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Meat borne parasitic zoonoses: Epidemiology, diagnosis, prevention, current issues and approaches

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Abstract
This paper represents the most important meat borne parasitic zoonoses with emphasis on epidemiology, diagnosis and treatment. This paper also highlights the importance of a collaborative approach to the prevention and control of food borne diseases and discusses the need to coordinate the efforts of international agencies working on human health, animal health and food production. These diseases are becoming more common as they are generally not recognised but have a major health impact on human population. Transmission of parasitic zoonoses through food has public health as well as socioeconomic importance.

Keywords: Zoonoses, cysticercosis, taeniasis, echinococcosis, coenurosis, sarcocystosis, toxoplasmosis

Introduction
Muscles post the resolution of rigor is referred as meat. Meat is an important source of protein and a valuable commodity in poor countries. Zoonoses are the diseases which are naturally transmissible between vertebrate animals and man. The prevalence of specific parasite in food supplies varies between countries and regions. Parasitic zoonoses directly affect human, livestock health and production. The environmental route of transmission is significant for many protozoan and helminthic parasites, with water, soil and food being particularly significant (Slifko *et al*. 2000) [1]. Food borne parasitic zoonoses occur through consumption of infected meat, fish, contaminated vegetables/plant and water (Zhou *et al*. 2008, Bhatia *et al.* 2010) [7, 3]. Meat borne zoonoses is less common in developed countries as compared to developing countries as the proportion of processed meat out of meat produced is very low in developing countries.

Cysticercosis and Taeniasis
The diversity of clinical manifestations reflects a series of contributing factors which include the number, size and location of the invading parasites, and particularly the inflammatory response of the host (Gonzales *et al*. 2016) [12]. The prevalence rate of *Taenia solium* in man varies from 0.75 to 1.00 per cent in certain communities, particularly in rural areas where there is more contact with pig populations (Singh *et al*. 2002) [4]. The prevalence of *Cysticercus cellulosae* in muscles of pigs is very well established in different parts of India, with an overall prevalence ranging from 3 to 26 percent (Singh *et al*. 2010) [11].

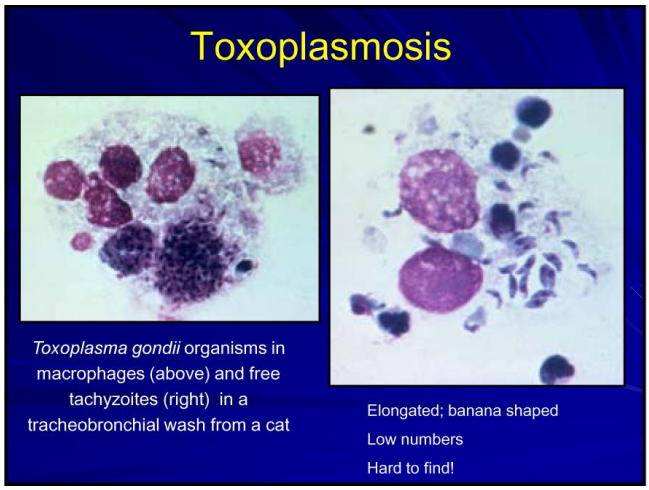
Diagnosis: Cysticercosis, caused by the presence of the larval stage (cysticercus) of *Taenia solium* in various organs, especially the CNS, is diagnosed by a variety of methods including radiology and serology (Parija *et. al.* 2002) [9]. A serological screening test (ELISA) is available. A minimum of one ml of clotted blood is required. Positive results should, where possible, be confirmed by non-serological means.

Treatment: The common treatment for cysticercosis is a combination of anti-parasitic and anti-inflammatory drugs. In some cases the patient does not respond to drug treatments and it becomes necessary to perform surgery on the cysts. Surgery can also be necessary to reduce brain swelling. If brain cysts are found calcified, they are considered dead and generally do not require treatment.

Prevention: To prevent cysticercosis, avoid eating raw or undercooked pork and other pig products. When traveling in developing countries, wash hands frequently and particularly before handling food. Wash and peel raw vegetables and fruits, and drink only bottled or boiled water. Carbonated water from cans or bottles is also safe to drink, but water from drinking fountains and ice cubes should be avoided.

Toxoplasmosis

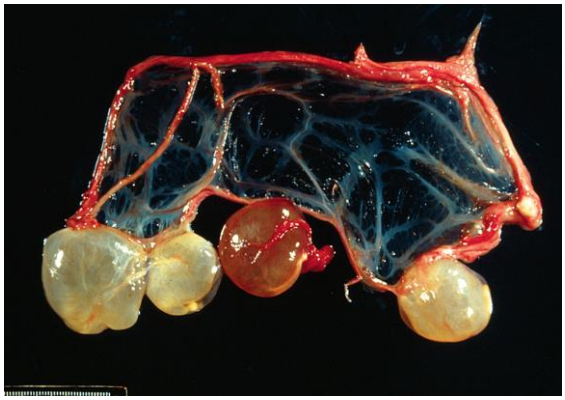
Toxoplasmosis is a congenital as well as postnatally acquired zoonosis characterized by retinochoroiditis and encephalitis. It causes abortion in pregnant women (Areshkumar *et al.* 2018) [16]. *Toxoplasma gondii* is an intestinal coccidium of felids with an unusually wide range of intermediate hosts e.g. sheep, goat, pig etc. including man. Central nervous system derived toxoplasmosis in Acquired Immune Deficiency Syndrome is an emerging disease in India. Dhumne *et al.* 2007[6] tested total of 23,094 serum samples for *T. gondii* IgG and IgM antibodies using solid-phase immunocapture ELISA. Antibodies IgG and IgM were found in 24.3 and 2 per cent samples respectively. There have been various reports of toxoplasmosis in man and animals from India (Singh *et al.* 2010) [11].



