of private property under the law, even wild animals are usually considered national heritage, and their exploitation a source of economic resources for countries; but for the owners, the moral consideration varies according to socioeconomic, cultural, awareness and/or recognition factors towards animals as sentient beings.

The characteristic that demands consideration of animals as moral beings, as proposed by Peter Singer and other philosophers, is sentience, defined as the capacity to experi-

ence positive and negative stimuli, to rejoice or suffer. Therefore, it matters morally what happens to them.

Additionally, I consider that human beings assume responsibility for domesticated species, and companion animals because we determine their environment, their habitat, their food, and their behavior. What we owe to CAPs must also consider CAPs' dependence on us, due to the high degree of domestication of these individuals.

Human control of CAPs' lives has sometimes generated damage, such as severe stress within the animal due to CAPs' dependence on humans, which in turn affects their mental well-being. Or anatomical modifications that have been made during genetic selection for the creation of some breeds, which are the result of capricious desires for aesthetic phenotypic manifestations that biased according to what is desirable to humans.

Some of these selections can result in congenital diseases and predisposition to some types of cancer in some breeds. They can also be influenced or magnified by environmental conditions, such as respiratory syndromes, which can undermine the health of individuals, or with CC, can manifest as a predisposition factor to heat stroke, respiratory distress, or other ailments, and even death. In Latin America and Mexico there are high rates of abandonment, and high numbers of dogs and cats living on the streets, who suffer from hunger, lack of shelter, thirst, malnutrition, infectious diseases, and adverse weather conditions.

According to the Mexican National Institute of Statistics and Geography (INEGI), it is estimated that 69.8% of households have some type of pet under their care, thus adding up to at least 80 million pets of various species in our country, of which 43.8 million of them are canines, and 16.2 million are felines. Additionally, it is estimated that there is a population of 23-27 million homeless dogs, making Mexico the Latin American country with the highest number of dogs in this condition, as well as the third Latin American country with the most animal abuse.[2] All of this is associated with multiple factors, but the lack of applicable public policies, sufficient budget, and general interest all contribute.

As part of the human responsibility for domesticating species, resulting in their dependence on humans, and human power to influence CAPs' characteristics, there should be more attention to the sharing of benefits across species, including sharing of research benefits and cross-species harm prevention measures. Below, I show that CAPs' inclusion and consideration in epidemiological studies is for the benefit of all living beings.

One Health Perspective

The One Health approach promotes the joint and coordinated activity of professionals in human health, animal health, and the environment in which they live, to address shared problems in a comprehensive manner.[3] This approach allows for a broader view of the etiology of diseases, and the development and implementation of cross-species prevention tools.

One Health proposal emphasizes the fair distribution of burdens and benefits for all those affected, both nonhuman animals and humans. Lysaught et al. share some examples of how the burden can be unfairly distributed when measures are taken that affect the health of animals, the environment, and humans.[4] For example, in cases of disease outbreaks, the slaughter or sacrifice of large numbers of animals that participate as reservoirs or are the cause of the outbreak is taken as a precautionary measure to prevent the transmission of the disease.

The same authors argue that emerging diseases and local problems that can potentially become a problem of global interest require being addressed with a sense of responsibility both regionally and globally.

From this One Health perspective, I reinforce the importance of including CAP within national and international epidemiological surveillance as part of the responsibility for tracking and mitigating the effects of CC on health.

The life span of CAP is shorter than ours, which is why I consider them sentinel models, in the use of comparative medicine, data collection, for the projection of future effects on human beings.

There are comparative studies with companion species regarding some diseases such as cancer, within what is known as comparative oncology,[5] others from epidemiological perspectives with a One Health approach. An example of them is the one described by Chandles et al. regarding obesity in companion animals, the evaluation of possible risk factors for developing this condition, and the shared comorbidities present in both owners and their companion animals.[6] There are also proposals already put forward for the use of animals as a sentinel model for zoonotic diseases.[7]

With this background, the proposal to generate information through the inclusion of CAP in CC research seems promising. This is rooted in the animals' interests and those of the human beings for the timely detection of diseases that can develop, even from some habits as risk factors, because of climate change.

Additionally, I consider that the empathy that responsible owners have toward their pet's suffering can be greater even than their concern for their own health. When veterinary and medical care is adequate, and the connection between owner and CAP is great, the data could also be beneficial for raising awareness of the human patient of similar ailments and generating a greater culture of prevention and care for the environment. INEGI tells us in its 2021-2022 survey that 85.7% of the adult population expressed some kind of empathy for nonhuman animal life.[8] This empathy can generate a comprehensive perspective of environmental awareness and care for other species.

