Leukemia Research Reports 21 (2024) 100402

Contents lists available at ScienceDirect

Leukemia Research Reports

journal homepage: www.elsevier.com/locate/lrr

# Is *Bartonella* sp. infection relevant in hematological malignancies in HIV-negative patients? A literature review

Elisa Nunes Secamilli [a,*], Marina Rovani Drummond [b], Juliana Yumi Massuda Serrano [a], Rafael Fantelli Stelini [c], Maria Leticia Cintra [c], Paulo Eduardo Neves Ferreira Velho [a]

[a] Department of Clinical Medicine, School of Medical Sciences, Universidade Estadual de Campinas, Campinas, SP, Brazil
[b] Laboratory of Applied Research in Dermatology and Bartonella Infection, School of Medical Sciences, Universidade Estadual de Campinas, Campinas, SP, Brazil
[c] Department of Pathology, School of Medical Sciences, Universidade Estadual de Campinas, Campinas, SP, Brazil

ARTICLE INFO

*Keywords:*
Bartonella
Angiomatosis
Bacillary
Leukemia
Lymphoma
Hematologic neoplasm

ABSTRACT

Bartonelloses are diseases caused by Bartonella sp., transmitted to humans by blood sucking arthropod vectors. Clinical presentations include bacillary angiomatosis, cat scratch disease and atypical forms. We performed a review of cases of bartonelloses and hematological malignancies published in HIV-negative patients. Terms used were Bartonella or Bacillary Angiomatosis and Leukemia, Lymphoma, Multiple Myeloma, or Cancer. Fifteen cases met our criteria. Clinical presentations included bacillary angiomatosis, chronic fever, chronic lymphadenopathy, osteomyelitis, neuroretinitis, chronic anemia and hepatosplenic peliosis. Fourteen patients were asymptomatic after antibiotic therapy, and one died before antibiotic treatment. Clinicians should be suspicious of Bartonella sp. infections in immunocompromised patients.

## 1. Introduction

Bartonelloses are diseases caused by bacteria of the genus *Bartonella*. These are fastidious gram-negative bacilli capable of infecting erythrocytes and endothelial cells and evading the host immune system inside them, causing recurrent bacteremia. Bacteria are mainly transmitted by blood sucking arthropod vectors, such as lice and fleas, and cat or dog scratches may contribute to transmission [1].

Classical clinical forms of bartonelloses include fever and intraerythrocytic bacteremia (Oroya fever and trench fever), vascular proliferative tumors (*verruga peruana* and bacillary angiomatosis) and chronic lymph node enlargement (cat scratch disease). There are other manifestations, such as endocarditis, erythema nodosum, erythema multiforme and fever of unknown origin [2].

Based on a case of bacillary angiomatosis in a patient with chronic lymphocytic leukemia, we performed a review of the literature aimed at describing the epidemiology, clinical manifestations, methods of diagnosis, treatment and prognosis of HIV-negative patients with hematologic malignancies who developed *Bartonella* sp. infections. This review is a compilation of all bartonelloses in oncohematological HIV-negative patients published in the literature until 2023.

## 2. Case report

We present a case of a 65-year-old male patient who was previously healthy and was referred to our tertiary hospital because of chronic anemia. He had complained of progressively worsening weakness for ten months, without fever or weight loss. He had a history of two blood transfusions in another hospital in the past three months because of anemia. His previous evaluation revealed anemia (hemoglobin level – Hb 5.9 mg/dL), mild leukocytosis (10,100 cells/mm$^3$), lymphocytosis (5252 cells /mm$^3$), normal platelet count (291,000 cells/mm$^3$), and elevated gamma-glutamyl transferase (GGT 95 u/L) and alkaline phosphatase (AKP 246 u/L). He had no palpable lymph nodes or hepatosplenomegaly on abdominal ultrasound. Upper gastrointestinal endoscopy was normal, and the fecal occult blood test was negative. Direct antiglobulin test and erythrocyte eluate screening were negative. Human immunodeficiency virus (HIV) serology was negative. The new complete blood count was similar to the previous one, despite the transfusion (Hb 6.0 mg/dL, leukocyte count 6730 cells/mm$^3$, lymphocyte count 4220 cells/mm$^3$ and platelet count 177,000 cells/mm$^3$). Immunophenotyping by flow cytometry showed CD20+ and CD19+ cells with coexpression of CD5, CD23+, CD45+ and CD10-. He was then

* Corresponding author at: Departamento de Clínica Médica - Department of Clinical Medicine, Rua Vital Brasil, 80, Cidade Universitária "Zeferino Vaz", Campinas, Zip Code: 13083-888, SP, Brazil.
*E-mail address:* elisans42@gmail.com (E.N. Secamilli).

https://doi.org/10.1016/j.lrr.2023.100402
Received 27 August 2023; Received in revised form 22 October 2023; Accepted 23 November 2023
Available online 13 December 2023

submitted to a bone marrow biopsy, which revealed extensive infiltration by leukemic cells. He was diagnosed with chronic lymphocytic leukemia.

