



Conservation Medicine: An Interdisciplinary Approach to One Health

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Abstract

As we attempt to tackle global challenges like species extinction, population decline of wild species, emerging infectious diseases, climate change, etc. It is worth exploring the collaborations between different fields to achieve the common goal of one health. One Health is a collaborative approach- working with local, regional and global levels- with the goal of achieving optimal health outcomes while recognising the connections between people, animals, plants and their environment. Conservation medicine is an interdisciplinary field where different individual working within the boundaries of their own field collaborate in order to provide solutions to a common problem. As the field of conservation medicine is evolves, it aims to become a transdisciplinary approach which requires people to develop new approaches and methodologies that span across disciplinary boundaries.

Keywords: Interdisciplinary; Conservation Medicine; One Health

Introduction

Conservation medicine is a continuously evolving field with its roots deep into the history. We can conceptualise health as the capability to react to all kinds of environmental events having the desired emotional, cognitive, physical and behavioural responses and avoiding those undesirable ones [1]. It is important to understand that the health of an individual cannot be studied in isolation; there are multiple factors that govern the wellbeing of any animal [2]. As all the physiological systems within an organism are studied together, it is essential to consider all the components of an ecosystem while studying the impact on one species or individual. Conservation medicine aims precisely at ecological health, hence by extension at its inhabitants [3]. The conservation medicine triad is a good model to describe the fundamental focuses of the field (Figure 1).

History

Although conservation medicine attempts to tackle the problems of the modern age, it has existed as a field for a long time. In 1996, Koch described how conservation of wildlife cannot be achieved, while neglecting development, economic and social factors [4]. Conservation cannot ignore the human needs, and devel-

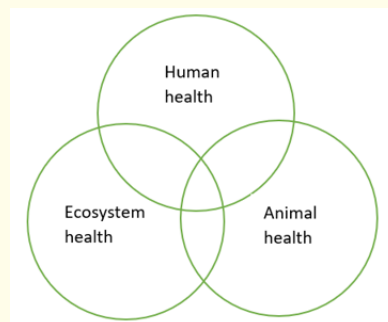


Figure 1: Conservation medicine triad is a functional model demonstrating the interconnectedness of the concept of health, with relation to its three components.

opment cannot ignore environmental limits. Further back in 1826, Charles Darwin left medical school to study religion and natural history. Darwin's medical background proved supportive in his observations of the natural world. A combination of medical knowledge and training in natural science, resulted in him writing *On the Origin of Species*.

As humans evolved intellectually, their actions reflected largely on the planetary health e.g., reduction in natural habitat due to farms and cultivation lands, increase in industrial pollutants, overexploitation of wild resources and species, wild animal trade, invasive species introduction, etc. The planet is currently in 'Anthropocene' which is an unofficial unit of geological time used to describe the profound impact of humans on climate, ecosystems and biodiversity [5]. The planet is experiencing the sixth mass extinction also known as the Anthropocene Extinction. Population decline, visible deaths, increased disease, extinction of species, reduced reproduction within wildlife are some of the signs of a weakened ecosystem. Modern day problems cannot be solved with the same approach with which they were created. Today, human health is studied in comparative isolation without considering its effects on other components of the ecosystem. Conservation medicine attempts to analyse the world in a more inclusive manner. Health is achieved on the balance of multiple fields, including human health, veterinary science, ecology, toxicology, epidemiology, etc. By integrating the knowledge of many disciplines, conservation medicine aims to be a 'transdisciplinary' model of health [6]. Over the course of scientific evolution, humans have separated the disciplines that were once united. Conservation medicine studies the interactions between host-pathogen, pathogen-environment, and host-environment. It promotes the focus on ecological health studies as opposed to the species-specific approach.

