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ORIGINAL ARTICLE

Seroprevalence of *Bartonella henselae* in patients awaiting heart transplant in Southern Italy

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KEYWORDS
awaiting heart transplant;
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Background: *Bartonella henselae* is the etiologic agent of cat-scratch disease. *B. henselae* infections are responsible for a widening spectrum of human diseases, although often symptomless, ranging from self-limited to life-threatening and show different courses and organ involvement due to the balance between host and pathogen. The role of the host immune response to *B. henselae* is critical in preventing progression to systemic disease. Indeed in immunocompromised patients, such as solid organ transplant patients, *B. henselae* results in severe disseminated disease and pathologic vasoproliferation. The purpose of this study was to determine the seroprevalence of *B. henselae* in patients awaiting heart transplant compared to healthy individuals enrolled in the Regional Reference Laboratory of Transplant Immunology of Second University of Naples.
Methods: Serum samples of 38 patients awaiting heart transplant in comparison to 50 healthy donors were examined using immunfluorescence assay.
Results: We found a *B. henselae* significant antibody positivity rate of 21% in patients awaiting heart transplant ($p = 0.002$). There was a positive rate of 8% ($p > 0.05$) for immunoglobulin (Ig) M and a significant value of 13% ($p = 0.02$) for IgG, whereas controls were negative both for IgM and IgG antibodies against *B. henselae*. The differences in comorbidity between cases and controls were statistically different (1.41 ± 0.96 vs 0.42 ± 0.32; $p = 0.001$).
Conclusions: Although this study was conducted in a small number of patients, we suggest that the identification of these bacteria should be included as a routine screening analysis in pre-transplant patients.

Introduction

Bartonella spp. are intracellular Gram-negative bacteria. *Bartonella henselae* has the ability to invade human erythrocytes[1–3] and other cells, such as hematopoietic stem cells (HSCs) proposed as putative niches of *Bartonella* spp.[4] It is known that *B. henselae* is able to adhere to and also invade endothelial progenitor cells (EPCs).[5] During *B. henselae* infection, the invasion of bacteria subverts many functions of human host cells[6]; indeed, it directly induces endothelial proliferation by inhibiting the host cell apoptosis, thus allowing its permanence into the cell host habitat.[7,8]

The pathological response to *B. henselae* infection depends on the host immune status.[9] The immune response has a reduced ability to control the infection resulting in a longer duration of bacteremia.[10] These bacteria are rapidly becoming prominent as emerging pathogens causing both acute or chronic infections and vascular proliferative or suppurative manifestations.[11] *B. henselae* infections may cause a variety of human diseases, often symptomless, that show different evolution and organ involvement due to the balance between host and pathogenic factors.[12] Indeed, in immunocompetents, these bacteria often cause self-limiting infections usually with fever and regional lymphadenopathy, known as cat-scratch disease, which can resolve spontaneously without treatment.[13] However, in immunocompromized patients *B. henselae* results in severe disseminated diseases and pathologic vasoproliferation known as bacillary angiomatosis and bacillary peliosis that most commonly involve skin or lymphonodes and liver or spleen, respectively.[11] In addition, *B. henselae* infection can result in endocarditis due to endovascular bacteria replication.[14] Because their evolutionary ability is to induce persistent intravascular infections, *B. henselae* is an unexpectedly major cause of blood culture-negative endocarditis, especially in patients with preexisting valve heart disease.[15,16]

Epidemiological human studies have increased in the past decade with a high degree of variation of antibody prevalence of *B. henselae* in the world.[12,17] However, *B. henselae* has been reported in several geographic areas of Europe.[18,19] In Italy, *B. henselae* infection is probably underdiagnosed due to the high frequency of atypical onset of clinical manifestations as reported by several studies.[20–23] The seropositivity of *B. henselae* in the stray cat populations in Northern Italy is approximately 40%, and 12.2% shows both bacteremia detection and seropositivity.[24] Until now, there are no data on *Bartonella* prevalence in our region, in either human or cat populations.[25]

The direct identification of *Bartonella* is difficult due to its slow growing characteristic and, therefore, is usually delayed.[15] Unlike molecular and histological methods that require a tissue sample, serological assays utilize only a small blood sample for a reliable diagnosis.[26] Therefore, diagnosis of *B. henselae* is mainly based on serological methods [immunoglobulin (Ig)M, IgG detection] for their ease and speed.