Diagnosis: Detection of *T. gondii* in human blood samples may be achieved by using the polymerase chain reaction (PCR). Inactive cysts may exist in a host which would evade detection. Toxoplasmosis can be detected with immunostaining. Lymph nodes affected by toxoplasma have characteristic changes, including poorly demarcated reactive germinal centers, clusters of monocytoid B cells and scattered epithelioid histiocytes.

Echinococcosis (Hydatidosis)

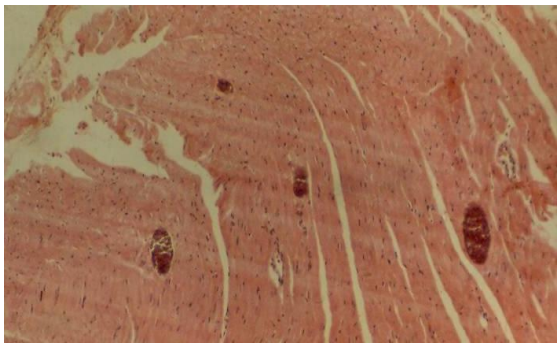
Echinococcosis in humans is an infection which is caused by a larval stage, the metacestode, of echinococcus species and may result in asymptomatic infection to severe disease; it may even be fatal. Human echinococcosis continues to be a significant public health problem in numerous countries (Barnes *et. al.* 2017) [13]. From several regions there are alarming indications of increasing human health risks caused by echinococcosis (WHO and WOAH 2001) [8]. Many reports and surveys available reveal its occurrence in most of the states in India (Singh *et al.* 2010) [11]. In Indian scenario, the conditions for the establishment and transmission of hydatidosis in both livestock and humans are very ideal. Factors like cultural, educational, socio-economical, agricultural and environment contribute to the transmission of the disease. In India, *Echinococcus granulosus* has a wide geographic distribution in livestock (WHO and WOAH 2001) [8], and is prevalent throughout the country. Information about epidemiology of hydatidosis in livestock in India has also been published by other workers (Juyal *et al.* 2010) [3].



Hydatid cysts in mesentery

Sarcocystosis

Sacrocystosis is of worldwide distribution. The ingestion of raw beef or pork infected with *Sarcocystis* can cause illness in humans, nausea and vomiting can occur with in three days of comsuming infected meat (Dubey, 2015) [15]. *Sarcocystis suihominis* (pig origin) and *Sarcocystis hominis* (cattle origin) are two major species affecting human beings. Cases of human sarcocystosis have been reported in Lucknow and other parts of India. Prevalence of *S. hominis* was 3.79 per cent (Singh 2001) [10], in cattle from Punjab. Prevalence of *S. suihominis* was 53.62 per cent (Avapal 2001) [2], in pigs from Punjab. The prevalence of *S. suihominis* is much higher than *S. hominis* due to non-consumption of beef in the country on religious grounds.



Sarcocysts in cardiac muscle

Coenurosis

It is worth to mention that several reports of human coenurosis can be found in the literature. While cerebral coenurosis is attributed to the species *Multiceps multiceps*, coenuri found in subcutaneous and intramuscular tissues in humans in America and Africa were caused by *M. serialis* and *M. brauni*, respectively.

Prevention and control of parasitic zoonoses

Global agencies like FAO and WHO have recommended continued greater surveillance of parasitic zoonoses in man and animals. At the Third Global Meeting for parasitic control held at WHO headquarters, Geneva in November, 2004, food-borne trematodosis including fasciolosis, were added to the list of helminthosis with a great impact on human development.

- Individuals with HIV or other immunocompromised states must be provided protection from contamination of food and water. Routine stool examination should desirably include new entities such as sporocysts of Sarcocystis and Cryptosporidium in the ambit of reportable infectious material. The role of the veterinarian is paramount in coordinating with medical and public health personnel for the common objective of minimising the challenge to health and economy posed by foodborne parasites.
- Climatic changes due to global warming, increased vector population, world tourism, demand for livestock food products, changing socioeconomic conditions, poverty, lack of personnel hygiene, defecating in open space, scarcity of potable water, abundance of stray animals, high population density and culinary habits are responsible for rising zoonoses in India.
- Emergence of diseases like human hydatidosis, neurocysticercosis, cryptosporidiosis, toxoplasmosis in acquired immune deficiency syndrome and reemergence of cutaneous leishmaniasis pose a great threat and challenge for prevention and control of parasitic zoonoses in India.
- Use of molecular epidemiological investigations, spatial analytical tools can help better understand current status of parasitic zoonoses in India.
- Health education, vector control, sanitary movements, controlled slaughtering, higher socioeconomic development and improved risk assessments can help control parasitic zoonoses in the country.
- There is need to have better coordination between medical and veterinary scientists in order to formulate appropriate control strategies.

Conclusion

The development of priorities for a national public health system is a competition and resources to food borne parasitic zoonoses is generally handicapped by lack of good health and economic impact data. It is imperative to have current information regarding prevalence of zoonotic parasites and the risk factors associated with human infections. This will help in more effective implementation of strategic control programme. The increased incidence of established protozoan zoonoses and the growing evidence of emerging parasitisms give cause for concern to various stakeholders in public health. Millions of people suffer worldwide every year and the situation is more critical in developing nations creating social and economic strain. The lack of appropriate slaughtering facilities and techniques plays a major role in meat borne zoonoses. The poverty, unhygienic living condition, lack of education, poor personal hygiene and occupation lead to dissemination of parasitic infection. The role of the veterinarian is paramount in coordinating with medical and public health personnel for the common objective of minimising the challenge to health and economy posed by foodborne parasites.

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