He was given chlorambucil at a dosage of 0.3 mg/kg/day for five consecutive days every four weeks for a total of five months. Subsequently, chemotherapy was discontinued for the following five months due to toxicity. During this period, he continuously needed blood transfusions (15 red blood cell units) and was leukopenic (1100–2000 cells/mm$^3$). Therefore, therapy was changed to filgrastim and cyclophosphamide 1200 mg/day for one day, vincristine 1 mg/day for one day and prednisone 100 mg/day for five days every 21 days (COP). After the first cycle of COP, the patient was pancytopenic and developed febrile neutropenia of unknown origin, treated with cefepime 6 g/day for five days, vancomycin 2 g/day and imipenem 3 g/day for ten days. The patient also developed erythema multiforme that, at the time, was considered to be due to the antibiotics. Afterward, without fever, he was started on a regimen of fludarabine at 38 mg/day and cyclophosphamide at 450 mg/day for three consecutive days every 28 days. Additionally, he received filgrastim and blood transfusions on a weekly basis. Twenty days after the first cycle, he developed a new episode of febrile neutropenia of unknown origin and was treated with cefepime 6 g/day for seven days. He had sustained pancytopenia (Hb: 6.6 mg/dL, leucocyte count 250 cells/mm$^3$, neutrophil count 220 cells/mm$^3$ and platelet count 16,000 cells/mm$^3$). After the second cycle of treatment, he developed multiple cutaneous angiomatous papules and nodules on his face, trunk and arms (Fig. 1) associated with fever. The patient reported having two cats as indoor pets. Skin biopsy showed dermal proliferating capillaries with epithelioid endothelial cells (Fig. 2), and Warthin Starry staining revealed clumps of bacilli (Fig. 3) consistent with the diagnosis of bacillary angiomatosis. Immunohistochemistry for human herpesvirus 8 was not reactive. Indirect fluorescence antibody assays for *B. henselae* and *B. quintana* were also not reactive. We were not able to perform molecular testing of the patient́s skin fragment or blood for *Bartonella* sp. infection prior to angiomatosis bacillary treatment.

Chemotherapy was discontinued, and treatment with doxycycline 200 mg/day was prescribed for six weeks. During the oral treatment, the patient was afebrile but still had new skin lesions, so he was admitted to the inpatient ward for intravenous treatment with erythromycin 2 g/day and gentamicin 240 mg/day for three weeks. Skin lesions started to resolve, pancytopenia improved (Hb: 7.2–9.7 mg/dL, leukocyte count 430–1630 cells/mm$^3$ and platelet count 58,000–82,000 cells/mm$^3$), and GGT and AKP normalized. After treatment, the patient rarely needed blood transfusions (two red blood cell units in four months), although pancytopenia remained. After three months, he began new COP cycles and died in another hospital due to febrile neutropenia after the fourth cycle.

## 3. Methods

Since bacillary angiomatosis is commonly associated with AIDS patients and unusual in oncologic patients, we performed a search in the literature (PUBMED) with the terms Bartonella or Bacillary Angiomatosis and Leukemia, Lymphoma, Multiple Myeloma, or Cancer in English, Spanish and Portuguese to identify all cases reported in patients with hematological malignancies and bartonellosis. Exclusion criterion was seropositivity for HIV. Literature research was performed from January 2020 to January 2023. Articles were screened to avoid duplicated data.

## 4. Results

We found 15 cases reported in the literature that met our criteria. All articles found were in English and ranged from 1990 to 2019. The cases were reported in America (United States and Peru), Europe (Hungary, Germany, France and Switzerland) and Australia.

Seven of the cases reported and this present case had chronic lymphocytic leukemia. Three of them had acute lymphocytic leukemia, and these patients were 12 years old or younger. Other diagnoses were chronic myeloid leukemia (2 cases), acute myeloid leukemia (2) and non-Hodgkin lymphoma (1). Clinical manifestations were cutaneous bacillary angiomatosis, fever, bacteremia, chronic lymphadenopathy, osteomyelitis, neuroretinitis, chronic anemia and hepatosplenic bacillary peliosis. Serology was performed in six patients and was not reactive in four of them (66.7 %), as observed in our patient. *Bartonella* sp. DNA was detected by PCR in nine of the 15 patients: *B. henselae* DNA was detected in five (55,5 %), *B. quintana* DNA was detected in three (33,3%), and both species were detected in one (11,1 %) of them. Six patients had no molecular *Bartonella* sp. diagnosis, similar to our patient. Fourteen of the patients reported were treated with antibiotics for long periods with remission, and one of them died of the malignancy before he could be treated [3–17]. A summary of the findings is available in Table 1 [3–17].

