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Invasive Candidiasis: Prevalence, Species Distribution and Trends in Antifungal Susceptibility in an Egyptian University Hospital

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THE RATE of *Candida*- induced infections has been increasing significantly. The magnitude of the problem is aggravated by the emerging antifungal resistance among various *Candida* species. Our study aimed to assess the antifungal susceptibility profiles of *Candida* isolates causing infections at Ain Shams University Hospitals from 2018 to 2022. A cross-sectional observational study of all cases of positive growth of *Candida* and antifungal susceptibility testing was performed using VITEK 2 compact automated system. Out of 342 specimens, *Candida albicans (C. albicans)* was the most common species (40.4%). *Candida* non *albicans* (CNA) was predominating (59.6%) and was mainly composed of *C. tropicalis* (36.3%) and *C. parapsilosis* (8.8%). Among total *Candida* isolates, 24 (7%) were resistant to Flucytosine, 20 (5.8%) were resistant to Amphotericin B as well as Caspofungin, 12 (3.5%) were resistant to Fluconazole, 5 (1.5%) were resistant to both Micafungin and Voriconazole. *Candida* non *albicans* which express decreased susceptibility to antifungals have been emerging as a serious cause of infection among hospitalized patients. Resistance was common to Flucytosine, Amphotericin B and Caspofungin, with low resistance rate to Fluconazole, Micafungin and Voriconazole.

Keywords: Antimicrobial sensitivity, *Candida*, Critically ill patients, Epidemiology, Yeast.

Introduction

During the last few decades, the rate of fungal infections have been rising tremendously (Sharma et al., 2022). The estimated global rate of invasive fungal infections is 1.5 million yearly, this rising frequency may be attributed to the wide use of broad-spectrum antibiotics as well as the increased number of immunocompromised individuals due to organ transplantation, HIV infections or cancer patients on chemotherapy (Bajpai et al., 2019).

Candida is the most common cause of invasive fungal infections. Up to half of the patients in intensive care units (ICUs) are colonized with *Candida*. Invasive candidiasis (IC) occurs in almost 9% of those patients, primarily by translocation to the bloodstream (Al-Dorzi et al., 2020). Invasive candidiasis results in prolonged hospital stay, increased costs of medical care and high mortality rates (Fernando et al., 2022).

Although *Candida albicans* (*C. albicans*) is the most commonly isolated species (spp.) in hospital settings, a progressive shift to *Candida non albicans* (CNA) spp. as a principal cause of serious infections including candidemia is taking place worldwide (Fuller et al., 2019). The epidemiology of *Candida* spp. and their antifungal susceptibilities vary greatly in different regions (Al-Dorzi et al., 2020). Four classes of antifungal drug were used for the treatment of systemic fungal infections. They include polyenes, azoles, echinocandins and the pyrimidine analogue flucytosine (5-FC) (Houst et al., 2020). Several factors have contributed to the emergence of resistance to antifungal agents such as their overuse in empirical treatment and in pesticides (Hendrickson et al., 2019).

Automated methods such as VITEK 2 compact can provide simultaneous identification and susceptibility results. Therefore, they reduce turnaround times and enhance result

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reproducibility (Abdu Salam et al., 2023). However, since the culture-based techniques usually require two to three days, and empirical treatment could be mandatory in critical patients as those with candidemia. Microbiology laboratory can aid clinicians through provision of regularly updated regional guidelines for the epidemiology and antifungal susceptibility profile (Hazrat et al., 2022). This study aimed to determine the *Candida* species most frequently isolated from different clinical specimens and to monitor the antifungal susceptibility profile of clinical isolates of *Candida* at Ain Shams University Hospitals.

Materials and Methods

Specimen collection

From January 2018 to September 2022, 48,309 specimens were submitted for routine culture and sensitivity testing to the Main Microbiology Laboratory of Ain Shams University Hospitals among which, 342 specimens showed growth of *Candida* spp.

