

Transfusion-transmitted babesiosis in Rhode Island

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BACKGROUND: Babesiosis is caused by an intraerythrocytic protozoan transmitted by ticks. Blood transfusion is another mode of transmission.

STUDY DESIGN AND METHODS: This was a retrospective study based on babesiosis cases reported to the Rhode Island Department of Health between 1999 and 2007. Additional cases were also identified.

RESULTS: Twenty-one cases of transfusion-transmitted babesiosis (TTB) were identified from 1999 through 2007. From 2005 through 2007, the incidence approached one case per 9000 units of blood transfused. One of 21 (5%) TTB cases was diagnosed in July, in sharp contrast to 65 of 152 (43%) of the total babesiosis cases diagnosed during July in Rhode Island. Many cases were identified when a complete blood count with a differential was routinely requested and parasites were noted by laboratory technologists. Most patients with TTB had underlying conditions known to predispose to symptomatic infection.

CONCLUSION: Blood transfusion is an important mode of *Babesia* transmission. The current screening method of omitting donors with a history of babesiosis may be effective in preventing some, but not all, cases of TTB and current processing of blood products does not eradicate this parasite. Thus, a better screening test is needed. Alternatively, pathogen reduction technology could be utilized to prevent this mode of transmission.

Babesiosis is a tick-borne zoonosis caused by an intraerythrocytic protozoan parasite. Most cases in the United States are caused by *Babesia microti*.¹ The disease is endemic in the Northeast, including Rhode Island, and the upper Midwest. Babesiosis is transmitted by *Ixodes scapularis* ticks.¹ Two less common modes of transmission are by a transplacental route² and by blood transfusion.³⁻²⁶ Babesiosis is the most common tick-borne illness transmitted by blood transfusion.²⁷ At present, the only means of screening blood donors is a questionnaire that includes a query regarding a known history of babesiosis.²⁸ However, the majority of *Babesia* infections are asymptomatic or minimally symptomatic;²⁹ hence, current screening has a low sensitivity for excluding donors with potentially transmissible babesiosis.

Based on our observations of increasing numbers of transfusion-transmitted babesiosis (TTB) cases, we initiated this study to gauge the extent of TTB in Rhode Island and to describe clinical and laboratory manifestations, predisposing factors, and the management of patients with TTB in our community.

MATERIALS AND METHODS

This was a retrospective study of TTB in Rhode Island. This study was approved by the institutional review boards of

ABBREVIATION: TTB = transfusion-transmitted babesiosis.

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LAM and SA developed the case report form, SA reviewed medical records, SA and JS obtained information pertaining to blood transfusions, all three authors analyzed the data, and all three authors contributed to writing the manuscript.

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TRANSFUSION **, **:*-**.*

the Rhode Island Department of Health, Rhode Island Hospital, Miriam Hospital, Roger Williams Hospital, and Women and Infant's Hospital.

Case definition for TTB

The following criteria were used: 1) babesiosis diagnosed in a patient who had received a transfusion in the 12 weeks before the diagnosis by Wright-stained peripheral blood smear or *Babesia*-specific polymerase chain reaction (PCR; i.e., direct testing); 2) identification of an implicated donor by the blood supplier who had evidence of *Babesia* infection based on a direct test (i.e., *Babesia*-specific PCR, *Babesia* observed on blood smear, or by hamster inoculation); and 3) demonstration of *Babesia* infection in the donor by indirect testing (i.e., *Babesia* antibody titer $\geq 1:64$). *Definite* TTB cases required Criteria 1 and 2 to be fulfilled. *Probable* cases required Criteria 1 and 3 to be fulfilled.¹² Cases in which only Criterion 1 was fulfilled and donor testing was not done were considered to be *possible* cases of TTB if there was a low likelihood of tick-borne infection, based on at least one of the following: 1) prolonged hospitalization lasting greater than 12 weeks and multiple initial peripheral blood smears which were negative for babesiosis; 2) in hospitalized patients admitted from nursing homes who were thus unlikely to have had tick exposure; or 3) diagnosed during the winter months when a recently acquired tick-borne infection would be unlikely. The incubation period for the definite and probable cases was defined as the time between the transfusion of the implicated blood component and the onset of clinical symptoms, the first observation of parasites in the peripheral blood smear, or the date blood was collected which detected *Babesia* by amplification of *Babesia* DNA using PCR. Immunosuppression was defined by the presence of one or more of the following: asplenia, neonates who were premature at birth, acquired immune deficiency syndrome (AIDS), cancer, or receipt of immunosuppressive medication.

