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Species distribution and susceptibility profile of *Candida* species in a Brazilian public tertiary hospital

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Abstract

Background: Species identification and antifungal susceptibility tests were carried out on 212 *Candida* isolates obtained from bloodstream infections, urinary tract infections and dialysis-associated peritonitis, from cases attended at a Brazilian public tertiary hospital from January 1998 to January 2005.

Findings: *Candida albicans* represented 33% of the isolates, *Candida parapsilosis* 31.1%, *Candida tropicalis* 17.9%, *Candida glabrata* 11.8%, and others species 6.2%. In blood culture, *C. parapsilosis* was the most frequently encountered species (48%). The resistance levels to the antifungal azoles were relatively low for the several species, except for *C. tropicalis* and *C. glabrata*. Amphotericin B resistance was observed in 1 isolate of *C. parapsilosis*.

Conclusions: The species distribution and antifungal susceptibility herein observed presented several epidemiological features common to other tertiary hospitals in Latin American countries. It also exhibited some peculiarity, such as a very high frequency of *C. parapsilosis* both in bloodstream infections and dialysis-associated peritonitis. *C. albicans* also occurred in an important number of case infections, in all evaluated clinical sources. *C. glabrata* presented a high proportion of resistant isolates. The data emphasize the necessity to carry out the correct species identification accompanied by the susceptibility tests in all tertiary hospitals.

Findings

Infections caused by opportunistic pathogens, such as yeasts, are becoming important causes of morbidity and mortality in many patients, because of alterations in the immune system and invasive hospital procedures [1]. Candidemia is commonly associated with high morbidity and mortality resulting in significant increases in the length of patients' hospitalization and in healthcare costs [2].

In the past two decades, nosocomial yeast infections have increased significantly worldwide [3]. In the United States, yeast infection ranks as the 4th most common cause of nosocomial bloodstream infection (BSI) [3]. In Brazil, *Candida albicans, Candida tropicalis* and *Candida parapsilosis* are the most common species isolated from BSI in several medical centers [2,4,5]. There has been an important shift in the species causing nosocomial candidemia, with the emergence of non-*albicans* species, particularly those more resistant to antifungal drugs [6,7]. Although studies demonstrate that antifungal resistance is relatively rare [2,4,8], antifungal drugs have been used intensively either to control such infections or as prophylactic in long-term treatments, creating serious worries that might select for drug resistances, thus greatly harming infection control [9,10]. *Candida* species have various degrees of susceptibility to the frequently used antifungal drugs. For example, while *Candida krusei* is intrinsically resistant to fluconazole, *Candida glabrata* is less susceptible or has higher MICs than other *Candida* species [10], which makes the correct species identifications and susceptibility tests pressing necessities.

In the present work, we present data on species frequency and antifungal susceptibility of *Candida* isolates obtained in a Brazilian public tertiary hospital.

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Results

Species identification

Table 1 demonstrates the species distribution of *Candida* isolates. In a total of 212 yeast cultures, 70 (33%) were isolates of *C. albicans*, 66 (31.8%) *C. parapsilosis*, 38 (17.9%) *C. tropicalis*, 25 (11.8%) *C. glabrata*, 10 (4.7%) *C. guilliermondii*, 2 (0.9%) *C. lusitaniae* and 1 (0.5%) *C. pelliculosa*. With regard to clinical materials, *C. parapsilosis* was the species most commonly isolated from bloodstream infections (BSI) and also from peritoneal fluid (PF), while *C. albicans* presented a homogeneous distribution among the three sources, BSI, PF and urinary tract infections (UTI). *C. tropicalis* and *C. glabrata* were observed mainly in UTI isolates.

Susceptibility tests

Susceptibility tests for fluconazole, itraconazole and amphotericin B were performed on 212 isolates of *Candida* species. Table 2 summarizes the MIC ranges that delimit inhibition of isolates at proportions of 50 and 90%, determined by visual inspection, after 48 h incubation. Among all evaluated isolates, including *C. glabrata*, 31(14.6%) were resistant to fluconazole, 43 (20.3%) to itraconazole and 1(0.5%) to amphotericin B. When excluding this species the resistant isolates decrease to 14 (7.8%) and 21 (11.2%) for fluconazole and itraconazole, respectively.

Fluconazole exhibited the greatest activity against *C. albicans* with resistance observed in 5 (7.1%) isolates. Seven (18.4%) *C. tropicalis*, 1(1.5%) *C. parapsilosis*, 17 (68%) *C. glabrata* and 1 (10%) *C. guilliermondii* isolates were resistant to fluconazole. Resistance to itraconazole was found in 8 (10%) *C. albicans*, 22 (88%) *C. glabrata*, 2 (3%) *C. parapsilosis*, 10 (21.1%) *C. tropicalis* and 1 (10%) *C. guilliermondii* isolates. One *C. parapsilosis* isolate was amphotericin B-resistant. Isolates of *C. lusitaniae* and *C. pelliculosa* were susceptible to amphotericin B and to the azoles.

Table 1 Distribution frequency of *Candida* species obtained from different clinical materials at the Brazilian Tertiary Hospital (Clinical Hospital of the UNESP School of Medicine, Botucatu, São Paulo State).

Species	BSI % (n)	UTI % (n)	PF % (n)	Total % (n)
C. albicans	32.4 (33)	34.1 (29)	32.0 (8)	33.0 (70)
C. glabrata	4.9 (5)	23.5 (20)	-	11.8 (25)
C. guilliermondii	6.9 (7)	1.2 (1)	8.0 (2)	4.7 (10)
C. lusitaniae	2.0 (2)	-	-	0.9 (2)
C. parapsilosis	48.0 (49)	8.2 (7)	40.0 (10)	31.1 (66)
C. pelliculosa	1.0 (1)	-	-	0.5 (1)
C. tropicalis	4.9 (5)	32.9 (28)	20.0 (5)	17.9 (38)
Total	102	85	25	212

The MIC for fluconazole, itraconazole and amphotericin B of the QC strains ranged, respectively, from 1-4 μg/mL, 0.12-0.5 μg/mL and 0.5-1 μg/mL, for *Candida parapsilosis* ATCC 22019, and from 16-128 μg/mL, 0.25-1 μg/mL and 1-4 μg/mL for *Candida krusei* ATCC 6258.

Discussion

The epidemiology of *Candida* infections has been extensively studied in North America and Europe [11], where large surveillance programs exist. In Latin America, these data are limited [2], with some regional studies in a few medical centers [4,5]. Colombo et al. [2] carried out the largest multicenter study in eleven medical centers of nine Brazilian cities; however, our hospital was not included in their study, and the data shown herein presented some peculiar differences both in the species frequency and in the susceptibility profile. The Botucatu Clinical Hospital is a regional state medical center that characteristically attends to a high proportion of patients from small communities and rural areas, with low access to medical assistance and low income, who are mainly in critical condition or in need of some advanced medical procedures, such as dialysis or chemotherapy. Consistent with several previous studies [2,4,5], the frequency of non-*albicans* species herein observed was greater than *C. albicans*. *C. parapsilosis* was the species most often isolated from BSI and PF, whose frequencies (43 and 40%) were higher than those observed in the previous Brazilian multicenter studies (7-40% in BSI) [2,4,5]. A peculiar species distribution was found in relation to the clinical sources. While in BSI and PF *C. parapsilosis* appears as the leading species, followed by *C. albicans* and *C. tropicalis*, in UTI, *C. albicans* occurs more frequently, followed by *C.tropicalis* and *C. glabrata*. Our findings confirm other studies that indicate *C. parapsilosis* as one of the most important species causing candidemia [2-8]. At the same time, the data also indicate that *C. glabrata* occurs less frequently, in substantial contrast to temperate countries of North America and Europe [11]. The predominance of *C. parapsilosis* in the peritoneal fluid under our casuistry also comes as no surprise, considering that this species appears to be common mainly in Latin America, and in other countries in patients receiving peritoneal dialysis [12,13]. The reasons why *C. parapsilosis* occurs more frequently in Latin American countries is not completely understood. *C. parapsilosis* is considered a commensal of human skin since it has been isolated from the hands of health workers [14], who have been identified as the major vectors in the infection acquisition [15]. At the same time, other local epidemiological factors also may make important contributions to the high frequency of *C. parapsilosis* in BSI and PF, such as a high proportion

Table 2 *In vitro* activity of antifungal agents against *Candida* spp. isolates from different clinical materials at the Brazilian Tertiary Hospital (Clinical Hospital of the UNESP School of Medicine, Botucatu, São Paulo State), from 1998 to 2005.

Isolates (n)	Drugs[a]	Cumulative % of isolates susceptible at a MIC (g/ml) of[d]:													
		0.03[b]	0.06	0.125[c]	0.25[a]	0.5	1	2	4	8	16	>16[c]	32	64	>64[b]
C. albicans (70)	FLU			5.7	30.0	40.0	65.7	74.3	80.0	84.3	**92.9**				100
	ITR	57.1	71.4	84.3	87.1	88.6	88.6	**90.0**	90.0	90.0	90.0	100			
	AMB				21.0	64.0	100								
C. glabrata (25)	FLU							4.0			16.0		32.0	**92.0**	100
	ITR		4.0	4.0	8.0	12.0	32.0	48.0	56.0	60.0	76.0	**100**			
	AMB					16.0	**100**								
C. guilliermondii (10)	FLU							30.0	30.0	80.0	90.0	90.0	90.0	**100,0**	
	ITR	20.0	50.0	60.0	**90.0**	90.0	90.0	90.0	90.0	90.0	90.0	100			
	AMB				10.0	30.0	100								
C. parapsilosis (66)	FLU			1.5	3.0	10.6	33.3	69.7	89.4	**98.5**	98.5	98.5	98.5	100	
	ITR	69.7	**90.9**	97.0	97.0	98.5	98.5	98.5	98.5	98.5	98.5	100			
	AMB				1.5	6.1	98.5	100							
C. tropicalis (38)	FLU			2.6	7.9	31.6	44.7	60.5	76.3	81.6	81.7	81.8	81.9	81.10	**100**
	ITR	21.1	31.6	55.3	68.4	73.7	78.9	84.2	84.2	84.2	84.2	**100**			
	AMB					21.0	100								
All *Candida* species[e] (212)	FLU[a]			2.8	11.3	17.9	37.7	57.1	67.9	80.7	86.3	88.2	94.3	100	
	ITR[b]	45.3	61.3	72.2	77.8	79.7	83.0	86.3	87.3	87.7	**90.1**	100			
	AMB				8.0	30.7	99.5	100							

[a] FLU: fluconazole, ITR: itraconazole, AMB: amphotericin B; [b] Fluconazole drug concentrations was evaluated from 0.125 to 64 μg/ml; [c] Itraconazole and amphotericin B drug concentrations were evaluated from 0.03 to 16 μg/ml; [d] Values corresponding to MICs at which at least 50% of isolates are inhibited are listed in underlined type and 90% in bold type; [e] Included 2 *C. lusitaniae* (FLU 2.0, ITRA 0.06; AMB 1.0) and 1 *C. pelliculosa* (FLU 2.0, ITRA 0.25; AMB 0.5).

of neonates in the casuistry, as suggested by Weems [16], as well as the intense use of vascular catheters, parenteral nutrition and peritoneal dialysis procedures [17].

The isolation of *C. pelliculosa*, the asexual form of *Pichia anomala*, and *C. lusitaniae*, both rarely causing BSI, was found in other medical reports from Brazil [2,18] and other countries [19,20]. *C. guilliermondii*, also considered a normal component of human skin and mucosal flora and less common in the northern hemisphere, has been more frequently isolated in Latin America and presented reduced susceptibility to fluconazole [21,11,2].

In the present study, most of the isolates were susceptible to the antifungal drugs tested. Resistance to fluconazole and itraconazole was observed relatively high, mainly in isolates of *C. glabrata, C. tropicalis* and *C. albicans*. Similar to other studies, the percentage of isolates resistant to fluconazole was smaller than to itraconazole [22,23]. As expected, high secondary resistance rates were observed in *C. glabrata* to fluconazole (68%) and itraconazole (88%); this resistance to multiple azoles has been explained by an upregulation of CDR genes that encode the CDR efflux pumps [24]. Herein one of nine isolates of *C. guilliermondii* presented resistance to the both azole drugs, and high levels of resistance in *C. guilliermondii* has been observed worldwide [25]. The fact that resistance to amphotericin B was observed in one isolate of *C. parapsilosis* is controversial since most studies report a lack of amphotericin B resistance in *Candida* species [2,20,26], while other studies also found resistance to this drug in *C. parapsilosis* [4,27]. Amphotericin B is used most commonly in several Brazilian public tertiary hospitals in the treatment of systemic mycosis, in which the patients remain hospitalized for long periods of treatments, as in our hospital for paracoccidiodomycosis [28]. The possible effect of this drug against selectively resistant *Candida* species should not be excluded and merits proper evaluation.

