

## Implementation of Molecular Surveillance After a Cluster of Fatal Toxoplasmosis at 2 Neighboring Transplant Centers

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After a cluster of fatal toxoplasmosis among stem cell transplant recipients at 2 hospitals, surveillance with polymerase chain reaction (PCR) (blood) was instituted. Rate of reactivation among seropositive recipients was 2.2 and 16%. Parasitemia was successfully managed with preemptive treatment. For seropositive recipients unable to take prophylaxis, toxoplasma PCR surveillance should be routinely performed.

**Keywords.** toxoplasmosis; stem cell transplant; reactivation; T-cell depleted; CD34+ selected.

*Toxoplasma gondii* (*T. gondii*) is an intracellular parasite that is estimated to infect one third of the world's population [1]. Humans can acquire the infection by ingesting infected undercooked meat, contaminated water, or handling feces from recently infected felids. Primary and reactivation toxoplasmosis in the immunocompromised host usually manifests as a central nervous system disease and less frequently with multivisceral involvement. Most infections in the post-transplant setting are attributed to reactivation; primary or reinfections are rare. Among recipients of stem cell transplant (SCT), risk of *Toxoplasma* reactivation after transplant varies by regional seroprevalence [2]. Reports from European centers found that toxoplasma reactivation occurs in 8.7%–16% of seropositive recipients. Overall incidence of disease is 2.9%–6% [3, 4]. Mortality among transplant recipients with *Toxoplasma* disease is high (63%–80%) [5, 6]. With an overall lower seroprevalence of toxoplasma in the United States compared to Europe, varied screening approaches are used across transplant centers in the United States.

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This study describes a cluster of fatal toxoplasmosis cases at 2 SCT centers in New York City and reports outcomes after implementation of polymerase chain reaction (PCR)-based surveillance.

### METHODS

The institutional review board at both institutions reviewed the study and granted a Health Insurance Portability and Accountability Act waiver of authorization.

The study was conducted at 2 neighboring transplant centers in New York City among recipients of allogeneic SCT as follows: 1. **Pre-surveillance:** Retrospective review of toxoplasmosis cases from December 2012 to September 2013. 2. **Post-surveillance:** Prospective serial testing for detection of *Toxoplasma* in blood from July 2013 to December 2014. Relevant data were obtained from clinical databases. Annually, 150–200 allogeneic SCT are performed at Memorial Sloan Kettering Cancer Center (Hospital A) and 90–100 at New York Presbyterian Hospital Weill Cornell Medicine (Hospital B). *Toxoplasma* serological testing (immunoglobulin M and immunoglobulin G [IgG]) for donor (D) and recipients (R) was routinely performed at Hospital A and for recipients only at Hospital B throughout.

### Transplant Approach for Pre-surveillance Cluster

At Hospital A, recipients of T-cell depleted (TCD) grafts underwent myeloablative conditioning and received CD34<sup>+</sup>-selected grafts obtained with the CliniMACS system (Miltenyi Biotech, Germany) [7]. All patients received anti-thymocyte globulin to promote engraftment. Both patients at Hospital B underwent myeloablative conditioning and received a single unit cord blood transplant with a CD34<sup>+</sup> selected graft from a haplo-identical donor.

### Post-Surveillance

#### *Toxoplasma* PCR

In response to the cluster, screening in high-risk patients using whole blood PCR was implemented. In July 2013, Hospital A began surveillance for recipients with positive pretransplant *Toxoplasma* serology (D+ or R+), twice weekly starting at day +14 until discharge. After discharge, weekly testing was conducted until day +100 or as clinically indicated. In October 2013, Hospital B implemented surveillance for all allogeneic transplants regardless of donor or recipient serostatus at weekly intervals from transplant until clinician discretion. *Toxoplasma* PCR assay for both hospitals was performed at the same reference laboratory (Viracor-IBT, Lenexa, Kansas). This PCR assay targets a 529 bp repeated element.

### Prophylaxis

At Hospital A, seropositive recipients (R+) received prophylaxis with trimethoprim/sulfamethoxazole (TMP-SMX) during

conditioning (days -7 until -2). Prophylaxis was resumed on day +14 with atovaquone, until TMP-SMX could be reintroduced (1 double-strength [DS] 3 times a week). At Hospital B, TMP-SMX was given from day -7 to day -2 and reintroduced on day +30 (1 DS twice a day on weekends). For patients allergic to TMP-SMX, atovaquone was used.

### Statistical Analysis

The incidence of toxoplasmosis was the cumulative probability of *Toxoplasma* reactivation at 4 months after transplant. Fisher exact test was used to compare categorical variables. All reported *P* values are 2-sided. A *P* value <.05 was considered statistically significant.