Diagnosis and management of *B. henselae* infection in solid organ transplant recipients has not been well characterized yet. Among solid organ transplant patients, *B. henselae* infection is uncommon with different clinical manifestations including disseminated diseases.[27] Recently, several reports describe cases of bartonellosis in transplant recipients.[28,29] To date, there are no available results about *B. henselae* seroprevalence in patients awaiting transplant who will undergo severe immunosuppressive therapy.

This study investigated the seroprevalence of *B. henselae* in patients awaiting heart transplant in comparison to

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healthy controls, who were enrolled in the Regional Reference Laboratory of Transplant Immunology of Second University of Naples, Italy.

Patients and methods

In 2013, we collected serum samples from 38 patients awaiting heart transplant and from 50 volunteers (control group), enrolled at the Laboratory of Transplant Immunology of Second University of Naples. Following blood collection, serum was separated by centrifugation and stored at -20°C. The patients selected and enrolled on the waiting list for heart transplantation have severe symptoms of heart failure, angina, or intractable rhythm disturbances, and they are in severe clinical condition (ejection fraction $<$ 30% and maximal oxygen consumption $<$ 8 mL/kg/min) with no alternative form of treatment available.[30] Once a patient with severe congestive heart failure has been identified as having a limited life expectancy and severely impaired quality of life, cardiac transplantation should be considered.[30] These patients in the pretransplant period were not subjected to any immunosuppressive drug therapy and had no previous infectious diseases.

Exclusion criteria for the control group were any clinical history of lymphadenopathy and/or fever in the last 6 months. Patients and controls were normalized for cat exposure. None of the individuals included in this study presented clinical symptoms. Written informed consent was obtained from patients and volunteers according to the Declaration of Helsinki.

Serological testing

A commercially available *Bartonella* indirect immunofluorescent assay (IFA; Focus Diagnostics, Cypress, CA, USA) was used to assess the qualitative detection and semi-quantitation of human serum IgM and IgG antibodies to *B. henselae* and *Bartonella quintana* according to the manufacturer's instructions. In the first stage, suitable dilutions of patient sera were added to appropriate slide wells in contact with the substrate for IgM and IgG, respectively. In the second stage, fluorescein-labeled antibody to IgM or IgG, was added, respectively. After the slide was washed, dried, and mounted, it was examined by fluorescence microscopy (Zeiss, Wetzlar, Germany) at magnifications of 40$\times$ and 100$\times$. Each kit included positive and negative controls. Positive reactions appeared as bright apple-green fluorescent bacteria. According to the recommendations of the manufacturer, titers from 1:20 for IgM and 1:64 for IgG were considered positive.

Data analysis

Quantitative data were expressed as numbers and percentages. Categorical variables were analyzed using the Chi-square test and continuous variables using one-way analysis of variance (ANOVA). A p value $<$ 0.05 was considered significant.

Results

Serum samples of 38 patients awaiting heart transplant and 50 healthy donors were examined using IFA. In our study, a *B. henselae* antibody significant positivity rate of 21% (n = 8) was found in patients awaiting heart transplant (p = 0.002; Table 1). Seroprevalence of *Bartonella* was not significantly associated with age, sex, ischemic and non-ischemic dilated cardiomyopathy, and other clinical parameters (p $>$ 0.05, data not shown), whereas, the differences in comorbidity between cases and controls were statistically different (1.41 $\pm$ 0.96 vs. 0.42 $\pm$ 0.32; p = 0.001). Moreover, the age of patients on the waiting list for heart transplant was higher than the control group (52.1 $\pm$ 17.0 vs. 38.8; p = 0.001). The prevalence of comorbidities evaluated (dilated cardiomyopathy, valve disease, renal failure, diabetes, and hypertension) and the differences between cases and controls are reported in Table 1.