In conclusion, the species distribution and antifungal susceptibility observed herein present several epidemiological features common to those observed in other tertiary hospitals in various Latin American countries,

although also exhibit some peculiarities, such as a very high frequency of *C. parapsilosis* both in BSI and PF. *C. albicans* continues to occur in an important number of infection cases, with homogeneous distribution among all the evaluated clinical sources. *C. glabrata* presents a high proportion of resistant isolates, which reinforces the necessity to carry out the correct species identification in association with the susceptibility tests.

Methods

Origin of isolates

A total of 212 clinical isolates of *Candida* spp., isolated from bloodstream infections - BSI (102 isolates), urinary tract infections - UTI (85 isolates) and and peritoneal fluid - PF (25 isolates), obtained from patients from Clinical Hospital of the UNESP School of Medicine, Botucatu, São Paulo State, between January 1998 and January 2005 were evaluated in the study. The criteria and/or condition for the selection of *Candida* isolates to be analyzed were: i) the patients must be presenting clinical evidence of infection; ii) the materials from blood and peritoneal fluid were always collected by sterile puncture; iii) the positive cultures both from blood and peritoneal fluid were obtained in BACTEC System (BD Microbiology, Cockeysville, MD), followed by plating culture and identification by microscopy, biochemical tests and VITEK·ONE® (BioMérieux, Durham, NC); iv) for the urine, the patients also must present clinical evidence of infection, the materials were collected in sterile cups from midstream urine specimen obtained after cleansing the external urethral meatus, cultured in MacConkey (Oxoid, Basingstoke, UK), Lactose Electrolyte Deficient agar (CLED; Oxoid,. Basingstoke, UK) and Sabouraud dextrose (Oxoid, Basingstoke, UK) agar plates, with counts equal to or above 10^4 colonies per ml. The peritoneal fluid materials were collected from patients in continuous ambulatory peritoneal dialysis (CAPD) by sterile puncture and we did not include samples from drainage tubes or bags. Repetitive isolates from the same patient were not included. All isolates were stored, in vial tubes containing Brain Heart Infusion plus 10% glycerol, in a freezer at -80°C. At the moment of the study each isolate was cultured on Sabouraud dextrose agar plates at 35°C.

Species identification

All *Candida* species isolates were re-identified based on colony morphology on Chromogenic agar (CHROMagar *Candida*, Difco), microscopy features on Corn-meal agar slide culture, as well as the assimilation and fermentation tests.

Susceptibility testing

Reference antifungal susceptibility testing of all 212 isolates was performed by BMD (broth microdilution) exactly as described in CLSI document M27-A2 [29] against fluconazole (Pfizer, Sao Paulo, Brazil), itraconazole (Janssen, Beerse, Belgium) and amphotericin B (Sigma, St. Louis, MO, USA). The isolates were incubated at 35°C and the presence or absence of growth, after 48 h, was observed by visual inspection. The MIC endpoint for amphotericin B was considered the lowest tested drug concentration able to prevent any visible growth, while the MIC for azoles was considered the lowest tested drug concentration causing a significant reduction (approximately 50%) in growth compared to the growth of the drug-free positive control [29]. MIC interpretations follow the CLSI breakpoints [29] for fluconazol (≤8 ug/ml, susceptible; 16-32 ug/ml, SDD, ≥64, resistant) and itraconazole (≤0.125 μg/ml, susceptible; 0.25-0.5 ug/ml, SDD, ≥1, resistant). For amphotericin B, due to a lack of consensus about the definition of this drug's MIC, previous interpretative breakpoints described elsewhere [30] were employed (≤1 ug/ml, susceptible, ≥2, resistant).

Quality control

QC was performed for BMD in accordance with CLSI documents M27-A2 [29] by using *Candida krusei* ATCC 6258 and *Candida parapsilosis* ATCC 22019.

List of abbreviations

BSI: bloodstream infection; UTI: urinary tract infection; PF: peritoneal fluid; CAPD: continuous ambulatory peritoneal dialysis; BMD: Broth microdilution.

