Analyzing Adherence to the 2016 Infectious Diseases Society of America Guidelines for Candidemia in Cancer Patients

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Background. Candidemia is associated with morbidity and mortality in cancer patients. We analyzed adherence to the 2016 Infectious Diseases Society of America (IDSA) candidiasis guidelines and the reasons for guideline nonadherence. We also investigated whether matrix-assisted laser desorption/ionization–time of flight (MALDI-TOF) improved time to effective antifungal therapy compared with historical data (median, 43.2 hours).

Methods. Cancer patients with candidemia between 1/1/17 and 12/31/19 were included. Adherence to 7 individual IDSA guideline components was assessed. Composite IDSA guideline adherence (defined as meeting ≥6 guideline components) was also assessed. Charts were reviewed to examine reasons for noncompliance.

Results. Of 157 patients with candidemia, 150 (95.5%) had infectious disease (ID) consultation. The median total time from blood culture collection to antifungal initiation was 42.1 hours. Excluding 39 patients with short treatment due to death, there was 100% adherence with surveillance blood cultures, followed by antifungal susceptibility testing (117/118, 99.2%), initial appropriate therapy (117/118, 99.2%), antifungal duration (110/118, 93.2%), line removal (82/91, 90.1%), eye exams (93/118, 78.8%), and step-down therapy (69/94, 73.4%). A quarter (30/118) did not meet composite IDSA guideline adherence. Univariate logistic regression suggested a relationship between poor cancer prognosis and incomplete adherence to the 2016 IDSA candidiasis guidelines (odds ratio, 8.6; 95% CI, 1.6–47).

Conclusions. The addition of MALDI-TOF did not shorten time to effective antifungal therapy. Nearly all patients were seen by ID for candidemia. Poor cancer prognosis was a common factor for incomplete composite adherence to the 2016 IDSA candidiasis guidelines.

Keywords. cancer patients; cancer prognosis; candidemia; guideline adherence.

Candida species are important causes of nosocomial bloodstream infections (BSIs) in cancer patients [1]. Although Candida albicans remains the most common cause of candidemia, increased isolation of non-albicans Candida has been observed among patients with solid and hematologic malignancies in recent years, with the incidence of each species varying by institution and geographic region [1–4]. Despite an expanded antifungal armamentarium, the crude 30-day mortality for cancer patients with candidemia ranges between 31.7% and 39% [1, 2, 5]. Owing to the known morbidity and mortality associated with candidemia in immunocompromised patients, there is growing emphasis on antifungal stewardship to optimize care [6].

Recommendations for managing candidemia can be found in the 2016 Infectious Diseases Society of America (IDSA) candidiasis guidelines [7]. These include susceptibility testing, initial and step-down therapy, dilated eye examination, removal of central venous catheters (CVCs), surveillance blood cultures, and duration of treatment (≥14 days from the first negative blood culture) for both neutropenic and non-neutropenic patients with Candida BSIs. An echinocandin is recommended as initial antifungal therapy, although fluconazole is an acceptable alternative in select patients who are not critically ill and who are unlikely to have fluconazole-resistant Candida species. Step-down therapy refers to the transition of the echinocandin...
to fluconazole within 5–7 days for clinically stable patients with fluconazole-susceptible isolates. Analyzing adherence to published guidelines for the management of candidemia may identify opportunities to improve antifungal stewardship at one’s institution and possibly patient outcomes [8, 9]. These prior studies, however, are not specific to cancer patients and do not examine the reasons for noncompliance to guidelines. Another aspect of antifungal stewardship is early administration of effective antifungal therapy. Therapeutic delays due to the time required for diagnosis of candidemia are a well-known risk factor for mortality [10]. While blood cultures remain the diagnostic gold standard, cultures can take 1–3 days to grow, and an additional 1–2 days are needed for fungal identification [11]. Previously, we reported that it took a median of 43.2 hours from blood culture collection to antifungal initiation in patients with candidemia [4]. Rapid detection of BSI would thus be crucial for timely administration of active drug. In 1 study of adults with BSIs, matrix-assisted laser desorption/ionization–time of flight mass spectrometry (MALDI-TOF) combined with antimicrobial stewardship intervention significantly decreased time to organism identification and time to effective therapy, but candidemia accounted for <10% [12]. It is unclear what the true impact of MALDI-TOF would be in the management of candidemia as incubation times are longer than for bacteria.

At Memorial Sloan Kettering Cancer Center (MSKCC), the clinical microbiology laboratory incorporated routine antifungal susceptibility testing for all Candida species between January 1, 2017, and December 31, 2019. When the updated IDSA candidiasis guidelines were published in February 2016, the institutional candidemia guideline was also revised. The purpose of this study was to evaluate syndrome-specific management of candidemia in cancer patients between January 1, 2017, and December 31, 2019. Specifically, we assessed adherence to the 2016 IDSA guidelines and investigated the reasons why clinicians did not follow guideline recommendations. Additionally, we aimed to see whether the time to effective therapy changed with integration of MALDI-TOF into the existing antimicrobial stewardship workflow.

METHODS

Study Population
The study, which was approved by the Institutional Review Board, was conducted at MSKCC, a 498-bed tertiary care cancer center in New York, New York. Study subjects consisted of adult and pediatric patients who had at least 1 blood culture positive for Candida species between January 1, 2017, and December 31, 2019. If a patient had multiple blood cultures positive for Candida during a hospitalization, only the first blood culture was counted as an observation. For patients who had >1 candidemia episode, only the first episode was included in the analysis. Patients were excluded if they died before initiation of antifungal therapy.

Blood Culture Protocol
The hospital’s microbiology laboratory was on-site until October 2017, when it moved off-site within 1 mile of the main hospital campus. The microbiology laboratory employs the Becton Dickinson BACTEC FX instrumented blood culture system (Franklin Lakes, NJ, USA), which provides continuous automated fluorescent monitoring of incubating blood cultures for 5 days. When a blood culture registers positive, the microbiology staff performs gram stain and microscopic assessment. Hospital protocol requires that the staff notify the patient’s health care provider (HCP) by phone, in addition to entering the finding of yeast into the laboratory system. Yeast identification has been performed via MALDI-TOF (bioMérieux, Marcy l’Étoile, France) since October 2014. Antifungal susceptibility testing is performed using the Sensititre YeastOne colorimetric microdilution susceptibility test (Trek Diagnostic Systems, Cleveland, OH, USA).

Result Management
Antifungal drugs for the treatment of invasive fungal infections are restricted. Once notified of the positive blood culture result, the HCP contacts the hospital’s antimicrobial stewardship program (ASP), which operates 7 days a week between 9 AM and 10 PM. After 10 PM, empiric antifungal therapy can be started, pending review and approval the following morning. For septic patients, approval is waived for the first antifungal dose so that it can be ordered and administered urgently, but continuation of the drug requires approval. The ASP also recommends formal infectious disease (ID) consultation for the management of candidemia if not already requested by the primary team.

Data Collection
For each episode of candidemia, the following were recorded: date and time of blood culture collection, date and time of blood culture positivity, and date and time of administration of the first appropriate antifungal agent. These data were obtained using computerized microbiology records and electronic medication administration records (EMARs). The following median time periods were then calculated: (i) incubation period (time needed for the blood culture to incubate and turn positive), (ii) antifungal initiation period (time from when the blood culture turned positive to administration of the first active antifungal dose), and (iii) total time period (time from blood culture collection to antifungal initiation). Time to effective therapy was equated with the total time period.

Other information that was gathered from electronic medical records included demographics, cancer diagnosis, date of hematopoietic cell transplantation (HCT) or chimeric antigen
receptor (CAR) T-cell therapy (if applicable), admission and discharge dates, date of death (if applicable), presence of neutropenia (absolute neutrophil count <500 cells/mm³) at the time of blood culture collection, ID consultation for candidemia, echocardiogram to rule out valvular involvement, management of CVCs, and antifungal duration. We also noted if a do-not-resuscitate (DNR) order was present, the date it was established, and the date when providers began to mention a focus on comfort care and/or transition to hospice in the daily progress notes during the hospitalization for candidemia. In this study, poor cancer prognosis was defined by the presence of a DNR order with or without initiation of hospice in a patient with end-stage cancer as goals shift toward palliative care.

Using the 2016 IDSA candidiasis guidelines, 7 broad components for the management of candidemia were identified: (1) testing for azole and echinocandin susceptibilities, (2) initial appropriate antifungal therapy, (3) performance of dilated eye examination within the first week of diagnosis for non-neutropenic hosts or within the first week after recovery from neutropenia, (4) CVC removal (if present), (5) use of surveillance blood cultures to document clearance, (6) duration of antifungal therapy (defined as a minimum of 2 weeks after documented bloodstream clearance), and (7) step-down therapy [7]. Adherence to the individual guideline component was measured. Additionally, a composite of adherence to the 2016 IDSA guidelines was defined as meeting ≥6 of 7 guideline components. Completion of <14 days of antifungal therapy due to death was not considered a guideline deviation. The absence of Clinical and Laboratory Standards Institute (CLSI) breakpoints for certain *Candida* species, azole resistance, concern for drug–drug interaction, and inability to tolerate oral intake were acceptable reasons for why step-down therapy could not be performed and were not counted as noncompliance.

Inappropriate antifungal therapy was defined as a mismatch between the antifungal agent and the susceptibility result of the recovered *Candida* species [13–16]. Step-down therapy was defined as de-escalation from an echinocandin or liposomal amphotericin B to an azole for clinically stable patients who had fluconazole- or voriconazole-sensitive isolates and documented bloodstream clearance with or without intravenous-to-oral (IV-to-PO) conversion [7]. Charts were reviewed to identify reasons for guideline deviations.

### Statistical Analysis

Descriptive statistics were presented as counts and percentages for categorical variables. For continuous variables, the mean and standard deviation or median and 95% CI were reported. Univariate logistic regression analysis was used to evaluate the relationship between composite 2016 IDSA guideline adherence and cancer prognosis. SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA), was used in all analyses. All statistical tests were 2-tailed, and *P* values <.05 were considered statistically significant.

### RESULTS

A total of 170 patients with *Candida* BSIs were identified during the study period. Thirteen episodes were excluded due to patient’s death before initiation of antifungal therapy. Thus, the analysis included 157 distinct patients with candidemia.

Patient characteristics are shown in Table 1. Fifty patients (31.8%) had a hematologic malignancy, and 27 (17.2%) were HCT recipients. The lone patient who underwent investigational CAR T-cell therapy had ovarian cancer. Thirty-nine individuals (24.9%) were on an antifungal agent at the time of incipient blood culture collection. Antifungal prophylaxis

| Table 1. Patient Characteristics | Mean (SD) or No. (%) |
|---------------------------------|----------------------|
| Total study population          | 157                  |
| Mean age (range), y             | 58 (0–88)            |
| Male sex                        | 80 (51)              |
| Malignancy                      |                      |
| Solid tumor                     | 105 (66.9)           |
| Hematologic malignancy          | 50 (31.8)            |
| Immunodeficiency                | 2 (1.3)              |
| HCT or cellular therapy         |                      |
| Allogeneic HCT                  | 26 (16.6)            |
| Autologous HCT                  | 1 (0.6)              |
| CAR T-cell therapy              | 1 (0.6)              |
| Neutropenia (ANC <500 cells/mm³) | 44 (28)            |
| Prior antifungal exposure       |                      |
| Antifungal prophylaxis          | 34 (21.7)            |
| Empiric treatment               | 5 (3.2)              |
| Duration of candidemia, d       | 3.4 (4)              |
| Patients in ICU at time of positive blood culture collection | 32 (20.4) |
| Patients who had infectious disease consultation | 150 (95.5) |
| Patients who had an echocardiogram | 117 (74.5) |
| Positive echocardiogram result$^{a}$ | 0 (0)          |
| Patients with results of *Candida* susceptibility testing | 156 (99.4) |
| Patients with initial appropriate antifungal therapy | 155 (98.7) |
| Patients who had a dilated eye examination | 110 (70.1) |
| Positive eye examination results$^{a}$ | 2 (1.8)        |
| Patients who had CVC removal$^{b}$ | 98 (77.2) |
| Patients who had surveillance blood cultures sent | 157 (100) |
| Patients who completed ≥14 d of antifungal treatment | 110 (70.1) |
| Patients transitioned to step-down therapy | 77 (49) |
| Patients with a do-not-resuscitate order | 43 (27.4) |
| Patients who transitioned to comfort care | 33 (21) |

Abbreviations: ANC, absolute neutrophil count; CAR, chimeric antigen receptor; CVC, central venous catheter; HCT, hematopoietic cell transplantation; ICU, intensive care unit.

