

# Rapid Molecular Diagnosis of a Disseminated Fungal Infection Presenting as Sudden Bilateral Visual Loss in a Patient With Acute Myeloid Leukemia

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**F***usarium* species are emerging human fungal pathogens and are widely distributed in soil, plants, food, and indoor environments. They have recently been found to be the cause of invasive systemic infections, primarily in the immunocompromised host.<sup>1-6</sup> *Fusarium* spp. are the most common cause of keratomycosis in the southeastern United States. In addition, exogenous endophthalmitis has been documented in this same patient population.<sup>7,8</sup>

Endogenous fungal endophthalmitis is a sight-threatening infection primarily caused by *Candida* species.<sup>9</sup> Other fungi have rarely been reported to cause endogenous fungal endophthalmitis, and include *Aspergillus* spp., *Cryptococcus neoformans*, and *Penicillium* spp.<sup>7,9</sup> Furthermore, only a handful of endogenous endophthalmitis cases have been caused by *Fusarium* spp.<sup>10-14</sup> Even more uncommon is the presentation of sudden bilateral fungal endophthalmitis, which has only been reported twice in the literature.<sup>11,15</sup> To date, there have been no cases reporting the sudden onset of blindness due to bilateral endophthalmitis caused by two different fungi simultaneously.

Most cases of fungal endophthalmitis are caused by disseminated fungal infections in patients with compromised immune function due to hematologic malignancies, high-dose steroids, or stem-cell transplantation. The overall prognosis of this infection is poor, and disease-related mortality is very high despite local and systemic antifungal therapy.<sup>2-5</sup>

The case presented herein is unique because it describes a patient with acute myeloid leukemia (AML) who presented to the ophthalmology department with sudden and bilateral visual loss, which was found to be secondary to endogenous fusarial and candidal endophthalmitis. Although the diagnosis was made early and antifungals were administered quickly, the patient died due to the disseminated fusariosis and candidiasis only 5 days after the initial presentation.

## Case Report

A 69-year-old woman was referred to the Kresge Eye Institute with acute bilateral vision loss. Five days prior to admission, she complained of white spots in both visual fields, with a rapid decrease in visual acuity. Her medical history was significant for myelodysplastic syndrome that converted to AML 4 months prior to her visual symptoms. In preparation for bone marrow transplantation she had received cyclophosphamide, topotecan, and cytarabine. The cycle had been completed 19 days before admission. During the neutropenic phase, which lasted 18 days, the patient developed *Klebsiella pneumoniae* and vancomycin-resistant enterococcal bacteremia that were treated with ciprofloxacin and linezolid.

Upon presentation to the ophthalmologist, the patient was afebrile, with stable vital signs. On examination, her visual acuity was to hand motion in both eyes. At the bedside, the portable slit lamp examination indicated mild (1+) cells and flare in the aqueous humor of both eyes and a small fibrin clot on the surface of both crystalline lenses. Intraocular pressures were 17 mm Hg OD and 15 mm Hg OS. The fundoscopic examination revealed a hazy view with significant vitritis in both eyes. The retina

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**Table 1.** Methodology

Method	Description
Fungal Isolates	Identification of the patient's fungal isolates was performed using conventional mycologic methods and the API 32C kit (bioMerieux).
PCR Assay	<p>PCR Primers</p> <p>A panfungal primer and three nested primers for <i>Candida albicans</i>, <i>Asperillus fumigatus</i>, and <i>Fusarium solani</i> previously published by Jeager and colleagues were used to identify the fungal DNA.<sup>7</sup> Because the nested primer for <i>C. albicans</i> has not been used to differentiate between the different <i>Candida</i> species, we also used a 10-mer primer that has been studied and is able to differentiate effectively and quickly between the different <i>Candida</i> species.<sup>15</sup></p>
	<p>PCR Parameters</p> <p>PCR assays were processed using a thermocycler (Robocycler 40, Stratagene) according to protocols described elsewhere.<sup>7,9</sup> Reaction products were analyzed by ethidium bromide agarose gel electrophoresis (1.5%). In order to insure accuracy, the PCR assays were performed in triplicate. Positive and negative controls of <i>C. albicans</i>, <i>Candida glabrata</i>, and <i>F. solani</i> were run simultaneously during each assay.</p>

PCR = polymerase chain reaction.

appeared white with nonperfused vessels. The rest of the examination was unremarkable except for an erythematous nontender macule on the patient's right forearm.