In Table 2, we report in detail the *B. henselae* seropositivity of patients awaiting heart transplant (n = 8) that resulted positive to IgM or IgG antibodies. The highest antibody dilution with a positive reaction was indicated. We found a positive rate of 8% (n = 3) with p $>$ 0.05 for IgM, whereas a significant value was found for IgG with 13% (n = 5) of positivity (p = 0.02). In Table 2, demographic and clinical characteristics of patients are also reported. All controls resulted negative for both IgM and IgG antibodies and they have shown only a low percentage of hypertension and mitral prolapsed. Fig. 1 shows the representative IFA images of one patient who tested positively to *B. henselae* IgG (A), and a negative control of *B. henselae* IgG (B). No individuals included in this study showed positive reactions

Table 1 Seroprevalence of *Bartonella henselae* in patients with advanced heart failure awaiting heart transplant and in controls

Variables	Advanced heart failure (n = 38)	Controls (n = 50)	p
Age (y)	52.1 $\pm$ 17.0	38.0 $\pm$ 8.0	0.001
Comorbidity	1.41 $\pm$ 0.96	0.42 $\pm$ 0.32	0.001
Bartonella antibody (%)	21	0	0.002
Valve disease (%)	16.2	2.0	0.016
Previous myocardial infarction (%)	37.8	0	0.001
Diabetes (%)	18.9	0	0.001
Hypertension (%)	24.3	8	0.005
Renal failure (%)	47.1	0	0.000

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Table 2 Seropositivity of *Bartonella henselae* immunoglobulin (Ig)M and IgG antibodies in patients living in Campania Region awaiting heart transplant

Sex (M/F)	Age (y)	IgM anti-*B. henselae*	IgG anti-*B. henselae* [a]	Heart disease	Valve implantation	Diabetes	Hypercholesterolemia	Hypertension	Transfusion
F	8	//	1:128	Nonischemic DCM	Yes	No	No	No	Yes
M	64	1:20	//	Ischemic DCM	No	Yes	Yes	Yes	No
M	50	//	1:128	Ischemic DCM	No	No	Yes	Yes	No
M	67	//	1:64	Ischemic DCM	No	No	Yes	No	Yes
M	55	//	1:64	Nonischemic DCM	Yes	No	No	No	No
F	56	1:20[b]	//	Nonischemic DCM	No	No	No	No	No
M	33	1:20	//	Ischemic DCM	No	No	Yes	No	Yes
M	66	//	1:64	Ischemic DCM	No	No	Yes	Yes	No

[a] The positivity rate of IgG anti-*Bartonella* is statistically significant with $p < 0.05$ ($p = 0.02$).
[b] Different sampling times have revealed seroconversion in live patients of IgM in IgG with 1:64 titer.
DCM = dilated cardiomyopathy; F = female; M = male.

to *B. quintana* antibody. All patients found to be positive for IgG and IgM antibodies were monitored at least twice at different sampling times, confirming the result or the seroconversion in live patients of IgM in IgG with 1:64 titer.