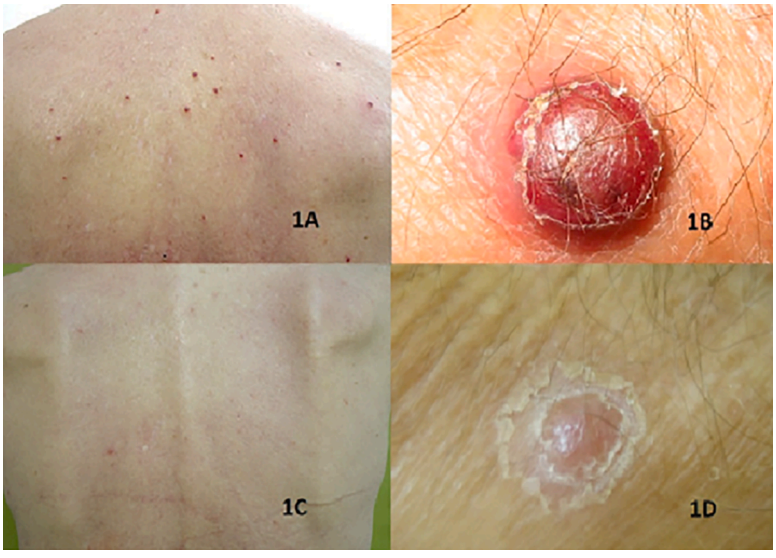


**Fig. 1.** A: multiple angiomatous papules on the torso. 1B: the papule are erythematous and angiomatous and exhibit a round desquamation. 1C and 1D: partial regression of lesions after 11 days of doxycycline *per os* treatment.

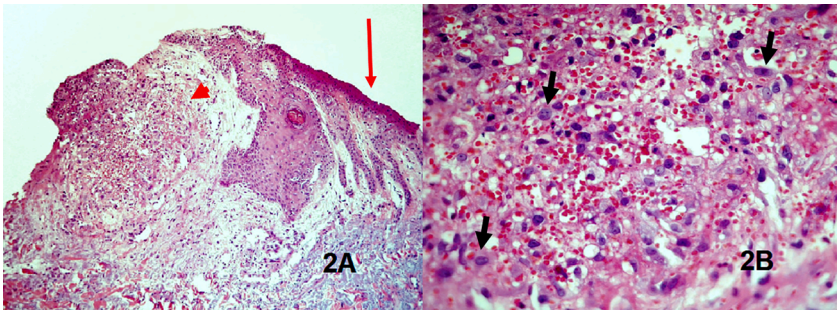


**Fig. 2.** . Arm: skin biopsy showing (2A) epidermal hyperplasia and solar elastosis at the ulcer edge (red arrow), dermal edema and proliferating capillaries (arrow head) with (2B) epithelioid endothelial cells (black arrows). Hematoxylin and eosin, original magnification x100 (2A) and x400 (2B).

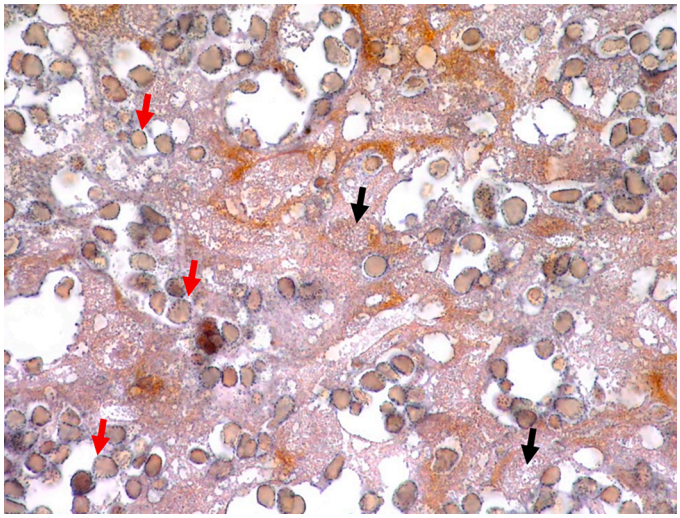

**Fig. 3.** . Arm: skin biopsy revealing clumps of bacilli within fibrinous exudate and around red blood cells (arrows). Warthin Starry stain, original magnification x 1000.

## 5. Discussion

The diagnosis of bacillary angiomatosis in our patient was clinical, epidemiological, histological, and evolutionary. He had typical angiomatous lesions, recurrent fever and excellent response to antibiotics classically used to treat bartonellosis. He also had two cats as indoor pets. Warthin-Starry stain positivity is not specific for *Bartonella* and may be found in other bacteria such as *Leptospira* spp., *Borrelia burgdorferi*, and *Treponema pallidum,* but none of these bacteria present with angiomatous papules and tumors, and the patient had a negative treponemal test. Indirect immunofluorescent assay negativity may be found in immunocompromised patients and was seen in two-thirds of the case reports included in this review as well as in our patient.