Bilateral anterior pars plana vitrectomies were performed. Vitreous specimens from both eyes were sent for Gram stain, culture, and polymerase chain reaction (PCR) studies. Vancomycin (1 mg/0.1 mL), amikacin (400 µg/0.1 mL), and amphotericin B (5 µg/0.1 mL) were injected into the vitreous cavity of both eyes. Blood cultures were drawn and the new skin lesion was biopsied and sent for histopathologic and microbiologic analysis. See Table 1.

Within 48 hours, analysis of vitreous and blood specimens using a PCR assay with a panfungal primer followed by nested fungal primers revealed DNA from *Fusarium* and *Candida* species in both vitreous specimens and from the blood (Table 2 and Figure 1). Amphotericin B lipid complex (Abelcet, Enzon) at 5 mg/kg/day was immediately initiated. Within 72 hours of admission, the blood cultures were positive for *Fusarium* and *Candida* species. At the same time, the vitreous and skin specimens were also reported to be culture-positive for *Fusarium* species.

Unfortunately, the patient's mental status declined rapidly over the next 48 hours and, despite early and aggressive therapy, she died from multisystem organ failure.

## Discussion

*Fusarium* spp. are ubiquitous filamentous molds; they are important plant pathogens commonly found in soil and on plants. Previously, fusarial infection was observed fol-

lowing ingestion of grain contaminated with *Fusarium*, and produced fusarial toxicosis associated with plastic anemia and death. The most common form of fusariosis involves blood stream infection in immunocompromised hosts. Hematologic malignancies with associated neutropenia due to chemotherapy are among the most frequent underlying conditions.<sup>12-14,16</sup> In addition, *Fusarium* is associated with infections due to local trauma or burns (direct inoculation), producing keratomycosis or burn-wound infections.<sup>8,17,18</sup>

Bilateral endogenous endophthalmitis is extremely rare, and has only been reported twice as the initial manifestation of disseminated fungal infection.<sup>11,12</sup> The cases, in an HIV-infected patient and an AML patient, were caused by *Fusarium* spp.<sup>7,19</sup> In most situations, the mortality rate associated with this infection is greater than 50%. It is possible that early local and systemic antifungal therapy can reduce the morbidity and mortality associated with this infection; however, neutrophil recovery plays a critical role and is a more important prognostic indicator in the eradication of any form of disseminated fungal infection.<sup>16</sup>

*Fusarium* spp. are unique due to their propensity to invade and occlude intraocular vasculature, leading to infarction and necrosis; this may explain the ischemic appearance of the retina in the patient.<sup>13</sup> For the same reason, it is not uncommon to find organisms in the bloodstream as well as dermatologic lesions. Autopsy evidence from patients with disseminated fusariosis frequently reveals diffuse involvement of the central nervous system.<sup>14</sup> The isolation of *Fusarium* from the patient's skin lesion and blood, along with the sudden development of

widespread organ dysfunction and the rapid decline of her mental status, are consistent with these findings.

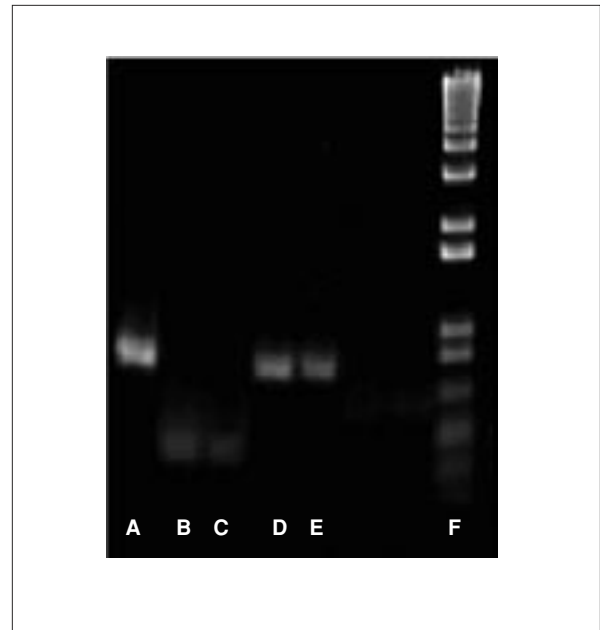
To the best of our knowledge, this is the first report of bilateral endogenous polyfungal endophthalmitis as the presenting manifestation of a disseminated fungal infection in a patient. Early recognition and diagnosis of the disease by an ophthalmologist and prompt treatment in collaboration with other specialists can potentially decrease the risk of a fatal outcome. In this setting, the ophthalmologist may play a crucial role in diagnosing systemic *Fusarium* infection in immunocompromised patients.<sup>11-13</sup>