Fungal culture of specimens

Each specimen was cultured on two plates of Sabouraud dextrose agar media supplemented with chloramphenicol (SDA) (Oxoid, UK). One plate was incubated at 25-28℃ and the other at 36℃ ±1℃. Plates were examined every day for growth up to 2 weeks. Positive fungal cultures were identified through colony morphology and Gram stain (Oxoid, UK), and then Vitek 2 Compact system was used for identification to the spp. level in addition to antifungal susceptibility testing (BioMérieux, Marcy l'Etoile, France), where, each yeast isolate was adjusted to 2.0 McFarland using Vitek 2 DensiCheck turbidimeter and then used to inoculate the colorimetric fungal susceptibility cards containing the biochemical substrates. Cards were incubated in the Vitek 2 instrument for 18h at 35°C and monitored every 15min. The final readings were interpreted through the established algorithm for yeast identification.

Statistical analysis

The collected data were revised, coded, tabulated, and introduced to a computer using Statistical Package for Social Science (SPSS 20). Data were presented and suitable analysis was done according to the type of data obtained for each parameter.

Results

From January 2018 to September 2022, 48,309 specimens were submitted for routine culture and sensitivity testing to the Main Microbiology Laboratory of Ain Shams University Hospitals including 42,709 inpatient samples and 5,600 outpatient. Where, 15131, 12100, 251, 1205,1397, 3466, 1645, 2296, 1818, 5500, 2000 and 1500 specimens were sent for urine, blood, bronchoalveolar lavage (BAL), Cerebrospinal fluid (CSF), pleural fluid, pus, central line, ascitic fluid, wound cultures, sputum, stool and drain respectively. A total of 342 *Candida* isolates collected from 342 subjects were tested through Vitek 2 Compact system for identification to the spp. level in addition to antifungal susceptibility testing, where; 69, 13, 83, 119, 58 isolates were collected in 2018, 2019, 2020, 2021 and 2022 respectively. These isolates were retrieved from intensive care unit (ICU) 66.1%, neonatal intensive care unit (NICU) 1.5%, ward patients 28%, transplantation unit 2%, outpatients 1.8%, oncology unit 0.3% and hematology unit 0.3% (Table 1), *C. tropicalis* was the most common isolate from ICU, however, in both NICU as well as transplantation units, *C. albicans* was the commonest. Isolates were recovered from blood 9.3%, urine 76%, sputum 6.4%, central line 3.2%, pus 1.8%, BAL 0.9%, wound 0.9% samples, 0.3 % were isolated from each of CSF, pleural fluid, ascitic fluid, stool and drain sample (Table 2).

Along the five years of the study period, *C. albicans* showed the highest incidence among different *Candida* spp., however, overall, CNA were greater (Fig. 1).

Total *Candida* isolates were 342; 138 (40.4%) *C. albicans* and 204 (59.6%) CNA and was composed of the following species; *C. tropicalis* 36.3%, *C. parapsilosis* 8.8%, *C. guilliermondii* 4.4%, *C. krusei* 3.2%, *C. glabrata* 2.3%, *C. lusitaniae* 1.4%, *C.dubliniensis* 1.4%, *C. ciferrii* 1.2%, *C. duobushaemulonii* 0.3% and *C. kefyr* 0.3% (Table 2).

As regard antifungal susceptibility as shown in Table 3, upon assessment of the minimum inhibitory concentration (MIC) for *Candida* isolates, all *C. albicans* were sensitive to micafungin (MFG), 5 (3.7%) were resistant to flucytosine (5-FC), 2 (1.5%) and 3 (2.3%) were moderately sensitive and resistant respectively to