## RESULTS

### Pre-Surveillance (Cluster)

The baseline average number of toxoplasmosis cases at Hospital A was 0–1 case/year (2008–2012). No cases occurred at Hospital B. From December 2012 to September 2013, 4 cases were diagnosed at hospital A and 2 at Hospital B (5 R+; 1 seronegative recipient). Four cases occurred within 2 months. The mean age was 58; 3 were males. Average duration from transplant was 55 days (median 38; range 23–135). Five patients had fever at onset and rapidly developed fatal hypoxic respiratory failure. Five patients had absolute lymphocyte count <500/mm<sup>3</sup>; peak levels of lactate dehydrogenase were >1000 U/L in 4 patients. Diffuse interstitial pneumonitis and multisystem organ failure were noted in all fatal cases.

Average duration from symptom onset to death was 7.5 days. Four patients died within 40 days of transplant. Three patients were taking atovaquone for prophylaxis against *Pneumocystis jiroveci* pneumonia but reported noncompliance. One R- patient was suspected to have developed acute infection. Diagnosis of toxoplasmosis was made by blood PCR (n = 4 patients at Hospital A, range 45 100–4 900 000 genomic copies/mL) or autopsy findings (n = 2 at Hospital B).

None of the patients had common donors for graft, red blood cell (RBC) or platelet units. Residual RBC units tested were negative for *Toxoplasma* by PCR. No common lot numbers for infusion products were identified. Procedural review of the ex-vivo T-cell depletion method did not reveal any lapses. The Centers for Disease Control and Prevention (CDC) were notified. CDC performed a nationwide query through the Emerging Infection Network that did not recognize additional transplant centers with a similar problem.