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Authors' contributions

ABN and CHC carried out the laboratory experiments, tabulated the data and drafted the manuscript. MFS, ALM and TS participated in the design of the study and in the discussion. ACM conceived the study. EB participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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References

1. White TC, Marr KA, Bowden RA: **Clinical, cellular, and molecular factors that contribute to antifungal drug resistance.** *Clin Microbiol Rev* 1998, **11**:382-402.
2. Colombo AL, Nucci M, Park B J, Nouér SA, Arthington-Skaggs B, da Matta DA, Warnock D, Morgan J: **Epidemiology of candidemia in Brazil: a nationwide sentinel surveillance of candidemia in eleven medical centers.** *J Clin Microbiol* 2006, **44**:2816-2823.

3. Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB: **Nosocomial bloodstream infections in US hospitals: analysis of 24,179 cases from a prospective nationwide surveillance study.** *Clin Infect Dis* 2004, **39**:309-317.
4. Passos XS, Costa CR, Araújo CR, Nascimento ES, e Souza LK, Fernandes Ode F, Sales WS, Silva Mdo R: **Species distribution and antifungal susceptibility patterns of Candida spp. bloodstream isolates from a Brazilian tertiary care hospital.** *Mycopathologia* 2007, **163**:145-151.
5. Medrano DJ, Brilhante RS, Cordeiro AR, Rocha MF, Rabenhorst SH, Sidrim JJ: **Candidemia in a Brazilian hospital: the importance of Candida parapsilosis.** *Rev Inst Med Trop Sao Paulo* 2006, **48**:17-20.
6. Snydman DR: **Shifting in patterns in the epidemiology of nosocomial Candida infections.** *Chest* 2003, **123**:500-503.
7. Sobel JD: **The emergence of non-albicans Candida species as causes of invasive candidiasis and candidemia.** *Curr Infct Dis Rep* 2006, **8**:427-433.
8. Aquino VR, Lunardi LW, Goldani LZ, Barth AL: **Prevalence, susceptibility profile for fluconazole and risk factors for candidemia in a tertiary care hospital in Southern Brazil.** *Braz J Infect Dis* 2005, **9**:411-418.
9. Pfaller MA, Diekema DJ, Messer SA, Boyken L, Hollis RJ: **Activities of fluconazole and voriconazole against 1,586 recent clinical isolates of Candida species determined by Broth microdilution, disk diffusion, and Etest methods: report from the ARTEMIS Global Antifungal Suscetibility Program, 2001.** *J Clin Microbiol* 2003, **41**:1440-1446.
10. Yang YL, Ho YA, Cheng HH, Ho M, Lo HJ: **Susceptibilities of Candida species to amphotericin B and fluconazole: the emergence of fluconazole resistance in Candida tropicalis.** *Infect Control Hosp Epidemiol* 2004, **25**:60-64.
11. Pfaller MA, Boyken L, Hollis RJ, Kroeger J, Messer SA, Tendolkar S, Diekema DJ: **In vitro susceptibility of invasive isolates of *Candida* spp. to anidulafungin, caspofungin, and micafungin: six years of global surveillance.** *J Clin Microbiol* 2008, **46**:150-156.
12. Wang AY, Yu AW, Li PK, Lam PK, Leung CB, Lai KN, Lui SF: **Factors predicting outcome of fungal peritonitis in peritoneal dialysis: analysis of a 9-year experience of fungal peritonitis in a single center.** *Am J Kidney Dis* 2000, **36**:1183-1192.
13. Manzano-Gayosso P, Hernandez-Hernandez F, Mendez-Tovar LJ, Gonzalez-Monroy J, Lopez-Martinez R: **Fungal peritonitis in 15 patients on continuous ambulatory peritoneal dialysis (CAPD).** *Mycoses* 2003, **46**:425-429.
14. Asbeck ECV, Huang YC, Markham NA, Clemons CV, Stevens DA: **Candida parapsilosis fungemia in neonates: genotyping results suggest healthcare workers hands as source, and review of published studies.** *Mycopathologia* 2007, **164**:287-293.
15. Trofa D, D Gácser A, Nosanchuk JD: **Candida parapsilosis, an emerging fungal pathogen.** *Clin Microbiol Rev* 2008, **21**:606-625.
