


Fusarium-Induced Cellulitis in an Immunocompetent Patient With Sickle Cell Disease: A Case Report

Journal of Investigative Medicine High Impact Case Reports
Volume 8: 1–6
© 2020 American Federation for Medical Research
DOI: 10.1177/2324709620934303
journals.sagepub.com/home/hic


Shaher Samrah, MBBS, FCCP¹ , Aroob Sweidan, MBBS¹, Abdelwahab Aleshawi, MBBS², and Mahmoud Ayesh, MBBS, MRCP¹

Abstract

Fungal infections due to *Fusarium* species are mostly present in immunocompromised and patients with poorly controlled diabetes mellitus. We report a case of lower extremity skin infection caused by *Fusarium* species in a 61-year-old woman diagnosed with sickle cell disease. Single skin ulceration caused by *Fusarium* species can result from fungal inoculation into damaged tissue, so any condition that damages the skin can be considered as a risk factor for inoculation. Long-standing sickle cell disease may develop vaso-occlusion in the skin that can produce lower extremity ulcers and myofascial syndromes. The mechanism is not completely characterized, but compromised blood flow, endothelial dysfunction, thrombosis, inflammation, and delayed healing are thought to contribute to locally compromised tissue that may eventually lead to opportunistic infection such as in our case. Other factors contribute to the pathophysiology of lower extremity ulcers such as diabetes mellitus, with the resulting peripheral vascular ischemia causing poor circulation to the lower extremity, and peripheral neuropathy, which can make patients with diabetes unaware of minor trauma leading to the development of skin infections.

Keywords

Fusarium, fungal, sickle cell, immunocompetent

Introduction

Fusarium species are commonly located in soil and organic materials.^{1,2} Recently, pneumonia, fungemia, and disseminated infection with *Fusarium* after inhalation or minor trauma have been recognized as major complications in patients with hematological malignancies and other disorders that decrease the immunity, but *Fusarium* infections are yet considered rare in immunocompetent patients.^{3–10}

Sickle-shaped red blood cells found in sickle cell disease (SCD) patients often complicate the chronic anemia by reducing the blood flow into different tissue and major organs as a result of its vaso-occlusive ability. One of the major morbidity in patients with SCD are the musculoskeletal complications that affect quality of life.¹¹ There are limited data on the incidence, management, and possible complications of chronic lower extremity ulcers in SCD. One study revealed that chronic ulcers in SCD patients are similar to chronic ulcers from peripheral arterial disease in the general population because they share the same mechanism of blood flow limitation due to vaso-occlusion, blood vessels malformation, and chronic inflammation.¹² On the other hand, acute development of superinfected lower extremity ulcers in SCD patients, the frequency, risk factors,

pathophysiology, and causative microorganisms are under-presented in the literature.

Case Report

We report a case of a 61-year-old Jordanian lady with SCD, known to have chronic atrial fibrillation, pulmonary hypertension associated with right-sided heart failure, asymptomatic-pigmented gallstones, hypertriglyceridemia, osteoporosis, and gout.

She presented to the hematology outpatient clinic with 2 right lower extremity skin lesions: one over the lateral malleolus and one on the lowest third of the lateral side of the leg (superior to the first ulcer; Figure 1A). She had these lesions

¹Jordan University of Science and Technology, Irbid, Jordan

²King Abdullah University Hospital, Irbid, Jordan

Received January 31, 2020. Revised May 1, 2020. Accepted May 9, 2020.

Corresponding Author:

Shaher Samrah, MBBS, FCCP, Department of Internal Medicine, Faculty of Medicine, Jordan University of Science and Technology, PO Box 3030, Irbid 22110, Jordan.

Email: samrah@just.edu.jo





Figure 1. (A) On admission (first encounter), 2 skin ulcers: one over the lateral malleolus and one on the lowest third of the lateral side of the leg. Lesions appear necrotic with no active secretions, tight skin is noticed around the lesions extending down to the foot indicating edema, this edema was pitting on examination. (B) After antibiotic use (piperacillin-tazobactam) as an empirical therapy while waiting for the culture results. Lesions were still the same size with no improvement of edema or pain on examination. (C) After 5 days of voriconazole and local terbinafine, base is not composed of necrotic tissue and is not dry, likely due to the effect of local antifungal cream. Much worse edema and pain were also witnessed on physical examination. (D) After 5 days of starting amphotericin-B, significant improvement in the lesions were noticed. Edema was grade 1 (after being grade 3 constantly on previous daily examination), pain was still there but significantly milder. We started noticing this gradual improvement on day 3 of starting amphotericin-B.

for 2 weeks prior to presentation with a query history of traumatic inoculation after walking around her garden with bare feet. The lesions started as papules and were enlarging over the course of 2 weeks, progressing to ulcerated and necrotic lesions, associated with grade 3 pitting unilateral edema of the right lower extremity and severe pain and tenderness to touch with occasional oozing of purulent discharge from the center.