Bartonelloses are emerging diseases, and host immunosuppression, either by the neoplasm itself or by chemotherapeutic treatment, may contribute to the higher detection of these infections. Other reasons for this increase include better diagnostic methods to identify these fastidious bacteria, indoor domestic animals, increased outdoor activity leading to exposure to wildlife reservoirs or vectors, poverty, higher predisposition to ectoparasite infestation, such as body lice, when living in large clusters, and finally the spread of the bacteria around the world [18].

There are two most reported clinical manifestations in bartonellosis: vascular proliferative disease (most described in HIV-infected patients or other immunocompromised hosts) or necrotizing granulomatous disease (seen most often in immunocompetent hosts) [19].

Fever of unknown origin is a rarely reported presentation of bartonellosis because *Bartonella* sp. cannot be cultivated in regular blood culture [20]. The patient described in this case initially presented with a fever of unknown origin, a common occurrence in hematological malignancy patients, before he manifested bacillary angiomatosis skin lesions. The etiology of his fever was probably *B. henselae* infection. Although most of the patients were asymptomatic after one cycle of antibiotics, our patient developed another manifestation in the skin after two treatments: the first one with cefepime, vancomycin and imipenem, and the second one with cefepime.

Koehler *et al.* conducted a study in 2003 to investigate the prevalence of *Bartonella* infection among HIV-infected patients with fever of unknown origin. Immunofluorescence assay serology yielded positive results in 17 % of the 382 patients studied. Among these, twelve patients exhibited positive cultures or PCR reactions for *Bartonella* species. The median CD4 count was 35 cells/mm$^3$, and only six of these patients presented with angiomatous skin lesions [21]. The classical manifestations of bartonelloses in acquired immunodeficiency syndrome, such as bacillary angiomatosis and hepatic peliosis, are now observed less frequently. This decrease in prevalence is possibly attributable to earlier recognition of HIV infection and the reduced number of individuals with CD4 lymphocyte cell counts below 50 cells/mm$^3$, thanks to antiretroviral therapy [22].

Recently, Boyle et al. described a series of cases of *Bartonella* sp. infections in solid-organ transplant recipients and compared with the cases of post-transplant lymphoproliferative disorders (PTLD) in the same population. In this study, compared to PTLD patients, *Bartonella* sp. infected solid-organ transplant recipients had a higher probability of a significant level of immunosuppression (100 × 52 %), an earlier presentation following transplantation (24 × 46 months), an earlier diagnosis after the first day of symptoms (9 × 55 days), and a higher percentage of constitutional symptoms (87 × 31 %). A widespread presentation was common in both diseases, but liver and spleen involvement were more common in *Bartonella* sp. infected group, and central nervous system involvement was more common in the PTLD group, although there were no decisive discerning features between the groups [23].

Patients with hematological cancer are at risk of *Bartonella* sp. bacteremia: in a Romanian investigation among these patients, Messinger et al. found that 37.5 % of participants were IgG seroreactive against one or more of five *Bartonella* sp. antigens [24]. Therefore, it is important that clinicians keep that in mind and have a high suspicion of typical and atypical lesions.

In addition to arthropod vectors and pet scratches, another potential route of infection is blood transfusion. Núñez et al., in Chile, detected *B. henselae* DNA in 13.6% of blood samples from donors at the moment of blood donation [25]. Our group found that 23% of asymptomatic blood donors had *Bartonella* sp. DNA detected in donated blood [26]. We have inoculated red blood cell units with *B. henselae* and demonstrated that it remains viable in red blood cell units at the end of the storage period, after 35 days [27]. We were also able to demonstrate *B. henselae* transmission through blood donation in a murine model [28]. Our