Discussion

In the present study, we report *Bartonella* serological status of a small group of patients awaiting heart transplant. We established that the overall prevalence of *B. henselae* seropositivity was of 21% ($n = 8$) in patients awaiting heart transplant ($p = 0.002$). In particular, we found that 8% of patients were positive for IgM ($p = 0.14$) and 13% were positive for IgG antibodies ($p = 0.02$). To our knowledge, this is the first report on the seroprevalence of *B. henselae* on patients awaiting heart transplant in our region and in Italy. Our analysis supports the hypothesis that age is a significant factor associated with prevalence of *B. henselae* infection in the patient population. Indeed, patients are older than controls and are likely to have had more years of possible exposure to infective agents. However, in our population, this factor together with the state of general impairment of these patients due to their severe heart failure is likely to increase the prevalence/incidence of infection. Heart transplant is the only therapeutic option for the survival of patients with severe end-stage heart failure.[29,30] Post-transplant, under the influence of immunosuppressive therapy, these patients are at risk for developing infectious diseases.[31,32] Despite significant advances in the management of solid organ transplant, infections still remain a considerable factor influencing transplant outcome.[32]

Although, in the post-transplant period, many risk factors for infection are known, the epidemiology of infections in patients awaiting heart transplant and the effect of

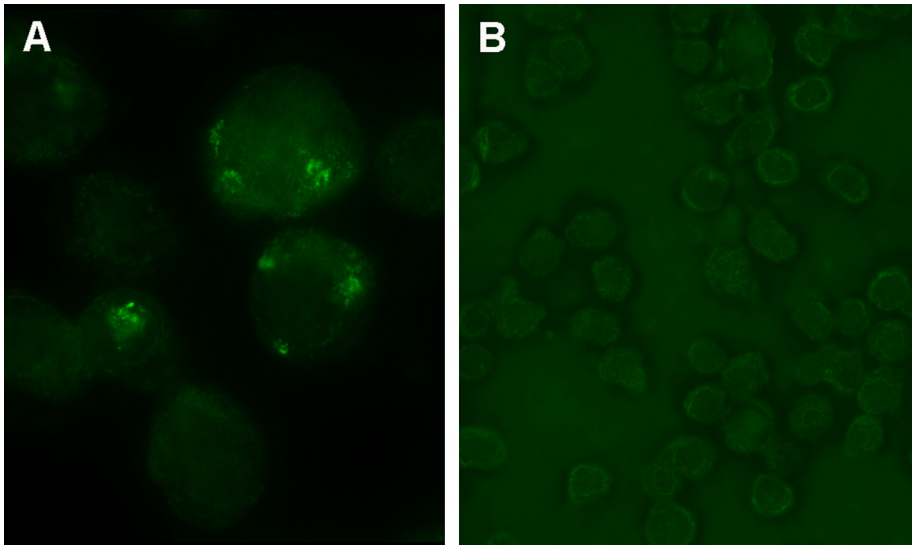

Figure 1. Immunofluorescent assay images. (A) Serum sample of a patient awaiting heart transplant positive to *Bartonella henselae* immunoglobulin G, magnification 100×. (B) Negative control of *B. henselae* immunoglobulin G supplied by the manufacturer (Focus Diagnostics, Cypress, CA, USA), magnification 40×.

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pretransplant infections in the post-transplant period remain to be investigated.[33] Most of the guidelines for pretransplant management recommend the screening of patients potentially exposed to infectious agents, however, they do not include fastidious pathogens such as *B. henselae*.[34]

