doi: 10.5123/S2176-62232010000100009

Human Toxoplasmosis Outbreak in the Monte Dourado District, Almeirim municipality, Pará, Brazil

Surto de toxoplasmose humana no Distrito de Monte Dourado, Município de Almeirim, Pará, Brasil

Brote de toxoplasmosis humana en la Comarca de Monte Dourado, en el Municipio de Almeirim (Estado de Pará, Brasil)

Ediclei Lima do Carmo
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil

Marinete Marins Póvoa
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil

Nair Salgado Monteiro
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil

Rodrigo Rodrigues Marinho
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil

José Maria Nascimento
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil

Sued Nazaré Freitas
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil

Cléa Nazaré Carneiro Bichara
Instituto Evandro Chagas/SVS/MS, Ananindeua, Pará, Brasil
Universidade do Estado do Pará, Belém, Pará, Brasil

ABSTRACT

OBJECTIVE: To report an outbreak of human toxoplasmosis that occurred in the District of Monte Dourado, Municipality of Almeirim, Pará State, Brazil. MATERIALS AND METHODS: After the positive diagnosis of five patients with symptoms suggestive of toxoplasmosis, clinical research and epidemiology were executed in the locality. A total of 186 individuals were evaluated, including symptomatic patients, their relatives and/or close contacts. All subjects underwent epidemiological inquiry, clinical assessment and serology by enzyme-linked immunosorbent assay (ELISA) for detection of anti-Toxoplasma gondii IgG and IgM. RESULTS: A total of 40 individuals presented a serological profile of acute toxoplasmosis. Epidemiological analysis indicated that the cases could be related to infection with oocysts eliminated by cats, whose population density was very high in the surveyed locality. The most likely hypothesis of transmission would be through direct contact with oocysts of the parasite, either by the ingestion of contaminated food or by the inhalation of these forms in the soil. The possibility of water transmission through the local supply system was discarded because the system is inaccessible to cats. Infected individuals were treated at the local health care units. Moreover, local health authorities were instructed to implement measures to control stray cats in order to prevent new cases or outbreaks. CONCLUSION: The outbreak that occurred between February and March 2004 in Monte Dourado was caused by T. gondii. The hypothesis of contamination via oocysts of the parasite is supported by several factors, such as a high population density of cats in the surveyed District, frequent gardening habits and a lack of reports of ingestion of raw or undercooked meat.

Keywords:: Toxoplasmosis; Seroepidemiologic Studies; Enzyme-Linked Immunosorbent Assay; Health Surveillance.

INTRODUCTION

Toxoplasmosis is an important zoonotic disease that is caused by the coccidian protozoan *Toxoplasma gondii*, a cosmopolitan parasite capable of infecting several species of homeothermic animals, including humans[27,16].

Correspondence / Correspondência / Correspondencia :
Ediclei Lima do Carmo
Seção de Parasitologia, Instituto Evandro Chagas
Rodovia BR 316, km 7, s/nº, Levilândia
CEP: 67030-000 Ananindeua-Pará-Brasil
Tel: 55 (91) 3214-2148
E-mail: edicleicarmo@iec.pa.gov.br

Translated by / Traduzido por / Traducido por:
American Journal Experts

The worldwide seroprevalence of this infection in humans is relatively high, reaching 90% in some regions[27,2,17,25]. Similar to what was observed in other areas, in the Brazilian Amazon, epidemiology studies have demonstrated that toxoplasmosis, in its other forms, is a very frequent infection with seroprevalence above 70%[4,10,5,9].

