In April 2010, a 57-year-old woman was diagnosed with acute myeloid leukemia. The patient was treated with induction therapy (cytarabine and idarubicin) prior to an allogeneic stem cell transplantation. Thereafter, the patient received antibiotic prophylaxis with levofloxacin and antifungal prophylaxis with fluconazole. On day 6, her temperature rose to 39 °C and she developed a severe skin rash leading to desquamation due to cytarabine, as well as persisting diarrhoea from day 7 onward. Samples for blood cultures were taken and she was subsequently started on broad spectrum antibiotic coverage (ceftazidim plus teicoplanin). At that time, the peripheral blood white cell count was 900/mm³ with an absolute neutrophil count of 250/mm³ and the platelet count was 35,000/mm³. Blood cultures remained negative and despite treatment with broad spectrum antibiotics her fever persisted. Although the results of an Aspergillus galactomannan assay in serum were negative (index value 0.1), empirical caspofungin was started on day 11 in accord with the reimbursement criteria in Belgium. On day 19, the peripheral blood white cell count rose to 43,000/mm³ and the fever disappeared. A new bone marrow puncture was performed which showed persisting myeloblasts. Subsequently, a second chemotherapeutic...
treatment consisting of cytarabine and amsacrin was started but due to relapsing fever, ceftazidim and teicoplanin were stopped on day 27 and meropenem was started with the continuation of the caspofungin therapy. The blood cultures taken on day 34, 35 and 36 yielded a yeast-like fungus. Those taken on day 35 and 36 were drawn through a central venous catheter. On day 36, the patient developed an acute abdomen which led to a CT scan that revealed two large hypodense zones in the liver. Fine needle aspirate of the lesions showed a minimal amount of pus, but Gram staining of a portion of this material did not show any micro-organisms or fungal structures. A few hours later, the patient developed an abdominal compartment syndrome requiring intubation and ventilation. Despite aggressive supportive therapy, the patient’s condition deteriorated and she died the next day. The central venous catheter had not been removed.

Meanwhile, the yeast-like fungus detected in the blood cultures was identified as *S. capitata*. Colonies on blood agar were white to cream-colored, while those on corn meal agar showed ‘bamboo-like’ conidiophores with elongated conidia flattened at the base suggesting *S. capitata* (teleomorph *Magnusiomyces capitatus*) (Fig. 1). Arthroconidia were evident on Sabouraud dextrose agar cultures (Fig. 2). Negative urease test results excluded *Trichosporon* spp. and the assimilation pattern found with the API ID 32 C (BioMérieux, Brussels, Belgium) confirmed the identification of *Geotrichum capitatum* (3210010001, %ID 99.6). *In vitro* susceptibility testing against fluconazole, voriconazole, amphotericin B, anidulafungin and caspofungin was performed using Sensititre® YeastOne (TREK Diagnostic System, East Grinstead, UK). Minimal inhibitory concentrations for amphotericin B, anidulafungin, caspofungin, fluconazole and voriconazole were 1 mg/l, 2 mg/l, >8 mg/l, 32 mg/l, and 1 mg/l, respectively.

**Discussion**

*Geotrichum capitatum*, formerly known as *Trichosporon capitatum* and *Blastoschizomyces capitatus* (teleomorph *Dipodascus capitatus*) has undergone extensive taxonomic evaluation [5]. In light of its cell wall structure and septal pores, as well as its tendency to produce numerous arthroconidia and few blastoconidia, it was included among the *Ascomycetes* [2]. A recent revision of the 32 taxa of the filamentous *Hemiascomycetes* suggested, based on the ribosomal structure, that this class could be divided into a Group 1 which includes *Geotrichum* anamorph consisting of *Galactomyces* and *Dipodascus* teleomorph and a Group 2 consisting of *Saprochaete* anamorph with *Magnusiomyces* teleomorph. According to this new taxonomic proposal, *Geotrichum capitatum* was renamed *S. capitata* (teleomorph *Magnusiomyces capitatus*) [5].

*S. capitata* is an emerging cause of invasive and disseminated infections, especially in immune compromised haematological patients, although solid tumour-associated pathologies and onychomycosis in immunocompetent hosts have also been reported [6]. In the past 4 years, there have been four reports of breakthrough infections caused by *S. capitata* in patients receiving empirical echinocandin therapy [4,7,8] (Table 1). Risk factors for systemic infections in these patients were prolonged neutropenia, aggressive chemotherapy, the use of broad spectrum antibiotics and the alteration of local defenses by breakdown of skin and mucosa [9]. The most common underlying haematological malignancy in patients with invasive infections is acute myeloid leukemia and the incidence rate among patients with acute leukemia is estimated to be around 0.5% [2,10]. Indeed, all of the described cases of breakthrough infections were in patients with acute leukemia (one acute lymphoblastic leukemia and four acute myelogenous leukemia) who received intensive chemotherapy. Furthermore, all patients
Table 1  Summary of data on five cases of breakthrough infection with *Saprochaete capitata* while receiving echinocandin therapy.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/Sex</th>
<th>Disease</th>
<th>Therapy</th>
<th>Antibiotic prophylaxis</th>
<th>Echinocandin prophylaxis</th>
<th>Time when <em>S. capitata</em> was first found in blood culture</th>
<th>Result GM Ag test</th>
<th>Other site from which <em>S. capitata</em> was recovered</th>
<th>Outcome</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65/male</td>
<td>AML</td>
<td>DC</td>
<td>Moxi Cftep and Van Mero</td>
<td>Micafungin</td>
<td>14 days after micafungin was started</td>
<td>NM</td>
<td>Peripherally inserted central venous catheter</td>
<td>Died</td>
<td>[4]</td>
</tr>
<tr>
<td>2</td>
<td>9/female</td>
<td>AML</td>
<td>Various Chm</td>
<td>NM</td>
<td>Caspofungin</td>
<td>1 week after caspofungin was started</td>
<td>Positive</td>
<td>NM</td>
<td>Died</td>
<td>[7]</td>
</tr>
<tr>
<td>3</td>
<td>7/NM</td>
<td>ALL</td>
<td>Various Chm</td>
<td>NM</td>
<td>Caspofungin</td>
<td>NM</td>
<td>Positive</td>
<td>Cerebral abscess</td>
<td>Died</td>
<td>[7]</td>
</tr>
<tr>
<td>4</td>
<td>59/male</td>
<td>AML</td>
<td>Various Chm</td>
<td>Pip/tazo and Amik Mero and Van</td>
<td>Caspofungin</td>
<td>11 days after caspofungin was started</td>
<td>Positive</td>
<td>NM</td>
<td>Died</td>
<td>[8]</td>
</tr>
<tr>
<td>Our case</td>
<td>57/female</td>
<td>AML</td>
<td>CIA</td>
<td>Levo, Cftz and Teico Mero</td>
<td>Caspofungin</td>
<td>23 days after caspofungin was started</td>
<td>Negative</td>
<td>Possible central venous catheter</td>
<td>Died</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient</th>
<th>Switch of antifungal therapy when <em>S. capitata</em> was known</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amphotericin B and Voriconazole</td>
</tr>
<tr>
<td>2</td>
<td>Amphotericin B</td>
</tr>
<tr>
<td>3</td>
<td>Voriconazole</td>
</tr>
<tr>
<td>4</td>
<td>Voriconazole and posaconazole</td>
</tr>
<tr>
<td>Our case</td>
<td>No switch</td>
</tr>
</tbody>
</table>

Susceptibility

1. Amphotericin B and Voriconazole
2. Amphotericin B
3. Voriconazole
4. Voriconazole and posaconazole

Caspofungin 8 mg/l
Anidulafungin 2 mg/l

Note. ALL, acute lymphoblastic leukemia; Amik, amikacin; AML, acute myelogenous leukemia; Cftep, ceftepime; Cftz, ceftazidime; Chm, chemotherapy; DC, daunorubicin-cytarabine; Levo, levofloxacin; Mero, meropenem; Moxi, moxifloxacin; NM, not mentioned; Teico, teicoplanin; Van, vancomycin.
received broad spectrum antibiotics because of neutropenic fever. The 30 day mortality associated with invasive disease ranges from 60–80% [2], but in the case series we describe, mortality was 100%.

The clinical features of invasive infection with *S. capitata* frequently resemble those of invasive candidiasis, with the exception that those with disseminated *S. capitata* infection frequently show microbiologically documented invasive tissue localization [11]. A brain abscess was demonstrated in only 1/5 patients with a breakthrough infection with invasive tissue localization. In our patient, the development of liver abscesses could have been a sign of tissue invasion by *S. capitata*, although cultures of the evacuated pus remained negative. Furthermore, candidemia is more frequently related to the presence of a central venous catheter than invasive *S. capitata* infection [11]. In our case series only one patient had proven central venous catheter infection. Our own patient probably had central venous catheter infection, although the catheter was not removed and cultured to prove infection.

Blood cultures, which are the standard for diagnosing *S. capitata* infections, are negative in about 30% of cases and usually take several days to show detectable growth [7]. *S. capitata* is known to have galactomannan as a cell wall component, which can be detected by using the *Aspergillus* galactomannan assay [7,8]. Knowledge of this phenomenon may be useful in the diagnosis and management of *S. capitata* infections. However, the detection of galactomannan antigen cannot be considered as a specific diagnostic marker of *S. capitata* deep infections because positive results due to *Aspergillus* spp. is much more likely in this patient population. Positive *Aspergillus* galactomannan assays were noted with three patients with breakthrough infections due to *S. capitata*. In our patient, *Aspergillus* galactomannan assays were repeatedly negative and the diagnosis could only be made due to the growth of the microorganism in the blood cultures.

Fungal infections are reported in 14% of the patients undergoing chemotherapy for acute leukemia [12]. The main risk group for which empirical caspofungin therapy might prove useful are patients with acute leukemia and prolonged neutropenia (< 500 cells per mm<sup>3</sup> for more than 10 days) or allogeneic stem cell transplantation [13]. In a recent paper, the incidence of breakthrough invasive fungal disease was reported to be 10.7% in patients treated empirically with caspofungin and 12.1% in patients treated empirically with micafungin [14]. In 2004, Walsh et al. described breakthrough infections in 5.2% of the patients treated empirically with caspofungin [15]. However, in neither of the two studies were breakthrough infections caused by *S. capitata*. In the past 4 years, there have been four cases of breakthrough infections due to this mould and our patient represents the fifth such case [4,7,8]. We instituted empirical caspofungin treatment when fever persisted despite administration of broad spectrum antibiotic coverage. Because of repeated negative results with the *Aspergillus* galactomannan assay, treatment with caspofungin was empirically continued and not switched to voriconazole or posaconazole. Blood cultures eventually yielded an isolate of *S. capitata* which was found to be resistant to caspofungin, but by that time our patient had died. In the other four reported cases, therapy was switched to voriconazole, with or without amphotericin B, but none of the patients survived.

**In vitro** susceptibilities determined by the clinical laboratory standards institute (CLSI) methods indicate that *S. capitata* is highly susceptible to amphotericin B, itraconazole and voriconazole. Although most isolates were susceptible to fluconazole and fluconazole, strains have been observed with decreased susceptibilities to both agents [16,17]. Data on the **in vitro** susceptibility of *S. capitata* to echinocandins are summarized in Table 2 [6,7,18–20]. While limited, the results suggest that echinocandins seem to lack activity against this fungus [16,17]. However, despite Franchi et al.’s reported successful treatment of *S. capitata* pneumonia in a leukemia patient with voriconazole and caspofungin, the correlation between **in vitro** test results and treatment outcomes for echinocandins in invasive *S. capitata* infection has not been fully established [20]. Chittick et al. reported a breakthrough infection caused by an isolate of *S. capitata* which showed **in vitro** susceptibility to micafungin in a patient who received micafungin [4,20]. Because **in vitro** susceptibility data are limited, a careful evaluation of each *S. capitata* isolate is needed. Our isolate showed susceptibility to amphotericin B and voriconazole and resistance to caspofungin which is in accordance with the known **in vitro** results [16,17]. The optimal antifungal therapy for *S. capitata* remains somewhat unclear. Although published clinical data are limited, **in vitro** data provide encouraging evidence of the potential role of voriconazole in the treatment of *S. capitata* infections [2].

In conclusion, our case shows that clinicians should be aware of a possible *S. capitata* infection in neutropenic patients, especially those with acute myeloid leukemia treated with chemotherapy who remain febrile despite
echinocandin therapy or who develop fungal bloodstream infections while receiving an echinocandin.

**Declaration of interest:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

**References**


13. Schuermans et al. This paper was first published online on Early Online on 25 November 2010.