E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.48047/ijprt/16.01.120

Research Article

Original Research Article

A STUDY ON THE PATTERN OF FUNGAL INFECTIONS AND CLINICAL PROFILE IN IMMUNOCOMPROMISED PATIENTS WITH SPECIAL REFERENCE TO CHARACTERISATION AND MOLECULAR STUDY OF CANDIDA SPECIES IN A TERTIARY CARE HOSPITAL

M.Akilamani[1]*, G. Jabeen fathima[2], C.P.Ramani[3], C.Nithya[4], S.Jayaviswa[5] , K.Selvam[6], G.Arthy[7]

[1]Assistant Professor, Department of Microbiology, Government Medical College and Hospital, Krishnagiri, Tamilnadu, India.
[2]Assistant Professor, Department of Microbiology, National Centre of Ageing, Madras Medical College and RGGGH, Chennai.
[3]Professor, Institute of Microbiology, Madras Medical College and RGGGH, Chennai.
[4]Professor, Department of Microbiology, Government Villupuram Medical college and Hospital.
[5]2nd Year MBBS, Sri Ramachandra Medical College and research institute, Porur, Chennai.
[6]Senior Assistant Professor, Department of General Surgery, Government Dharmapuri Medical College and hospital, Dharmapuri
[7]Microbiologist

***Corresponding author: Dr. M.Akilamani**
Assistant Professor, Department of Microbiology, Government Medical College and Hospital, Krishnagiri, Tamilnadu, India.
Email id –drakila12@gmail.com

Received date: 25-02-2026, Accepted date: 27-02-2026, Publication date: 05-03-2026

Abstract:

Background: In immunocompromised patients, there are advances in medical care leading to significant increase in Invasive Fungal Infections (IFIs). Fungal species are approximately 7 percent (6,11,000 species) and they are distributed in soil, plant debris and other organic substrates. Only 600 species are human pathogens.

Objective: To study the pattern of fungal infections and clinical profile in immunocompromised patients with special reference to characterisation and molecular study of candida species in a tertiary care hospital.

Methods: This cross sectional study was conducted at Government tertiary care hospital in Chennai ,Tamilnadu for a period of one year.

Results: Among the study population, 41% of the patients showed fungal growth. Proven IFI was found in 15% of the cases and remaining were under the category of probable IFI (85%). Among the 41 fungal isolates, majority of them were Candida non-albicans (31.7%) followed by Candida albicans (24.39%), Aspergillus fumigatus (21.95%), Aspergillus

flavus (12.20%), Aspergillus niger (4.88%) and Rhizopus (4.88%). Among the patients with Proven and Probable IFI , Candidiasis constitutes 56.09% followed by Aspergillosis (39.03%) and Zygomycosis (4.88%). Antifungal susceptibility testing was performed for Candida isolates by Disk diffusion method. Fluconazole resistance was observed among C.albicans and C.tropicalis with 70% and 42.86% respectively. Virulence characters such as Phospholipase and hemolysin activity was tested for Candida isolates. Fluconazole resistance among Candida species tested by PCR showed the presence of ERG11 gene in 2 isolates of Candida albicans.

Conclusion: Invasive fungal infections are a major cause of morbidity and mortality in immunocompromised patients. The patients with suspected IFI in the study population was in the age group of 31-40 years and they were predominantly males. Etiological agent was identified in 41% of infected patients. On categorization, 15% had Proven IFI and 85% had Probable IFI. The leading cause of IFI was invasive Candidiasis followed by Aspergillosis. Invasive Candidiasis was mainly caused by Candida non-albicans followed by Candida albicans. Increasing rate of Fluconazole resistance among C.albicans may be due to frequent use of these agents in the prophylaxis of fungal infections in immunocompromised patients.

Keywords: Fungal Infections, Clinical Profile, Immunocompromised Patients, Characterisation, Molecular Study, Candida

INTRODUCTION

In immunocompromised patients, there has been a steady increase in the frequency of opportunistic Invasive Fungal Infections (IFIs)[1]. Invasive fungal infections caused by candida species and Aspergillus species are major causes of morbidity and mortality[1]. A definite increase in candida non-albicans species associated with a higher mortality has been reported[2].

Aspergillus species are soil inhabitants. They cause life threatening disease, if Conidia are inhaled into the respiratory tract [3]. Invasive Aspergillosis occurs in patients with risk factors like prolonged neutropenia, hematological malignancy and solid organ transplantation [3,4].

Over a 12 year period, the prevalence of invasive fungal infection is increased from 2.2% to 5.1% [4]. Several reasons for the increase in invasive fungal infections are the use of antineoplastic and immunosuppressive agents, broad spectrum antibiotics, patients with uncontrolled Diabetes mellitus, neutropenia and aggressive surgery [4]. Some of the candida non-albicans are highly virulent and associated with treatment failure due to reduced susceptibility to antifungal agents[4].

