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Outcomes, Impact on Management, and Costs of Fungal Eye Disease Consults in a Tertiary Care Setting

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Objective: To determine the frequency of clinical management changes resulting from inpatient ophthalmic consultations for fungemia and the associated costs.

Design: Retrospective case series.

Participants: Three hundred forty-eight inpatients at a tertiary care center between 2008 and 2012 with positive fungal blood culture results, 238 of whom underwent an ophthalmologic consultation.

Methods: Inpatient charts of all fungemic patients were reviewed. Costs were standardized to the year 2014. The Student *t* test was used for all continuous variables and the Pearson chi-square test was used for categorical variables.

Main Outcome Measures: Prevalence of ocular involvement, rate of change in clinical management, mortality rate of fungemic patients, and costs of ophthalmic consultation.

Results: Twenty-two (9.2%) of 238 consulted patients with fungemia had ocular involvement. Twenty patients had chorioretinitis and 2 had endophthalmitis. Only 9 patients (3.7%) had a change in management because of the ophthalmic consultation. One patient underwent bilateral intravitreal injections. Thirty percent of consulted patients died before discharge or were discharged to hospice. The total cost of new consults was $36 927.54 ($204.19/initial level 5 visit and $138.63/initial level 4). The cost of follow-up visits was $13 655.44 ($104.24/visit). On average, 26.4 patients were evaluated to find 1 patient needing change in management, with an average cost of $5620.33 per change in 1 patient's management.

Conclusions: Clinical management changes resulting from ophthalmic consultation in fungemic patients were uncommon. Associated costs were high for these consults in a patient population with a high mortality rate. Together, these data suggest that the usefulness of routine ophthalmic consultations for all fungemic patients is likely to be low. *Ophthalmology 2014;121:2334-2339 © 2014 by the American Academy of Ophthalmology.*

Systemic fungemia is a common cause of nosocomial infection. Risk factors for disseminated fungal infection include parenteral nutrition, indwelling intravenous lines, immunocompromised status, recent surgery, intravenous drug abuse, and diabetes.[1,2] Ocular involvement in fungemic patients is an uncommon, but potentially disastrous, cause of vision loss in hospitalized patients. The Infectious Diseases Society of America currently recommends that all patients with fungemia undergo at least 1 dilated eye examination to rule out ocular involvement.[3]

Because of the considerable burden presented by hospitalized patients with fungemia, consultations to rule out ocular involvement in fungemic patients is one of the most common reasons for inpatient ophthalmologic consultation.[4,5] The recommendation for routine consultation persists despite improved efficacy and side-effect profiles of newer generations of antifungal classes such as triazoles (fluconazole) and echinocandins (caspofungin). Quicker laboratory detection of systemic fungal infections also has allowed earlier and more consistent treatment in at-risk patients.[6] The earlier recognition of infection and use of systemic antifungal therapy have been suggested as the main reason for the decrease in the prevalence of ocular involvement in fungemia.[7–10] Furthermore, because many patients with fungal disease are already on systemic antifungals at the time of consultation, it is unclear how frequently ophthalmic consultation benefits these patients by altering their management.

Because disseminated ocular fungal infection is becoming less common and the need for intervention in those few patients is even more rare, routine ophthalmologic consultation on all fungemic inpatients may not be an efficient use of clinical resources.[7–10] The present report is the largest to examine the impact of ophthalmologic consultation on the management of fungemic patients and the costs associated with this care.

Methods

This study was a retrospective case series at the Hospital of the University of Pennsylvania conducted between January 1, 2008, and December 31, 2012. Penn Medicine's Clinical Data Warehouse containing clinical diagnostic codes and pharmacy and laboratory data for all patients treated at the Hospital of the University of Pennsylvania was queried twice. The first query returned all inpatients who had a positive fungal blood culture results.

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Fungal genera searched for included *Candida*, *Aspergillus*, and *Cryptococcus*. The second query returned all inpatients who were given systemic antifungal medications during the study period. The 2 lists were cross-referenced, and all patients appearing on both lists had their chart reviewed. Patients younger than 18 years of age were excluded. Repeat positive fungal cultures were considered new events if 90 days had passed since the previous positive culture results. Because there was often a delay of at least 2 days between blood culture sampling and results of the fungal culture, we excluded patients who were discharged or died before positive fungal culture results were reported.

All eligible patient charts were reviewed for documentation of formal comprehensive ophthalmologic examination. Visual acuity was assessed with standard near card at the bedside or with Snellen chart in the clinic. The anterior segment was examined with either a penlight or portable slit lamp at the bedside and a standard slit lamp in the clinic. All dilated fundus examinations were performed with indirect ophthalmoscopy after pupillary dilation with mydriatic agents.

