Article/Artigo

Candida spp. isolated from inpatients, the environment, and health practitioners in the Pediatric Unit at the Universitary Hospital of the Jundiaí Medical College, State of São Paulo, Brazil

Candida spp. isoladas de pacientes internados, profissionais da saúde e de ambiente na Unidade de Pediatria do Hospital Universitário da Faculdade de Medicina de Jundiaí, Estado de São Paulo, Brasil

Lucas Ruiz Storti[1], Giuliano Pasquale[1], Rogério Scomparim[1], Ana Lúcia Galastri[2], Flávio Alterthum[2,3], Walderez Gambale[2,3] and Claudete Rodrigues Paula[3]

ABSTRACT

Introduction: This study aimed to isolate and identify *Candida* spp. from the environment, health practitioners, and patients with the presumptive diagnosis of candidiasis in the Pediatric Unit at the Universitary Hospital of the Jundiaí Medical College, to verify the production of enzymes regarded as virulence factors, and to determine how susceptible the isolated samples from patients with candidiasis are to antifungal agents. **Methods:** Between March and November of 2008 a total of 283 samples were taken randomly from the environment and from the hands of health staff, and samples of all the suspected cases of *Candida* spp. hospital-acquired infection were collected and selected by the Infection Control Committee. The material was processed and the yeast genus *Candida* was isolated and identified by physiological, microscopic, and macroscopic attributes. **Results:** The incidence of *Candida* spp. in the environment and employees was 19.2%. The most frequent species were *C. parapsilosis* and *C. tropicalis* among the workers, *C. guilliermondii* and *C. tropicalis* in the air, *C. lusitanae* on the contact surfaces, and *C. tropicalis* and *C. guilliermondii* in the climate control equipment. The college hospital had 320 admissions, of which 13 (4%) presented *Candida* spp. infections; three of them died, two being victims of a *C. tropicalis* infection and the remaining one of *C. albicans*. All the *Candida* spp. in the isolates evidenced sensitivity to amphotericin B, nystatin, and fluconazole. **Conclusions:** The increase in the rate of hospital-acquired infections caused by *Candida* spp. indicates the need to take larger measures regarding recurrent control of the environment.

Keywords: Candidemia. Neonatal Intensive Care Unit. Nosocomial infection. Pediatric Intensive Care Unit.

RESUMO

Introdução: Isolar e identificar *Candida* spp. do ambiente, dos profissionais de saúde e de pacientes com diagnóstico presuntivo de candidíase, em Unidade de Pediatria do Hospital Universitário da Faculdade de Medicina de Jundiaí, verificar a produção de enzimas consideradas fatores de virulência e identificar a resistência das cepas isoladas dos pacientes aos antifúngicos. **Métodos:** Foram feitas 283 coletas no período entre março e novembro de 2008 de forma randomizada do ambiente, das mãos de profissionais de saúde e de todos os pacientes com casos suspeitos de infecção hospitalar por *Candida* spp., triados pelo Comitê de Infecção Hospitalar. Todo o material coletado foi processado e as leveduras do gênero *Candida* foram isoladas e identificadas pelas características macroscópicas, microscópicas e fisiológicas. **Resultados:** A incidência de *Candida* spp. no meio-ambiente e funcionários foi de 19,2%. Destes, as espécies mais frequentes entre os funcionários foram *C. parapsilosis* e *C. tropicalis*; no ar ambiente, *C. guilliermondii* e *C. tropicalis*; nas superfícies dos ambientes, *C. lusitanae* e nos sistemas de climatização, *C. tropicalis* e *C. guilliermondii*. No período de estudo, foram feitas 320 internações, e 13 (4%) apresentaram infecção hospitalar por *Candida* spp, sendo que 3 pacientes foram a óbito, dois apresentando infecção por *C. tropicalis* e um por *C. albicans*. Todas as espécies de *Candida* spp. isoladas dos pacientes foram sensíveis à anfotericina B, nistatina e fluconazol. **Conclusões:** Verificamos um aumento crescente de infecções hospitalares por *Candida* não albicans, o que sugere a necessidade de maiores precauções em relação a um controle ambiental destas espécies.

Palavras-chaves: Candidemia. Unidade Neonatal de Terapia Intensiva. Infecção hospitalar. Unidade Pediátrica de Terapia Itensiva.

1. Curso de Medicina, Faculdade de Medicina de Jundiaí, Jundiaí, SP. 2. Departamento de Morfologia e Patologia Geral, Faculdade de Medicina de Jundiaí, Jundiaí, SP. 3. Departamento de Microbiologia, Instituto de Ciências Biomédicas, Universidade de São Paulo, São Paulo, SP.

Address to: Dr. Lucas Ruiz Storti. Av. Nove de Julho 1450/161, Parque do Colégio, 13209-011 Jundiaí, SP, Brasil.

Phone: 55 11 4521-7918

e-mail: l.storti@gmail.com

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INTRODUCTION

An increasing number of fungal infections have been detected on a global level. This raises an important matter of public health[1], as it makes hospital stays longer[2] and stands as relevant cause of morbidity and mortality among patients[2-9]. The mortality rate associated with Candidemia in the United States has recently been estimated at 49%[1], a rate that may reach 75% in neonatal intensive care units (NICU)[5], while the expenses attributed to an episode of invasive candidiasis are estimated at approximately $28,000 and $48,000 for pediatric and adult patients, respectively[1].

In the last 20 years, the whole world has seen a meaningful increase in infections caused by *Candida* spp., especially in intensive care units (ICU)[2,10]; the main risk factors have been established, namely, low weight, preterm birth, immunological deficiency, congenital disorders, use of third-generation cephalosporins, invasive routine procedures, use of vascular catheters, and a long period of hospital ingression[3-5,8]. *Candida albicans* is the species that mainly causes nosocomial infections, although some non-*albicans* species are also reported as causal agents[2,3,9]. Among the most recurrent species of *Candida* non-*albicans*, *C. tropicalis*, *C. parapsilosis*, *C. krusei*, and *C. glabrata* find more prominence. In the 1980s, *C. albicans* used to be the most frequent pathogen of nosocomial bloodstream infections, and since the 1990s its yeasts have become the third main cause of hospital-acquired infections[8,10].

Nosocomial fungal infections may have their origin in endogenous strains (introduced into the hospital by the patients themselves) or in exogenous sources, transmitted to patients via contaminated infusions, biomedical devices, or even by the hands of the hospital staff members[1,3,11,12]. Besides, it has been noticed that constant contact with patients in a hospital environment facilitates cross-contamination inside the ICU[1,2,3,8,11,12]. Considering the relevance of *Candida* spp. as infectious agents in dissemination,

the diversity of such species, and the occurrence of strains that can resist the main antifungal agents, the aims of this study were to isolate and identify the *Candida* spp. in the environment, health professionals, and patients with the presumptive diagnosis of candidiasis in the pediatric unit at the hospital in the Jundiaí Medical College; to verify the production of enzymes regarded as virulence factors (phospholipase and proteinase); and to identify how susceptible the isolated samples from patients with candidiasis are to antifungal agents.

METHODS

This research was developed at the hospital associated with the Medical College of Jundiaí and integrated into the Single Health System (SUS, in Portuguese) in the City of Jundiaí, State of São Paulo, Brazil. The hospital stands on the intermediate level of care and allocates 62 beds, consisting of 13 in the NICU, 19 in the semi-NICU and late admission wards, 6 in the pediatric intensive care unit (PICU), and 24 pediatric beds, which earns it the title of third-level medium-sized hospital. The hospital staff comprises 30 physicians and 40 nurses at the NICU and semi-NICU, 14 physicians on duty, 34 nurses at the pediatric ward and PICU, and 10 resident physicians.

From March to November 2008, monthly random samples were collected from the hospital air and staff in the following manner: 108 samples from the hospital staff (doctors, nurses, and healthcare assistants), 72 samples from room air (pediatric ward rooms, toy room, operating room, NICU, and PICU), 63 from contact surfaces in the toy room and from the NICU and PICU (door handles, light switches, counters, chairs, toys, remote controls), and 27 from the water-collection trays in the climate control equipment.

Air samples were collected through the technique of Sabouraud dextrose agar plate preparation (DIFCO™) and CHROMagar Candida (Microbiology™). The samples were exposed to the environment for 30min and kept in a stove at 37°C for 96h[13].

The samples from contact surfaces were collected by sterile swab suspension in 1ml of saline solution rubbed on a 5cm^2 area of walls, toys, and trays in the climate control equipment. The same method was employed in collecting the samples from the hospital staff, by rubbing the sterile swab on the hands and nails. The collected material was immediately processed in the lab through the culture of Sabouraud dextrose agar plates and CHROMagar and was maintained in a stove at 37°C for 96h.

All the suspected cases of hospital-acquired invasive candidiasis were selected by the Infection Control Committee during the period of this study. Samples were collected and immediately sent to the laboratory for identification.

The isolated yeasts were identified by physiological, microscopic, and macroscopic attributes, following the methodology supported by Kurtzman and Fell[14].

The proteinase secretion of the isolated *Candida* species was tested through the procedure described by Ruchel et al.[15], and the phospholipase activity was tested according to Price et al.[16]; the activity rate of those enzymes (Pz) was achieved by following Price et al., and the samples considered as positive were those revealing Pz < 1.0[16].

The *Candida* spp. isolates from patients were submitted to susceptibility testing via disk diffusion antibiotic sensitivity testing. The isolates had been previously grown in Sabouraud dextrose agar (DIFCO™) at 37°C for 24h; after this culture, the isolates experienced suspension in sterile saline solution to 0.5 McFarland scale. With a sterile swab, the inoculum was spread on Muller Hinton agar (DIFCO™), supplemented with 2% of glucose and 0.5ug/ml of methylene blue. Disks of amphotericin B, fluconazole, econazole, itraconazole, 5-fluorocytosine, and ketoconazole were also employed. The plates were incubated in a stove at 37°C for 24h. The results were interpreted as sensitive (S), intermediate (I), or resistant (R), following the instructions given by the manufacturer (CECON™).

The associations were statistically evaluated by Fisher's exact test (significance level 5%) and SAS software version 9.1.3.

Ethical considerations

The protocol was conducted following the ethical principles established in the Declaration of Helsinki proposed by the World Medical Association (Declaration of Helsinki, 1964, 1975, 1983, 1989, 1996, 2000). The project was submitted for approval by the Ethics Committee in Research of the Jundiaí Medical College. All participants were informed about the project and degree of involvement in it, and were asked to sign the Instrument of Consent (Ministry of Health/National Health Foundation, 1996), consisting of clarification regarding the following aspects: I) justification, objectives, and procedures used; II) discomfort, potential risks, and expected benefits; III) a follow-up and assistance and their respective officers; IV) the freedom to refuse to participate or withdraw their consent at any stage of the research without penalty or loss; and vi) assurance of confidentiality regarding the data collected.

RESULTS

During the study, a total of 270 sample involving both the environment and its workers were collected, and *Candida* spp. were isolated in 52 (19.2%) of these samples. The species *C. albicans* was isolated only once, from a healthcare assistant. Considering all the other places, only *Candida* non-*albicans* species were isolated. The largest isolation rate happened in the system of climate control (33.3%), followed by the contact surfaces (23.8%), staff (15.7%), and room air (15.3%) **(Table 1)**.

Considering the members of the hospital staff, the largest isolation rate occurred among the healthcare assistants (20.4%), and the single room-air isolation was from the toys room. In relation to the contact surfaces analyzed and the climate control system, the largest rates occurred at the PICU at 44.4% and 66.7%, respectively. No isolation was obtained from the climate control equipment in the operating room **(Table 1)**.

In view of the isolated species, the most frequent was *C. tropicalis* (27.4%), followed by *C. guilliermondii* (23.5%), *C. parapsilosis* (19,6%), *C. lusitanae* (17.6%), and *C. krusei* (11.8%) **(Table 2)**.

The most frequent species were *C. parapsilosis* and *C. tropicalis* among the hospital employees, *C. guilliermondii* and *C. tropicalis* in the room air, *C. lusitanae* on the contact surfaces, and *C. tropicalis* and *C. guilliermondii* in the climate control devices **(Table 2)**.

During this research, the hospital attended to 320 ingressions, of which 13 (4%) revealed hospital-acquired infections by *Candida* spp. (invasive candidiasis); 5 of these patients were staying at the NICU and 8 at the PICU.

TABLE 1 - Frequency of *Candida albicans* and *Candida* non-*albicans* in 270 samples from The environment and staff at the Universitary Hospital of the Jundiaí Medical College, State of São Paulo, Brazil, from March to November 2008.

	Collected samples (n)	*Candida albicans*	*Candida* non- *albicans*	Frequency (%)
Workers				
physicians	27	0	4	14.8
nurses	27	0	2	7.4
healthcare assistants	54	1	10	20.4
Total	**108**	**1**	**16**	**15.7**
Room air				
rooms	27	0	5	18.5
toy room	9	0	0	0.0
ICUs and operating room	36	0	6	16.7
Total	**72**	**0**	**11**	**15.3**
Contact surface				
toy room	36	0	9	25.0
NICU	18	0	2	11.1
PICU	9	0	4	44.4
Total	**63**	**0**	**15**	**23.8**
Climate control system				
PICU	9	0	6	66.7
NICU	9	0	3	33.3
operating room	9	0	0	0.0
Total	**27**	**0**	**9**	**33.3**
Sum total	**270**	**1**	**51**	**19.3**

ICUs: intensive care units; **PICU:** pediatric intensive care unit; **NICU**: neonatal intensive care unit.

TABLE 2 - Incidence of *Candida* non-*albicans* species in 51 isolates from the environment and staff at the Universitary Hospital of the Jundiaí Medical College, State of São Paulo, Brazil, from March to November 2008.

	Candida				
	tropicalis	*parapsilosis*	*krusei*	*lusitaneae*	*guilliermondii*
Workers					
physicians	1	1	2	0	0
nurses	1	1	0	0	0
healthcare assistants	3	4	1	0	2
Total	**5**	**6**	**3**	**0**	**2**
Room air					
rooms	3	1	0	1	0
toy room	0	0	0	0	0
ICUs and operating room	1	0	0	0	5
Total	**4**	**1**	**0**	**1**	**5**
Contact surface					
toy room	0	1	2	6	0
NICU	0	1	0	0	1
PICU	1	1	1	1	0
Total	**1**	**3**	**3**	**7**	**1**
Climate control system					
PICU	3	0	0	0	3
NICU	1	0	0	1	1
operating room	0	0	0	0	0
Total	**4**	**0**	**0**	**1**	**4**
Sum Total	**14**	**10**	**6**	**9**	**12**

ICUs: intensive care units; **PICU:** pediatric intensive care unit; **NICU**: neonatal intensive care unit.

Seven of the 13 cases presented *C. albicans* infection; 3 were *C. tropicalis*, 1 *C. parapsilosis*, 1 *C. krusei*, and 1 *C. guilliermondii* **(Table 3)**. The isolates of *Candida* spp. from the infections were obtained through blood culture (9 of the cases) and urine culture (4 of the cases). Three patients died. Two of them were inpatients at the NICU, with one infected by *C. albicans* and the other by *C. tropicalis*; the third patient who died was at the PICU and presented an infection by *C. tropicalis.*

All the *Candida* spp. isolated from the patients were sensitive to amphotericin B, nystatin, and fluconazole. In relation to econazole and itraconazole, some samples presented intermediate susceptibility, but only one sample of *C. albicans* was resistant to econazole **(Table 4)**.

To calculate the enzyme activity of proteinase and phospholipase, the Pz value was applied according to Price et al., with isolates with Pz < 1.0 considered as positive. Considering the 8 *C. albicans* isolates, 87.5% were regarded as positive for phospholipase activity, whereas only 8.8% of the *Candida* non-*albicans* presented positivity. In the light of the proteinase, only 12.5% of *C. albicans* and 21.1% of *Candida* non-*albicans* were positive, presenting no significant differences among the isolates from the range of groups. In relation to phospholipase activity in the patients' isolates, a relevant difference was observed between the *C. albicans* and *Candida* non-*albicans* isolates **(Table 5)**.

TABLE 3 - Hospital-acquired infection by *Candida* spp. detected in 13 patients in the NICU and PICU at the Hospital of the Jundiaí Medical College, State of São Paulo, Brazil, from March to November 2008.

Species	Cases	
	n	%
Candida albicans	7	53.8
Candida tropicalis	3	23.1
Candida parapsilosis	1	7.7
Candida krusei	1	7.7
Candida guilliermondii	1	7.7

PICU: pediatric intensive care unit; **NICU**: neonatal intensive care unit.

TABLE 4 - Antifungal susceptibility testing of *Candida* spp. isolates from 13 patients in the NICU and PICU at the hospital of the Jundiaí Medical College, State of São Paulo, Brazil, from March to November 2008.

	Samples	Amphotericin B	Econazole			Nystatin	Ketoconazole		Itraconazole		Fluconazole
Species of *Candida*	**n**	**S**	**S**	**I**	**R**	**S**	**S**	**I**	**S**	**I**	**S**
albicans	7	7	5	1	1	7	3	4	7	0	7
tropicalis	3	3	2	1	0	3	3	0	2	1	3
parapsilosis	1	1	1	0	0	1	1	0	1	0	1
krusei	1	1	1	0	0	1	1	0	0	1	1
guillermondii	1	1	1	0	0	1	1	0	1	0	1

PICU: pediatric intensive care unit; **NICU**: neonatal intensive care unit; **S**: sensitive; **I:** intermediate; **R:** resistant.

TABLE 5 - Positivity of proteinase and phospholipase activities (Price et al., 1982) in *Candida albicans* and *Candida* non-*albicans* isolates from patients and environment at the Hospital of the Jundiaí Medical College, State of São Paulo, Brazil SP, from March to November 2008.

	Number of patients	Isolations environment	Total
Candida albicans	7	1	8
Proteinase activity (n/%)	1/14.3	0/0.0	1/12.5
Phospholipase activity (n/%)	6/85.7*	1/100.0	7/87.5
Candida non-*albicans*/number of isolations	6	51	57
Proteinase activity (n/%)	1/16.7	11/21.5	12/21.1
Phospholipase activity (n/%)	1/16.7*	4/7.8	5/8.8

*statistically significant difference p>0.05.

DISCUSSION

Nosocomial infections caused by *Candida* spp. currently represent a serious matter for the public health, since the rates of incidence and mortality associated with these infections have revealed a considerable increase in third-level hospitals during the last decades[17-19]. Species of the genus *Candida* have been the most frequently isolated agents, which correspond to approximately 80% of the hospital-acquired fungal infections that cause death to 12% to 60% of the patients who develop candidemia[19-21].

The occurrence of nosocomial infections by invasive candidiasis at the Universitary Hospital of the Jundiaí Medical College during the period covered by this research was of 4% above the average described by national and international references, which report an occurrence rate of 1.49 to 6.6 cases in 1,000 hospital admissions[22-26].

The hospital sector where cases of candidemia are most commonly found is the ICU, for besides being the place where patients find themselves more impaired, it also completes a routine of invasive procedures, probes, and long-term catheters[19,27-29]. All the candidemia cases in this study were observed in patients in ICUs, a point that is also discussed by other studies that recognize the ICU as a place of utmost susceptibility to the incidence of such infection[30-33].

The absolute mortality rate due to candidemia was 23.1%, a result that is also consonant with the data provided by the bibliographic references[18-20]. Two of the patients who died were immunosuppressive newborns; they were in the NICU, and they acquired sepsis. The third patient who died was a 7-year-old child who had heart co-morbidity and was settled in the PICU. The two *Candida* species responsible for these mortality cases were *C. albicans* and *C. tropicalis.*

Candida albicans was the species most frequently found among patients (53.8%), corroborating what other studies have been demonstrating in different anatomical sites[19,30,31,34,35].

On the other hand, many researches have exposed the last decades' increase of infections as caused by other species of *Candida*[2,3,18,19,30,31]. This point was also verified in our study, which showed the relevance of identifying different *Candida* spp., aimed at gaining better epidemiological knowledge about the disease and its usual resistance to therapy, typical of the *Candida* non-*albicans* species that not only make the treatment difficult and expensive, but also provide an inaccurate prognostic[36].

Among the *Candida* non-*albicans* species, the most recurring one was *C. tropicalis* (23.1%), which along with *C. albicans* accounts for 76.9% of the candidemia cases and stands as the second most common pathogen, a fact that was already noticed in another work[37]. Fifty percent to 60% of the patients who present this species are expected to develop systemic infections[38]. Other studies point to *C. parapsilosis* as the most prevalent species among the *Candida* non-*albicans*[1-4,18,24,34,35,39]. In pediatric or neonatal units, *C. parapsilosis* has been marked as the second most common agent in patients with candidemia, a fact that is linked to the exogenous contamination because of the patients' manipulation by the hospital staff, the patients' exposure to invasive procedures in the ICU, prematurity, immunosuppression, and long-course antibiotic therapy[34,35,39-41]. Results from many other works have evidenced *C. tropicalis* or *C. parapsilosis* as the main *Candida* non-*albicans* agent involved in the different types of candidemia around us[38,42-47], which is different from what has been observed in Europe and North America, where *C. glabrata* has been detected as the second most recurrent pathogen after *C. albicans*[43,44,47-49]. This species was not isolated in our research.

Displaying an inferior occurrence that represents 23.1% of the remaining candidemia cases, *C. parapsilosis* (7.7%), *C. krusei* (7.7%), and *C. guilliermondii* (7.7%) were also identified in this study.

In relation to the samples isolated from the room air and the staff, the *Candida* non-*albicans* species were predominant and represented by *C. tropicalis*, *C. parapsilosis*, *C. guilliermondii*, *C. lusitaneae*, and *C. krusei*, a fact that confirms what other studies have demonstrated[2,24,50,51]. With reference to health practitioners, some researches inform that *C. albicans* is the most commonly isolated species from the hands of the healthcare staff[51,52], while some authors have identified *C. tropicalis* and *C. parapsilosis* as dominant species[2,12,24,50,51]. In this work, *C. albicans* was isolated only once from the hand of a healthcare assistant; it was never isolated from the room air.

The incidence of *Candida* spp. among the workers was 15.7%, an average that is below the result previously verified by other studies[52,53]. However, except for *C. lusitaneae*, which was not isolated from any patient in this research, the remaining isolates of *Candida* non-*albicans* from the environment and the hands of the hospital staff members were also isolated from the patients. This fact might indicate an exogenous transmission via direct contact, which makes necessary a number of comparative molecular studies to confirm this hypothesis. Although most candidemia cases occur because of a pre-existent colonization in the patient (by the same species of yeast that causes the infection), hematopoietic infections of difficult control may also be acquired through manipulation and direct contact made by the hands of healthcare professionals[54-58].

There was a correlation between the incidence of *C. tropicalis* and *C. guilliermondii*, the room air, and the trays in the climate control equipment: all the *Candida* spp. samples from these places were *Candida* non-*albicans*, with a positivity rate of 15.3% in the room air and 33.3% in the climate control system. In view of the results, it is not possible to state that the same species detected in the climate control system were responsible for contamination and migration to the room air, since the operating room did not have *Candida* spp. positive in its climate control equipment, although *C. guilliermondii* actually had a positive detection in the room air. Nevertheless, both the climate control system and the room air in the PICU presented *C. guilliermondii* positivity, which might imply a yeast migration through the climate control system.

Considering the total samples collected from the furniture surface, 23.8% were positive for *Candida* spp., all of them being *Candida* non-*albicans*, with a prevalence of *C. lusitaneae*, which differs from a similar study that found a dominance of *C. guilliermondii* on the surface of the hospital furniture[51].

The *Candida* non-*albicans* isolates verified in this range of sectors, plus the growing increase in hospital-acquired infections caused by these species observed in recent years, suggest the importance of being attentive to frequent control of environment. A number of works have implied that the proteinase and phospholipase enzymes might be virulence factors of *Candida* spp[59-62].

In relation to proteinase, there was no significant difference in the production of this enzyme between *C. albicans* and the *Candida* non-*albicans* isolated from patients, corresponding to 14.3% and 16.7% of the samples, respectively. It is important to note that 21.5% of the *Candida* non-*albicans* samples isolated from the environment showed proteinase activity. Other studies demonstrate a larger incidence of proteinase production by *Candida* non-*albicans* species[25,29,59,60].

On the other hand, 85.7% of the *C. albicans* samples isolated from patients were positive for phospholipase activity, whereas only 16.7% of the *Candida* non-*albicans* revealed phospholipase positivity, suggesting that this enzyme and *C. albicans* might be associated but are independent of virulence, as confirmed by other works that attest to the predominant production of phospholipase among *C. albicans* isolates from both healthy individuals and pathogenic cases, proving that phospholipase synthesis is not restricted to pathogenic samples[24,28,36,46,52,58]. Such fact also implies that phospholipase is not a determinant factor of the disease settlement, once the host immunity, the endogenous presence of *C. albicans*, and the effectiveness of the pathogenicity in the samples are also considered.

Other studies demonstrate that pathogenic samples produce more proteinase than phospholipase[47,53,59,60,63]. However, this is a controversial statement, and this discussion concerning enzyme activity as a virulence factor of *Candida* spp. remains unresolved.

Analysis of the antifungal susceptibility testing of *Candida* spp. isolates from pediatric patients showed all the samples to be *in vitro* sensitive to the main treatment drugs used in our hospital, fluconazole and amphotericin B. Nevertheless, there are several divergences concerning the resistance to antifungal therapies, especially among the *Candida* non-*albicans* species, which have presented resistance to the treatment elected in different parts of the world[2,4,8,9,64,65].

The treatment accomplished in our work was satisfactory and is according to the reality in most public hospitals in Brazil, where the first-choice drug for candidemia is fluconazole[22]. However, there is a new therapeutic class of antifungal drugs for invasive candidiasis. This class is known as the echinocandins, which are showing to be more safe and effective and with fewer side effects than the other drugs; they can be used as an excellent therapeutic option, especially in cases of recent history of exposure to an azole, moderately severe to severe illness (i.e., hemodynamically unstable), and allergy or intolerance to azoles[66-71]. Although amphotericin B remains a therapeutic option because of its broad spectrum and low cost, it produces side effects related to infusion and nephrotoxicity[71-73]. Thus, it is only used in case of microorganisms that are resistant to azoles and echinocandins and in patients who have an intolerance to these drugs, because their use may become more expensive and prolong hospital stay[73].

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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