each of Amphotericin B (AMB) and caspofungin (CAS), 2 (1.5%) were resistant to voriconazole (VRC). *C. tropicalis* showed resistance to 5-FC 5 (4.1%), fluconazole (FLC) as well as AMB 3 (2.5%). All isolates of *C. parapsilosis* were sensitive to AMB, 5-FC, CAS, MFG, VRC, only one isolate was resistant to FLC. Three isolates of *C. guilliermondii* were resistant to AMB and CAS, two isolates were resistant to 5-FC and FLC. *C. krusei* showed the highest resistance where, out of 11 isolates, 10 were resistant to 5-FC, 8 and 4 were moderately sensitive to CAS and AMB respectively. *C. glabrata* were sensitive to AMB, 5-FC, CAS, FLC, VRC, only one isolate was resistant to MFG. Among total *Candida* isolates, 24 (7%) were resistant to 5-FC, 20 (5.8%) were resistant to AMB as well as CAS, 12 (3.5%) were resistant to FLC, 5 (1.5%) were resistant to both MFG and VRC.

Discussion

In this study, we investigated the species distribution and determined the antifungal susceptibility of 342 *Candida* isolates collected at Ain Shams University Hospitals from 2018 to 2022.

TABLE 1. Locations of isolation

	ICU N (%)	NICU N (%)	Ward N (%)	Transplant N (%)	Oncology N (%)	Outpatient N (%)	Hematology unit N (%)	Total
C. albicans	83 (36.7)	4 (80)	42 (43.8)	6	1	2		138
C. tropicalis	89 (39.4)		31 (32.3)			3	1	124
C. parapsilosis	17 (7.5)		11 (11.4)	1		1		30
C. guilliermondii	10 (4.4)		5 (5.2)					15
C. krusei	5 (2.2)	1 (20)	5 (5.2)					11
C. galabrata	8 (3.5)							8
C. lusitaniae	4 (1.8)		1 (1.0)					5
C. ciferrii	4 (1.8)							4
C.dubliniensis	4 (1.8)		1 (1.0)					5
C. duobushaemulonii	1 (0.4)							1
C. kefyr	1 (0.4)							1
Total	226	5	96	7	1	6	1	342
	66.1%	1.5%	28%	2%	0.3%	1.8%	0.3%	100%

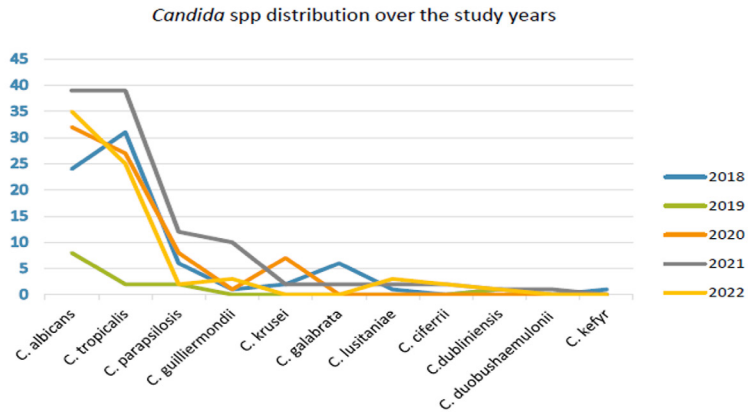

Fig.1. *Candida* spp distribution over the study years

TABLE 2. List of specimens from which *Candida* was isolated

	Blood	Urine	Sputum	BAL[a]	CSF	Pleural fluid	Pus	CL[b]	Ascitic fluid	stool	wound	Drain	Total (N)	Total %
C. albicans	15	101	9	1	1	1	4	4	1	1			138	40.4
C. tropicalis	9	97	11				2	4			1		124	36.3
C. parapsilosis	6	17		2				3			2		30	8.8
C. guilliermondii		14	1										15	4.4
C. krusei		10										1	11	3.2
C. galabrata	1	7											8	2.3
C. lusitaniae		4	1										5	1.4
C. ciferrii		4											4	1.2
C.dubliniensis		5											5	1.4
C duobushaemulonii .	1												1	0.3
C. kefyr		1											1	0.3
Total	32	260	22	3	1	1	6	11	1	1	3	1	342	100
%	9.3	76	6.4	0.9	0.3	0.3	1.8	3.2	0.3	0.3	0.9	0.3	100	

[a] Bronchoalveolar lavage

[b] Central line

TABLE 3. Fungal species distribution and antifungal susceptibility among all specimens

	Total N (%)	AmpB[a] tested (n)	MS*	R*	Flucytosine[b] tested (n)	MS*	R*	Caspo[c] tested (n)	MS*	R*	Fluconazole[d] tested (n)	MS*	R*	Mica[e] tested (n)	MS*	R*	VOR[f] tested (n)	MS*	R*
C. albicans	138 (40.4)	131	2 (1.5)	3 (2.3)	134	0	5 (3.7)	131	2 (1.5)	3 (2.3)	135	0	3 (2.2)	133	0	0	135	0	2 (1.5)
C. tropicalis	124 (36.3)	118	1 (0.8)	3 (2.5)	121	1 (0.8)	5 (4.1)	120	0	2 (1.7)	119	2 (1.7)	3 (2.5)	119	0	1 (0.8)	121	0	2 (1.7)
C. parapsilosis	30 (8.8)	28	0	0	28	0	0	29	0	0	27	0	1 (3.7)	27	0	0	27	0	0
C. guilliermondii	15 (4.4)	15	1 (6.7)	3 (20)	14	0	2 (14.3)	13	0	3 (23)	4	0	2 (50)	12	0	1 (8.3)	12	0	1 (8.3)
C. krusei	11 (3.2)	11	4	0	11	0	10	11	8	0	3	1	0	9	0	0	10	0	0
C. galabrata	8 (2.3)	8	0	0	8	0	0	8	0	0	8	0	0	8	1 (12.5)	1 (12.5)	8	0	0
C. lusitaniae	6 (1.8)	6	0	1 (16.7)	6	0	1 (16.7)	4	0	1 (25)	1	0	0	3	0	1 (33.3)	6	0	0
C. ciferrii	4 (1.5)	4	0	1 (25)	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0
C. dubliniensis	4 (1.5)	4	0	0	3	0	0	3	0	1 (33.3)	2	0	0	3	0	0	4	0	0
C. duobushae-mulonii	1 (0.3)	1	0	1 (100)	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C. kefyr	1(0.3)	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0
Total	342																		

The 342 clinical isolates were collected from; urine 76.3%, blood 9.4%, sputum 6.4%, central line 3.2%, pus 1.8%, BAL and wound 0.9% each, CSF, pleural fluid, ascitic fluid, stool and drain samples 0.3% each. This was concordant with Yang et al., (2013) where, the majority of *Candida* isolates were found to be the most commonly recovered isolates from urine 45.2%, blood 19.7% and sputum 13%. However, our data disagree with Pu et al. (2017), who reported that the main specimens from which *Candida* was isolated were, blood 36.2%, ascitic fluid 11.3%, catheters 11.3%, drainage fluid 7.0%, pus 5.1%, CSF 3.5%, bile 3.1%, vitreous body 2.3% and pleural fluid 1.9%. Song et al. (2020) stated that yeast were isolated from blood 34.9%, BAL 27.1%, ascitic fluid 15.2%, pleural fluid 7.4%, pus 4.2%, CSF 3.6%, and peritoneal dialysis 3.0%, central line tips <5%.

According to the location of patients, 66.1% of the cases were ICU patients. The remaining isolates were collected from neonatal intensive care unit (NICU), ward patients, transplantation unit, outpatients, oncology unit and hematology unit with the following percentages respectively; 1.5%, 28.1%, 2%, 1.8%, 0.3%, 0.3%. This agrees with Pu et al., (2017), where the *Candida* isolates were mainly recovered from ICUs 31.1%, gastrointestinal surgery 15.6%, the hepatobiliary surgery 10.1%, urinary surgery 5.8%, and neurosurgery 5.1% wards. According to Song et al. (2020), *Candida* spp. were mainly isolated from ICU patients 75.9%, surgical wards 11.0%, and bone marrow transplant unit 0.8%. These results are discordant with Diaz-García et al. (2021) who found that fungemia cases were mainly those admitted to medical wards 30.2%, followed by ICUs 20.1%, surgical wards 15.7%, oncology-hematology 14.5%, neonatology 12.5%, and other wards 7%.