Climate Change and Its Shared Consequences

There are very clear examples regarding the effects of climate change on health, some of which are consequences of an increase in temperature through direct consequences for individuals or indirect consequences through the modification of natural systems and the consequent effects on economic and social systems.

Within the direct consequences on the health of individuals, both nonhuman animals and humans, it is expected that the increase in temperature will generate exhaustion, stress, heat strokes, and even death. Vulnerable populations, such as people or pets who are homeless, without access to food, water, shelter, or other basic goods, are likely to suffer worse effects.

Another example of shared effects is the loss of lives caused by natural disasters such as storms and hurricanes, whose intensity and frequency are increasing because of climate change. In the case of human beings, there is loss of lives due to a lack of early warnings, or because they are in areas not considered within evacuation plans. CAPs are given little consideration in evacuation plans for shelters or resources allocated to solve the damages after the disaster. The consequences of the effects of natural disasters not only affect survival, but also the preservation of health, which will depend on minimum nutritional conditions, or the reduction of the impact of diseases derived from environmental changes for all individuals involved.

An increase in vector-borne diseases (VBD) is observed after natural disasters.[9] The increase in VBDs, due to CC, does not occur only due to the greater incidence of natural disasters, but also due to the increase in temperature.[10] There is evidence that some vector populations have established themselves in places where they were not commonly found, a consequence of their adaptation to other ecological niches, which now favor their proliferation. Special importance is given to the CAPs that are close to us, and equally susceptible, but also serve as reservoirs of infectious diseases transmitted by vectors.

These phenomena of vector presence dynamics can be seen within my professional veterinary practice, and I have been able to observe this phenomenon of adaptation of populations, especially ticks, in geographic areas where they could not previously establish themselves. I have observed an increase in cases of canine patients with this type of external parasitosis. CAPs are in close contact with their owners, sharing beds, chairs and rooms. The presence of ticks represents a shared health risk and a shared consequence.

In October 2023, within the veterinary center where I work as an attending physician, 6 patients from different homes were managed, all from the northern area of the state of Querétaro, Mexico, with no history of travel to known endemic areas, or contact with livestock with a high parasitic load (ticks). In addition, the owners of the CAPs reported observing free-living ectoparasites in their homes. I infer from this that the tick population was newly established in their area.

Possibly contributing to this phenomenon is the movement of CAPs to endemic areas. Once the population of ectoparasites is established in an area, some animals, namely dogs and cats, that have a home but remain semi-domiciled, may go out without supervision to nearby areas and return home on a recurring basis. This may contribute to the proliferation and establishment of these vectors in large geographic areas, thus representing a public health problem.

Who should warn, disseminate or alert about this type of phenomena? In Mexico, there is at least the National Campaign for the control of the *Boophilus* tick.[11] However, there is no tendency to report finding ticks, and different species of ticks, other than *Boophilus*, are not included in the indicators. Therefore, not all tick cases are counted.

There is also the National Reference Center for Animal Parasitology and Analytical Technology (CENAPA). The tick identification and notification services offered at this center are rarely utilized by veterinarians, both for livestock and small species. But the most worrying thing is that CENAPA has little or no relationship with the Ministry of Health or government institutions, which would join this information with an outlook on the implications for public health.

I believe that veterinarians should be interested in having and utilizing the necessary tools to link their findings with the information handled by the appropriate authorities. Additionally, training and recognition of the impact of CC on the dynamics of vector behavior should be reinforced.

Other health effects that can be exacerbated by global warming are a consequence of the loss of the ozone layer. Stratospheric ozone represents the main filter of ultraviolet radiation from the sun. We know that the accumulation of ozone-depleting substances (ODS) and hydrofluorocarbons (HFCs) contribute to the greenhouse effect. The accumulation of greenhouse gases puts at risk the integrity of the ozone layer, and the benefits of its participation as the first filter of radiation.[12]

The weakening of the ozone layer increases the incidence of cancerous lesions in the skin due to greater exposure to UVA and UVB radiation. This is the greatest risk factor for the development of squamous cell carcinoma,[13] melanoma, and epithelial carcinoma.[14]

In the area of oncology of my clinical practice, most cancers are skin tumors such as squamous cell carcinoma, basal cell carcinoma, melanoma and precancerous lesions such as actinic keratosis in CAPs.