This case is also unique because the disseminated infection was detected by use of molecular biology techniques (PCR assays) in both the blood and vitreous fluid within 48 hours of presentation and later confirmed by positive fungal cultures. PCR-based methods offer the possibility of establishing an etiologic diagnosis in less time than standard cultures, and, because they can detect very low numbers of DNA copies, these methods have the potential to be extremely sensitive.<sup>15,20,21</sup> Furthermore, because the specimen volume from intraocular infections is relatively small and the culture-positivity rate is quite low, a PCR-based assay should prove extremely useful in this patient population.<sup>9,21</sup>

Our results suggest a potential role for PCR-based assays in the diagnosis of infectious endophthalmitis. Alexandrakis and associates<sup>22</sup> used a PCR-based assay to detect *Fusarium* in the vitreous fluid of a patient who died from a disseminated fusariosis. Recently, other investigators have also reported using PCR-based assays to establish a diagnosis of fungal endophthalmitis and posttraumatic keratitis.<sup>9, 21</sup>

Because this is a relatively new technique, however, there are several disadvantages. The lack of standardization of PCR-based techniques for fungi detection is a major limitation, as protocols may vary from investigator to investigator. In addition, PCR-based assays have a reputation for producing false-positive reactions if there is specimen contamination or amplicon carryover. Furthermore, some biologic fluids, including vitreous, may contain substances that inhibit the PCR assay by acting directly on the Taq polymerase.

In conclusion, in patients with suspected invasive fungal infections, including endophthalmitis, the detection of fungal DNA by use of PCR assays of blood, skin, and vitreous specimens may be clinically useful. It may also be able to establish a rapid and accurate etiologic diagnosis of infection prior to positive cultures or in the presence of negative cultures. Larger prospective studies are required to validate this technique and for comparison with standard microbiologic methods. Furthermore, the availability of this technique in the early stages of



**Figure 1.** Results demonstrating the detection of fungal DNA from vitreous and blood specimens by species-specific polymerase chain reaction assay. Lane A is *Candida glabrata* control strain; lane B is vitreous fluid positive for *Fusarium* spp.; lane C is blood positive for *Fusarium* spp.; lane D is vitreous fluid positive for *C. glabrata*; lane E is blood positive for *C. glabrata*; and lane F is the molecular marker.

**Table 2.** Comparison of Fungal Cultures and PCR Assay Results

Specimen	PCR Assay	Culture
Vitreous fluid	<i>Fusarium</i> spp. <i>Candida glabrata</i>	<i>Fusarium</i> spp.
Blood	<i>Fusarium</i> spp. <i>C. glabrata</i>	<i>Fusarium</i> spp. <i>C. glabrata</i>
Skin	ND	<i>Fusarium</i> spp.

ND = not done, PCR = polymerase chain reaction.

infection would allow for the prompt institution of appropriate antifungal therapy and possibly improve patient outcome.

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## Review

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*Fusarium* spp. cause a broad spectrum of infections in humans, including superficial (eg, keratitis and onychomycosis), locally invasive, and disseminated infection, with the latter occurring almost exclusively in severely immunocompromised patients.<sup>1</sup> The most common infections in immunocompetent individuals are keratitis and onychomycosis. Less frequently, the infection may occur as a result of skin breakdown (eg, burns and wounds<sup>1</sup>) or the presence of foreign bodies (eg, keratitis in contact lens wearers,<sup>2</sup> peritonitis in patients receiving continuous ambulatory peritoneal dialysis,<sup>3</sup> and catheter-associated fungemia<sup>4</sup>). Other infections in immunocompetent patients include pneumonia,<sup>5</sup> septic arthritis,<sup>6</sup> sinusitis,<sup>7</sup> thrombophlebitis,<sup>8</sup> fungemia with or without organ involvement,<sup>1,9</sup> osteomyelitis,<sup>10</sup> and endophthalmitis.<sup>11,12</sup>