Laboratory testing

Recipient testing

Peripheral blood smears were examined using Romanowsky-stained slides. Modified Giemsa staining was performed of thick preparations when specifically requested for parasitic evaluation, but most commonly, a Wright-stained thin preparation was used for identification, confirmation and quantification of the degree of parasitemia (i.e., percentage of infected erythrocytes). All blood smear testing of recipients was done at Rhode Island Hospital. The Rhode Island Hospital laboratory diagnoses many cases of babesiosis per year based on blood smear examination and, hence, is proficient in

blood smear evaluation for intracellular parasites. PCR testing for recipients was performed using primers to amplify *B. microti*-specific sequences (Mayo Clinic Reference Laboratories, Rochester, MN).

Donor testing

All testing on donor blood (i.e., *Babesia*-specific PCR, indirect immunofluorescence assay, and hamster inoculation) was performed on samples sent from the Rhode Island Blood Center to the Centers for Disease Control and Prevention. All these laboratories are experienced in the test methods used for the diagnosis of babesiosis as described above.

Case finding

Babesiosis became a reportable disease in Rhode Island in 1994. Records of all babesiosis cases reported to the Rhode Island Department of Health between January 1999 and December 2007 were reviewed and information regarding blood donors was obtained from the Rhode Island Blood Center. Additional cases of TTB were identified by reviewing records in the blood banks of six hospitals that collectively transfused more than 70% of all red blood cells (RBCs) transfused in Rhode Island. Finally, we contacted infectious diseases physicians in the Division of Infectious Diseases at the Warren Alpert Medical School of Brown University to identify additional cases. Data were collected using a case report form. If insufficient information was available from records at the Rhode Island Department of Health, data were obtained from medical records at the hospital where a patient had been treated.

RESULTS

A total of 346 cases of Babesiosis were reported to the Rhode Island Department of Health between 1999 and 2007.³⁰ Twenty-one cases of TTB were identified, six definite, 10 probable, and five possible cases. All transfusions occurred in Rhode Island and were from the Rhode Island Blood Center, the sole source supplier and were presumed to be, though not confirmed to be, collected from donors living in Rhode Island. One of these cases was previously published.³¹ Cases were diagnosed in January (three), February (two), March (one), July (one) September (one), October (five), November (three), December (five), and none in other months. One or more of the authors was involved in the care of five of the definite cases. The yearly number of total babesiosis cases reported and TTB cases are shown in Table 1, together with the number of units of RBCs transfused per year at six Rhode Island hospitals. From 1999 through 2007, the number of TTB cases per number of units of blood transfused per year increased. There was a mean of at least one case of TTB per approximately 15,000 units of RBCs transfused during the entire

study period (1999-2007) and during the 2-year period of 2005 through 2007, the incidence approached one case per 9000 units.

Patient demographics and blood products received

The median age of the 21 recipients was 57 years (range, premature infants—88 years of age; Table 2). All six neonates were premature at birth. One patient had AIDS, two patients were asplenic, and two had functional asplenia due to advanced sickle cell syndrome. For the 16 patients with data available regarding the total number of RBCs

transfused, the median was 8 units (range, 1-25 units; Table 2). Four of the 16 patients also received platelet (PLT) transfusions.

Diagnosis

All cases were diagnosed when a complete blood count with a differential was requested and parasites were noted by laboratory technologists, except for two neonates in whom the diagnosis was made by PCR. In most cases, in addition to parasite identification, quantitation of the parasite burden was performed (Table 3).

Clinical features

Three patients had no signs or symptoms of babesiosis. These included one patient who was diagnosed incidentally when a complete blood count was performed and a blood smear showed parasitemia and two neonates diagnosed by *Babesia*-specific PCR who were identified when an investigation was performed after an index case of TTB occurred. The median incubation period for definite and probable cases was 39 days (range, 24-84 days; Table 4). Most of the symptomatic patients had malaise and anorexia. Only seven of the 15 adults had febrile symptoms at the time of hospital admission. The signs most commonly noted on physical examination were fever, jaundice, pallor, and hepatosplenomegaly. Of note, Cases 4 to 6 and 12 to 14 reflected two clusters in neonates from contaminated blood products (31).