The patient was started on hydroxyurea more than 5 years prior to presentation. Most recent hemoglobin (Hb) electrophoresis showed: HbS level = 77%, HbF level = 8%, HbA1 level = 11%, HbA2 level = 3%, and baseline Hb = 7.0 g/dL; her CHA2DS2-VASc score equals one; she is on aspirin and carvedilol. Other medications include furosemide, gemfibrozil, allopurinol, calcium carbonate, alfacalcidol, and alendronate.

On presentation, the patient was found to have a baseline normal kidney function, normal ionized calcium, magnesium, and phosphorus levels. White blood cell count was $7.2 \times 10^3/\text{mm}^3$ (lymphocytes = 36.8%, monocytes = 9.8%, neutrophils = 45.3%, eosinophils = 6.8%, basophils = 1.3%), C-reactive protein = 1.82 mg/dL, and erythrocyte sedimentation rate = 52 mm/1 h. There was no evidence of any underlying immunocompromising condition and she was

never diagnosed with any opportunistic infection previously. Ankle X-ray and magnetic resonance imaging were performed and showed to underlying tissue collection or bone involvement.

She was admitted to the center as a case of skin ulcers associated with surrounding cellulitis. She was empirically commenced on intravenous (IV) antibiotics (piperacillin-tazobactam and teicoplanin) after sending swab cultures from the purulent discharge from both lesions. A set of blood cultures obtained prior to starting the antibiotics were negative. Vascular surgery team was consulted and closely followed-up the clinical progression of the ulcers. Debridement was not needed as there was no significant necrotic tissue. After 5 days of IV antibiotics, there was no evidence of any improvement of the lesions (Figure 1B), swab culture results came back positive for a heavy growth of *Fusarium*. Infectious Disease team was consulted and IV voriconazole was immediately started, accompanied by local terbinafine cream. After 5 days of IV voriconazole, edema and pain were getting worse but with the absence of necrotic tissue (Figure 1C). A set of blood cultures taken before starting voriconazole were negative for fungemia. Swab cultures were repeated after 5 days and showed persistent heavy growth of *Fusarium*. After 6 days of IV voriconazole, a trial



Figure 2. (A) On day of discharge, 2 days after stopping amphotericin-B (9 days of treatment). Lesions were surrounded by viable red skin, base was raised, and pus was dry almost all over the lesion. Trace pitting edema was still there but pain was completely absent on examination. Swab cultures were taken from the small area of wet pus from the lesion over the lateral malleolus came back negative for *Fusarium* infection or any microorganism growth. (B) This photo was taken after 4 weeks of stopping treatment. Lesions appeared well healed, base was raised, and dry, in the process of peeling. No edema or pain on physical examination. (C) This photo of the previously ulcerated lesion on lower third of lateral leg was taken in the clinic, after 12 weeks of stopping the treatment. Completely healed with no pus, edema, or pain.

of conventional amphotericin-B dose was initiated with a loading dose of 30 mg (0.45 mg/kg) over 6 hours, followed by 50 mg/day (0.75 mg/kg) maintenance dose. Amphotericin B was chosen over liposomal amphotericin-B and amphotericin-B lipid complex due to financial limitation. The course of treatment was complicated by hypokalemia and mild impairment in kidney function requiring reduction of amphotericin-B maintenance dose to 30 mg/day (0.45 mg/kg). Precise hydration, daily blood cell count, liver and kidney function test, and pain management were carried out. After 5 days of amphotericin-B, a significant improvement in the skin lesions was noticed. A repeated set of blood cultures were again negative for fungemia. Swab cultures were repeated and were negative for *Fusarium* growth for the first time. In the light of the significant clinical improvement, along with the ongoing renal impairment, decision was made to stop amphotericin-B and closely monitor the ulcer (Figure 1D). Her kidney function and electrolytes were back to her baseline within 2 days off the treatment, her lesions were steadily improving regarding edema and pain (Figure 2A). An arranged clinic visit, after 1 week, showed that the lesions were healing well with no associated necrosis, and no active purulent secretion, edema, erythema, or pain. Another follow-up clinic visit was arranged after 4 weeks with the same improving results (Figure 2B). Hydroxyurea that was held on day 2 of admission for better chances of healing was restarted back 3 weeks after finishing the treatment. The last outpatient follow-up encounters 12 weeks after stopping the treatment, lesions were well healed (Figure 2C).

Discussion

Fungal infections from soil and plant pathogens were reported in many countries. These types of infections are mainly reported in the immunocompromised hosts, where the most encountered site of infection is the skin.¹³ Reports of *Fusarium* infections are usually resulting from tissue breakdown or trauma. Infections are mostly localized to involve the cornea,¹⁴⁻¹⁶ skin and nail,^{17,18} cellulitis after injury,^{19,20} sinusitis,²¹⁻²⁴ and pneumonia.^{25,26} *Fusarium* osteomyelitis was also reported in multiple case reports, mostly in immunocompromised and type 2 diabetic patients.^{1,27-29} The compromised immune system is the most common risk factor for invasive fusariosis.^{8,30-35} In this case, the patient's clinical status was consistent with localized *Fusarium* soft tissue infection (ulceration and cellulitis) with no osteomyelitis or hematogenous dissemination (fungemia) in the light of repeatedly negative sets of blood cultures. In immunocompetent patients, *Fusarium* cutaneous infections are preceded by tissue breakdown that may take place for long time, and they present mostly as necrotic lesions that complicate extensive wounds or cellulitis.³⁶ To our knowledge, our patient did not have any skin lesions older than 3 weeks prior to presentation, history of traumatic inoculation could not be ruled out and was considered to be the causative event as our patient remembers walking around her garden with bare feet during the time of injury.

Fusarium species can produce mycotoxins, such as trichothecenes, which have the ability to inhibit humoral and cellular immunity and may also cause tissue breakdown.³ The



Figure 3. Petri dish *Fusarium* growth pattern after culturing on Sabouraud agar.

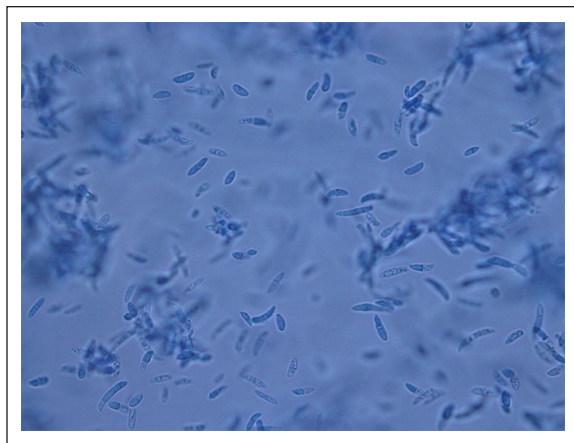


Figure 4. *Fusarium* spp visualized using lactophenol cotton blue stain under an electronic microscope with 40 \times magnification.

diagnosis of fusariosis is made by a combination of clinical behavior, microscopic features as hyaline, banana-shaped, multicellular macroconidia with a foot cell at the base, and the molecular studies. *Fusarium* is rarely encountered in our microbiology laboratories. It was last reported in our laboratory more than 10 years prior to this case. The swab taken from the lesions was cultured on Sabouraud agar (Figure 3). Lactophenol cotton blue stain was used for visualization under the microscope (Figure 4). The organism then was detected in reference to *Koneman's Color Atlas and Textbook of Diagnostic Microbiology*, 6th edition; *Manual of Clinical Microbiology*, 9th edition; and *Baily & Scott's Diagnostic Microbiology*, 12th edition. Since our microbiology laboratory does not perform fungal susceptibility test routinely, we rely on the guidelines of treatment in addition to patients' clinical response to predict the best antifungal treatment.