Bartonella infections display different progression and organ involvement due to a balance between host and bacterial factors.[12] Recently, several reports described cases of solid organ transplant recipients who developed disseminated infections with *B. henselae* depending on the immunosuppressive therapy, at several times from transplant.[27,28,35] Usually, the transmission of *B. henselae* occurs via traumatic contact with infected cats or cat fleas.[13] Some studies support the possibility of *Bartonella* infections through blood transfusion, probably due to its intraerythrocytic viability during storage at 4°C.[36] In addition, in patients who develop bartonellosis within a few months after transplant, a possible source of transmission of *B. henselae* could be the organ donor.[37] Indeed, Scolfaro et al[37] reported a case of liver bartonellosis in a recipient whose donor was positive for *B. henselae* IgG antibodies. Moreover, in immunocompromised patients a possible source of bartonellosis could be the reactivation of previous infections, although this complication is uncommon for bacteria.[27] In this regard, *Bartonella* spp., as intracellular bacteria, may develop various processes to facilitate their uptake into the intracellular compartment of the host cells.[1] Intraerythrocytic colonization is a hallmark of *B. henselae* also, if endothelial cells have been assumed as a potential niche in *Bartonella* infections, *in vivo*.[2,3] However, an increasing number of studies have demonstrated that an alternative niche may be represented by HSCs[4] and EPCs.[5,37–40] Mobilized EPCs could carry this pathogen to other organs and, more important, to the endothelium of microcirculation.[5] Moreover, *B. henselae* induces endothelial proliferation through apoptosis inhibition thus allowing its permanence into cell host habitat.[6,7] *B. henselae* colonized cells might play a central role not only in the pathogenesis of infection but also in the possible reactivation; this issue remains to be elucidated.[41] Therefore, during the pretransplant period *B. henselae* infection could evolve in several complications such as endocarditis.[15,42] However, post-transplant, as a consequence of immunosuppressive therapy, bacterial reactivation could result in a severe and disseminate bartonellosis that could compromise several organs.

Therefore, an early diagnosis and an adequate treatment could be crucial in the pretransplant period in order to prevent the course of the disease in the post-transplant phase when the patients are immunocompromised.[27] However, a substantial portion of the pretransplant patients had acute infection and a positive IgM serology.

In conclusion, our retrospective observational study, although performed on a small number of pretransplant patients at a Regional Hospital not allowing generalizability of the results suggests that *B. henselae*, together with other emerging bacteria, should be included as a routine analysis in the list of opportunistic infections. Therefore, the pretransplant monitoring of *Bartonella* infections may be useful in the management of patients in post-transplant phase.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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References

1. Eicher SC, Dehio C. *Bartonella* entry mechanisms into mammalian host cells. *Cell Microbiol* 2012;**14**:1166–73.
2. Harms A, Dehio C. Intruders below the radar: molecular pathogenesis of *Bartonella* spp. *Clin Microbiol Rev* 2012;**25**:42–78.
3. Dehio C. *Bartonella* interactions with endothelial cells and erythrocytes. *Trends Microbiol* 2001;**9**:279–85.
4. Mändle T, Einsele H, Schaller M, Neumann D, Vogel W, Autenrieth IB, et al. Infection of human CD34+ progenitor cells with *Bartonella henselae* results in intraerythrocytic presence of *B. henselae*. *Blood* 2005;**106**:1215–22.
5. Salvatore P, Casamassimi A, Sommese L, Fiorito C, Ciccodicola A, Rossiello R, et al. Detrimental effects of *Bartonella henselae* are counteracted by L-arginine and nitric oxide in human endothelial progenitor cells. *Proc Natl Acad Sci U S A* 2008;**105**:9427–32.
6. Pulliainen AT, Dehio C. *Bartonella henselae*: subversion of vascular endothelial cell functions by translocated bacterial effector proteins. *Int J Biochem Cell Biol* 2009;**41**:507–10.
7. Schmid MC, Schulein R, Dehio M, Denecker G, Carena I, Dehio C. The VirB type IV secretion system of *Bartonella henselae* mediates invasion, proinflammatory activation and antiapoptotic protection of endothelial cells. *Mol Microbiol* 2004;**52**:81–92.
8. Pulliainen AT, Dehio C. Persistence of *Bartonella* spp. stealth pathogens: from subclinical infections to vasoproliferative tumor formation. *FEMS Microbiol Rev* 2012;**36**:563–99.
9. Resto-Ruiz S, Burgess A, Anderson BE. The role of the host immune response in pathogenesis of *Bartonella henselae*. *DNA Cell Biol* 2003;**22**:431–40.
10. Kaiser PO, Riess T, O'Rourke F, Linke D, Kempf VA. *Bartonella* spp.: throwing light on uncommon human infections. *Int J Med Microbiol* 2011;**301**:7–15.
11. Mosepele M, Mazo D, Cohn J. *Bartonella* infection in immunocompromised hosts: immunology of vascular infection and vasoproliferation. *Clin Dev Immunol* 2012;**2012**:612809.
12. Mogollon-Pasapera E, Otvos Jr L, Giordano A, Cassone M. Bartonella: emerging pathogen or emerging awareness? *Int J Infect Dis* 2009;**13**:3–8.
13. Zangwill KM. Cat scratch disease and other *Bartonella* infections. *Adv Exp Med Biol* 2013;**764**:159–66.
14. Chomel BB, Kasten RW, Williams C, Wey AC, Henn JB, Maggi R, et al. *Bartonella* endocarditis: a pathology shared by animal reservoirs and patients. *Ann N Y Acad Sci* 2009;**1166**:120–6.
15. Fournier PE, Thuny F, Richet H, Lepidi H, Casalta JP, Arzouni JP, et al. Comprehensive diagnostic strategy for blood

