



REVIEW

Rabies in Greece; historical perspectives in view of the current re-emergence in wild and domestic animals



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Summary Greece has been rabies free since 1987 while no human cases have been seen since 1970. The re-emergence of rabies in Northern Greece during 2012–2013 in wild and domestic animals prompted a systematic review of historical evidence of the presence of the disease in the country from ancient years till the present. Historical data is presented along with efforts to prevent disease in animals and humans especially during the high prevalent periods in the country in the mid-20th century. These efforts serve as a guide to current extensive efforts to prevent spread especially in the wild and domestic animal populations.

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1. Introduction

Rabies, a zoonosis with world-wide distribution continues to remain an important cause of death in many developing and third world countries [1]. It is caused by viruses-members of the genus *lyssavirus*. The majority of human exposure is related to the classical rabies virus (present in all continents except for Antarctica) which has both terrestrial and bat reservoirs but mainly transmitted by dog bites [2]. Strict eradication programs may be necessary to control the disease however complete elimination in animal species is almost impossible due to the variety of the animal reservoirs of rabies virus. Nevertheless, the development of the first vaccine against rabies by Louis Pasteur and further evolutions in human vaccines have assisted in a great reduction of disease incidence in humans. Greece was rabies free since 1987 and up until 2012 when the re-emergence of rabies in wild and domestic animals in Northern Greece was presented [3]. No cases of human rabies have been seen in Greece since 1970 or during the recent re-emergence in animals. The current paper attempts to present a review of historical data of the presence of the virus in the country in order to derive lessons and or strategies to be used against the current re-emergence.

2. Methods

Ten scientists 3 Public Health officers working for the Ministry of Health and the Hellenic Center for Disease Control and Prevention (ST, GR, GD), 3 veterinarians working for the Ministry of Rural Development and Food (LMK, MT, KET), 3 experts with previous knowledge of the rabies epidemiology in animals and humans in the country (OMV, AMS, VK) and 1 historian (KK) critically reviewed all rabies pertinent literature available from the NCBI PUBMED database. Each group of authors independently performed the literature search, study selection, and data extraction. The following terms were used in searches of the Entrez-PubMed database alone and in combination: "Rabies", "Human Rabies", "Animal Rabies", "Sylvatic rabies", "Greece", "Europe", "Balkans", "Mediterranean", "Epidemiology", "Rabies History". The literature search was focused on Greece but we included also data pertaining to the Roman, Byzantine and Meta-Byzantine period. We also screened articles related to the initially identified publications to expand our data sources especially with regards to the current situation in neighboring countries (Former Yugoslav Republic of Macedonia, FYROM) or international guidelines for rabies control in animals.

3. Historical data

3.1. Ancient Greece

In Greece early descriptions of the disease reach back to the 9th–10th century BC in literature texts and often in a metaphorical phasion. For example in Homer's *Iliad* the term raging dog is used for Ector [4,5]. or the hydrophobia described in the torment of Tantalus in Hades [5,6].

However it is unclear whether this refers to rabies existence at these times. Prof. Jean Théodoridès (1926–1999, France), parasitologist and historian in biological and medicinal sciences, was the authority par excellence on the history of rabies. In his book entitled "Histoire de la rage" supported that Hippocrates was not convinced that disease can be transmitted to humans [7].

The disease was also known and referred to in the works of the historian Democritus and by the Greek tragic poets Euripides [5,8] and Sophocles where it is described as some kind of mania [9] that is sent by ancient Gods [10]. The famous Greek philosopher Aristotle (4th Century BC) states that dogs amongst other diseases are subject to rabies that leads to raging madness transmissible to other animals by biting [11].

3.2. Roman period

During the Roman period, a detailed description of the main symptoms of rabies in animals is reported in the works of the Stoic philosopher Epictetus (1st century AD) [12] and the famous doctor Galenus where rabies is described as commonly occurring in dogs and its major symptom is hydrophobia [13].

Philumenus and Dioscorides (both physician from 2nd century AD) describe in detail the disease and its symptoms in dogs (mainly fierce attitude along with hydrophobia) [14,15] as well as first attempts at treatment e.g. a combination of crab and gentian ashes dissolved in old wine ([5] and references therein).

In the 5th Century AD, Caelius Aurelianus reports the common occurrence of a canine disease with similar characteristics in Crete [6,16].

The above data point towards the existence of the disease in Ancient and pre-Byzantine Greece at least 2000–3000 years ago with the occurrence of outbreaks in canines which appeared to also serve as a reservoir of the virus [5]. Alternatively, though unlikely, the reference to rabies in this period might not correspond in all cases to this specific disease but to other diseases with similar symptoms. In addition, the death of humans after bites of dogs could be attributed to the general sepsis produced and not due to rabies [11].

3.3. Byzantine and meta-Byzantine/Ottoman periods

Clear indications that the disease existed during the Byzantine period exist. The term "lyssodi" i.e. rabid is widely used by theological scholars such as Gregorius Nysenus (4th century AD) [17] and Michael Psellus (11th century AD) [18] to describe an aggressive attitude as well as erotic passion. Aetius Amidenus and other scholars (5th and 6th cen. AD) describe a disease where dogs suffer from a mania called lyssa (rabies) [19]. Similar to Philumenus, Aetius claims that the disease becomes more severe in case of extreme weather conditions and gives a list of the main symptoms for the animals and more specifically: a) loss of voice and mind i.e. they cannot even recognize their family; b) hydrophobia despite thirst; c) protruding tongue; d) copious amounts of frothy saliva; e) lowered ears and tail;

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