TABLE 1. TTB, 1999-2007

Year	Total number of babesiosis cases reported to the Rhode Island Department of Health or identified by contacting treating physicians*	TTB cases	Number of units of RBCs transfused†
1999	19	1	35,129
2000	35	1	36,813
2001	27	1	37,072
2002	30	2	39,180
2003	25	1	38,180
2004	48	3	37,327
2005	46	3	35,998
2006	63	3	34,691
2007	60	6	31,691
Total	353	21	326,081

* Data from the Rhode Island Department of Health.
 † Data from the Rhode Island Blood Center.

TABLE 2. Patient demographics*

Patient	Age (years)	Sex	Immunosuppression	Transfusion history
<i>Definite cases</i>				
1	84	Female	None	2 units of RBCs
2	69	Male	Chemotherapy	6 units of RBCs
3	72	Female	Steroids	13 units of RBCs
4	Neonate	Male	Prematurity	Unit given to index case
5	Neonate	Female	Prematurity	Unit given to index case
6	Neonate	Male	Prematurity	8 doses of RBCs†
<i>Probable cases</i>				
7	88	Male	Chronic myeloid leukemia	8 units of RBCs
8	77	Female	None	2 units of RBCs; 5 units of PLTs
9	79	Female	None	1 unit of RBCs
10	45	Male	AIDS	2 units of RBCs
11	39	Male	Functional asplenia due to sickle cell syndrome	11 units of RBCs
12	Neonate	Female	Prematurity	RBC doses and PLTs
13	Neonate	Male	Prematurity	RBC doses
14	Neonate	Male	Prematurity	7 doses of RBCs
15	57	Male	Steroids and infliximab	3 units of RBCs
16	14	Male	Functional asplenia due to sickle cell syndrome	25 units of RBCs
<i>Possible cases</i>				
17	72	Male	None	8 units of RBCs
18	48	Male	Splenectomy	5 units of RBCs
19	69	Male	Asplenia	23 units of RBCs; 10 units of PLTs; 12 units of FFP
20	61	Female	Non-Hodgkin's lymphoma	8 units of RBCs; 11 units of PLTs
21	78	Female	None	22 units of RBCs

* Patients 4-6 and 12-14 represent two clusters of TTB (see Fox et al.³¹).
 † Dose = 15 mL/kg.

TABLE 3. Laboratory data at the time of presentation in symptomatic patients or at the time of diagnosis in asymptomatic patients

Patient	Hb (g/dL)	PLT count ($\times 10^9/L$)	Parasitemia (%)*	LDH (IU/L)†	Haptoglobin‡
<i>Definite cases</i>					
1	9.5	73	Quantification not determined	NA	NA
2	6.9	16	0.2	530	<5.8
3	10.1	388	0.1	317	NA
4	NA	NA	0§	NA	NA
5	NA	NA	0§	NA	NA
6	NA	NA	Quantification not determined	NA	NA
<i>Probable cases</i>					
7	8.6	61	1.6	265	NA
8	9.4	140	1.3	322	NA
9	7.6	94	Quantification not determined	581	<5.8
10	12.4	117	1.2	331	8
11	7.8	164	Quantification not determined	511	<5.8
12	7.1	21	17	NA	NA
13	7.8	155	<1	NA	NA
14	8.4	NA	1.5	481	NA
15	9.1	NA	0.8	219	33
16	9.2	424	0.3	NA	NA
<i>Possible cases</i>					
17	6.6	165	1.4	938	<5.8
18	7.1	893	0.9	403	21
19	9.9	256	10.4	648	<5.8
20	9.5	18	<1	NA	NA
21	9.1	160	0.7	NA	NA

* Parasitemia = % of RBCs infected.

† Normal range, 91-180 IU/L.

‡ Normal range, 16-200 IU/L.

§ *Babesia* confirmed by PCR.

NA = not available.

TABLE 4. Clinical features at presentation

Patient	Incubation period (days)*	Symptoms	Signs
<i>Definite cases</i>			
1	28	Chills	Fever
2	24	Fatigue, weakness, myalgias and arthralgias	Fever
3	84	Malaise	Fever
4	34	Asymptomatic	None
5	34	Asymptomatic	None
6	34	NA	Fever, jaundice, pallor
<i>Probable cases</i>			
7	38	Fatigue, weakness, anorexia	Hypotension
8	41	Fever and chills	Fever, splenomegaly
9	47	Fatigue, weakness, anorexia	Jaundice, pallor, dehydration
10	39	Malaise	None
11	77	Fever	Fever
12	42	NA	Fever, jaundice, pallor
13	37	NA	Fever, jaundice, pallor
14	41	NA	Jaundice, hepatosplenomegaly, pallor
15	41	Chills	Fever
16	42	Asymptomatic	None
<i>Possible cases</i>			
17	NA	Fatigue, weakness, anorexia, shortness of breath, chills, night sweats, nonproductive cough	Jaundice, hepatosplenomegaly
18	NA	NA	Fever
19	NA	Fatigue, weakness, anorexia	Fever
20	NA	NA	Fever
21	NA	NA	NA

* The time between the day of transfusion of the implicated blood component and the onset of clinical symptoms, the initial day parasites were observed in the blood smear, or the day blood was obtained for which was PCR-positive, whichever was earlier.