culture-negative endocarditis: a prospective study of 819 new cases. *Clin Infect Dis* 2010;**51**:131–40.
16. Lamas Cda C, Ramos RG, Lopes GQ, Santos MS, Golebiovski WF, Weksler C, et al. *Bartonella* and *Coxiella* infective endocarditis in Brazil: molecular evidence from excised valves from a cardiac surgery referral center in Rio de Janeiro, Brazil, 1998 to 2009. *Int J Infect Dis* 2013;**17**:e65–6.
17. Sun J, Fu G, Lin J, Song X, Lu L, Liu Q. Seroprevalence of *Bartonella* in Eastern China and analysis of risk factors. *BMC Infect Dis* 2010;**10**:121.
18. Vorou RM, Papavassiliou VG, Tsiodras S. Emerging zoonoses and vector-borne infections affecting humans in Europe. *Epidemiol Infect* 2007;**135**:1231–47.
19. Pandak N, Daković-Rode O, Cabraja I, Kristof Z, Kotarac S. Prevalence of *Bartonella henselae* antibodies in children and blood donors in Croatia. *Infection* 2009;**37**:166–7.
20. Massei F, Messina F, Talini I, Massimetti M, Palla G, Macchia P, et al. Widening of the clinical spectrum of *Bartonella henselae* infection as recognized through serodiagnostics. *Eur J Pediatr* 2000;**159**:416–9.
21. Massei F, Messina F, Gori L, Macchia P, Maggiore G. High prevalence of antibodies to *Bartonella henselae* among Italian children without evidence of cat scratch disease. *Clin Infect Dis* 2004;**38**:145–8.
22. Mansueto P, Pepe I, Cillari E, Arcoleo F, Micalizzi A, Bonura F, et al. Prevalence of antibodies anti-*Bartonella henselae* in western Sicily: children, blood donors, and cats. *J Immunoassay Immunochem* 2012;**33**:18–25.
23. Brunetti E, Fabbi M, Ferraioli G, Prati P, Filice C, Sassera D, et al. Cat-scratch disease in Northern Italy: atypical clinical manifestations in humans and prevalence of *Bartonella* infection in cats. *Eur J Clin Microbiol Infect Dis* 2013;**32**:531–4.
24. Fabbi M, De Giuli L, Tranquillo M, Bragoni R, Casiraghi M, Genchi C. Prevalence of *Bartonella henselae* in Italian stray cats: evaluation of serology to assess the risk of transmission of *Bartonella* to humans. *J Clin Microbiol* 2004;**42**:264–8.
25. Ciceroni L, Pinto A, Ciarrocchi S, Ciervo A. *Bartonella* infections in Italy. *Clin Microbiol Infect* 2009;**15**:108–9.
26. Vermeulen MJ, Herremans M, Verbakel H, Bergmans AM, Roord JJ, van Dijken PJ, et al. Serological testing for *Bartonella henselae* infections in The Netherlands: clinical evaluation of immunofluorescence assay and ELISA. *Clin Microbiol Infect* 2007;**13**:627–34.
27. Psarros G, Riddell 4th J, Gandhi T, Kauffman CA, Cinti SK. *Bartonella henselae* infections in solid organ transplant recipients: report of 5 cases and review of the literature. *Medicine (Baltimore)* 2012;**91**:111–21.