Humans acquire the infection primarily through the ingestion of infecting forms of *T. gondii*, such as oocysts, which are eliminated in the feces of felids and contaminate foods, water and soil[27,26,14], and through the ingestion of raw or undercooked meat containing the parasite's cystic tissue[27,26,1]. Among other mechanisms, besides the congenital form of exposure, some researchers consider the possibility of inhalation of the oocysts[19,23]. In general,

toxoplasmosis tends to be asymptomatic or manifests itself with symptoms common to other pathologies, with patient developing a clinical diagnosis known as Mononucleosis-*Like* Syndrom[22]. However, in some situations, the infection can become considerably severe, especially in the congenital form or when the infected individual is immunosuppressed, in which case the manifestation of the disease in general compromises the central nervous system, sometimes even causing death[26,3,23]. Numerous human toxoplasmosis outbreaks have been reported in some countries, including Brazil, due to the consumption of meat containing parasite cysts or due to consumption of other food and water contaminated with the *T. gondii*, oocysts, with the emphasis on the outbreak that occurred in Santa Izabel do Ivaí-PR, which is considered the greatest outbreak ever registered in the whole world[13,20,7,6,21,15].

The objective of this study was to describe a human toxoplasmosis outbreak that occurred in the Monte Dourado District, Almeirim municipality-PA, Brazil, due to its uncommon presentation in the northern region of the country, which involved a significant number of cases.

MATERIALS AND METHODS

AREA OF STUDY

The investigated area was the Monte Dourado District, which belongs to the Almeirim municipality and is about 450 km from the capital city, Belém. Monte Dourado is situated in the north of Pará state (0° 53' 22" S, 52° 36' 6" W) and has an estimated population of 12 thousand inhabitants (Figure 1). Jari Celulose S/A, a multinational cellulose-producing company, is located in this district in the Amazonian Region.

OUTBREAK INVESTIGATION

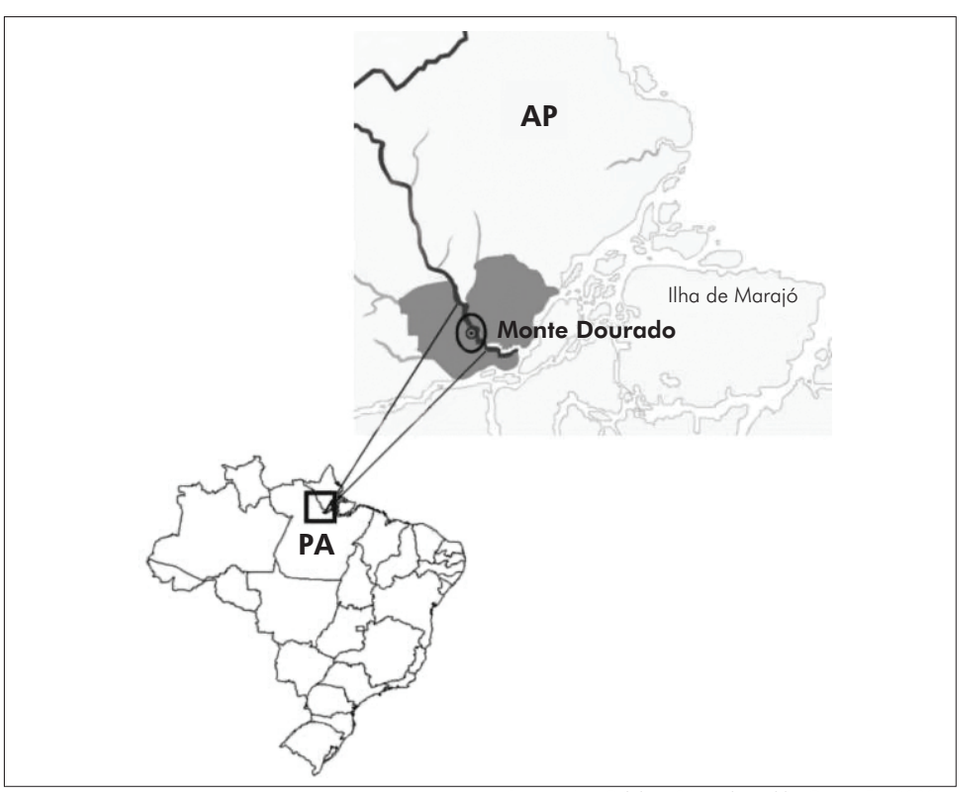
Five company employees, residents of Monte Dourado, presented with the first signs and suggestive symptoms of acute toxoplasmosis between February 20 and March 10, 2004. During clinical evaluation, high and persistent fever (38° C a 40° C) prostration, anorexia, weight loss and lymphadenopathy, especially around the neck, were observed. Patients were sent to a hospital in Belém where laboratory tests for several infectious pathologies were performed, and a diagnosis of acute toxoplasmosis was confirmed.

Due to the observation of similar cases in the same region, the company appealed to the Evandro Chagas Institute (ECI) for instructions on how to proceed. A technical team from ECI, composed of a medical infectologist, an ophthalmologist, a biologist and laboratory technicians, was sent to Monte Dourado to conduct clinical, laboratorial and epidemiological evaluations in the area and to establish the following investigation strategies:

a) Visit the neighborhoods of the district for observation of the soil condition (dry or humid, etc); visit the system of water abstraction, treatment and distribution; and observation of the presence of felines and other stray animals in the urban area of the District;

b) Clinical and epidemiological evaluation of patients, family members and close contacts with completion of individual questionnaires and blood sampling;

c) Educational lectures on toxoplasmosis for health professionals from the municipality, engineers, professors, veterinarians and community leaders of the Jari Company;



Source: Jari Celulose S/A (Adapted by Carmo EL, 2009).

Figure 1 – Localization of Monte Dourado District.

d) Definition of control measures made together with the authorities of the Health and Agriculture Secretaries of Pará state and of the Jari Company.

LABORATORIAL METHODS

Total blood (5 ml) was collected by venous puncture from each investigated person, resulting in two serum aliquots (100 μL/each). The serological test performed was an enzyme immunoassay (ELISA) to detect anti-T. *gondii* antibodies. Indirect ELISA was used for detection of IgG antibodies and immunocapture ELISA for IgM detection. Commercial kits (*Toxoplasma gondii IgG/IgM-In vitro Diagnostica/Human*) were used, and the technical procedural methods were done according to the manufacturer's recommendations.

Furthermore, smear and thick blood drop slides were collected to exclude a diagnosis of malaria, which is severely endemic in the region with signs and symptoms similar to that of acute toxoplasmosis in some cases.

RESULTS

EPIDEMIOLOGICAL ANALYSIS OF THE ARE:

After analysis, it was observed:

a) Innumerable población felina doméstica errante, habitando casas abandonadas, jardines y plazas, favoreciendo la intensa eliminación de ooquistes;

b) The lack of pavement in the streets in the District allowed for higher survival of oocysts in the soil;

c) The distribution of cases in various neighborhoods of the District, not only in punctual agglomerates;

d) The impossibility of feline access to any of the phases of water abstraction and distribution systems destined to the local population;

e) The first cases appeared concurrently with a period of intense rain, which can cause erosion of the soil and suspension of feline feces and consequently, the dispersion of the oocytes to the majority of neighborhoods in the District;

f) There was a greater frequency of cases after this period of rain when the Brazilian carnival holiday was celebrated, which was during a dry spell, and several families decided to garden or clean their backyards;

g) Coincidence between the outbreak and the reported large number of cat births, which generally disperse the majority of the oocysts, favoring the contamination of the environment.

CLINICAL EVALUATION

A total of 186 patients, varying between 1 and 65 years of age (average: 23,3 16,3), were clinically evaluated. Forty-one (22%) presented suggestive clinical symptoms of acute toxoplasmosis (lymphadenopathy, persistent fever, hepatosplenomegaly, exanthema and others); twelve (6.45%), with unspecific symptoms (respiratory symptoms, nausea, migraine, others); and the remaining cases were asymptomatic.

LABORATORIAL EVALUATION

Results from the serological analysis of the 186 persons are presented in table 1. In relation to the *plasmodium* research, all collected slides (thick blood drop and smear) presented negative results.

Table 1 – Results of ELISA tests (IgG, IgM) for toxoplasmosis in 186 persons living in Monte Dourado District, Almeirim-PA, in accordance with the observed symptoms.

Serological Profile	Presenting suggestive symptoms of toxoplasmosis		Presenting unspecific symptomss		Asymptomatic		Total	
	N	%	N	%	N	%	N	%
IgG + / IgM +	34	82,9	5	41,7	1	0,8	40	21,5
IgG + / IgM -	3	7,3	4	33,3	75	56,4	82	44,1
IgG - / IgM -	4	9,8	3	25,0	57	42,8	64	34,4
Total	41	100	12	100	133	100	186	100

DISCUSSION

The serological results demonstrated an elevated frequency in individuals with a profile compatible with acute toxoplasmosis (21.5%, 40/186). Of these individuals, 85% (34/40) presented classic clinical symptoms, 12.5% (5/40) showed unspecific symptoms and 2.5% (1/40) did not present any symptoms. This evidence is in accordance with what has been observed in other outbreaks of toxoplasmosis, in which the majority of persons diagnosed with acute toxoplasmosis presented classic symptoms of the disease[13,20]. Due to the fact that the majority of cases are clinically symptomatic and present high levels of IgG and IgM, there was no doubt that residual IgM characterized the persistence, and thus, the IgG test for avidity was not performed.

The observation of symptomatic individuals with a profile of immunity towards the infection (8.5%; 7/82) can be justified by the possibility that some cases had not yet established the seroconversion; in relation to symptomatic individuals with an immunity profile (reactive IgG and non-

reactive IgM), there is a possibility that these were cases of re-infection because the region belongs to an area of primary forest, and these patients could have come in contact with atypical strains that were, until then, restricted to the wild environment. However, the lack of isolation and molecular analysis of the strains do not allow for confirmation of this hypothesis.

The epidemiologic analysis performed in Monte Dourado demonstrated a different reality than what is observed in other national and international outbreak reports. In these outbreaks, the confirmed form of infection has been directly linked to oral transmission, consumption of oocyte-contaminated water and/or meat and derivatives of different origins containing parasites cystic tissue[13,20,7,6,24]. In Monte Dourado, it was established that the transmission of the infection by *T. gondii* oocytes was related to the association of factors, such as: the high population of felines in all the urban areas of the District and in its surrounding forest; a period of high procreation and birth of cats; erosion of the soil due to abundant rain with probably re-suspension of oocytes that were disseminated by dust in the air due to gardening and/or wind; and contamination of commercialized foods in the area with parasite oocytes. These factors can relate the means of infection by oocytes to the ingestion of contaminated foods, the possible inhalation of oocytes dispersed by the air and even with the direct contact with cats and other mechanical vectors (flies and roaches) present both outdoors and in. These observations can be corroborated by the results from studies done both in Europe and the United States[11,18].

At first, the possibility of infection associated with the ingestion of meat containing parasite cysts was excluded because there were no accounts of raw or undercooked meat ingestion, even though the local inhabitants, especially the natives of other regions of the country, ingest meat of different origins (bovine, swine and ovine) in barbecue form.

In 2002, the largest outbreak of toxoplasmosis in the world was registered in Santa Izabel do Ivaí, municipality of Paraná state, in which 70% of 600 persons who looked for medical assistance presented an acute infection profile. In this outbreak, the transmission occurred through water contaminated by oocysts eliminated in the feces of kittens that inhabited the area around the cistern that holds the water that is distributed to the city[20]. In Monte Dourado, the infection via the local water distribution network was excluded because there was no possibility of direct contact between cats and oocysts during the process. However, it was observed that in some houses, water for consumption was not adequately stored and was exposed to the risk of oocyte contamination.

It was also observed that stray cats were frequently seen in the surrounding local forest and could have been infected in the wild environment with oocytes of virulent atypical strains of *T. gondii*, disseminated by wild felids, and upon returning to the urban areas, they contaminated the environment with the atypical strains of oocytes. This possibility can justify the occurrence of the severe cases of toxoplasmosis and possibly even the cases of re-infection. The severe form of toxoplasmosis in humans, which is associated with atypical virulent strains, has been previously reported in forest areas, on the border of Suriname with French Guiana, including accounts of death[8,12]. This occurrence is also possible in Monte Dourado, especially due to the geographic proximity and similarity between the forests of the Almeirim municipality and of Suriname and French Guiana, which favor the circulation of these strains in both areas.

Through the dispersion of cases throughout the District, it was not possible to perform a case-controlled study to determine the common risk factors associated with the transmission of toxoplasmosis in the outbreak region.

After the etiology clarification, lectures and technical meetings were established between the public and private institutions involved in the investigation to implement of measures aimed at avoiding the upsurge of new cases or even other outbreaks of the disease, such as stray animal control and preventive orientations for the habitants and workers of the District.

Future studies still need to be performed to isolate and genotype the strains found in the area. In addition, it will be necessary to re-evaluate the individuals who were sick or susceptible (seronegative) during the outbreak so that possible ocular sequelae or seroconversion can be detected.

CONCLUSION

The observed laboratorial, clinical and epidemiological evidence indicates that the protozoan *T. gondii* was the pathogen responsible for the outbreak in the Monte Dourado District between February and March of 2004. The transmission of the infection possibly occurred through the ingestion of food containing the parasite's oocyte, direct contact with dirty hands after gardening activities or even the inhalation of oocytes suspended and dispersed through dust in the air.

ACKNOWLEDGEMENTS

We thank Jari Celulose S/A for their logistic support during the outbreak investigation.

Surto de toxoplasmose humana no Distrito de Monte Dourado, Município de Almeirim, Pará, Brasil

RESUMO

OBJETIVO: Relatar um surto de toxoplasmose humana ocorrido no Distrito de Monte Dourado, Município de Almeirim, Pará, Brasil. MATERIAIS E MÉTODOS: Após diagnóstico confirmatório de cinco pacientes-índices com sintomas sugestivos de toxoplasmose aguda, teve início uma investigação clínica e soroepidemiológica de toxoplasmose na localidade de procedência dos pacientes. Foram avaliados 186 indivíduos, incluindo pacientes sintomáticos, seus familiares e/ou contatos próximos. Todos, espontaneamente, submeteram-se a inquérito epidemiológico, avaliação clínica e sorologia pelo ensaio imunoenzimático (ELISA) para detecção de anticorpos IgG e IgM anti-Toxoplasma gondii. RESULTADOS: Quarenta indivíduos (21,5%) apresentaram perfil sorológico de toxoplasmose aguda, considerando-se IgM e IgG reagentes em elevados títulos. A análise epidemiológica indicou que os casos poderiam estar vinculados à infecção com oocistos eliminados pelos gatos, cuja população era elevada. A hipótese provável de transmissão seria pelo contato direto com oocistos do parasito, na ingestão de alimentos contaminados, ou, possivelmente, até por inalação dessas formas presentes no solo. A possibilidade de transmissão hídrica por meio do sistema de distribuição de água local foi descartada, já que o sistema é inacessível aos gatos. Os indivíduos doentes foram tratados nos serviços de saúde do Município. As autoridades sanitárias locais foram orientadas para implementar medidas de controle de gatos errantes, visando prevenir novos casos ou surtos. CONCLUSÃO: O surto ocorrido entre fevereiro e março de 2004, em Monte Dourado-PA, foi causado pelo T. gondii. Admite-se que houve uma somatória de fatores que mantêm a hipótese sustentada da contaminação via oocistos, tais como: elevada população de gatos no Distrito; procedimentos frequentes de jardinagem; e ausência de relatos de ingestão de carne crua ou mal cozida.

Palavras-chave: Toxoplasmose; Estudos Soroepidemiológicos; ELISA; Vigilância Sanitária.

Brote de toxoplasmosis humana en la Comarca de Monte Dourado, en el Municipio de Almeirim (Estado de Pará, Brasil)

RESUMEN

OBJETIVO: Relatar un brote de toxoplasmosis humana ocurrido en la Comarca de Monte Dourado, Municipio de Almeirim (Estado de Pará, Brasil). MATERIAL Y MÉTODOS: Tras confirmar el diagnóstico en cinco pacientes índices con síntomas sugestivos de la toxoplasmosis, se llevó a cabo en esa localidad un estudio clínico y seroepidemiológico. Se evaluaron 186 personas, incluidos los pacientes sintomáticos, sus familiares y/o contactos cercanos. Todos fueron sometidos a la investigación epidemiológica, la evaluación clínica y la serología por ensayo inmunoenzimático (ELISA) para la detección de IgG e IgM contra *Toxoplasma gondii*. RESULTADOS: Cuarenta individuos presentaban perfil serológico de la toxoplasmosis aguda. Los análisis epidemiológicos indican que los casos podrían estar vinculados a la infección con ooquistes eliminados por los gatos, cuya población en la ciudad era muy elevada. Una hipótesis probable de transmisión sería el contacto directo con los ooquistes del parásito, ya sea por la ingestión de alimentos contaminados o por inhalación de estas formas presentes en el suelo. La posibilidad de transmisión hídrica a través del sistema de distribución de agua local se descartó, ya que el sistema es inaccesible para los gatos. Los individuos enfermos fueron tratados en los servicios de salud del Municipio. Además, las autoridades sanitarias locales se encargaron de aplicar medidas de control de gatos callejeros, para prevenir nuevos casos o brotes. CONCLUSIÓN: El brote que se produjo entre febrero y marzo de 2004 en Monte Dourado fue causado por *T. gondii*. La posibilidad de contaminación a través de los ooquistes del parásito se ve apoyada por factores tales como: la alta población de gatos en la Comarca, los procedimientos habituales de jardinería y la ausencia de informes de ingestión de carne cruda o poco cocida.

Palabras clave: Toxoplasmosis; Estudios Seroepidemiológicos; Prueba ELISA; Vigilancia Sanitaria.

REFERENCES

1 Aspinall TV, Marlee D, Hyde JE, Syms PE. Prevalence of *Toxoplasma gondii* in commercial meat products as monitored by polymerase chains reaction - food for thought? Int J Parasitol. 2002 Aug;32(9):1193-9.

2 Beaman M, McCabe RE, Wong SY, Remington JS. *Toxoplasma gondii*. In: Mandell GL, Douglas RG, Bennet JE, editors. Enfermidades Infecciosas-Principios y Práctica. Buenos Aires: Editorial Medica Panamericana; 1997. p. 2754-70.

3 Bhopale GM. Pathogenesis of toxoplasmosis. Comp Immunol Microbiol Infect Dis. 2003 Jul;26(4):213-22.

4 Bichara CNC. Perfil epidemiológico da toxoplasmose humana na área metropolitana de Belém-Pará: a experiência no Serviço de Parasitologia do Instituto Evandro Chagas [dissertação]. Belém: Universidade Federal do Pará, Centro de Ciências Biológicas; 2001.

5 Bóia MN, Carvalho-Costa FA, Sodré FC, Pinto GMT, Amendoeira MRR. Seroprevalence of *Toxoplasma gondii* infection among indian people living in Iauareté, São Gabriel da Cachoeira, Amazonas, Brazil. Rev Inst Med Trop Sao Paulo. 2008 Jan-Feb;50(1):17-20.

6 Bonametti AM, Passos JN, Silva EMK, Bortoliero AL. Surto de toxoplasmose aguda transmitida através da ingestão de carne crua de gado ovino. Rev Soc Bras Med Trop. 1997 jan-fev;30(1):21-5.

7 Bowie WR, King AS, Werker DH, Isaac-Renton JL, Bell A, Eng SB, et al. Outbreak of toxoplasmosis associated with municipal drinking water. Lancet. 1997 Jul; 350(9072):173-7.

8 Carme B, Demar-Pierre M. Toxoplasmosis in French Guiana. Atypical (neo-) tropical features of a cosmopolitan parasitosis. Med Trop (Mars). 2006 Oct;66(5):495-503.

9 Carmo EL, Silva MCM, Xavier UAM, Costa BO, Póvoa MM. Inquérito sorológico de toxoplasmose em candidatos a transplante renal no Hospital Ofir Loyola, Belém, Pará, Brasil. Rev Panam Infectol. 2004;6(4):15-7.