Immunocompromised patients at high risk for fusariosis are those with prolonged neutropenia and T-cell immunodeficiency. Cancer is the most frequent underlying disease,<sup>1</sup> especially acute leukemia.<sup>13</sup> Unlike infection in the normal host, fusariosis in the immunocompromised population is typically invasive and disseminated. The most frequent organs involved in disseminated infection are the skin, lungs, and sinuses. A striking characteristic of fusariosis, as opposed to aspergillosis and most other invasive mold infections, is the high frequency of positive blood cultures, mostly in the context of disseminated disease. In a series of 84 cases in cancer patients, 55% had positive blood cultures.<sup>13</sup>

In immunocompetent individuals, endophthalmitis caused by *Fusarium* spp. may occur as a complication of advanced keratitis<sup>14</sup> or ocular surgery, such as cataract extraction.<sup>15</sup> By contrast, fusarial endophthalmitis in the immunosuppressed host results from hematogenous

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seeding, in the setting of disseminated infection.<sup>16,17</sup> Among 84 cancer patients with fusariosis, 7 (8%) developed blindness during the course of disease, as a result of eye involvement.<sup>13</sup>

The case reported by Vazquez and colleagues<sup>18</sup> illustrates the typical natural history of invasive fusariosis occurring in patients with AML. The patient had received chemotherapy for the treatment of AML, resulting in a prolonged period of neutropenia. What is remarkable in this case is the fact that a decrease in visual acuity seemed to be the first manifestation of disseminated fusariosis. Another interesting feature of this case was the concomitance of candidiasis and fusariosis, with confirmation by PCR of both vitreous specimens and blood cultures. The results of PCR assays were available 24 hours before the positive blood cultures, and this may be an advantage of using these techniques, as noted by the authors.

The prognosis of fusariosis is largely dependent on the immune status of the host. In severely immunocompromised patients, reversal of immunosuppression is critical. An analysis of 84 patients with hematologic diseases revealed 30- and 90-day survival rates of 50% and 21%, respectively.<sup>13</sup> Multivariate predictors of poor outcome were persistent neutropenia (hazard ratio [HR] = 5.43; 95% confidence interval [CI] 2.64–11.11) and recent therapy with corticosteroids (HR=2.18; 95% CI 1.98–3.96). The actuarial survival of patients was 0% for patients with both unfavorable prognostic factors, and 4% for those with persistent neutropenia only. By contrast, patients who had neither of these two risk factors had a survival rate of 67%, with a survival rate of 30% for recipients of corticosteroids who had adequate neutrophil counts ( $P < .0001$ ). Among the hematopoietic stem cell transplant recipients, 90-day survival after diagnosis was only 13%, and the single predictor of poor outcome was persistent neutropenia (HR=12.05, 95% CI 1.46–100).<sup>19</sup>

The disease course of the case presented by Vazquez and colleagues<sup>18</sup> was that of a rapidly fatal disease. Interestingly, only 1 of the 7 cancer patients with fusariosis from our database who developed blindness survived, with a median survival of only 24 days from diagnosis.<sup>13</sup>

The optimal treatment for patients with disseminated fusariosis remains unclear as there are no controlled trials and because the outcome is largely influenced by the immune status of the host. In a retrospective analysis of 84 patients with hematologic diseases and invasive fusariosis, the response rate to a lipid formulation of amphotericin B appeared superior to that of deoxycholate amphotericin B (46% vs 32%), although the difference was not statistically significant ( $P = .36$ ).<sup>13</sup> In addition to a lipid formulation of amphotericin B, three salvage trials with antifungal therapy have been reported. Amphotericin B lipid complex was given to 28 patients with fusariosis, 8 as

first-line, and 20 as salvage therapy because of intolerance (8 patients) or lack of response to primary therapy (12 patients).<sup>20</sup> The response rate (cure or improvement) in 26 evaluable patients was 46%. In another study, voriconazole was given to 11 patients with fusariosis, all intolerant of or refractory to primary therapy.<sup>21</sup> The response rate (complete and partial response) was 45%, with a 90-day actuarial survival of 71%. Posaconazole has also been used as salvage therapy for 21 patients with proven or probable fusariosis, with a response rate of 48%.<sup>22</sup> The potential of these new azoles as primary treatment of disseminated fusariosis, as well as the role of combination therapy, remains to be determined.

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