Coinciding with my practice's observation, a retrospective study that was carried out in the municipality of Toluca, Mexico, during 2002-2016, recognized epithelial tumors as the most frequent among oncological lesions among dogs, representing 59%; however, those tumors associated with ultraviolet radiation were the most common of this group, with 15.1%. This study mentions that an average time of

exposure to UV radiation (10-25 min) is sufficient for the development of skin cancer.[15] There is strong circumstantial evidence supporting the hypothesis that factors related to climate change, such as stratospheric ozone depletion, global warming, and ambient air pollution, have probably contributed to the increase in the incidence of skin cancer.[16]

This increase in the incidence of skin cancer in CAPs has received little attention due to the high cost of diagnosis, treatment, and little consideration by both owners and veterinarians, which results in a lack of prevention programs for CAPs.

These diseases, which in humans have a later onset, are of interest due to their relationship with CC, and reinforce the interest in including CAPs as a sentinel model.

But how is disease incidence tracked and managed? That is, through which agencies could we, as animal health professionals and researchers, channel the information for its relevance in terms of global impact, and early prevention?

Currently in Mexico there is the National System for Epidemiological Surveillance of Animals (SIVE, per its acronym in Spanish) within the National Service for Health, Safety and Agri-Food Quality (SENASICA, per its acronym in Spanish), the same system that is responsible for collecting, analyzing and processing health information on pests and diseases within the national territory. SIVE is meant to identify outbreaks and assess risks to act in a timely manner in control and/or eradication actions.

It is known that these institutions have surveillance campaigns for certain diseases, directly linked to the availability of public resources, and to the importance of the diseases, and their economic value for food animals. They typically do not track phenomena derived from the effects of CC, non-communicable diseases or losses due to natural disasters. However, one exception is important to mention. In May 2024, SENASICA and SIVE issued a statement informing the public of the death of howler monkeys in the states of Chiapas and Tabasco, likely a result of excessive heat and heat stroke.[17] In a joint work with the National Reference Center for Animal Parasitology and Analytical Technology (CENAPA, per its acronym in Spanish), the Institute for Epidemiological Diagnosis and Reference (INDRE) of the Ministry of Health and the National Center for Diagnostic Services in Animal Health (CENASA, per its acronym in Spanish), they conclude that the deaths of 157 howler monkeys were not related to infectious or toxicological agents, or that they were emerging diseases, thus confirming that the deaths of these specimens were caused by excessive heat and heat stroke. Insufficient water in the streams of the region was also mentioned.

This example, although it is not about CAPs, already considers the effects of CC discovered through animal epidemiological surveillance systems, and the joint work with the Ministry of Health. I believe this same collaborative relationship should be considered going forward as part of informing gathering on the effects of CC on CAPs.

There are other types of international epidemiological systems such as the World Organization for Animal Health (WHOAH/OIE) which since 1924 has been dedicated to monitoring and disseminating knowledge about animal diseases, as well as how to use scientific data to limit the adverse effects of these diseases on society. This organization monitors diseases in all animals, however, there is an agreement between the World Small Animal Veterinary Association (WSAVA) and the World Organization for Animal Health (OIE) approved by both on 26 May 2011.[18] This is perhaps another system that could be leveraged to monitor the effects of CC on CAPs.

Maximizing Shared Benefits

Research into the effects of CC on human health usually draws funding for projects related to surveillance, prevention, morbidity, risk factors, and case projections as expected. As stated above, the inclusion of CAP as a statistical and epidemiological sentinel model, whenever possible, would generate the benefits described in terms of prevention and immediate results, and a decrease in suffering on the part of animals and humans. The aforementioned institutions could be involved in epidemiological surveillance, and training for veterinarians could facilitate their participation in this research. Veterinarians would benefit from training about climate change and the importance of studies for data generation.

In this way, the identification of institutions that can assist in the detection of effects and issue the necessary information to address and mitigate the effects of CC could inform ways to enhance human and nonhuman resilience to this phenomenon in a forward-looking manner.

The One Health perspective acknowledges that both nonhumans and humans have an interest in avoiding suffering, and that health risks, including effects of CC, are shared among species. And are there already proposals of achieving shared benefits for both humans and nonhumans, including CAPs, in face of shared risks. Research design and inclusion of nonhumans in research can produce shared benefits for humans and nonhumans. For example, one paper makes the case of the inclusion of affected apes in the emerging Ebola outbreaks in 2014-2016.[19] This study represents a great example of how to maximize the resources of research. But it also represents an opportunity to obtain benefits for the animals included and for human beings.

Rabinowitz and colleagues talk about the inclusion of One Health approaches within educational programs, within the training of physicians, or even high school programs, that emphasize identification of intersections of coexistence, and how everyone can be affected, whether human, animal, or environment and their interrelated health.[20]

This same author also mentions a case study where a human patient presented to the emergency service with se-

rious stress condition. This happened because they observed that his beloved dog was in an unfavorable state during a heat wave. The emergency care physicians observed that the owner expressed great concern for the dog's health and went to seek help for the dog. However, in the process, the owner experienced adverse effects from the heat, too.

This case shows the confluence of factors, where the emotional, physical health, and the bond between companion animals and humans, also represents an area of opportunity to influence the health of both.[21]

Recommendations

With a One Health approach to both monitoring and addressing CC risks, I consider important to prioritize within epidemiological surveillance the following:

The relationship between emerging zoonoses and food insecurity

Food insecurity can have various origins, such as economic and social factors, or derive from the multiple effects of CC in the agriculture sector. Poor production, resulting from changes in crops due to rainfed crops and heat stress in producing animals can generate high food costs and lead to insufficient food at local and national levels. This insufficiency, or poor access to safe and innocuous food, can increase the likelihood of eating animals that are not suitable for human consumption, and are not intended, raised, or cared for this purpose.

At the same time, zoonoses can potentially develop due to the growth of urban sprawl, which causes a displacement of animals. As mentioned, this can lead to an increase of vector-borne diseases, and higher incidence of VBDs in CAPs. And, combined with the problem of human consumption of animals that are not suitable for this purpose, it would be wise to monitor the relationship between emerging zoonoses and food insecurity.

Monitoring the effect of heat waves and radiation on animal individuals

The incidences of specimens that show heat stroke and susceptibility to heat waves could be an indirect indicator, not only of the increase in temperature, but also of the depletion of local freshwater sources. In addition, it is important to include and monitor cancer-type diseases with environmental influence, such as the different types of skin cancer induced by UV radiation, and respiratory lesions.

Conclusion

The lack of consideration and monitoring of the impacts of climate change (CC) in CAPs, leaves aside an opportunity to enhance CC resilience, and limits research benefits. We are failing to care for individuals for whom we have moral responsibility, and who in addition, are considered in multiple homes as family members. And we are also failing to take advantage of research opportunities that can benefit both nonhumans and humans.

CAPs' inclusion in epidemiological studies of CC and even in different studies that can use comparative medicine, has many potential benefits. It would maximize resources since it would also show to animal health professionals the health importance of CC in their patients and would raise awareness among responsible owners for the care and prevention of pets in the face of CC. Furthermore, it could sensitize the population to act in favor of environmental protection and mitigating CC. The information generated from epidemiological surveillance in the CAP could produce valuable data for the use and consideration of preventive measures, damage mitigation strategies, as well as help with resilience to CC, with shared benefits.

In Mexico there are epidemiological alert regulations for diseases that must be reported, but there are no agreements with small species veterinary organizations. It is necessary to consider agreements with the Mexican association of veterinarians specializing in small species to generate a link between the aforementioned institutions for data collection, but also to train veterinarians in matters of health from a One Health and climate change approach.

The inclusion of this type of agreement between institutions, professional organizations and boards of small species doctors, with the National Epidemiological Surveillance System, would facilitate inclusion of CAPs in epidemiological surveillance, such that CAPs can serve as CC sentinel model. In time, this could be used for the prevention and timely management of its impacts.

Considering all the arguments described in this work, both the scientific community, the corresponding authorities, and animal health professionals should take steps to include animal patients in epidemiological surveillance research studies within CC and other diseases.

Furthermore, the description of cases of the impact of CC on health in animals as close as CAP, can be useful for generating awareness about the implications for one's own health, and for caring for the environment. Since, as mentioned above and in the case described by Rabinowitz et al., it is interesting how the sense of care, the good relationship between this type of animals and us, generates greater empathy for their problems.

I hope that the research community will facilitate research that uses this One Health approach, for example, research oversight committees that review epidemiological studies of the CC should encourage the One Health approach whenever possible. National research systems should be involved in issuing this type of call for research with cross-species benefits, to maximize the benefits for all.

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