Fusarium species have different susceptibilities to antifungal agents.^{2,37-41} Many reports recommended treatment regimens with voriconazole and amphotericin-B, with one review reported a success rate of 70%.⁴² When available, susceptibility testing should be performed to establish the most effective medication.³⁷ However, this should not delay antifungal choice when susceptibility data are not available. High-dose amphotericin-B and especially its liposomal and lipid complex preparations are the antifungal therapies of choice to manage fusariosis.^{38,43-45} Voriconazole also has a role against *Fusarium* species.⁴⁵⁻⁴⁸ A combination systemic antifungal therapies and local antifungals were also reported to be effective in resistant cases.^{27,39,49-53} Recent guidelines suggest treating disseminated fusariosis with a combination of voriconazole and lipid amphotericin-B.⁵⁴ Since we did not have a readily available antifungal susceptibility test in our laboratory, the decision was to start with voriconazole. Since we had no clinical improvement after 6 days of IV voriconazole with persistent positive cultures, a trial of conventional amphotericin-B treatment was commenced with significant clinical improvement of the lesions only after 5 days of initiating the treatment and negative cultures from both lesions after 9 days were obtained. There are no reports in the literature about the effectiveness of using a short course of amphotericin-B followed by voriconazole.

Conclusion

Sickle cell disease was never reported to be a risk factor for *Fusarium* infection, and our case report should raise awareness to search for *Fusarium* spp and other opportunistic fungal infections in patients with SCD presenting with skin ulcers. *Fusarium* spp infections are rare in immunocompetent patients; nonetheless, having conditions like SCD can lead to local immunosuppression probably due to the microvascular pathological changes. Investigating lesions and consideration for such an organism in such conditions can lead to earlier diagnosis, treatment, and prevention of dissemination. *Fusarium* spp infection should be suspected in case of no improvement on antibacterial agents as it can lead to significant morbidity and mortality if disseminated. Antifungal susceptibility should be tested along with the culture to better guide an effective antifungal therapy. We report the first case of a locally invasive *Fusarium* infection in a SCD patient, successfully treated with a short course of amphotericin-B followed by voriconazole. Such response might indicate stewardship opportunities toward treating such a rare infection.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics Approval

Institutional review board is not required. The study was conducted according to the World Medical Association Declaration of Helsinki.

Informed Consent

Written informed consent was obtained from the patient for his anonymized information to be published in this article.

ORCID iD

Shaher Samrah  <https://orcid.org/0000-0002-8811-3741>

References

- Gupta AK, Baran R, Summerbell RC. *Fusarium* infections of the skin. *Curr Opin Infect Dis*. 2000;13:121-128.
- Tortorano AM, Rigoni AL, Biraghi E, Viviani MA. ECMM survey of candidemia in Italy: in vitro susceptibility of non-albicans candida species. *Mycoses*. 2002;45(suppl 2):63-64.
- Nelson PE, Dignani MC, Anaissie EJ. Taxonomy, biology, and clinical aspects of *Fusarium* species. *Clin Microbiol Rev*. 1994;7:479-504.
- Cooke NS, Feighery C, Armstrong DKB, et al. Cutaneous *Fusarium solani* infection in childhood acute lymphoblastic leukaemia. *Clin Exp Dermatol*. 2009;34:e117-e119.
- Anaissie E, Kantarjian H, Ro J, et al. The emerging role of *Fusarium* infections in patients with cancer. *Medicine (Baltimore)*. 1988;67:77-83.
- Tanase A, Colita A, Ianosi G, et al. Rare case of disseminated fusariosis in a young patient with graft vs. host disease following an allogeneic transplant. *Exp Ther Med*. 2016;12:2078-2082.
- Rabodonirina M, Piens MA, Monier MF, Guého E, Fièrè D, Mojon M. *Fusarium* infections in immunocompromised patients: case reports and literature review. *Eur J Clin Microbiol Infect Dis*. 1994;13:152-161.
- Muhammed M, Anagnostou T, Desalermos A, et al. *Fusarium* infection: report of 26 cases and review of 97 cases from the literature. *Medicine (Baltimore)*. 2013;92:305-316.
- Nucci M, Anaissie E. *Fusarium* infections in immunocompromised patients. *Clin Microbiol Rev*. 2007;20:695-704.
- Paredes EMG, Pérez LG, Rodríguez AJG, Quiles DR, Castro CM, Cuevas EJ. Disseminated fusariosis in immunocompromised patients. *Eur J Dermatol*. 2011;21:753-756.
- Benenson I, Porter S. Sickle cell disease: bone, joint, muscle, and motor complications. *Orthop Nurs*. 2018;37:221-227.
- Minniti CP, Delaney KMH, Gorbach AM, et al. Vasculopathy, inflammation, and blood flow in leg ulcers of patients with sickle cell anemia. *Am J Hematol*. 2014;89:1-6.
- Bader M, Jafri AK, Krueger T, et al. *Fusarium* osteomyelitis of the foot in a patient with diabetes mellitus. *Scand J Infect Dis*. 2003;35:895-897.
- Guarro J, Rubio C, Gené J, et al. Case of keratitis caused by an uncommon *Fusarium* species. *J Clin Microbiol*. 2003;41:5823-5826.
- Gopinathan U, Garg P, Fernandes M, Sharma S, Athmanathan S, Rao GN. The epidemiological features and laboratory results of fungal keratitis: a 10-year review at a referral eye care center in South India. *Cornea*. 2002;21:555-559.
- Al-Hatmi AMS, Bonifaz A, de Hoog GS, et al. Keratitis by *Fusarium temperatum*, a novel opportunist. *BMC Infect Dis*. 2014;14:588.
- Romano C, Miracco C, Difonzo EM. Skin and nail infections due to *Fusarium oxysporum* in Tuscany, Italy. *Mycoses*. 1998;41:433-437.
- Calado NB, Sousa F, Gomes NO, et al. *Fusarium* nail and skin infection: a report of eight cases from Natal, Brazil. *Mycopathologia*. 2006;161:27-31.
- Halpern M, Balbi E, Carius L, et al. Cellulitis and nodular skin lesions due to *Fusarium* spp in liver transplant: case report. *Transplant Proc*. 2010;42:599-600.
- Hiemenz JW, Kennedy B, Kwon-Chung KJ. Invasive fusariosis associated with an injury by a stingray barb. *J Med Vet Mycol*. 1990;28:209-213.
- Rajmane VS, Rajmane ST, Patil VC, et al. Maxillary rhinosinusitis due to *Fusarium* species leading to cavernous sinus thrombosis. *J Mycol Med*. 2013;23:53-56.
- Wickern GM. *Fusarium* allergic fungal sinusitis. *J Allergy Clin Immunol*. 1993;92:624-625.
- Twarużek M, Soszyczyńska E, Winiarski P, Zwierz A, Grajewski J. The occurrence of molds in patients with chronic sinusitis. *Eur Arch Otorhinolaryngol*. 2014;271:1143-1148.
- Kurien M, Anandi V, Raman R, Brahmadathane KN. Maxillary sinus fusariosis in immunocompetent hosts. *J Laryngol Otol*. 1992;106:733-736.
- Smith JA, Kauffman CA. Pulmonary fungal infections. *Respirology*. 2012;17:913-926.
- Gorman SR, Magiorakos AP, Zimmerman SK, Craven DE. *Fusarium* oxysporum pneumonia in an immunocompetent host. *South Med J*. 2006;99:613-616.
- Koehler P, Tacke D, Cornely OA. Bone and joint infections by *Mucorales*, *Scedosporium*, *Fusarium* and even rarer fungi. *Crit Rev Microbiol*. 2016;42:158-171.
- Sierra-Hoffman M, Paltiyevich-Gibson S, Carpenter JL, Hurley D. *Fusarium* osteomyelitis: case report and review of the literature. *Scand J Infect Dis*. 2005;37:237-240.
- Edupuganti S, Roupheal N, Mehta A, et al. *Fusarium falciforme* vertebral abscess and osteomyelitis: case report and molecular classification. *J Clin Microbiol*. 2011;49:2350-2353.
- Musa MO, Al Eisa A, Halim M, et al. The spectrum of *Fusarium* infection in immunocompromised patients with hematological malignancies and in non-immunocompromised patients: a single institution experience over 10 years. *Br J Haematol*. 2000;108:544-548.
- Blazar BR, Hurd DD, Snover DC, Alexander JW, McGlave PB. Invasive *Fusarium* infections in bone marrow transplant recipients. *Am J Med*. 1984;77:645-651.
- Schwartz KL, Sheffield H, Richardson SE, Sung L, Morris SK. Invasive fusariosis: a single pediatric center 15-year experience. *J Pediatr Infect Dis Soc*. 2015;4:163-170.
- Hennequin C, Lavarde V, Poirot JL, et al. Invasive *Fusarium* infections: a retrospective survey of 31 cases. The French "Groupe d'Etudes Des Mycoses Opportunistes" GEMO. *J Med Vet Mycol*. 1997;35:107-114.
- Litvinov N, da Silva MTN, van der Heijden IM, et al. An outbreak of invasive fusariosis in a children's cancer hospital. *Clin Microbiol Infect*. 2015;21:268.e1-e7.
- Garnica M, da Cunha MO, Portugal R, Maiolino A, Colombo AL, Nucci M. Risk factors for invasive fusariosis in patients

- with acute myeloid leukemia and in hematopoietic cell transplant recipients. *Clin Infect Dis*. 2015;60:875-880.
36. Nucci M, Anaissie E. Cutaneous infection by *Fusarium* species in healthy and immunocompromised hosts: implications for diagnosis and management. *Clin Infect Dis*. 2002;35:909-920.
 37. Taj-Aldeen SJ, Salah H, Al-Hatmi AMS, et al. In vitro resistance of clinical *Fusarium* species to amphotericin B and voriconazole using the EUCAST antifungal susceptibility method. *Diagn Microbiol Infect Dis*. 2016;85:438-443.
 38. Cofrancesco E, Boschetti C, Viviani MA, et al. Efficacy of liposomal amphotericin B (AmBisome) in the eradication of *Fusarium* infection in a leukaemic patient. *Haematologica*. 1992;77:280-283.
 39. Barrios NJ, Kirkpatrick DV, Murciano A, Stine K, Van Dyke RB, Humbert JR. Successful treatment of disseminated *Fusarium* infection in an immunocompromised child. *Am J Pediatr Hematol Oncol*. 1990;12:319-324.
 40. Letscher-Bru V, Campos F, Waller J, et al. Successful outcome of treatment of a disseminated infection due to *Fusarium dimerum* in a leukemia patient. *J Clin Microbiol*. 2002;40:1100-1102.
 41. Stanzani M, Tumietto F, Vianelli N, Bacarani M. Update on the treatment of disseminated fusariosis: focus on voriconazole. *Ther Clin Risk Manag*. 2007;3:1165-1173.
 42. Liu JY, Chen WT, Ko BS, et al. Combination antifungal therapy for disseminated fusariosis in immunocompromised patients: a case report and literature review. *Med Mycol*. 2011;49:872-878.
 43. Muhammed M, Coleman JJ, Carneiro HA, Mylonakis E. The challenge of managing fusariosis. *Virulence*. 2011;2:91-96.
 44. Jensen TG, Gahrn-Hansen B, Arendrup M, Brunn B. *Fusarium fungaemia* in immunocompromised patients. *Clin Microbiol Infect*. 2004;10:499-501.
 45. Selleslag D. A case of fusariosis in an immunocompromised patient successfully treated with liposomal amphotericin B. *Acta Biomed*. 2006;77(suppl 2):32-35.
 46. Takenaka M. A case of cutaneous fusariosis of the scrotum as a complication of acute myeloid leukemia [in Japanese]. *Med Mycol J*. 2016;57:J65-J70.
 47. Muramatsu T, Ueki T, Ohashi K, et al. Successful treatment with voriconazole for disseminated cutaneous and visceral infection by *Fusarium solani* in a patient with acute myeloid leukemia. *Rinsho Ketsueki*. 2006;47:753-757.
 48. Consigny S, Dhedin N, Detry A, Choquet S, Leblond V, Chosidow O. Successful voriconazole treatment of disseminated *Fusarium* infection in an immunocompromised patient. *Clin Infect Dis*. 2003;37:311-313.
 49. Al-Hatmi AMS, Bonifaz A, Ranque S, de Hoog GS, Verweij PE, Meis JF. Current antifungal treatment of fusariosis. *Int J Antimicrob Agents*. 2018;51:326-332.
 50. Campo M, Lewis RE, Kontoyiannis DP. Invasive fusariosis in patients with hematologic malignancies at a cancer center: 1998-2009. *J Infect*. 2010;60:331-337.
 51. Valentin T, Schmidt H, Rohn A, et al. Topical and systemic treatment of *Fusarium solani* infection in a neutropenic patient. *Mycoses*. 2010;53:415-416.
 52. Esnakula AK, Summers I, Naab TJ. Fatal disseminated *Fusarium* infection in a human immunodeficiency virus positive patient. *Case Rep Infect Dis*. 2013;2013:379320.
 53. Al-Hatmi AMS, Meis JF, de Hoog GS. *Fusarium*: molecular diversity and intrinsic drug resistance. *PLoS Pathog*. 2016;12:e1005464.
 54. Tortorano AM, Richardson M, Roilides E, et al. ESCMID and ECMM joint guidelines on diagnosis and management of hyalohyphomycosis: *Fusarium* spp, *Scedosporium* spp and others. *Clin Microbiol Infect*. 2014;20(suppl 3):27-46.