28. Rostad CA, McElroy AK, Hilinski JA, Thompson MP, Drew CP, Denison AM, et al. *Bartonella henselae*-mediated disease in solid organ transplant recipients: two pediatric cases and a literature review. *Transpl Infect Dis* 2012;**14**:E71–81.
29. Moulin C, Kanitakis J, Ranchin B, Chauvet C, Gillet Y, Morelon E, et al. Cutaneous bacillary angiomatosis in renal transplant recipients: report of three new cases and literature review. *Transpl Infect Dis* 2012;**14**:403–9.
30. Edwards BS, Rodeheffer RJ. Prognostic features in patients with congestive heart failure and selection criteria for cardiac transplantation. *Mayo Clin Proc* 1992;**67**:485–92.
31. Toyoda Y, Guy TS, Kashem A. Present status and future perspectives of heart transplantation. *Circ J* 2013;**77**:1097–110.
32. Crudele V, Picascia A, Infante T, Grimaldi V, Maiello C, Napoli C. Repeated immune and non immune insults to the graft after heart transplantation. *Immunol Lett* 2011;**141**:18–27.
33. González-Padilla M, Castón JJ, Vidal E, Arizón JM, Segura C, Montejo M, et al. Epidemiology and clinical impact of infection in patients awaiting heart transplantation. *Int J Infect Dis* 2013;**17**:e681–5.
34. Fischer SA, Avery RK, AST Infectious Disease Community of Practice. Screening of donor and recipient prior to solid organ transplantation. *Am J Transpl* 2009;**4**:S7–18.
35. Bonatti H, Mendez J, Guerrero I, Krishna M, Ananda-Michel J, Yao J, et al. Disseminated Bartonella infection following liver transplantation. *Transpl Int* 2006;**19**:683–7.
36. Ruiz J, Silva W, Pons MJ, Del Valle LJ, Tinco CR, Casabona VD, et al. Long time survival of *Bartonella bacilliformis* in blood stored at 4 °C. A risk for blood transfusions. *Blood Transfus* 2012;**10**:563–4.
37. Scolfaro C, Mignone F, Gennari F, Alfarano A, Veltri A, Romagnoli R, et al. Possible donor-recipient bartonellosis transmission in a pediatric liver transplant. *Transpl Infect Dis* 2008;**10**:431–3.
38. Costa V, Sommese L, Casamassimi A, Colicchio R, Angelini C, Marchesano V, et al. Impairment of circulating endothelial progenitors in Down syndrome. *BMC Med Genomics* 2010;**13**:40.
39. Napoli C, Hayashi T, Cacciatore F, Casamassimi A, Casini C, Al-Omran M, et al. Endothelial progenitor cells as therapeutic agents in the microcirculation: an update. *Atherosclerosis* 2011;**215**:9–22.
40. Sommese L, Pagliuca C, Avallone B, Ippolito R, Casamassimi A, Costa V, et al. Evidence of *Bacteroides fragilis* protection from *Bartonella henselae*-induced damage. *PLoS One* 2012;**7**:e49653.
41. Kotton CN. Zoonoses in solid-organ and hematopoietic stem cell transplant recipients. *Clin Infect Dis* 2007;**44**:857–66.
42. Hoffman RM, AboulHosn J, Child JS, Pegues DA. *Bartonella* endocarditis in complex congenital heart disease. *Congenit Heart Dis* 2007;**2**:79–84.

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