Title: Modeling and analysis of Coccidioidomycosis in the endemic areas: Effectiveness of preventive measures

Summary: Coccidioidomycosis is a fungal infection acquired by inhalation of fungal conidia present in the ambient air or entered in the air by soil-disrupting activities (e.g. digging or natural disasters). Recent studies suggest that infected carcasses should not be buried, because the fungus in the carcasses can grow and transform into the infectious forms. A mathematical model will be constructed to quantify the effectiveness of burial avoidance as a preventive measure. In a broader context, this study seeks to estimate the reduction of the infection in the endemic areas when such a measure alone or combined with the other measures is applied. The model will be partly validated with the diagnostic laboratory data associated with the pets residing in Texas for the past 10 years.

Background: Coccidioidomycosis, also known as Valley fever, is a non-contagious infection caused by fungi Coccidioides immitis and C. posadasiispecies. In addition to humans, the infection affects several species of animals, with dogs being the most severely affected non-human hosts. Valley fever is primarily a respiratory disease (Saubolle, 2007), which occasionally spreads hematogenously to other parts of the body (Johnson & Baqi, 2008). Over the past few years the number of valley fever cases in the United States has been growing. Valley fever is endemic to southern and central regions of Arizona, California, Nevada, New Mexico, Texas and Utah. Valley fever is not transmitted from person to person. Soil is the main source of valley fever transmission (Johnson & Baqi, 2008). Considering that most dogs have digging habits, they have a high risk of being infected. Recent studies indicate that outdoor, working and sporting dogs are five times more likely to become infected compared to those kept indoors (Graupmann-Kuzma, 2008).

Preventive measures: (1) Avoidance of burial of human and pet animals infected by Coccidioidomycosis [4] “(2) Although complete prevention of infection is not possible, travelers, especially those at increased risk for severe and disseminated disease, can decrease their risk by limiting their exposure to outdoor dust in disease-endemic areas. (3) Dust-control measures that include wetting soil before disturbing the earth may be effective. (4) Other protective measures aimed at reducing exposure to dust, such as wearing well-fitted dust masks capable of filtering particles as small as 0.4 µm and using vehicles with enclosed, air-conditioned cabs, can provide added protection for those with high occupational exposure to dust.” (CDC 2010)

Objectives: The goals of this study are: (1) construct a mathematical model of Coccidioidomycosis infection; (2) quantify the effectiveness of preventive measures; (3) validate the model predictions with Texas valley fever data.

Method: A mathematical model (a set of ordinary differential equations) is constructed to simulate the dynamics of Coccidioidomycosis infections in dogs and humans residing in the endemic areas. The soil is the common source of infection for pets (especially dogs) and humans. This factor and the above-mentioned control measures will be incorporated in the model construction. Equilibrium analysis of the model and will quantify the effects of
parameter changes (i.e. those related to the preventive measures) in reduction of infection in the endemic areas.

**Significance:** Analysis of the model may provide valuable information that can be used by decision-makers and healthcare professionals. Specifically, (1) the proposed research will quantify the effectiveness of the preventive measures. (2) It will quantify the reduction of infection when burial avoidance is strictly applied. (3) The outcomes of the proposed research will serve as sentinels for public health. Namely, an overall increase to the number of infected dogs is a warning sign to people with soil related occupations (e.g., construction workers and gardeners) working in the same endemic area. Also children being exposed to the same surroundings (e.g., playgrounds and baseball fields) can bare the same risk.

**Key Articles:**

Please consult with the instructor. Some Keywords: susceptible-infected-recovered model, Loss of immunity, preventive measures.


**More information**

*Spatial distributions* Data analysis of different geographical areas indicates an overall increase of valley fever infection in southern states of the United States (Hector & Laniado-Laborin, 2005). A comparison of endemic areas of Texas in 1980 and 1996 indicates a significant increase in geographical distribution of the disease in Texas (Kirkland & Fierer 1996; Kolivras & Comrie 2003).

*Climatologic effects* An underlying question in several time series studies of valley fever is whether fluctuations in the number of cases are related to climate anomalies or to some biological reasons. Attempts to link valley fever incidence to climate changes dates back to early 1970s (Teela, Yowa & Williams 1970). Yet, assessments of climatologic effects on valley fever incidence have been highly controversial. For instance, time series and sensitivity analysis of data from Arizona indicates significant relationships between climate and valley fever incidence (Comri & Glueck 2007). On the contrary, statistical analysis of data from California rejects the hypothesis of such link (Talamantes, Behseta & Zender 2007). Other studies suggest minor improvement of time series forecasts when weather-related factors are taken into account (see for instance, Kolivras & Comrie 2003).
References:


