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Toxoplasmosis outbreak in Brazil, 2006 - Revisited

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ABSTRACT

Waterborne outbreaks of human toxoplasmosis can have great magnitude due to the number of persons infected while smaller-scale outbreaks are also possible. This is a study based on a historical database investigating a toxoplasmosis outbreak occurred in 2006 in a residential community in São Luís, in the Brazilian state of Maranhão. Ninety of the 110 residents, employees and domestic helping persons had blood samples collected and tested. The diagnosis of toxoplasmosis was established by quantification of anti-*Toxoplasma gondii* immunoglobulin M and immunoglobulin G antibodies using enzyme immunoassay. The subjects were classified as past infection, acute/recent infection or seronegatives. The definition of acute infection was based on the presence of indicative symptoms and immunoglobulin M positivity. There were 33 cases of acute infection. The outbreak was concluded to be waterborne: consumption of faucet-mount filtered water was indicated as risk factor. We discuss the challenges of investigating waterborne toxoplasmosis outbreaks.

1. Introduction

Toxoplasma gondii is a zoonotic protozoan parasite of global importance. Several outbreaks of toxoplasmosis among animals and humans have occurred in various parts of the world and in Brazil, often associated with the culture and eating habits of each locality (Lopes and Berto, 2012; Tenter et al., 2000). However, often there is insufficient description of these outbreaks because toxoplasmosis is a disease that occurs in small groups, or yet due to the low pathogenicity of the infecting strain or dose and the host's own immune response, situations that add difficulty to registering cases (Almeida et al., 2011). The ingestion of tissue cysts present in meat products derived mainly from pigs, sheep or goats has been highlighted in several outbreaks as an important route of transmission of toxoplasmosis (Tenter et al., 2000). Moreover, water can be a transmission route for toxoplas-

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mosis because it can be a vehicle for dissemination of oocysts. In terms of the number of infected individuals, three waterborne outbreaks of human toxoplasmosis are considered of major global importance. The first one of these outbreaks occurred in 1995 in the province of *Greater Victoria*, in Canada, with 100 infected persons (Bowie et al., 1997). The second one took place in 2001, when the contamination of water reservoirs by oocysts via the feces of infected felines resulted in 176 cases in the city of Santa Isabel do Ivaí, in the state of Paraná, Brazil (Daufenbach et al., 2002; Moura et al., 2006). A third major outbreak started in April 2018 in the city of Santa Maria, in the Brazilian state of Rio Grande do Sul, with 809 confirmed cases and another 401 still under investigation mid-October 2018 (Sul and da Saúde, 2018).

The present study revisits a probable waterborne outbreak of human toxoplasmosis that occurred in a gated residential community. The only fact connecting the individuals diagnosed with acute toxoplasmosis was that they all resided in the same community. They denied having taken part in any recent event held in the community that included ingesting food or drinks.

2. Methods

This is a study based on a historical database on the investigation of an acute toxoplasmosis outbreak that occurred in 2006 in a residential community located in the metropolitan area of São Luís (capital city of the Brazilian state of Maranhão), conducted by the Superintendence of Epidemiological and Sanitary Surveillance of the Municipal Health Secretariat of São Luís (SVES/SEMUS/SL).

The community is comprised of 40 houses, 126 residents and domestic helping persons and four employees, totaling 130 people. Six of the houses had no residents during the investigation of the outbreak.

In June of 2006, an infectious disease specialist informed the SVES/SEMUS/SL of the occurrence of five cases of acute toxoplasmosis in that community and an investigation was conducted between June 2006 and August 2006 by a team of technicians with the Zoonosis Control Center and SVES/SEMUS/SL, who performed a sanitary inspection in the community and collected 14 samples of gardening soil, five samples of cat feces and eight water samples from water reservoirs (artesian wells and the water tanks serving the community and the houses) for direct testing for *T. gondii*. For indirect immunofluorescence test for antibodies against *T. gondii* (details of the method not reported), five serum samples were collected from cats belonging to residents inside the community.

The water sources consisted of both a well located inside the community and water supplied to the community by the public water provider – the Water & Sewerage Company of Maranhão (CAEMA), which supplies the community on an intermittent basis. The devices used to treat well water were faucet-mount filters and common ceramic filters, both simple and inexpensive. Faucet-mount filters contain a single filter element and filtration occurs when the tap is opened. Ceramic filters may contain two filters elements and water is filtered by gravity.

The SVES/SEMUS/SL multidisciplinary team interviewed 110 of the 130 individuals. Twenty people were not located during the investigation. The team recorded the symptoms, determined the incidence of acute toxoplasmosis and investigated probable sources of infection, using a questionnaire for personal data, epidemiological information and clinical history. Among the 110 individuals interviewed, 90 agreed to have their blood tested for immunoglobulin M (IgM) and immunoglobulin G (IgG) antibodies against *T. gondii*.

The serological diagnosis of toxoplasmosis was established by quantifying IgM and IgG antibodies by enzyme immunoassay at the Central Public Health Reference Laboratory (details of the methods not reported). Avidity of IgG antibodies was not tested. The subjects were classified as past infection, acute/recent infection or seronegatives. The definition of acute toxoplasmosis (case) was based on the presence of symptoms and IgM positivity.

The categorical variables were presented in absolute frequencies and in proportions. Case (yes or no), sex (male or female), situation (resident, domestic helping person or employee), result of the test for IgM and IgG, pregnancy (yes or no), consumption of bottled mineral water (yes or no), and consumption of home-filtered water: faucet-mount filter (yes or no) or common ceramic filter (yes or no).

The data were submitted to the open source statistical analysis program applied to epidemiology EPI INFO version 7.1.2.0, and the statistical analysis employed software STATA version 10.0. The risk factors were evaluated in 2×2 tables comparing them in cases vs. seronegatives.

Considering the ethical principles for conducting research involving humans provided under Resolution No. 466/2012 by the National Health Council (CNS), the study was approved by the Research Ethics Committee of the Presidente Dutra University Hospital in the Federal University of Maranhão (UFMA) and was registered on the Brazil Platform (CAAE: 49732315.5.0000.5086).

3. Results

The outbreak of acute toxoplasmosis involved 33 cases (Table 1). The investigation found no *T. gondii* in any of the environmental samples (soil, cat feces, reservoir water) or antibodies against the parasite in the blood samples collected from cats belonging to residents of the community. Although residents reported the presence of a cat in the vicinity of the community's water tank, it was not possible to collect the samples from it. The highest frequency of cases per locality occurred in one household, with six cases among nine residents (66.6%).

The distribution by number of cases starting as of the date of symptom onset (May 5) showed that the outbreak reached a peak on May 25 (20 days after identification of the first case) and ended on August 15, 2006. The most common symptoms included headache, fever and lymphadenopathy.

Table 1
Distribution of participants with regard to clinical conditions, social-demographic aspects and immunoglobulin M (IgM) and immunoglobulin G (IgG) antibodies against *Toxoplasma gondii*. Outbreak of toxoplasmosis. São Luís, Maranhão, Brazil, 2006.

Variable	n	%
Clinical condition (n = 110)		
Cases of acute toxoplasmosis	33	30.00
Chronic infection, seronegative, or not tested	77	70.00
Sex (n = 110)		
Male	46	41.82
Female	64	58.18
Housing situation (n = 110)		
Resident	85	77.27
Domestic helping person	21	19.09
Employee	4	3.64
Anti-*T. gondii* antibodies (n = 90 persons tested)		
IgM positive and IgG positive	30	33.33
IgM positive and IgG negative	3	3.33
IgM negative and IgG positive (past infection)	37	41.11
Seronegative	20	22.22

Of the 90 subjects tested with serology, the results of 37 indicated past infection, 33 acute/recent infection, and 20 were seronegative (Table 1). Of the cases, 20 were female, including one who was pregnant (Table 2). The consumption of home-filtered water by faucet-mount filter was identified as a risk factor. All cases reported using faucet-mount filter (Table 3).

Table 2
Comparison of cases and seronegatives according to demographic characteristics and pregnancy. Outbreak of toxoplasmosis. São Luís, Maranhão, Brazil, 2006.

Variable	Cases (n = 33)	Seronegatives (n = 20)
Age (years)		
Minimum	1	0
Maximum	57	54
Mean ± SD	27.81 ± 14.24	20.85 ± 14.48
Median	29	22
	n (%)	n (%)
Housing situation		
Resident	27 (81.82)	17 (85.00)
Domestic helping person	5 (15.15)	3 (15.00)
Employee	1 (3.03)	0 (0.00)
Sex		
Male	13 (39.39)	9 (45.00)
Female	20 (60.61)	11 (55.00)
Pregnancy (n = 15 females aged 14–49 years)		
Yes	1 (6.67)	0 (0.00)
No	14 (93.33)	8 (100.00)

Table 3
Comparison of the cases with the seronegatives, according to the consumption of bottled mineral water or home-filtered water. Outbreak of toxoplasmosis. São Luís, Maranhão, Brazil, 2006.

Variable	Cases (n = 33)	Seronegatives (n = 20)	p-Value[a]
	n (%)	n (%)	
Bottled mineral water			0.535
Yes	9 (27.27)	6 (30.00)	
No	24 (72.73)	14 (70.00)	
Common ceramic filter			0.377
Yes	0 (0.00)	1 (5.00)	
No	33 (100.00)	19 (95.00)	
Faucet-mount filter			0.049
Yes	33 (100.00)	17 (85.00)	
No	0 (0.00)	3 (15.00)	

[a] Fisher's exact test.

4. Discussion

In the investigation of this outbreak, using faucet-mount filter was the key risk factor identified. In this type of filter, water filtration occurs when the tap is opened, and the water pressure may push particles that have been stopped by the filter into the drinking water. It would have been interesting to investigate these filters. Well water as source of tap water has been identified as risk factor for seropositivity also in the USA (Krueger et al., 2014).

Considering that in this outbreak the cases did not participate in any group event in which they could have been exposed to the same food, the water reservoir serving the community was concluded to be the source, particularly because all 33 cases of acute toxoplasmosis reported consuming water from faucet-mount filters. Conversely, it was not possible to verify the presence of infective parasite forms in the water largely due to operating difficulties. When SVES/SEMUS/SL became aware of the outbreak, 30 people had already developed symptoms of the disease. For example, no water was collected from the water tanks of the houses that were closed and uninhabited prior to and during the outbreak, which could still contain contaminated water.

In this outbreak, there were 33 cases. In the outbreak of toxoplasmosis occurred in a Surinamese village in 2004, 11 people became ill among total of 33 residents studied (33%) (Demar et al., 2007). In the outbreak of toxoplasmosis in the Monte Dourado District of the municipality of Almeirim - PA in 2004, of the 186 people tested, 40 (21.5%) presented a serological pattern of acute/recent infection (Carmo et al., 2010). These kinds of smaller-scale outbreaks would merit more attention.

In this outbreak, most of the cases were female. In the investigation of a 2006 outbreak of toxoplasmosis associated with the consumption of raw meat in the cities of Guarujá and São Paulo, 67% of cases were female (Eduardo et al., 2007). Conversely, in the intrafamilial outbreak in Santa Vitória do Palmar - RS, 60% of cases were male (Almeida et al., 2006).

In this outbreak one of the cases was a pregnant woman. Based on literature, it can be expected that acute infections may occur more frequently in young individuals, and young pregnant women may merit particular attention in outbreak investigations (Avelino et al., 2003).

The date of symptom onset of the first case was May 5, 2006, and the last day was August 15 of that year. It was not possible to determine the incubation period because there was no specific date of exposure to *T. gondii*, since it was likely a waterborne outbreak. However, it is assumed that the exposure occurred in April, considering what is known about the incubation period (Ministério da Saúde, 2010).

The most frequent symptoms the cases reported were headache, fever and lymphadenopathy. Headaches and fever are non-specific signs and symptoms and therefore are of limited use to rule out other pathogens. The frequency of reports of lymphadenopathy in this outbreak has been highlighted because this is the most common clinical manifestation during the acute phase of acquired toxoplasmosis, and usually occurs in the cervical region (McCabe et al., 1987).

A limitation of this study is the lack of information about the serological methods (cut-offs, sensitivity, specificity). Avidity of IgG antibodies was not tested; it would be part of the typical serology to perform to evaluate whether the infection is recent. A strong point of this study is the finding that consumption of water filtered by faucet-mount filters was identified as a risk factor. It would have been interesting to investigate those filters, as well as water samples from the houses that were not inhabited. The serology method used could not distinguish between infections from oocysts vs. tissue cysts, nor provide information on whether the type of the infecting parasite was the same for all the cases. Perhaps with more awareness and improved methods available, the number of smaller-scale waterborne outbreaks of toxoplasmosis in humans will increase; currently, they may be underdetected, and there are challenges in investigating them.

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Declaration of competing interest

The authors declare that there is no conflict of interest.

Author contributions

GNRS, **RCSQ**, **JAJ**: contributed to data interpretation, conception of the article and writing. **MRFCB**: contributed to the research and the conception of the article; took part in the investigation of the outbreak; contributed to data interpretation; conducted all stages of the research until the final draft of the article. **ZMRR**, **AMS**, **PRMP**: contributed to data interpretation and writing of the article. **MSS**, **ATSN**, **MNLM**: contributed to the investigation of the outbreak and writing of the article. **ARGJ**, **CMPSA**: contributed to the writing of the article. All authors approved the final version of the manuscript.

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