**Table 1**
Clinical and laboratorial findings in patients with hematological malignancies and bartonelloses.

| Patient | Reference (n°) | Age | Sex | Hematologic malignancy | Lymphocyte count (/mm3) | Neutrophil count (/mm3) | *Bartonella* sp. manifestation | Diagnostic method | IFA Bartonella | PCR + | Treatment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 3 | 28 | F | CML, allogenic BMT | 1000 | 6500 | Fever, bacteremia | BC | NA | NA | CFZ 6 days + GEN 2 days+ CIP 10 days |
| **2** | 4 | 12 | M | ALL, chemotherapy | 820 | 820 | Bacillary angiomatosis | WSS, EM, PCR | NA | B. quintana | ERY 42 days |
| **3** | 5 | 78 | M | CLL, chemotherapy | 24,300 | 2430 | Bacillary angiomatosis | WSS, EM | NA | NA | ERY 42 days |
| **4** | 6 | 55 | M | CLL, chemotherapy | 78,705 | 795 | Bacillary angiomatosis | GGS, EM | NA | NA | CLA 28 days |
| **5** | 7 | 48 | M | NHL, chemotherapy, autologous SCT | NA | NA | Fever, bacteremia | BC, PCR | NA | B. henselae | CFX + IMI+ VAN 8 days |
| **6** | 8 | 61 | M | AML, chemotherapy | NA | NA | Bacillary angiomatosis | PCR | NA | B. henselae | – |
| **7** | 9 | 60 | M | AML, chemotherapy | 100 | <100 | Bacillary angiomatosis, fever of unknown origin | PCR | Negative | B. henselae | PIP + AMI, TEI + FUA, IMI + AMI + TEI |
| **8** | 10 | 60 | M | CLL, chemotherapy | 29,575 | 650 | Bacillary angiomatosis, fever | WSS | Negative | NA | DOX 42 days |
| **9** | 11 | 15 | F | CML, imatinib | NA | NA | Neuroretinitis, cat scratch disease | SE | B henselae 1:512 | NA | DOX + RIF 30 days |
| **10** | 12 | 79 | M | CLL, chemotherapy | NA | NA | Bacillary angiomatosis | PCR | NA | B. henselae | ERY 90days |
| **11** | 13 | 66 | F | CLL, chemotherapy | NA | 520 | Bacillary angiomatosis, osteomyelitis | WSS, PCR | Negative | B. quintana | DOX 49 days, DOX + CLA 56 days, DOX+ CLA + CEF, GEN 42 days, AZI + RIF 450 days |
| **12** | 14 | 5 | F | ALL, chemotherapy | <690 | 1340 | Bacillary angiomatosis, cat scratch disease | WSS, PCR, SE | B. henselae 1:128 | B. henselae and B. quintana | AZI 90 dias |
| **13** | 15 | 63 | M | CLL, chemotherapy | 70 | 2500 | Bacillary angiomatosis, bacteremia | PCR | NA | B. quintana | DOX+ GEN 14 days, DOX 180 days |
| **14** | 16 | 11 | F | ALL, chemotherapy | 2221 | 19,989 | Hepatosplenic bacillary peliosis | PCR | NA | B. henselae | AZI 30 days |
| **15** | 17 | 76 | M | CLL | 4284 | NA | Cat scratch disease | Clinical | Negative | NA | AZI 21 days |
| **16** | current case | 65 | M | CLL, chemotherapy | 400 | 2760 | Chronic anemia, bacillary angiomatosis, fever of unknown origin, erythema multiforme | Epidemiological, Clinical, WSS | Negative | Negative after treatment | DOX 42 days, GEN + ERY 21 days |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CML- Chronic myeloid Leukemia | | ALL - Acute lymphocytic leukemia | BMT - bone marrow transplantation | | CFZ - ceftazidime | GEN - gentamicin | CIP - ciprofloxacin | AMI - amikacin | |
| NHL - Non Hodgkin lymphoma | | SCT - stem cell transplantation | AML - acute myeloid Leukemia | | ERY - erythromycin | CLA - clarithromycin | CFX - cefotaxime | TEI - teicoplanin | |
| BC - Blood culture | WSS: Warthin-Starry stain | GGS- Grocott–Gomori stain | EM- transmission electron microscopy | | IMI -imipenem | VAN - vancomycin | PIP - piperacillin | FUA - fusidic acid | |
| PCR - polymerase chain reaction | | SE -serology | NA - not assessed | | DOX - Doxycycline | RIF - rifampicine | CEF - ceftriaxone | AZI - azithromycin | |

ALL - Acute lymphocytic leukemia, AMI – amikacin, AML - acute myeloid leukemia, AZI – azithromycin, BC - Blood culture, BMT - bone marrow transplantation, CEF – ceftriaxone, CFX – cefotaxime, CFZ – ceftazidime, CIP – ciprofloxacin, CLA – clarithromycin, CML- Chronic myeloid Leukemia, DOX – doxycycline, EM - transmission electron microscopy, ERY – erythromycin, GEN – gentamicin, FUA – fusidic acid, GGS- Grocott–Gomori stain, IFA - Indirect immunofluorescent assay, IMI -imipenem, NA - not assessed, NHL - Non Hodgkin lymphoma, PCR - polymerase chain reaction, PIP – piperacillin, RIF – rifampicin, SCT - stem cell transplantation, SE - serology, TEI – teicoplanin, VAN – vancomycin, WSS - Warthin–Starry stain.

patient regularly needed blood transfusions, which may also occur in other hematological malignancy patients.

The cases included in our review highlight the difficulty of diagnosing bartonellosis. A history of contact with cats, dogs or fleas should be pursued. Multiple diagnostic tests, such as indirect immunofluorescence assay, PCR, blood culture and Warthin-Starry staining of histopathologic specimens, may enhance sensitivity [29]. An accurate diagnosis is important due to the resolution of symptoms with proper antibiotic treatment. The current patient had epidemiological, clinical, and histological diagnosis of bacillary angiomatosis. Even though the patient́s primary manifestation of chronic lymphocytic leukemia was anemia, it improved partially with erythromycin and gentamycin intravenous treatment, as he needed fewer blood transfusions after the treatment.