In our study, *C. albicans* was the predominant species 40.4%, while, the *Candida non albicans* represented 59.6%. *C. tropicalis* 36.3% was the most prevalent CNA spp., followed by *C. parapsilosis* 8.8%, *C. guilliermondii* 4.4%, *C. krusei* 3.2%, *C. glabrata* 2.3%. As per department, CNA spp. were mainly implicated in ICU infections 63.3%, with *C. tropicalis* showing the highest frequency 39.4%. However, in NICU, transplantation units and both medical as well as surgical wards, *C. albicans* was the commonest. A shift in the epidemiological pattern has been noted all over the world during the last 40 years from the prevailing *C. albicans* to CNA (Hou et al., 2022). This may be explained by the wide use of azoles, which favored the prevalence of the more resistant CNA spp. over the generally susceptible *C. albicans* (Koehler et al., 2019). This was concordant with Kmeid et al. (2020) who reported that *C. albicans* was the most common spp. accounting for 22.3% to 60% of the isolates. It also showed the increased ratio of CNA over the study years. *C. tropicalis* was the most frequent CNA (10.8%–37.7%) of all *Candida* spp., followed by *C. glabrata* (4.8%–19.2%), *C. parapsilosis* (7.9%–36.6%), and *C. krusei* (0–7.8%). Also, Al-Dorzi et al., (2020) where CNA accounted for the majority of spp. causing IC 56.2%. *C. albicans* represented 38.3%, *C. tropicalis* 16.7%, *C. glabrata* 16%, and *C. parapsilosis* 13.6% of all *Candida* isolates. This is also close to the results reported by Hendrickson et al. (2019) from the USA, where *C. albicans* represented 42.7%. However, it is noticed that the distribution CNA spp. differs according to the region, center and even the unit (Hou et al., 2022), while *C. tropicalis* was prevalent in Taiwan in agreement with our results, *C. parapsilosis* predominated in Latin America 25%, Canada 16%, and Europe 17% (Al-Dorzi et al., 2020). In addition, the distribution according to the department was discordant with Zeng et al. (2019), where *C. albicans* was predominant 50% in the ICU, and in medical wards, *C. glabrata* was more common than *C. albicans*.

Overall, the resistance among all the isolated *Candida* spp. in our study was encountered with 5-FC 7%, AMB as well as CAS 5.8% followed by FLC 3.5%, then VRC and MFG 1.5%. 5-Flucytosine inhibits nucleic acid biosynthesis through transforming to a metabolite that interferes with protein translation from RNA. It can also inhibit DNA synthesis through inhibiting thymidylate synthase enzyme (Bhattacharya et al., 2020). Emergence of resistance to 5-FC is prompt and is attributed to modifications in the set of genes responsible for drug uptake and transformation (Houst et al., 2020). Therefore, 5-FC is used as a combination therapy with azoles or AMB for yeast and dematiaceous infections rather than as a monotherapy (Shamithra & David, 2023). Amphotericin B belongs to polyenes. It unites with ergosterol in the fungal cell membrane leading to pore formation, leakage of cell constituents and eventually cell death. Resistance to AMB may be explained by target alteration, namely ERG3 and

ERG6 leading to lower ergosterol level. Generally, the use of AMB should be deferred unless resistance to other agents has developed, or the target could not be reached (Bhattacharya et al., 2020). Echinocandins that include CAS, MFG are directed against β1-3 glucan synthase, therefore inhibiting cell wall synthesis. Echinocandin-resistant strains may escape through mutations in the gene homologues coding for the target enzyme. Another suggested mechanism is genome plasticity such as chromosome 2 trisomy in *C. albicans*, which increases resistance to echinocandins (Bhattacharya et al., 2020).