$^{a}$The denominator is 117.

$^{b}$The denominator is 110.

$^{c}$The denominator is 127.
during receipt of HCT or cytotoxic chemotherapy for hematologic malignancy was the most common indication, with micafungin being the most frequently prescribed (n = 22), followed by the mold-active azoles (n = 10) and fluconazole (n = 2). Five patients with solid tumor malignancies had anatomic disruptions of the gastrointestinal (GI) or urinary tract and received micafungin as part of empiric broad-spectrum treatment for sepsis. DNR orders were present for 43 patients who had end-stage cancer (27.4%) and were written a median (interquartile range) of 4 (1–13) days from the first positive blood culture for Candida. The 30-day mortality rate was 28.7% (45/157).

When analyzing the distribution of time periods for the 157 study patients, the median total time from blood culture collection to antifungal initiation was 42.1 hours (95% CI, 35.9–49.5 hours). The median incubation time was 44.7 hours (95% CI, 40.5–52.6 hours), whereas the median time to antifungal initiation was 2.5 hours (95% CI, 1.9–3.5 hours).

Supplementary Table 1 depicts susceptibilities for the 5 Candida species commonly associated with invasive candidiasis and accounts for 144 of 161 (89.4%) recovered isolates.

Surveillance blood cultures were sent for all 157 study patients (100%), and results of susceptibility testing were available for 156 patients (99.4%) (Table 1). Initial appropriate antifungal therapy was met in 155 of 157 (98.7%) patients. Of the 2 patients (1.3%) with inappropriate antifungal therapy, both were initially treated with fluconazole but were subsequently switched to micafungin due to fluconazole-resistant Candida (1 C. krusei, 1 C. tropicalis). The choice of initial treatment for 118 patients who had no prior antifungal exposure is shown in Table 2. Of the remaining 39 patients who developed candidemia while on an antecedent antifungal drug, therapeutic switch occurred in 37 (94.9%) instances (Supplementary Table 2). Patients on fluconazole (n = 2) or isavuconazole (n = 9) prophylaxis were switched to micafungin, whereas the single person on posaconazole prophylaxis was switched to liposomal amphotericin B. Micafungin was continued in 2 cases, both of whom had echinocandin-susceptible Candida, or switched to liposomal amphotericin B (n = 14), isavuconazole (n = 1), posaconazole (n = 2), or voriconazole (n = 8).

Table 3 summarizes the reasons why the 2016 IDSA candidiasis guidelines were not performed for 4 individual guideline components. Poor cancer prognosis was noted in 57.5% (27/47), 72.4% (21/29), 83% (39/47), and 32.5% (26/80) of patients lacking eye exams, CVC removal, adequate antifungal duration, and step-down therapy, respectively. Table 4 shows the extent of adherence to the individual components of the 2016 IDSA candidemia guidelines but excludes 39 patients who died before completion of at least 14 days of antifungal therapy from the first negative blood culture. Table 5 shows the relationship between cancer prognosis and the composite 2016 IDSA guideline adherence. Patients with composite IDSA

### Table 2. Initial Antifungal Drug Administered to Patients With No Prior Antifungal Exposure

| Drug                        | No. (%) |
|----------------------------|---------|
| Micafungin                 | 95 (60.5) |
| Fluconazole<sup>a</sup>    | 18 (15.3) |
| Liposomal amphotericin B<sup>b</sup> | 3 (2.5) |
| Voriconazole<sup>c</sup>   | 2 (1.7) |
| Total                      | 118 (100) |

<sup>a</sup> Two patients were subsequently switched to micafungin due to fluconazole-resistant Candida (1 C. krusei, 1 C. tropicalis).

<sup>b</sup> One patient had C. albicans, 1 patient had C. parapsilosis, and 1 patient had C. fabianii; all 3 isolates had a minimum inhibitory concentration <1 to amphotericin B.

<sup>c</sup> One patient had fluconazole-sensitive C. albicans, and 1 patient had fluconazole-sensitive C. parapsilosis.

### Table 3. Reasons Why the 2016 IDSA Candidiasis Guidelines Were Not Followed

| Reasons                                      | Total No. (%) |
|----------------------------------------------|---------------|
| Performance of dilated eye examination (n = 47) |               |
| − Poor prognosis                             | 27 (57.5)     |
| − No ID consultation                         | 1 (2.1)       |
| − ID recommendation not followed             | 5 (10.6)      |
| − Eye exam not mentioned by ID, no reason provided | 14 (29.8)  |
| CVC removal (n = 29)                         |               |
| − Poor prognosis                             | 21 (72.4)     |
| − ID recommendation not followed             | 1 (3.4)       |
| − Alternative source or difficult venous access | 7 (24.1)   |
| Duration ≥14 d from first negative blood culture (n = 47) |           |
| − Patient died before completion of course<sup>a</sup> | 39 (83)      |
| − No ID consultation                         | 1 (2.1)       |
| − ID recommendation not followed             | 1 (2.1)       |
| − Miscalculation of stop date by 1–2 d       | 6 (12.8)      |
| Step-down therapy (n = 80)                   |               |
| − Poor prognosis                             | 26 (32.5)     |
| − No ID consultation                         | 1 (1.3)       |
| − ID recommendation not followed             | 1 (1.3)       |
| − No CLSI breakpoints for azoles<sup>b</sup> | 3 (3.8)       |
| − Azole resistance                           | 9 (11.3)      |
| − Concern for DDI or SAE secondary to azole  | 9 (11.3)      |
| − Inability to tolerate oral medications     | 8 (10)        |
| − Step-down recommended only if discharged   | 3 (3.8)       |
| − Step-down not mentioned by ID, no reason provided | 20 (25)    |

Abbreviations: CLSI, Clinical and Laboratory Standards Institute; CVC, central venous catheter; DDI, drug–drug interaction; ID, infectious diseases; IDSA, Infectious Diseases Society of America; SAE, serious adverse event.

<sup>a</sup> Thirteen patients had persistent neutropenia; 28 had advanced malignancy.

<sup>b</sup> C. dubliniensis, C. guilliermondii, C. kefyr.
Table 4. Adherence to Individual Components of the 2016 IDSA Candidiasis Guidelines for Candidemiaa

| Component                                      | No. (%) |
|------------------------------------------------|---------|
| Total study population                        | 118     |
| 1 Performance of Candida susceptibilities     | 117 (99.2) |
| 2 Initial appropriate antifungal therapy      | 117 (99.2) |
| 3 Performance of dilated eye examination      | 93 (78.8) |
| 4 Central venous catheter removalb            | 82 (90.1) |
| 5 Surveillance blood cultures to document clearance | 118 (100) |
| 6 Duration ≥14 d from first negative blood culture | 110 (93.2) |
| 7 Step-down therapyc                          | 69 (73.4) |

Abbreviation: IDSA, Infectious Diseases Society of America.

aThirty-nine patients who died before completion of at least 14 days of antifungal therapy from the first negative blood culture were excluded from this analysis.
bThe denominator is 91.
cThe denominator is 94 as 24 patients had valid reasons for why step-down therapy could not be performed: the lack of Clinical and Laboratory Standards Institute breakpoints for azoles (n=2; 1 C. dublinensis and 1 C. guilliermondii); azole resistance (n=6); concern for drug-drug interaction or serious adverse effect secondary to azole (n=8); and the inability to tolerate oral medications (n=8).