NA = not available.

Laboratory data at the time of presentation

The level of parasitemia detected by microscopy varied from 0% to 17% (Table 3). At presentation, the median hemoglobin (Hb) level was 8.9 mg/dL (range, 6.6-12.4 mg/dL). Of the eight patients in whom it was measured, haptoglobin was below the level of detection in five patients and was low in two patients. Lactate dehydrogenase (LDH) was elevated in all patients for whom it was measured (median, 442 IU/L; range, 219-938 IU/L).

Treatment and outcomes

Eight patients were treated with atovaquone and azithromycin, five patients received clindamycin and quinine, and two patients received both regimens sequentially. One patient received doxycycline in addition to clindamycin and quinine. A premature infant with 17% parasitemia also received exchange transfusions (Table 5). Treatment information was not available for five cases. The median duration of treatment was 10 days (range, 2-20 days). Three patients expired during the hospitalization in which babesiosis was diagnosed. One of these cases (Case 7) was reported as a death attributable to babesiosis. The two others (Cases 2 and 21) were considered to have expired due to their underlying disease.

Evaluation of implicated donors

Donor *Babesia* serology was positive in the 16 definite or probable cases (Table 5). In 11 cases, *Babesia*-specific PCR was done on donor blood, which helped confirm the six definite cases. The peripheral smear was examined in five donors and was found to be negative for parasites. Hamster inoculation of blood from a single suspected donor was negative.

DISCUSSION

Babesia are intraerythrocytic protozoa. The majority of babesiosis cases in the United States are caused by *B. microti*, with rare reports of disease due to other species including WA-1³² (*Babesia duncani*)³³ and a *B. divergens*-like organism MO-1.³⁴ *B. microti* is transmitted to humans by the deer tick, *I. scapularis*. Babesiosis may also be transmitted by blood transfusion and transplacentally. Although most TTB in the United States involves *B. microti*, two cases of WA-1 *Babesia* acquired from a RBC transfusion have been reported.^{6,21}

Numerous cases of TTB have been reported,³⁻²⁶ including the first *B. microti* case in 1980.¹⁴ Seroprevalence estimates for *B. microti* in blood donors are markedly influenced by seasonal and geographic variations. Seroprevalence among donors is 0.3% in Wisconsin; 1.4% in

TABLE 5. Treatment and outcomes

Patient	Antimicrobial therapy	Duration of treatment	Outcome	Donor testing
<i>Definite cases</i>				
1	Clindamycin + quinine	10	Survived	Serology (+)* PCR (+)
2	Atovaquone + azithromycin	2	Expired	Serology (+) PCR (+) Smear (-)
3	Atovaquone + azithromycin	8	Survived	Serology (+) PCR (+)
4	NA	NA	Survived	Serology (+) PCR (+)
5	NA	NA	Survived	Serology (+) PCR (+)
6	NA	NA	Survived	Serology (+) PCR (+)
<i>Probable cases</i>				
7	Atovaquone + azithromycin followed by clindamycin + quinine	3	Expired	Serology (+) PCR (-)
8	Atovaquone + azithromycin	10	Survived	Serology (+) PCR (-) Hamster inoculation (-)
9	Atovaquone + azithromycin	7	Survived	Serology (+) Smear (-)
10	Atovaquone + azithromycin	10	Survived	Serology (+)
11	Clindamycin + quinine + doxycycline	10	Survived	Serology (+)
12	Clindamycin + quinine followed by azithromycin + atovaquone; exchange transfusions	20	Survived	Serology (+) PCR (-) Smear (-)
13	Clindamycin + quinine	10	Survived	Serology (+) PCR (-) Smear (-)
14	Clindamycin + quinine	14	Survived	Serology (+) PCR (-) Smear (-)
15	Atovaquone + azithromycin	7	Survived	Serology (+)
16	Exchange transfusion done every 6 weeks for sickle cell syndrome	NA	Survived	Serology (+)
<i>Possible cases</i>				
17	Clindamycin + quinine	10	Survived	Donor not identified
18	Atovaquone + azithromycin	7	Survived	Donor not identified
19	Atovaquone + azithromycin	14	Survived	Donor not identified
20	NA	NA	Survived	Donor not identified
21	NA	NA	Expired	Donor not identified

* *Babesia* antibody titer $\geq 1 : 64$ as determined by indirect immunofluorescence.
NA = not available.

Connecticut; 3.7% in Cape Cod, Massachusetts; 4.3% in Shelter Island, New York; and 4.6% in Block Island, Rhode Island.^{22,33,35} In one study, 53% of seropositive blood donors were parasitemic³⁶ and in one study, only 20% of seropositive donors recall having had a tick bite.³⁷ Once *Babesia* is transmitted to a potential donor by a tick, asymptomatic infection may persist for months,³⁸ thereby facilitating transmission through blood donation. Once present in donated blood, *Babesia* survives routine blood bank conditions, including refrigeration up to 35 days.³⁹

We found the mean rate of TTB to be approximately one case per 15,000 units of RBCs transfused. In 2007, transfusion-transmitted cases accounted for 10% of the total Babesiosis cases reported in Rhode Island. It should be noted that there may be underreporting of symptomatic tick-borne disease, which could result in this percentage being much lower.

A study in Connecticut found that the risk of acquiring *B. microti* from a unit of RBCs transfused was 1 in 601 units of transfused RBCs or 0.17% per unit of RBCs transfused.¹³ More recent estimates of TTB in Connecticut have varied from one case in 1800 units of transfused RBCs⁴⁰—1 case per 100,000 or 18 cases over an 11-year period and 1.8 million units of transfused RBCs.⁴¹ Differences between the predicted rate of transfusion-transmitted infection and rates reported to state departments of health likely reflects the high incidence of asymptomatic and unrecognized disease.

Only one of 21 (5%) TTB cases was diagnosed in July, in sharp contrast to 43% of the total babesiosis cases diagnosed during July in Rhode Island (calculation based on 152 cases of babesiosis reported to the Rhode Island Department of Health between 2004 and 2006, of which 65 cases were diagnosed in July).³⁰ Thus, the diagnosis of babesiosis in winter and early spring in northern latitudes (i.e., when deer ticks are less prevalent) should raise suspicion of transmission due to transfusion of infected blood products (Table 6).

The majority of TTB cases involve RBCs; however, at least three cases attributed to PLT transfusion have been reported.^{8,12,14} This is likely due to residual RBCs (up to 0.5 mL) routinely found in PLT bags or because of extracellular parasites.⁴² Plasma has not been reported to

transmit *Babesia*. Although there are a few cases of TTB in organ transplant recipients, no transplantation-transmitted babesiosis has been reported.^{7,11,43}

We found a median incubation period of 39 days. The incubation period of TTB generally reported in the literature is 4 to 9 weeks,⁴⁴ compared with 1 to 4 weeks in naturally acquired illness.^{1,45} However, rare cases of TTB have had an incubation period of as long as 6 months.²⁵ Clinical manifestations reflect the level of parasitemia and the immune status of the host¹ and include a spectrum of illness ranging from asymptomatic infection to fulminant disease complicated by acute respiratory failure, disseminated intravascular coagulation, renal failure, coma, and death.⁴⁶⁻⁴⁹ In our case series, three of 20 patients were clearly asymptomatic. Patients with babesiosis are commonly asymptomatic or experience mild flulike symptoms.^{50,51} Physical exam findings at presentation may include fever, pallor, jaundice, and mild hepatosplenomegaly. Patients with intact spleens, but who present with moderate to severe illness, are usually premature neonates or older than 50 years of age, suggesting that age is a risk factor for severe disease.^{52,53} Other risk factors for more severe disease include asplenia,⁵⁴ cancer, AIDS, and other forms of immunosuppression,⁵⁵⁻⁵⁷ as well as patients with concurrent Lyme disease.⁵⁸ In our study, 14 of 21 patients with TTB had one of these predisposing features.