This observation leads to another question: Does *Bartonella* sp. take part in the oncogenic process? It is known that in cat scratch fever, *B. henselae* may cause long-term lymphadenopathy by immune stimulation [30]. Both B and T cells are prone to genetic instability and malignant transformation, and chronic antigenic exposure may enhance this risk through constant activation and proliferation [31].

*B. henselae* has been discovered to infect myeloid angiogenic cells (MACs), a type of circulating myeloid progenitor cells crucial for angiogenic processes. When infected with *B. henselae*, MACs undergo a significant transformation, adopting a tumor-associated macrophage (TAM)-like phenotype with enhanced angiogenic, matrix remodeling, and immune regulatory properties. This transformation mirrors the role of TAMs in malignant tumors, which are known to promote tumor vascularization and progression through angiogenic cytokine release, immunomodulation, and matrix remodeling. *B. henselae*-infected MACs also integrate into growing vascular structures, boosting sprouting angiogenesis, and can even form vascular mimicry structures on basement membrane matrices. The cytokine secretion profile of these transformed cells fosters a tumor-like microenvironment, characterized by inflammatory angiogenic cytokines, M2 anti-inflammatory macrophage activation, and matrix remodeling compounds. Consequently, *B. henselae*'s influence on MACs, shifting them toward a TAM-like phenotype, indirectly contributes to vascular tumor formation by stimulating pathological angiogenesis and creating a microenvironment conducive to tumor growth in nearby vasculature [32]. *B. henselae* can infect both macrophages and epithelial cells and promote the production of vascular endothelial growth factor (VEGF) and also induce the proliferation of endothelial cells, even without direct contact. This suggests that the bacteria release a protein that acts as an analog of the host's VEGF, inducing cell proliferation and angiogenesis [33]. Ericson *et al.* successfully detected *B. henselae* inside melanoma cells in a co-culture containing both bacteria and melanoma cells. In these *B. henselae*-infected melanoma cells, there was a notable increase in the expression of VEGF and interleukin-8 compared to melanoma cells cultured alone [34].

Other chronic infections have been associated with non-Hodgkin lymphomas by direct transformation, in which viral-infected cells initiate oncogenesis, such as Epstein Barr virus and Human T Lymphotropic Virus 1, or by indirect transformation, such as *Helicobacter pylori* in gastric lymphoma derived from mucosa-associated lymphoid tissue (MALT), *Chlamydophila psittaci* in adnexal ocular MALT lymphoma and *Borrelia burgdorferi* in primary cutaneous marginal zone B-cell lymphoma [35]. No studies in humans have yet been performed to investigate this possibility in patients with *Bartonella* sp. chronic infections and lymphomas.

One last consideration should be made about *Bartonella* spp.: they may mimic hematological neoplasms. These patients may present with fever, weight loss, enlarged lymph nodes, and splenomegaly with multiple hypoechogenous nodules with or without liver involvement that are suspicious for lymphoma [36].

This is a retrospective study describing all cases of bartonellosis in patients with hematological malignancies reported to date. Apart from the limitations of a retrospective study itself, some case reports date back to the early nineties, when the bacteria were recently discovered, in an old nomenclature (*Rochalimaea quintana*) and before molecular tests were developed, which may represent a bias.

## 6. Conclusion

We described the occurrence of bacillary angiomatosis in a chronic lymphocytic leukemia patient and found 15 earlier reports in HIV-negative patients with hematological malignancies. Bartonelloses are emerging diseases, and immunocompromised individuals other than HIV-positive patients are at risk of typical and atypical manifestations of these diseases. They are neglected diseases, and further studies should be performed to elucidate their behavior in hematologic diseases and their relationship with the hematological oncogenic process.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Declaration of Competing Interest

None.

## Acknowledgement

To Dr Luiza Helena Urso Pitassi for providing clinical images.