Table 5. The Relationship Between Cancer Prognosis and Composite 2016 IDSA Guideline Adherence

| Poor Cancer Prognosis | n = 7 | n = 111 | P Value |
|-----------------------|-------|---------|---------|
| Noncompliance         |       |         |         |
| Yes                   | 5 (71.4) | 25 (22.5) | <.01 |
| No                    | 2 (28.6) | 86 (77.5) |       |

Abbreviation: IDSA, Infectious Diseases Society of America.

guideline nonadherence (defined as meeting <6 guideline components for candidemia) had 8.6-fold elevated odds (95% CI, 1.6–47) of poor cancer prognosis compared with patients with composite IDSA guideline adherence (defined as meeting ≥6 guideline components for candidemia).

**DISCUSSION**

In this study of 157 cancer patients with candidemia, nearly all patients (150/157, 95.5%) received ID consultation for candidemia. Performing antifungal susceptibilities, administering initial appropriate antifungal therapy, and sending follow-up blood cultures to document clearance were observed in ≥98% of study patients. Poor cancer prognosis was frequently cited in patients lacking eye exams, CVC removal, completion of at least 14 days of antifungal treatment, and step-down therapy. When 39 patients who had short antifungal courses due to death were excluded, 88 of 118 patients (74.6%) met the composite 2016 IDSA guideline adherence, defined as meeting ≥6 guideline components. Findings suggested a relationship between poor cancer prognosis and lack of composite of 2016 IDSA guideline adherence.

The creation of institution-specific, evidence-based guidelines is an established component of antimicrobial stewardship [17]. Guidelines certainly have the potential to improve quality of care by promoting interventions of proven benefit, discouraging ineffective ones, and reducing variability in clinical practice regardless of clinician, hospital, or geographic location [18]. At the same time, guidelines are based on results of trials of homogenous patient groups, whereas there is considerable patient heterogeneity in the real world [19]. Achieving partial rather than complete guideline adherence is more likely to be expected, as observed in these prior studies on the management of candidemia [8, 20–22]. It would be important to understand the reasons for guideline deviations in order to design quality improvement interventions.

Besides measuring the degree of adherence, this study is the first, to our knowledge, to systematically assess the reasons why guidelines were not followed in cancer patients with candidemia. Poor prognosis due to advanced malignancy was the leading reason for why eye exams, CVC removal, or antifungal duration was not completed. Of the 39 patients who died before finishing antifungal therapy, 13 did not recover the neutrophil count, and the remaining 26 patients had progressive or refractory malignancy. Both persisting neutropenia and advanced malignancy also happen to be adverse prognostic factors for mortality in cancer patients with candidemia [1, 23]. While the inability to complete adequate treatment due to death cannot be classified as nonadherence, we found it understandable if there were other guideline deviations for these patients with terminal cancer as following the guidelines strictly would not be within the scope of goals of care, nor would it impact their overall outcome.

With the exception of initial therapy for candidemia that is derived from high-quality evidence, many other recommendations in the 2016 IDSA guidelines, while categorized as “strong,” are based on moderate-quality (eg, CVC removal in non-neutropenic patients, antifungal duration) or low-quality evidence (eg, susceptibility testing, dilated ophthalmologic examination, CVC removal in neutropenic patients, follow-up blood cultures, step-down therapy for C. glabrata BSI) [7]. Certain recommendations like step-down therapy or CVC removal have some leeway for individualization to the patient [7]. We found more varied reasons besides poor prognosis that accounted for the inability to transition to step-down therapy, including the lack of CLSI breakpoints for certain Candida species, azole resistance, concern for drug–drug interactions or adverse effects due to an azole, and inability to tolerate oral medications. One potential area for improvement is to have the ID consult service document the plan for step-down therapy, as it was not specified in 20 of 80 patients (25%). The necessity of performing an eye exam may be worth revisiting in future national guideline updates due to the low frequency of ocular involvement in our study (2/110, 1.8%) and others [24, 25].
Several studies of other infectious conditions (eg, invasive aspergillosis, fever, and neutropenia) have found improved outcomes even if guideline adherence was not 100% [26–28]. The challenge, though, is that guidelines may not be followed by providers who lack familiarity with the published literature outside of their field or who have infrequent encounters with patients with particular medical conditions [29, 30]. Consultation by a specialist who can provide the expertise is potentially a way to put guidelines into practice. In our study, nearly all patients with candidemia were followed by the ID consult service, which likely accounted for the relatively high degree of adherence to the individual components of the 2016 IDSA candidiasis guidelines. Other studies have found that patients with Candida BSI receiving ID consultation have higher receipt of nonpharmacological, evidence-based interventions (eg, CVC removal, ophthalmologic examination), a lower rate of nontreatment, and significantly lower 30- and 90-day mortality in comparison with those without ID consultation [21, 22]. These data suggest that integrating ID consultation would be helpful in the care of patients with candidemia.