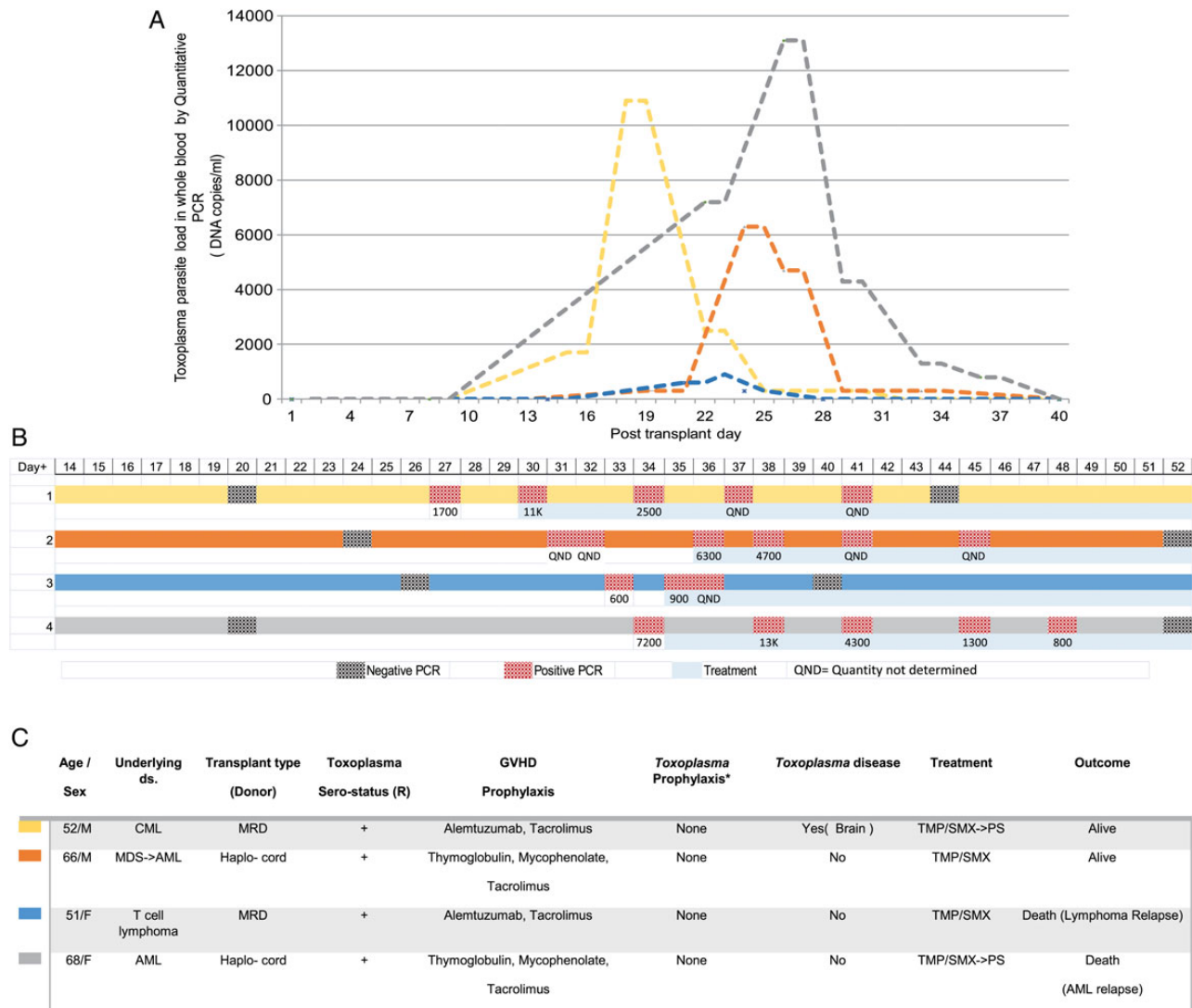
### Post-Surveillance

#### Hospital A

From July 2013 to December 2014 (18 months), 274 patients underwent allogeneic SCT 46/274 (17%) patients were IgG+ on screening (R+). Additionally, 23 (8%) recipients received grafts from seropositive donors (D+/R-). Surveillance tests for a follow-up period of at least 4 months were included (until April 2015). A summary of *Toxoplasma* testing is shown in Table 1.

**Table 1. Summary of *Toxoplasma* Surveillance Testing at Hospital A and B for Transplants Performed During the Post-surveillance Period**

Hospital	Transplant type	Number of patients	Recipient Negative /Donor Positive			Recipient Positive		
			D+/R-	D+ or D-/R-	D+ or D-/R+	Parasitemia detected (%)	Number of patients	Number of tests
Hospital A	Conventional	96	12	121	20	0/12	208	0/20
	CD34+ selected PB	140	11	148	19	0/11	277	0/19
	Cord blood +/-CD34+ selected PB	38	0	0	7	N/A	132	1/7 (14%)
	Total	274	23 (8%)	269	46 (17%)	0/23	617	1/46 (2.2%)
	Total		R-	Recipient negative <sup>a</sup>	R+	Recipient positive		
Hospital B	Conventional	96	12	121	20	0/12	208	0/20
	CD34+ selected PB	140	11	148	19	0/11	277	0/19
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Hospital B	Conventional	96	12	121	20			



**Figure 1.** Hospital B: *Toxoplasma* infection in 4 patients detected during the surveillance period. *A*, Graphic representation of *Toxoplasma* parasite load in blood, relative to day of transplant. *B*, Timing of surveillance testing and treatment for the four patients. *C*, Clinical and transplant characteristics. Color bars are coordinated to depict the corresponding patient in part (*A*, *B*) and embedded table *C*. \*All received TMP-SMX from day -7 until day -2. Abbreviations: AML, acute myelogenous leukemia; CML, chronic myelogenous leukemia; GVHD, graft versus host disease; MDS, myelodysplastic syndrome; MRD, male related donor; PCR, polymerase chain reaction; PS, pyrimethamine sulfadiazine; R, recipient; TMP-SMX, trimethoprim sulfamethoxazole.

The characteristics of the seropositive recipients are shown in [Supplementary Table 1](#). Among 617 surveillance tests in R+ patients (n = 46), one case of reactivation occurred (1/46; 2.2%): 65 year-old male with AML with CD34+ selected SCT from an unrelated donor had *Toxoplasma* parasitemia (4400 copies/mL) on day +115. He was asymptomatic and known to be noncompliant with prophylaxis. Treatment with pyrimethamine and sulfadiazine was initiated, and blood *Toxoplasma* PCR became undetectable 15 days later.

#### Hospital B

From October 2013 to December 2014 (15 months), 120 allogeneic transplants were performed, 25 (20.8%) were R+ (Table 1).

In total, 591 surveillance tests were performed among this cohort (Table 1). Parasitemia was detected in 4 patients with an overall infection rate of 16%; 1 had *Toxoplasma* disease. The clinical characteristics of the 4 cases are shown in Figure 1. All patients responded to treatment and no *Toxoplasma* related deaths occurred.

#### DISCUSSION

Early symptoms of toxoplasmosis among SCT patients are non-specific, making diagnosis challenging. In a recent review of intensive care unit admissions for disseminated toxoplasmosis in France, 1 of 21 allogeneic SCT recipients survived [5],

emphasizing that outcomes of *Toxoplasma*-related illness in this population is dismal [8]. We report a cluster of 6 cases among SCT recipients at 2 neighboring institutions in New York City. All of our patients were at high risk for toxoplasmosis and experienced a fulminant course. A detailed epidemiologic investigation did not reveal any common link. Although the etiology for the increased incidence of toxoplasmosis could not be elucidated, endogenous reactivation is most likely. Recent reports from European centers have suggested PCR screening for toxoplasmosis in high-risk patients [9]. As a prevention strategy, prophylaxis for toxoplasmosis with TMP-SMX is effective. However, noncompliance is common as occurred among 3/6 patients in the reported cluster.

We describe different approaches adopted by two transplant centers that perform a large number of TCD and cord transplants but have different transplant related practices. Hospital A implemented early prophylaxis based on timing of cases in the cluster. Surveillance results from this center show an overall low rate of parasitemia (2.2%), with one late breakthrough due to noncompliance with prophylaxis. Hospital B implemented an extended surveillance that included seronegative recipients; TMP-SMX prophylaxis was started at day +30. Parasitemia was detected in 4/25 patients (16%), between days 27 and 34. All patients who developed parasitemia at Hospital B had received prophylaxis with TMP-SMX during conditioning but developed parasitemia before prophylaxis could be reintroduced after transplant. All reactivations were identified and successfully treated without subsequent relapse. Differences in clinical practices, including method of T-cell depletion (CD34+ selection in Hospital A vs Alemtuzumab in Hospital B), and timing of post-transplant prophylaxis may account for these differences.

Notably, none of the D− or D+/ R− had evidence of *Toxoplasma* infection; the cost of surveillance in this group should be weighed against the rare reports of *Toxoplasma* reactivation or acute infection among seronegative recipients. Although screening is not warranted, a high index of suspicion should be maintained for clinically compatible illness in seronegative recipients due to risk of acute infection. Our case series is limited by the small number of cases, retrospective design, and limitations of PCR diagnosis [4, 10, 11]. Heterogeneous transplant related practices were used across the 2 centers; compliance with prophylaxis could not be assessed [4].

Disseminated toxoplasmosis is a devastating disease in SCT recipients. Prophylaxis with TMP-SMX is effective for toxoplasma reactivation but despite best efforts, assuring adherence can

be challenging. Our report shows that PCR is an effective surveillance method for detection of *T. gondii* infection, and preemptive treatment of parasitemia improves clinical outcomes [12]. PCR surveillance targeting seropositive recipients unable to take prophylaxis should be strongly considered as a standard for early detection of toxoplasma reactivation after SCT.

### Supplementary Data

Supplementary materials are available at <http://cid.oxfordjournals.org>. Consisting of data provided by the author to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the author, so questions or comments should be addressed to the author.

### Notes

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### References

1. Weiss LM, Dubey JP. Toxoplasmosis: A history of clinical observations. *Int J Parasitol* **2009**; *39*:895–901.
2. Derouin F, Pelloux H; Parasitology ESGoC. Prevention of toxoplasmosis in transplant patients. *Clin Microbiol Infect* **2008**; *14*:1089–101.
3. Meers S, Lagrou K, Theunissen K, et al. Myeloablative conditioning predisposes patients for *Toxoplasma gondii* reactivation after allogeneic stem cell transplantation. *Clin Infect Dis* **2010**; *50*:1127–34.
4. Martino R, Bretagne S, Einsele H, et al. Early detection of *Toxoplasma* infection by molecular monitoring of *Toxoplasma gondii* in peripheral blood samples after allogeneic stem cell transplantation. *Clin Infect Dis* **2005**; *40*:67–78.
5. Schmidt M, Sonneville R, Schnell D, et al. Clinical features and outcomes in patients with disseminated toxoplasmosis admitted to intensive care: a multicenter study. *Clin Infect Dis* **2013**; *57*:1535–41.
6. Mele A, Paterson PJ, Prentice HG, Leoni P, Kibbler CC. Toxoplasmosis in bone marrow transplantation: a report of two cases and systematic review of the literature. *Bone Marrow Transplant* **2002**; *29*:691–8.
7. Hobbs GS, Hamdi A, Hilden PD, et al. Comparison of outcomes at two institutions of patients with ALL receiving ex vivo T-cell-depleted or unmodified allografts. *Bone Marrow Transplant* **2015**; *50*:493–8.
8. Small TN, Leung L, Stiles J, et al. Disseminated toxoplasmosis following T cell-depleted related and unrelated bone marrow transplantation. *Bone Marrow Transplant* **2000**; *25*:969–73.
9. Gea-Banacloche J, Masur H, Arns da Cunha C, et al. Regionally limited or rare infections: prevention after hematopoietic cell transplantation. *Bone Marrow Transplant* **2009**; *44*:489–94.
10. Fricker-Hidalgo H, Bulabois CE, Brenier-Pinchart MP, et al. Diagnosis of toxoplasmosis after allogeneic stem cell transplantation: results of DNA detection and serological techniques. *Clin Infect Dis* **2009**; *48*:e9–15.
11. Saadatnia G, Golkar M. A review on human toxoplasmosis. *Scand J Infect Dis* **2012**; *44*:805–14.
12. Gajurel K, Dhakal R, Montoya JG. Toxoplasma prophylaxis in haematopoietic cell transplant recipients: a review of the literature and recommendations. *Curr Opin Infect Dis* **2015**; *28*:283–92.