Study data were collected and managed using Research Electronic Data Capture tools hosted at the University of Pennsylvania.[11] Research Electronic Data Capture is a secure, web-based application designed to support data capture for research studies, allowing for data entry, tracking of data manipulation and export procedures, and an automated export procedure for data downloads to common statistical packages. Data extracted from the inpatient record included patient demographics, cultured fungal species, suspected cause of fungemia, duration of antifungal therapy before consultation, antifungal at time of consultation, time from positive culture results to ophthalmic consultation, ability to verbalize symptoms, visual symptoms, visual acuity, fundus examination findings, any recommended change in management from the consultation, and whether the primary team followed through with the recommended change in management. We used the classification system for ocular fungemia proposed by Donahue at al.[7] Chorioretinitis was defined as deep focal, fluffy white lesions localized within the chorioretinal layers. Vitreitis or endophthalmitis was defined as extension into the vitreous with fluff balls, vitreous haze, or vitreous abscess.

Costs of new inpatient and subsequent inpatient visits were obtained from the Centers for Medicare and Medicaid Services 2014 Physician Fee Schedule.[12] Because actual billing data were not available for review, total new patient costs were estimated by combining the costs of level 5 and level 4 new inpatient visits. Patients who received a consultation and needed follow-up presumably were more complex, requiring additional medical decision making, and were assigned a level 5 new visit. Patients who received a consultation and did not need follow-up presumably required less medical decision making, and thus a level 4 visit was used for cost calculations. The national average cost of a level 5 new inpatient consultation (Current Procedural Terminology code 99255) was $204.19. The national average cost of a level 4 new inpatient consultation (Current Procedural Terminology code 99254) was $138.63. The national average cost of a level 3 subsequent inpatient follow-up visit (Current Procedural Terminology code 99233) was $104.24. All statistical analyses were performed with STATA software (College Station, TX). The Student *t* test was used for all continuous variables, and the Pearson chi-square test was used for categorical variables. Two-sided *P* values of less than 0.05 were considered statistically significant. This study was approved by the University of Pennsylvania's Institutional Review Board and adhered to the tenets of the Declaration of Helsinki.

Table 1. Baseline Characteristics of Fungemic Patients Who Had Ophthalmology Consultation versus Those Who Did Not Have an Ophthalmology Consultation

	Ophthalmology Consultation	No Ophthalmology Consultation	*P* Value
Total no.	109	239	
Male gender (%)	56.9	55.6	0.83
Mean age (yrs)	57.8	56.9	0.62
Mortality + hospice rate (%)	56.9	28.9	<0.001
Pathogen			0.04
Candida albicans	50	108	
Candida glabrata	22	52	
Candida parasilosis	12	36	
Candida tropicalis	7	19	
Candida krusei	2	7	
Candida lusitaniae	2	3	
Candida dubliniensis	0	3	
Candida famata	0	2	
Candida guilliermondii	0	1	
Cryptococcus	12	3	
Malassezia	0	1	
Rhodotorula	0	1	
Fusarium	0	1	
Trichosporon	1	0	
Unspecified budding yeast	1	0	
Multiple species	0	2	

Results

During the study period, 390 patients had positive blood culture results for fungus. Of these, 42 patients were excluded for the following reasons: 23 did not have a complete inpatient record, 13 had positive fungal culture results only after death or hospital discharge, 4 were younger than 18 years, 1 patient was thought to have a contaminant rather than true positive fungal culture results, and 1 patient was consulted only for diplopia without mention of positive fungal culture. Of the 348 patients meeting inclusion and exclusion criteria, the ophthalmology department was consulted for 239 patients (68.7%). Of these, 238 patients underwent a complete ophthalmic examination and 1 patient declined examination.

Of the 348 study patients meeting inclusion and exclusion criteria, 56% were male and the mean age was 57.2 years, with a range of 19 to 92 years (Table 1). The most common species identified on fungal culture were *Candida albicans*, *Candida glabrata*, and *Candida parapsilosis*, which were found 45.4%, 21.2%, and 13.8% of the time, respectively. *Cryptococcus* was identified in 4.3% of blood cultures. The most frequent primary suspected cause of fungemia was indwelling line, and the second most frequent was intravenous hyperalimentation. There were no significant differences in gender or mean age between patients for whom the ophthalmology department was and was not consulted (Table 1). The rate of mortality or transfer to hospice was significantly higher for patients for whom ophthalmology was not consulted ($P < 0.001$). Also, patients who did not receive an ophthalmology consult were significantly less likely to have *C. glabrata* identified on fungal culture ($P = 0.037$).

The overall incidence of ocular involvement in fungemic patients with ophthalmologic consultation was 9.2% (22 of 238 patients; Table 2). There were 20 cases of chorioretinitis (8 unilateral and 12 bilateral). There were 2 cases of endophthalmitis (both bilateral). Comparisons of the group of patients with and without ocular involvement are shown in Table 2. The groups did