Meaning of conservation medicine can be explained as follows [3]. "Conservation Medicine examines the interactions between pathogens and disease and their linkages with the synergies that occur between species and ecosystems. Thus, it focuses on the study of the ecological context of health and the remediation of ecological health problems. In response to the growing health implications of environmental degradation, Conservation Medicine includes examining the relationship among

- Changes in climate, habitat quality, and land use
- Emergence and re-emergence of infectious agents, parasites, and environmental contaminants
- Maintenance of biodiversity and ecosystem functions as they sustain the health of plant and animal communities, including humans.'

Development in the field

As per the description, conservation medicine not only deals with diseases but also all the factors that impact the ecosystem. Some species affect the ecosystem more than others, they are

termed as keystone species. Decline in the number of these species can have catastrophic effect on the ecosystem. For example, vultures are extremely effective and efficient scavengers. Southeast Asia hosts multiple Gyps and non-Gyps species of vultures. In the recent past the vulture population has declined drastically.

During the early 1990s, there were an estimated 100 to 160 million vultures in India. According to recent studies [7] population decline exceeds 40% per year for Oriental-White backed vultures with a staggering 99% decline already having taken place since 1990. To understand how conservation medicine works, it is important to first understand the significance of the species.

Importance of vultures in their ecosystem (Saving Asia Vultures from Extinction)

- In early 1990, vultures consumed over 20 million tonnes of carcass. Each bird consumes over 120kg per year.
- Vultures are known to reduce an adult cow carcass to bare skeleton within an hour.
- Vultures, due to higher body temperature and naturally acquired antibodies, help digest pathogens such as anthrax [8].
- Other scavengers who cannot digest these pathogens, become carriers and spread the disease further.
- Vultures are the most efficient scavengers who function as the cleaning agents of the ecosystem.

Consequences of vulture decline

- Uneaten livestock carcasses act as a breeding ground for pathogens which pose a direct and indirect threat to human and animal health.
- These carcasses can also be the source of infectious diseases such as anthrax, which in absence of vultures, spreads to other species [9,10]
- Decline in number of vultures supports population growth of feral dogs due surplus food availability [11]
- Increase in dog population results in more incidences of dog bites, dog attacks, rabies cases [12] (Figure 2).
- Increase in disease occurrence of brucellosis in livestock [13]
- Parsi community depends on vultures for disposal of human bodies during 'sky funerals' [14]

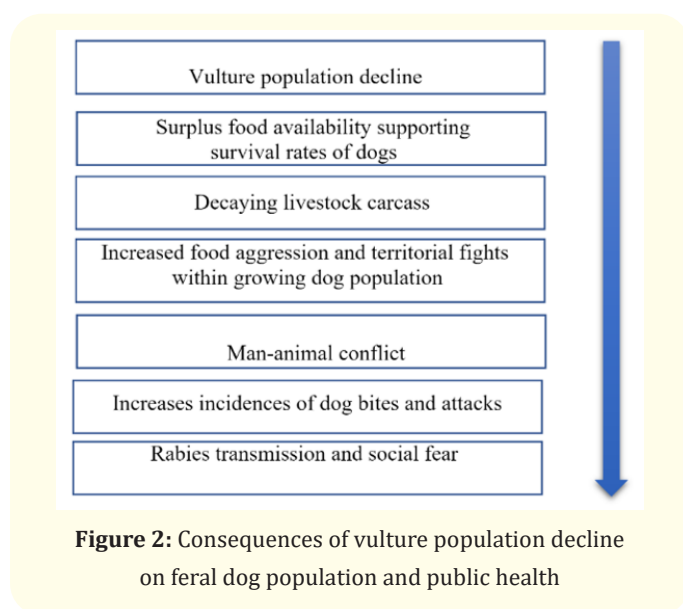


Figure 2: Consequences of vulture population decline on feral dog population and public health