In a prior study at our center that consisted of 106 episodes of candidemia between January 1, 2005, and December 31, 2007, we found that there was a delay in administration of antifungal therapy for candidemia, primarily due to the long incubation time required for growth of the organism [4]. Incorporation of MALDI-TOF into the existing antimicrobial stewardship workflow did not significantly reduce the median total time from blood culture collection to antifungal initiation when compared with historical data from our institution (42.1 vs 43.2 hours) [4]. In the only other study that included BSIs of fungal origin, the combination of MALDI-TOF and active antimicrobial stewardship intervention led to significantly improved time to effective therapy for the entire cohort (30.1 vs 20.4 hours; \( P = .021 \)) but not for the subgroup of patients with fungemia (68.6 vs 45.6 hours; \( P = .280 \)), although this can possibly be explained by the low number of Candida BSIs [12].

MALDI-TOF, which is dependent on positive blood cultures, may not lead to faster diagnosis of candidemia. In this study, the time from blood culture positivity to administration of active drug was short, but the preceding incubation period constituted the bulk of the total time. The time to positivity of Candida species in our study may have been affected by the possibly longer specimen transport time due to the move of the microbiology laboratory to an off-site location, albeit within a mile of the main hospital [31]. We also note a change in epidemiology, with C. glabrata rather than C. parapsilosis now being the second most common isolate behind C. albicans. While blood culture detection times are similar for most Candida species, the time to positivity has been reported to be longer for C. glabrata [32]. This was true for our study, with a median incubation of 73 hours for C. glabrata vs 44 hours for non–C. glabrata species. Diagnostic strategies that can bypass blood culture incubation are of interest as the length of the incubation period is a significant predictor of mortality for cancer patients with candidemia [4]. Non-culture-based rapid diagnostics such as multiplex polymerase chain reaction and T2 magnetic resonance shorten time to detection and have the potential to improve time to effective therapy [33–35]. Larger studies incorporating antimicrobial stewardship interventions are needed to confirm improved clinical outcomes.

In terms of study limitations, these results may not be generalizable to hospitals with differing patient populations, antimicrobial stewardship practices, and Candida epidemiology. We found a 30-day mortality rate of 28.7%, similar to previous studies of cancer patients with candidemia (31.7%–39%) [1, 2, 5]. Hence, we are unable to comment on whether ID consultation or adherence to specific individual 2016 IDSA guideline components affected mortality. Another limitation is incomplete documentation in the progress notes for guideline deviations for eye exams and step-down therapy. A strength of our study is that we examined the reasons for guideline deviations to see how we could improve antifungal stewardship. While nearly all patients had antifungal susceptibility testing, appropriate initial antifungal therapy, and surveillance blood cultures, adherence to eye exams, CVC removal, and antifungal duration were affected by the underlying cancer prognosis. Documenting the plan for step-down therapy may be one area for improvement at our center but may not lead to better outcomes.

In conclusion, while we undertook this study to assess guideline adherence, we were unable to find major opportunities for improvement. Almost all cancer patients with candidemia in this study had testing for azole and echinocandin susceptibilities and received ID consultation, with high rates of initial appropriate antifungal therapy and submission of surveillance blood cultures. Performance rates were lower for eye exam, CVC removal, adequate antifungal duration, and step-down therapy, with poor cancer prognosis being a commonly cited factor. Findings suggested a relationship between poor cancer prognosis and incomplete composite adherence to the 2016 IDSA candidiasis guidelines. The incorporation of MALDI-TOF at our institution did not shorten time to effective therapy for candidemia.

**Supplementary Data**

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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