16. Weems JJ: ***Candida parapsilosis*: epidemiology, pathogenicity, clinical manifestations, and antimicrobial susceptibility.** *Clin Infect Dis* 1992, **14**:756-766.
17. Girmenia C, Martino P, De BF, Gentile G, Boccanera M, Monaco M, Antonucci G, Cassone A: **Rising incidence of *Candida parapsilosis* fungemia in patients with hematologic malignancies: clinical aspects, predisposing factors, and differential pathogenicity of the causative strains.** *Clin Infect Dis* 1996, **23**:506-514.
18. Godoy P, Tirabochi IN, Severo LC, Bustamante B, Calvo B, Almeida LP, Matta DA, Colombo AL: **Species distribution and antifungal susceptibility profile of *Candida* spp. bloodstream isolates from Latin American Hospitals.** *Mem Inst Oswaldo Cruz* 2003, **98**:401-405.
19. Kersun LS, Reilly AF, Ingram ME, Nicholaou MJ, McGowan KL: **Antifungal susceptibility against yeasts isolated from pediatric oncology patients.** *Med Mycol* 2008, **46**:337-343.
20. Odds FC, Hanson MF, Davidson AD, Jacobsen MD, Wright P, Whyte JA, Gow NAR, Jones BL: **One year prospective survey of Candida bloodstream infections in Scotland.** *J Med Microbiol* 2007, **56**:1066-1075.
21. Pfaller MA, Diekema DJ, Mendez M, Kibbler C, Erzsebet P, Chang SC, Gibbs DL, Newell VA, the Global Antifungal Surveillance Group: ***Candida guilliermondii*, an opportunistic fungal pathogen with decreased susceptibility to fluconazole: geographic and temporal trends from the ARTEMIS DISK Antifungal Surveillance Program.** *J Clin Microbiol* 2006, **44**:3551-3556.
22. Cheng MF, Yu KW, Tang RB, Fan YH, Yang YL, Hsieh KS, Ho M, Lo HJ: **Distribution and antifungal susceptibility of Candida species causing candidemia from 1996 to 1999.** *Diagn Microbiol Infect Dis* 2004, **48**:33-37.
23. Laverdiere M, Labbé AC, Restieri C, Rotstein C, Heyland D, Madger S, Stewart T: **Susceptibility patterns of Candida species recovered from Canadian intensive care units.** *J Crit Care* 2007, **22**:245-251.
24. Pfaller MA, Diekema DJ: **Azole antifungal drug cross-resistance: mechanisms, epidemiology, and clinical significance.** *J Invasive Fungal Infect* 2007, **1**:74-92.
25. Pfaller MA, Diekema DJ, Gibbs DL, Newell VA, Meis JF, Gould IM, Fu W, Colombo AL, Rodriguez-Noriega E, Global Antifungal Surveillance Study: **Results from the ARTEMIS DISK Global Antifungal Surveillance study, 1997 to 2005: an 8.5-year analysis of susceptibilities of Candida species and other east species to fluconazole and voriconazole determined by CLSI standardized disk diffusion testing.** *J Clin Microbiol* 2007, **45**:1735-1745.
26. Chen SC, Tong ZS, Lee OC, Halliday C, Playford EG, Widmer F, Kong FR, Wu C, Sorrell TC: **Clinician response to Candida organisms in the urine of patients attending hospital.** *Eur J Clin Microbiol Infect Dis* 2008, **27**:201-208.
27. Knechtel SA, Klepser ME: **Amphotericin B Resistance: Epidemiology, Mechanisms, and Clinical Relevance.** *J Invasive Fungal Infect* 2007, **1**:93-98.
28. Dillon NL, Sampaio SAP, Habermann MC, Marques SA, Lastória JC, Stolf HO, Silva NCC, Curi PR: **Delayed results of treatment of paracoccidioidomycosis with amphotericin B plus sulfomides versus amphotericin B alone.** *Rev Inst Méd Trop S Paulo* 1986, **28**:263-266.
29. Clinical and Laboratory Standards Institute: **Reference Method for Broth Dilution Antifungal Susceptibility Testing of Yeasts; Approved Standard-Second Edition M27-A2.** National Committee for Clinical Laboratory Standards, Wayne, Pennsylvania, USA 2002.
30. Nguyen MH, Clancy CJ, Yu VL, Yu YC, Morris AJ, Snydman DR, Sutton DA, Rinaldi MG: **Do in vitro susceptibility data predict the microbiologic response to amphotericin B? Results of a prospective study of patients with Candida fungemia.** *J Infect Dis* 1998, **177**:425-430.

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