



## TUBERCULOSIS IN ASIAN ELEPHANTS – A THREAT TO CONSERVATION AND PUBLIC HEALTH

K.S. Subramanian\*, K. Kumanan, N.D.J. Chandran, P.I. Ganesan, A. Raja  
and B.S.M. Ronald

Vaccine Research Centre – Bacterial Vaccines, Centre for Animal Health Studies - TANUVAS,  
Madhavaram Milk Colony, Chennai – 51

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### ABSTRACT

Tuberculosis, a re-emerging infectious, contagious disease of high zoonotic importance caused by *Mycobacterium tuberculosis* complex. In recent times, it is becoming a threat in the conservation of captive Asian elephants because of their exposure and close contact with infected human, animals and environment. Though there are evidences of infected and ailing captive elephants in our country, no systematic study is carried out to understand the status of tuberculosis in captive elephants maintained in diversified environments throughout India. The major practical limitations like lack of effective diagnostic techniques for early diagnosis of tuberculosis in elephants, practical challenges in proper sampling, pathogenic complexity of mycobacteria, lack of awareness and reluctance of control measures among elephant keepers especially the private owners, administration of drugs, high cost of treatment, issues related to screening of elephant handlers infected with mycobacteria and application of prospective biotechnological tools in early diagnosis, treatment and control are discussed.

### INTRODUCTION

Tuberculosis is one of the most important infectious, contagious diseases of livestock including elephants caused by *Mycobacterium tuberculosis* complex organisms and is of great zoonotic importance. India has highest human tuberculosis cases in the world.

Elephants are considered to an integral part of our culture and are worshipped as the living symbol of Lord Ganesha. Asian elephant is an endangered specie and special importance is being given for its conservation. It is regarded as National Heritage Animal since India has more than 50 % of the existing Asian elephant population in the world. In India captive elephant lives in close association with human.

The transmission of mycobacterial infection will be more phenomenal when these captive elephants share the infective environment by human and other livestock especially in the Human–Livestock–Wildlife interface which is more common in north east region of the country. Moreover, most of the captive elephants are maintained in semi-captive condition and will be regularly let out for grazing in to the forest during which they may mingle closely with the wild elephant population. Under such conditions, the infected captive elephant can easily transmit the infection in to the wild herd which

may endangering the wild population. Disease status in captive elephants of India is poorly understood and there is no systematic study on the status of emerging zoonotic diseases like tuberculosis, leptospirosis, brucellosis etc., Hence, it is of great significance to understand the actual status of these zoonotic diseases among all the captive elephants of India for their effective conservation.

### Types of captive elephants

**(a) Temple elephants:** Of all the wild animals, elephant is considered to be an integral part of the culture, tradition and mythology in Asia, especially in India ever since the Vedic age. South India has the historical distinction of having the presence of many age old temples with very rich cultural heritage and they have the unique tradition of maintaining elephants for various celebrations, cultural and religious ceremonies involving close association with public. Indians, especially the children irrespective of their religion and status are socially and emotionally connected intimately with the elephants. Blessing from these elephants by their trunk and splashing water on the face are considered as sacred. During religious functions and festivals where in thousands of devotees of different health status congregate together, the temple elephants in the ceremonial parade are exposed to diversified contaminated environment facilitating transmission of diseases.

\*Corresponding author; e-mail: drkswildlifevet@gmail.com

**(b) Zoo elephants:** Zoological parks in India play an important role in *ex-situ* conservation of wildlife and have significant role in creating awareness to the public by acting as eco-education centers for conservation of wildlife. Of all the wild animals, the elephant is considered as a hot-spot, charismatic specie of animal in any zoo and irrespective of the age, people love to watch and be in close association with elephants.

Many of the large and medium zoos in India maintain captive elephants for conservation, education and recreational purposes and many times zoos also act as refuge and rehabilitation centers for orphaned wild elephants especially elephant calves. Zoological parks invariably provide ambient environment for the transmission of pathogens because of the close association of multiple species of wild animals, zoo workers and diverse public with different health status creating an environment of microbial interface acting as repository of microorganisms.

Under the circumstances, zoo elephants with tuberculosis and other zoonotic infection will not only lead to public health hazard but also a potential threat to other elephants and to other wild animals in the zoo and zoo personnel.

**(c) Private elephants:** Among the captive elephant population in India, more than 50% are owned by private people/parties. Health care and management of these elephants are many times compromised because of absence of regular health monitoring. These elephants, if infected with tuberculosis and other zoonotic diseases, will be of a real threat to the society since they mingle very closely with public and livestock and also travel to different places with in the state and country.

### Elephant Tuberculosis – An Overview

The ancient treatise on elephants 'Hasthayurveda' written over 2000 years ago has information about the incidence of tuberculosis in elephants (Evans, 1910). Narayanan (1925) reported that a necropsy of an elephant conducted in North India showed extensive tuberculous lesions in both lungs. Bopaya (1928) has reported tuberculous lesion in the large intestine, mesenteric lymphnodes, lungs and spleen of an elephant belonging to Coorg forest department, Karnataka. These incidences were brought to the notice mostly during post mortem examinations and until recently there were no effective sampling techniques and efficient diagnostic tools for early diagnosis of this devastating disease. Mikota (2010) opined that though tuberculosis in elephants was recognised as a disease over 2000 years ago

in Hastayurveda. The first published report of TB in elephants in modern times was by Garrod (1875) which is based on a case report on an Indian elephant which died at zoological society gardens of London Zoo.