The extensive empirical use of echinocandins as a first choice has prompted the emergence of resistance to this class of antifungals (Hendrickson et al., 2019). Therefore, the use Echinocandins is better reserved for moderate to severe cases or after failed treatment with azoles (Bhattacharya et al., 2020). Azoles are largely categorized into imidazole and triazole. Both FLC and VRC belong to triazoles. Azoles have a fungistatic action, which is accomplished by two pathways. The first is by targeting the enzyme 14α–demethylase (Erg11p), therefore affecting ergosterol synthesis. The second is generation of reactive oxygen species (ROS) (Bhattacharya et al., 2020). Since azoles have been the pillar of antifungal prophylaxis and treatment for more than 50 years, the emergence of resistance is much expected (Hendrickson et al., 2019).

Mechanisms of resistance include over-expression of membrane transporters, altered ergosterol biosynthesis, altered sterol import, genome plasticity, altered azole import and *Candida* biofilm formation (Houst et al., 2020). Our results were concordant with Al-Dorzi et al., (2020), who reported resistance to AMB among seven isolates of *C. albicans* and one *C. krusei*. However, in contrast to our results, none of the tested *C. lusitaniae* and *C. guilliermondii* was resistant to any of the studied antifungals.

In contrast to our results, resistance to azoles was much higher in many studies done in other regions, where Al-Dorzi et al. (2020), performed a study on 162 cases of IC and candidemia revealed that 27.9% of the studied cases were resistance to FLC and 8.1% to VRC. However, the resistance to other agents was close to our results, with 3.1% to AMB and 2.9% to CAS. Also, Zeng et al. (2019) in Southwest China which involved in his study 243 episodes of IC isolated from blood, body fluids, central venous catheter tips and sterile tissues, found that azole resistance was also much higher, with 18.8% of the evaluated strains resistant to FLC and 18.5% resistant to VRC, resistance to 5-FC 4.1% and none of the studied isolates showed resistance to AMB. Also, Khan et al. (2019) study done in Kuwait revealed the resistance among *C. albicans* and *C. parapsilosis* isolates to FLC is developing as indicated by the higher MIC levels. Also Zhang et al. (2019) study that included 179 cases of candidemia, reported resistance to FLC 6.7% and VRC 5.6%. On the other hand, all strains were susceptible to AMB except one *C. glabrata* isolate. It is important to mention that the difference encountered as regard antifungal susceptibility among our isolates and those in other studies may be attributed to the variability in the type of samples collected and their proportion in relation to the total sample size.

As per *Candida* spp., the highest resistance was seen among *C. krusei* with 90.9% resistance to 5-FC, 72.7% and 36.3% of the isolates were moderately sensitive to CAS and AMB, respectively. *C. albicans* showed 3.7% resistance to 5-FC, 2.3% to CAS, 1.5% to VRC and 1.5% moderately sensitive to AMB. *C. tropicalis* showed resistance mainly to 5-FC 4.1%, FLC 2.5% as well as AMB 2.5%. All isolates of *C. parapsilosis* were sensitive to all tested antifungals, except one isolate that was resistant to FLC. *C. glabrata* isolates were sensitive to all tested antifungals, with only one isolate resistant to MFG (Table 3). This was concordant with the study of Al-Dorzi et al. (2020) in Saudi Arabia where, the antifungal resistance was highest among *C. krusei*. However, resistance was observed mainly against azoles. All of the tested *C. krusei* isolates were resistant to FLC and VRC. *C. parapsilosis* resistance reached 57.9% to FLC and 5.3% to VRC. *C. glabrata* and *C. albicans* showed 33.3% and 16.7% resistance to FLC respectively. Our results were disconcordant with the study of Zeng et al. (2019) which reported that the highest rate of resistance was seen among *C. tropicalis*. Resistance was the highest against to FLC and VRC 29.7% and 27.0%, respectively.

Several factors affect the development of antifungal resistance. The first is the fungal spp., where certain strains are inherently resistant to specific agents. That is why timely and prompt identification to species level is important. The

second is the past medical history of the patient. The third is the selection of the antifungal agent. For instance, the prolonged use of fungistatic agents for the purpose of prophylaxis or treatment, promotes the emergence of resistance to that agent, in addition to limiting the proper drug choice. Therefore, proper dose and duration is crucial for proper management.

Conclusion

This study shows that CNA spp. have been emerging as a serious cause of infection among the hospitalized patients and their rate of isolation was greater than *C. albicans*. Overall, *C. albicans* was the most frequently isolated spp. causing IC. *C. tropicalis* was the most prevalent CNA spp. followed by *C. parapsilosis*. Resistance to antifungal agents was mainly detected against 5-FC, AMB and CAS. It is noteworthy that the species distribution and the antifungal susceptibility varies from one region to another, therefore, constant monitoring of antifungal susceptibility is needed to limit the spread of resistant strains. In addition, clear strategies and guidelines should be provided on a large scale for efficient prophylaxis and treatment of fungal infections.

List of abbreviations

Candida albicans: C. albicans
Candida non albicans: CNA
Candida: C.
Intensive care units: ICUs
Invasive Candidiasis: IC
Flucytosine: 5-FC
Statistical Package for Social Science: SPSS 20
Bronchoalveolar lavage: BAL
Cerebrospinal fluid: CSF
Neonatal intensive care unit: NICU
Minimum inhibitory concentration: MIC
Micafungin: MFG
Amphotericin B: AMB
Caspofungin: CAS
Voriconazole: VRC
Fluconazole: FLC
Several species: spp.
Reactive oxygen species (ROS)

Availability of data and materials: The authors declare that data supporting the findings of this study are available within the article and its additional files.

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تحديد الأنواع والحساسية لمضادات الفطريات بين عزلات ميكروب المبيضات

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يعتبرمعدل العدوى التي يسببها المبيضات آخذ في الازدياد بشكل ملحوظ، و يتفاقم حجم المشكلة بسبب مقاومة مضادات الفطريات بين أنواع المبيضات المختلفة. هدفت الدراسة إلى تقييم حساسية المبيضات المسببة للعدوى في مستشفيات جامعة عين شمس من عام 2018 إلى 2022. تم إجراء دراسة رصدية مقطعية لجميع حالات النمو الإيجابي للمبيضات واختبار القابلية للفطريات باستخدام جهاز VITEK 2. و قد أظهرت النتائج أن من بين 342 عينة، كانت المبيضات البيضاء هي النوع الأكثر شيوعًا (40.4%). كانت المبيضات غير البيضاء هي السائدة (59.6%) وتتكون بشكل رئيسي من *C. Tropicalis* (36.3%) و (8.8%) *C. parapsilosis*. من بين مجموع عزلات المبيضات، 24 (7%) كانت مقاومة للفلوسيتوزين ، 20 (5.8%) كانت مقاومة للأمفوتريسين B وكذلك الكاسبوفنجين، 12 (3.5%) كانت مقاومة للفلوكونازول، 5 (1.5%) كانت مقاومة لكل من المايكافونجين وفوريكونازول. وبذلك تشير هذه الدراسة إلى ارتفاع معدلات العدوى الناتجة عن المبيضات غير البيضاء التى تتميز بمقاومة أعلى لمضادات الفطريات مقارنة بالمبيضات البيضاء، و قد كانت أغلب العزلات مقاومة للفلوسيتوزين، الأمفوتريسين B وكذلك الكاسبوفنجين. الجدير بالذكر أن أنواع المبيضات المسببة للعدوى وحساسيتها لمضادات الفطريات تختلف من منطقة إلى أخرى. وبالتالي، هناك حاجة إلى المتابعة المستمرة لنتائج الحساسية لمضادات الفطريات للحد من انتشار السلالات المقاومة. بالإضافة إلى ذلك، يجب توفير إرشادات واضحة على نطاق واسع للوقاية الفعالة وعلاج العدوى الفطرية.