We found a crude mortality of 14%. The reported mortality from clinically apparent, tick-borne *B. microti* infection is 5% to 9%.^{45,49} This contrasts sharply with *B. divergens* infection in Europe with mortality reported as high as 42%.⁴⁷ All five reported deaths due to TTB were due to *B. microti* infections.^{15,18,19,59,60} From 1997 through 2007, there were nine deaths reported to the FDA due to *Babesia* infection transmitted through blood transfusions. Eight of these nine deaths, including one of our cases, occurred since November 2005.⁶¹

The diagnosis of TTB starts with a high index of suspicion when a patient in an endemic area presents with a febrile illness after blood transfusion. However, suspicion of TTB should also be suspected in other regions as exemplified by the fact that five of 10 donors of recently reported fatal cases had traveled to endemic areas where they likely became infected and transmitted *Babesia* after returning to low-incidence States.⁶¹ As was the case in the majority of the patients we studied, the diagnosis is often made incidentally by laboratory technologists during routine examination of a peripheral blood smear. Nonspecific laboratory findings include anemia, thrombocytopenia, elevated LDH, a low haptoglobin, and mild transaminitis. Methods for diagnosis include microscopic examination of a Wright-stained or Giemsa-stained peripheral blood smear, an indirect immunofluorescence antibody test, *Babesia*-specific PCR, or hamster inoculation.¹ The amplification of *Babesia* DNA using PCR is more sensitive than a blood smear for the detection of *B. microti*

TABLE 6. Comparison of tick-borne babesiosis and TTB in this study

Variable	Tick-borne babesiosis	TTB
Peak incidence	Summer	Year round
History of blood transfusion within 3 months	No	Yes
Male : female ratio	2:1	1.6:1
Neonatal cases	Uncommon	Reported
Incubation period (weeks)	Generally 1-4	Generally 4-9

infection.⁶² However, the absence of detectable *B. microti* DNA in patients with serologic evidence of babesiosis does not rule out infection.⁶² Patients who are *Babesia*-specific PCR-positive are likely to be parasitemic, as microbial DNA is rapidly cleared from the blood in the absence of active replication.⁶³

A combination of clindamycin and quinine sulfate was the first widely used regimen to treat babesiosis.^{17,64} A combination of atovaquone and azithromycin was equally effective and associated with fewer side effects in a study excluding severely ill patients.⁶⁵ A 7- to 10-day treatment course is often used. For severe infections, intravenous clindamycin and oral quinine sulfate should be administered. A longer duration of antimicrobial therapy (i.e., a minimum of 6 weeks and for at least 2 weeks after the last blood smear reveals *Babesia*) is necessary in persistent and relapsing babesiosis in immunocompromised patients.^{64,66} In addition, partial or complete exchange transfusion is indicated for those with severe babesiosis.^{64,67-70} Retreatment should be considered if *Babesia* is found on blood smears or if *Babesia*-specific PCR is positive 3 months after treatment.

Limitations of the study reflect the retrospective study design such that we were unable to obtain complete information on all patients with TTB and that this case series has focused on the transfusion recipients without detail on the blood donors. However, for practical purposes, all cellular blood components transfused in the state are collected from in-state donors, many of whom live in areas in the state with a high density of *I. scapularis* ticks. We did not survey all hospitals within the state nor was the study primarily conducted through the blood supplier. Therefore, we do not have specific information on the time intervals between the implicated donation and the return of the implicated donor for follow-up testing. In addition, unsuspected cases may have been missed if parasites were not observed on routinely obtained blood smears. Furthermore, the increased incidence of TTB over time may also reflect a general increase in awareness of this condition. Physicians contacted regarding additional cases may have been less likely to report older cases to us than more recent ones. Some transfusion-transmitted cases that occurred during the summer months may have been misclassified as tick-borne cases since cases occurring in our endemic area at this time of year may not have prompted an inquiry regarding recently administered blood products. Many cases are likely to be asymptomatic and, hence, the true incidence of TTB reported herein is likely to be underestimated. Finally, the incidence of tick-borne babesiosis varies dramatically by location within our state⁷¹ but we have not determined how this correlates with the location of patients with TTB or their donors. Despite these limitations, it is hoped that this study serves as a basis for future investigations aimed at further elucidating the epidemiology of TTB and its prevention.

In conclusion, in *Babesia*-endemic areas, blood transfusion is an important mode of transmission as approximately one in 10 cases in Rhode Island during 2007 were transfusion-transmitted. Current methods for screening blood donors (i.e., questions regarding previous infection) and processing of whole blood does not completely mitigate the risk of TTB. Based on this study, we propose that it is now timely to reduce the risk of TTB by use of more sensitive screening methods of prospective donors in regions where *Babesia* is endemic. Alternatively, application of pathogen reduction technology could be considered.⁷²

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CONFLICT OF INTEREST

None of the three authors has any potential conflicts of interest.

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