## References

[1] M. Québatte, C. Dehio, Bartonella gene transfer agent: evolution, function, and proposed role in host adaptation, Cell. Microbiol. 21 (11) (2019) e13068. Nov.
[2] K.A. Lins, M.R. Drummond, P.E. Velho, Cutaneous manifestations of bartonellosis, An. Bras. Dermatol. 94 (2019) 594–602.
[3] L.N. Slater, D.F. Welch, D. Hensel, D.W. Coody, A newly recognized fastidious gram-negative pathogen as a cause of fever and bacteremia, N. Engl. J. Med. 323 (23) (1990) 1587–1593. Dec 6.
[4] S.A. Myers, N.S. Prose, J.A. Garcia, K.H. Wilson, K.P. Dunsmore, H. Kamino, Bacillary angiomatosis in a child undergoing chemotherapy, J. Pediatr. 121 (4) (1992) 574–578. Oct.
[5] L. Török, S.Z. Virágh, I. Borka, M. Tápai, Bacillary angiomatosis in a patient with lymphocytic leukaemia, Br. J. Dermatol. 130 (5) (1994) 665–668. May.
[6] P. Milde, M. Brunner, F. Borchard, T. Südhoff, M. Burk, M. Zumdick, G. Goerz, T. Ruzicka, Cutaneous bacillary angiomatosis in a patient with chronic lymphocytic leukemia, Arch. Dermatol. 131 (8) (1995) 933–936. Aug.
[7] P. Rathbone, S. Graves, D. Miller, D. Odorico, S. Jones, A. Hellyar, V. Sinickas, Grigg A. Bartonella, Rochalimaea) quintana causing fever and bacteremia in an immunocompromised patient with non-Hodgkin's lymphoma, Pathology 28 (1) (1996) 80–83. Jan.
[8] S. Gasquet, M. Maurin, P. Brouqui, H. Lepidi, D. Raoult, Bacillary angiomatosis in immunocompromised patients, AIDS 12 (14) (1998) 1793–1803. Oct 1Review.
[9] O. Lortholary, J.L. Mainardi, B. La Scola, V. Gallais, P. Frenaux, P Casassus, Consecutive bacillary angiomatosis and Rhodococcus equi bacteremia during acute leukemia: zoonoses may cause fever in neutropenic patients, Clin. Microbiol. Infect. 6 (6) (2000) 334–336. Jun.
[10] K. Petersen, K.C. Earhart, M.R. Wallace, Bacillary angiomatosis in a patient with chronic lymphocytic leukemia, Infection 36 (5) (2008) 480–484. Oct.
[11] F.A. Irshad, R.A. Gordon, Bartonella henselae neuroretinitis in a 15-year-old girl with chronic myelogenous leukemia, J AAPOS 13 (6) (2009) 602–604. Dec.
[12] D. Lange, C. Oeder, K. Waltermann, A. Mueller, A. Oehme, R. Rohrberg, W. Marsch, M. Fischer, Bacillary angiomatosis, J. Dtsch. Dermatol. Ges. 7 (9) (2009) 767–769. Sep.
[13] N.E. Holmes, S. Opat, A. Kelman, T.M. Korman, Refractory Bartonella quintana bacillary angiomatosis following chemotherapy for chronic lymphocytic leukaemia, J. Med. Microbiol. 60 (Pt 1) (2011) 142–146. Jan.
[14] A.K. McElroy, J.A. Hilinski, C.R. Abramowsky, R. Jaffe, S.I. Park, B.M. Shehata, T. M. Cooper, Bacillary angiomatosis in patients with cancer: a pediatric case report and a review of the literature, J. Pediatric Infect. Dis. Soc. 2 (2) (2013) 175–178. Jun.
[15] R. Fulchini, G. Bloemberg, K. Boggian, Bacillary angiomatosis and bacteremia due to Bartonella quintana in a patient with chronic lymphocytic leukemia, Case Rep. Infect. Dis. 2013 (2013), 694765.
[16] C. Weilg, O. Del Aguila, F. Mazulis, W. Silva-Caso, C. Alva-Urcia, R. Cerpa-Polar, E. Mattos-Villena, J Del Valle Mendoza, Seronegative disseminated Bartonella spp. infection in an immunocompromised patient, Asian Pac. J. Trop. Med. 9 (12) (2016) 1222–1225. Dec.

[17] A. Balakumar, B. Lao, D. Papanagnou, X.C. Zhang, Isolated axillary lymphadenitis due to Bartonella infection in an immunocompromised patient, Cureus 11 (8) (2019) e5456. Aug 21.
[18] H.J. Boulouis, C.C. Chang, J.B. Henn, R.W. Kasten, B.B. Chomel, Factors associated with the rapid emergence of zoonotic Bartonella infections, Vet. Res. 36 (3) (2005) 383–410. May-JunReview.
[19] D. Daybell, C.D. Paddock, S.R. Zaki, J.A. Comer, D. Woodruff, K.J. Hansen, J. E. Peacock Jr., Disseminated infection with Bartonella henselae as a cause of spontaneous splenic rupture, Clin. Infect. Dis. 39 (3) (2004) e21–e24. Aug 1.
[20] M. Landes, Y. Maor, D. Mercer, Z. Habot-Wilner, E. Bilavsky, B. Chazan, R. Cohen, D. Glikman, J. Strahilevitz, M. Katzir, V. Litachevsky, R. Melamed, A. Guri, H. Shaked, O. Perets, Y. Wiener-Well, A. Stren, M. Paul, O. Zimhony, I. Srugo, G. Rahav, J. Bishara, A.A. Kuperman, R. Ben-Ami, M. Ephros, M. Giladi, Cat scratch disease presenting as fever of unknown origin is a unique clinical syndrome, Clin. Infect. Dis. (2019). Nov 23.
[21] J.E. Koehler, M.A. Sanchez, S. Tye, C.S. Garrido-Rowland, F.M. Chen, T. Maurer, J. L. Cooper, J.G. Olson, A.L. Reingold, W.K. Hadley, R.R. Regnery, J.W. Tappero, Prevalence of Bartonella infection among human immunodeficiency virus-infected patients with fever, Clin. Infect. Dis. 37 (4) (2003) 559–566. Aug 15.
[22] C.C. Lamas, M.A. Mares-Guia, T. Rozental, N. Moreira, A.R. Favacho, J. Barreira, A. Guterres, M.N. Bóia, E.R. de Lemos, Bartonella spp. infection in HIV positive individuals, their pets and ectoparasites in Rio de Janeiro, Brazil: serological and molecular study, Acta Trop. 115 (1–2) (2010) 137–141. Jul-Aug.
[23] E.M. Boyle, C. Baillet, C. Dupré, G. Lassailly, F. Vuotto, M. Hazzan, L. Terriou, F. Morschhauser, A. Lionet, M. Frimat, Bartonellosis mimicking post-transplant lymphoproliferative diseases, Nephrol. Dial. Transplant. 37 (3) (2022) 599–601. Feb 25.
[24] C.J. Messinger, E.S. Gurzau, E.B. Breitschwerdt, C.I. Tomuleasa, S.J. Trufan, M. M. Flonta, R.G. Maggi, I. Berindan-Neagoe, P.M. Rabinowitz, Seroprevalence of Bartonella species, Coxiella burnetii and Toxoplasma gondii among patients with hematological malignancies: a pilot study in Romania, Zoonoses Public Health 64 (6) (2017) 485–490. Sep.
[25] M.A. Núñez, K. Contreras, M.S. Depix, E. Geoffroy, N. Villagra, S. Mellado, A. M. Salinas, Prevalence of Bartonella henselae in blood donors and risk of blood transmission in Chile, Rev. Chilena Infectol. 34 (6) (2017) 539–543. Dec.
[26] Drummond, M.R., Santos, L.S., Almeida, A.R., Lins, K.A., Barjas-Castro, M.L., Diniz, P.P.V.P., Velho, P.E.N.F. Comparison of molecular methods for Bartonella henselae detection in blood donors. PLoS Negl. Trop. Dis. In print.
[27] R.F. Magalhães, L.H. Pitassi, M. Salvadego, A.M. de Moraes, M.L. Barjas-Castro, P. E. Velho, Bartonella henselae survives after the storage period of red blood cell units: is it transmissible by transfusion? Transfus. Med. 18 (5) (2008) 287–291. Oct.
[28] M.N. Silva, G. Vieira-Damiani, M.E. Ericson, K. Gupta, R. Gilioli, A.R. de Almeida, M.R. Drummond, B.G. Lania, K. de Almeida Lins, T.C. Soares, P.E. Velho, Bartonella henselae transmission by blood transfusion in mice, Transfusion 56 (6 Pt 2) (2016) 1556–1559. Jun.
[29] M.R. Drummond, R. Gilioli, P.E. Velho, Bartonellosis diagnosis requires careful evaluation, Braz. J. Infect. Dis. 14 (3) (2010) 217.
[30] S. Kunz, K. Oberle, A. Sander, C. Bogdan, U. Schleicher, Lymphadenopathy in a novel mouse model of Bartonella-induced cat scratch disease results from lymphocyte immigration and proliferation and is regulated by interferon-alpha/beta, Am. J. Pathol. 172 (4) (2008) 1005–1018.
[31] F.W. Alt, Y. Zhang, F.-L. Meng, C. Guo, B. Schwer, Mechanisms of programmed DNA lesions and genomic instability in the immune system, Cell 152 (2013) 417–429.
[32] F. O'Rourke, V.A.J. Kempf, Interaction of bacteria and stem cells in health and disease, FEMS Microbiol. Rev. 43 (2) (2019) 162–180. Mar 1.
[33] K. Tsukamoto, N. Shinzawa, A. Kawai, M. Suzuki, H. Kidoya, N. Takakura, H. Yamaguchi, T. Kameyama, H. Inagaki, H. Kurahashi, Y. Horiguchi, Y. Doi, The Bartonella autotransporter BafA activates the host VEGF pathway to drive angiogenesis, Nat. Commun. 11 (1) (2020) 3571. Jul 16.
[34] M.E. Ericson, E.B. Breitschwerdt, P. Reicherter, C. Maxwell, R.G. Maggi, R. G. Melvin, A.H. Maluki, J.M. Bradley, J.C. Miller, G.E. Simmons Jr, J. Dencklau, K. Joppru, J. Peterson, W. Bae, J. Scanlon, L.T. Bemis, Bartonella henselae detected in malignant melanoma, a preliminary study, Pathogens 10 (3) (2021) 326. Mar 10.
[35] F. Suarez, M. Lecuit, Infection-associated non-Hodgkin lymphomas, Clin. Microbiol. Infect. 21 (11) (2015) 991–997. Nov.
[36] U. Dhal, R.S. Hicklen, J. Tarrand, D.P. Kontoyiannis, Cat scratch disease as a mimicker of malignancy, Open Forum Infect. Dis. 8 (11) (2021) ofab500. Oct 5.