10 Cavalcante GT, Aguiar DM, Camargo LMA, Labruna MB, Andrade HF, Meireles LR, et al. Seroprevalence of *Toxoplasma gondii* antibodies in humans from rural Western Amazon, Brazil. J Parasitol. 2006 Jun;92(3):647-9.

11 Cook AJC, Gilbert RE, Buffolano W, Zufferey J, Petersen E, Jenun PA, et al. Sources of toxoplasma infection in pregnant women: European multicentre case-control study. BMJ. 2000 Jul;321(7254):142-7.

12 Demar M, Ajzenberg D, Maubon D, Djossou F, Panchoe D, Punwasi W, et al. Fatal outbreak of human toxoplasmosis along the Maroni River: epidemiological, clinical, and parasitological aspects. Clin Infect Dis. 2007 Oct;45(7):88-95.

13 Dias RA, Freire RL. Surtos de toxoplasmose em seres humanos e animais. Semina Cienc Biol Saude. 2005 out-dez;26(2):239-48.

14 Dubey JP. Toxoplasmosis – a waterborne zoonosis. Vet Parasitol. 2004 Dec;126(1-2):57-72.

15 Franco RMB. Protozoários de veiculação hídrica: relevância em saúde pública. Rev Panam Infectol. 2007;9(1):36-43.

16 Frenkel JK. Toxoplasmosis in Humans Beings. J Am Vet Med Assoc. 1990 Jan;196(2):240-8.

17 Jenum PA, Kapperud G, Stray-Pedersen B, Melby KK, Eskild A, Eng J. Prevalence of *Toxoplasma gondii* specific immunoglobulin G antibodies among pregnant women in Norway. Epidemiol Infect. 1998 Feb;120(1):87-92

.18 Jones JL, Kruszon-Moran D, Wilson M, McQuillan G, Navin T, McAuley JB. *Toxoplasma gondii* infection in the United States: seroprevalence and risk factors. Am J Epidemiol. 2001;154(4):357-65.

19 Kolbekova P, Kourbatova E, Novotna M, Kodym P, Flegr J. New and old risk-factors for *Toxoplasma gondii* infection: prospective cross-sectional study among military personnel in the Czech Republic. Clin Microbiol Infect. 2007 Oct;13(10):1012-7.

20 Ministério da Saúde (BR). Fundação Nacional de Saúde. Surto de Toxoplasmose no município de Santa Isabel do Ivaí-Paraná. Bol Eletro Epidemiol. 2002;2(3):2-9.

21 Ministério da Saúde (BR). Secretaria de Vigilância em Saúde. Surto intra familiar de toxoplasmose, Santa Vitória do Palmar-RS, julho de 2005. Bol Eletro Epidemiol. 2006 out; 6(3):2-7.

22 Neves ES, Bicudo LN, Curi AL, Carregal E, Bueno WF, Ferreira RG, et al. Acute acquired toxoplasmosis: clinical-laboratorial aspects and ophthalmologic evaluation in a cohort of immunocompetent patients. Mem Inst Oswaldo Cruz. 2009 Mar;104(2):393-6.

23 Remington RM, Desmonts G. Toxoplasmosis. In: Remington JS, Klein JO, editors. Infectious diseases of the fetus and newborn infant. Philadelphia: Sanders; 1997. p. 140-267.

24 Robson JMB, Wood RN, Sullivan JJ, Nicolaides NJ, Lewis BR. A probable foodborne outbreak of toxoplasmosis. Commun Dis Intell. 1995;19:517-22.

25 Sobral CAQ, Amendoeira MRR, Teva A, Patel BN, Klein CH. Seroprevalence of infection with *Toxoplasma gondii* in indigenous brazilian populations. Am J Trop Med Hyg. 2005 Jan;72(1):37-41.

26 Sukthana Y. Toxoplasmosis: beyond animals to humans. Trends Parasitol. 2006 Jun;22 (3):137-42.

27 Tenter AM, Heckeroth AR, Weiss LM. *Toxoplasma gondii*: from animals to humans. Int J Parasitol. 2000 Nov;30(12-13):1217-58.

Recebido en / Recibido em / Received: 17/7/2009
Aceito en / Aceito en / Accepted: 21/9/2009