Conservation efforts

- The reason for vulture population decline was directly linked to the use of diclofenac in livestock [15]
- With studies proving that diclofenac causes almost 100% mortality in Gyps vulture, Nepal and Pakistan declared ban on manufacturing of the drug in 2006, followed by withdrawal of licenses to manufacture veterinary diclofenac in India. (<https://save-vultures.org/advocacy/>)
- With advanced studies it is proven that not only diclofenac but also other NSAID- nonsteroidal anti-inflammatory drugs such as carprofen, ketoprofen, acecloprofen, flunixin, nimesulide are also lethal to vultures [16,17]
- Vultures reach sexual maturity at five years of age and lay a single egg per year. Vultures reproduce poorly in captivity. After establishing the link between diclofenac and the unprecedented population decline, three breeding centres were started in India and one in Nepal [18]
- Complimentary to the breeding centres, five-year plan to create Vulture Safe Zones (VSZ) was initiated. These areas are geographical locations where the chances of NSAID poisoning has been eliminated [19]
- With captive born vultures reaching sexual maturity within the same five years, researchers plan to release these birds in VSZ.
- Three years into the program, with a functioning VSZ and a complimentary breeding centre, nesting numbers have increased from 17 to 45 in Nepal VSZ.

- Gujarat, India hosts a concentrated population of cows, and the carcasses are left for vultures. With intense awareness programs these cow shelters have made a sudden shift from Diclofenac to Meloxicam which is the only NSAID safe for vultures [20]

With captive breeding, timely research and intervention, VSZs and awareness programs vultures still have a chance of survival, even with drastic decline in the wild population in the past. Here we can appreciate how conservation can result in positive outcome by including multiple factors of the situation. If vulture decline is studied only from the aspect of veterinary treatment and breeding without any drug regulations, community awareness and creating safe areas for their introduction, then the recovery would not have been as much of a success. Here, conservation medicine works for preservation of an endangered species by determining cause of decline, ensuring ban on the harmful cause, supporting captive population, creating safe areas for reintroduction, protecting public health, reducing risk of zoonotic diseases, and creating awareness within and along the veterinary community. This example only scratches the surface of what can be achieved if health is studied through multiple disciplines simultaneously instead of in isolation.

Role of a veterinarian in conservation

Veterinarians have unique knowledge of clinical, environmental, and public health. They can contribute to conservation in multiple ways mentioned in table 1.

As previously described conservation medicine being an interdisciplinary field requires veterinarians to collaborate with other fields in order to achieve the common goal of one health. Preservation of ecosystem balance cannot be achieved only through clinical interference. It is with collaboration of biologist, community leaders, human healthcare workers, policy makers, veterinarians, activist, etc that we can restore the ecological balance.

In the above-mentioned example of vulture conservation, one can see that only veterinarians banning diclofenac would not solve the problem. It requires following collaborations for the project to be effective:

- Biologists, to notice the population decline.
- Microbiologist, pathologists, and toxicologists to conduct post-mortem examinations and determine cause of death.
 - Community leaders to convince locals, not to use these harmful drugs.

Non-clinical	Clinical
Human-Animal conflict	Responsible use of antibiotics
Policy making	Dog and cat population management
Research & trials	Immunisation
Zoo management & Captive breeding	Immobilisation of wild animals
Animal welfare	Euthanasia
Milk & meat production	Pathology
Quality control	
Population monitoring	
Wildlife tracking	
Education & awareness	
Zoonotic surveillance	
Public health	

Table 1: Examples of veterinary contributions to the field of conservation.

- Scientist, politicians, activists, and policy makers to impose ban on manufacturing of these harmful drugs.
- Veterinary surgeons to conduct dog sterilisation and vaccination programs to control the stray dog population and rabies spread.
- Veterinarians to immunise livestock.
- Human health care workers to offer pre and post exposure rabies vaccination and treatment of dog attack victims.
- Epidemiologist, to conduct surveillance of vulture population re introduced in the wild.
- There are multiple examples of how individuals with different backgrounds are essential in making any conservation project a success.

Conclusion

Conservation medicine is a discipline that aims at One health by including all the factors that influence not only species but ecosystem as whole. By extension it also includes all the disciplines, each studying a different factor of the ecosystem. Veterinarians play a vital role in conservation due to their unique skillset. Conservation medicine is the only way forward towards the inclusive health model of not just ecosystems but the planet.

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