Tuberculosis in elephants in US re-emerged in 1996 when two circus elephants died three days apart raising significant public and political concern. A summary of report on incidence of TB in elephants in the US from 1994–2010 revealed 50 culture positive cases belonging to 46 Asian elephants (*M. tuberculosis*), three African elephants (*M. tuberculosis*) and One African elephant with *M. bovis* ( Mikota, 2010). There were three cases of infection with *M. szulgai*, an unusual mycobacteria that was associated with the death of three African elephants. The higher incidence of cases among Asian elephants was attributed to their closer association with infected human and environment when compared to the African elephants. Out of these 50 cases 31 were diagnosed *ante-mortem* and 19 at *post-mortem*.

Tuberculosis has reemerged as an important infectious disease among elephants and due to its zoonotic nature the incidence of tuberculosis in elephants has potential public health hazard, creating major concern for the health and well being of human and other livestock (Mikota *et al.*, 2000). It has been implicated as a main factor in the extinction of the Mastodon, one of the recent ancestors of present day elephants based on the examination of 56 out of 113 Mastodon skeletons by a forensic anthropologist (Rothschild, 2006). According to Mikota *et al.* (2000) though culture test is the approved 'gold standard' for tuberculosis but it is practically far from ideal for screening as it takes very long time (> 12 weeks) to grow even with sufficient concentration of mycobacterial organisms. Further the shedding of organisms will often be intermittent that too at the final stage of the disease and hence this may not be useful for regular monitoring and surveillance. Therefore, it is the need of the time to have some innovative rapid diagnostic techniques like molecular techniques using modern biotechnological tools such as polymerase chain reaction (PCR) which will facilitate rapid and early diagnosis of infection.

DNA amplification by PCR is currently adopted for the rapid diagnosis of tuberculosis as a more sensitive and specific method by targeting the insertion sequence *IS 6110* since it is present in *Mycobacterium tuberculosis* complex only (Thierry *et al.*, 1990). *IS 6110* targeted PCR offer promise as a useful test for the detection of *M. tuberculosis* complex organisms in elephant trunk wash specimens Meagan *et al.*, (2011).

### Problems in tuberculosis diagnosis in elephants and biotechnological perspectives

Diagnostic tests for tuberculosis are either direct or indirect. Direct methods to detect tuberculous organisms include culture, acid fast staining and nucleic acid amplification techniques such as PCR. Indirect tests like intra-dermal skin test (which is not useful in elephants), antigen and antibody based tests (which are considered as ancillary tests with varying results), ELISA and Interferon gamma assay (which are under trial in US). Though the antigen and antibody based tests are validated in US and tried in Nepal and some parts of south India, they need further validation in different zoogeographic regions. Moreover the field level lateral flow test and dual path platform tests for elephant tuberculosis are not available commercially at present in India. The problem of control and elimination of tuberculosis is complicated by the inability to detect tuberculous animals at the early stage of the disease, since clinical signs may not be evident until progressive pulmonary lesions develop (Mikota, 2010). Hence, the major practical limitations like lack of effective diagnostic techniques for early diagnosis of tuberculosis in elephants, practical challenge of proper sampling, pathogenic complexity of mycobacteria, lack of awareness and reluctance in carrying out regular disease screening in elephants by elephant keepers especially the private owners, challenges in the administration of drugs for a long period, high cost of continuous treatment, issues related to screening of elephant handlers infected with mycobacteria need to be addressed. Scientists from zoological society of San Diego have stated that if tuberculosis mutates in elephants and moves back to human and other livestock in a novel and more virulent form, none of our present day drugs can control the episode and in such circumstances reciprocal transmission between humans and elephants could have devastating consequences (Modi, 2007).

There is a great need for biotechnological/nanotechnological therapeutic intervention for simple, easy, concentrated and animal friendly form of administration of medicaments in captive and free ranging wild animals including elephants. This will be more signifi-

cant in the treatment of tuberculosis affected elephants since it is very challenging in the field to administer large quantities of oral medication for a long period. Mishra *et al.*, (2010) reported that nano-technology based drug delivery systems can lead to improved half-life, controlled release over short or long durations and highly specific site-targeted delivery of therapeutic compounds.

World Health Organization (2007) has reported that regular monitoring and surveillance, early diagnosis and treatment will be the best way to control tuberculosis, thus reducing the impact of infection and transmission of the disease. Hence it is the essential need of the hour to carry out complete health assessment of all captive elephants including private elephants by coordinated efforts of all departments, scientists concerned in order to understand their health and disease status with special relevance to tuberculosis. Application of prospective biotechnological tools for early diagnosis of tuberculosis, its treatment and control will pave way in providing effective early warning system for conservation of this National Heritage Animal—The Asian Elephant.

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