The clinical manifestations of fungal infections are not specific[5]. A high degree of suspicion is necessary for the early diagnosis and treatment of fungal infections[5] . The gold standard for the diagnosis of invasive fungal infections (IFIs) is culturing the clinical specimen (sputum, urine, blood) to isolate the fungal agent [5].

Several new antifungals has expanded prophylaxis and treatment options for invasive fungal infections [6] . The identification of candida species is important in the diagnostic laboratory [7]. There is a prognostic and therapeutical significance, in the identification of candida species and

thus early and correct antifungal therapy can be initiated.

Hence this study was focused to find the pattern of fungal infections and clinical presentation in immunocompromised patients and to identify the different fungal isolates.

MATERIALS AND METHODS

This cross sectional study was conducted at Government tertiary care hospital in Chennai, Tamilnadu for a period of one year. Approval for the study was obtained from the Institutional Ethical Committee, and written informed consent was obtained from all patients.

INCLUSION CRITERIA

1. Patients aged more than18 years.

2. Immunocompromised patients included in the study are patients with acute hematological malignancy with intensive chemotherapy, cancer patients, complicated intensive care unit patients and patients on long term steroids and antibiotic therapy.

EXCLUSION CRITERIA

1. Age of patients below 18 years.

2. Patients on antifungal therapy.

DATA COLLECTION

Data collection included Name, Age, Sex, IP number, Ward, Occupation, Address, Date of admission, Diagnosis at admission, presenting complaints, personal history, past history, H/o Diabetes mellitus, chronic kidney disease, neoplasm, immunosuppressive therapy, previous IFI, prior antibiotic therapy / antifungal therapy.

CASE DEFINITIONS[21]

Invasive fungal infections are defined in terms of Proven IFD, Probable IFD and Possible IFD.

PROVEN IFD

Molds

- Positive culture obtained by sterile procedure from a normally sterile site clinically and radiologically abnormal site consistent with an infectious disease process excluding BAL fluid, a cranial sinus activity specimen and urine.
- Blood culture yields a mold accompanied with compatible infectious disease

process.

Yeasts

- Positive culture obtained by sterile procedure from a normally sterile site clinically or radiologically abnormal site consistent with an infectious disease process.
- Positive blood culture of Candida species, Cryptococcus species, Trichosporon species.

PROBABLE IFD

It requires the presence of a host factor, a clinical criterion and a mycological criterion.

POSSIBLE IFD

Cases that meet the criteria for a host factor and a clinical criterion for which mycological criteria are absent.

SPECIMEN COLLECTION FOR FUNGAL CULTURE [22]

- Sputum- The first early morning sample was collected after vigorous rinsing of mouth with water. Sputum was coughed out following a deep breath, collected into a sterile, screw capped container.
- Bronchoscopy- Bronchial brushing, bronchoalveolar lavage fluid was collected and transported in sterile sealed container.
- Urine- The first early morning clean catch mid stream urine specimen was collected aseptically in sterile, screw capped container and processed immediately. If delay more than 2 hours is anticipated, sample should be refrigerated at 4°C.
- Blood- After disinfecting the venipuncture site with 70% alcohol, blood samples were collected at the febrile episode in a sterile culture broth.

MICROSCOPY

1) KOH Wet Mount

On a clean, grease free glass slide, a drop of KOH (10%) was placed and a small quantity of specimen was mixed with it. A sterile coverslip was placed over the drop. The aqueous potassium hydroxide (KOH) softens and digests protein debris as well as dissolves cement substance, which holds keratinized cells together. The fungal elements become quite clear and easy to visualize in clinical specimens observed under low and high power of the light microscope for the presence of yeast or hyphal forms.

2) Gram Stain

Direct Gram staining was performed as per standard protocol.

CULTURE

A minimum amount of specimen was inoculated onto 2 slants of Sabouraud dextrose agar of pH 5.6 with antibiotic Gentamicin at 50 mg/liter inoculated tubes and then incubated for a period of 4-6 weeks before discarding the tubes as sterile and negative.

Interpretation of fungal culture

The significance of fungal isolate depends on its source and identity. The following points should be considered in case of commensal or opportunistic fungi that are otherwise considered as contaminants.

- Growth of same strain in all culture tubes.
- Repeated isolation of same strain in multiple specimens.
- Immune status of patients and
- Serological evidence to confirm significance of isolate.

RESULTS

A total of 100 patients satisfying the inclusion criteria, admitted with signs and symptoms of Invasive Fungal Infections (IFIs) were included in the study. Out of 100 patients, 41 patients were found to be positive for fungal growth.

Table-1: Age and Sex Distribution among study population n=100

AGE(YRS)	RISK FACTORS										TOTAL n (%)
	RENAL TRANSPLANT (RT)		DIABETES MELLITUS (DM)		CHEMO THERAPY (CT)		RT & DM		CT &DM		
	M	F	M	F	M	F	M	F	M	F	
18-20	-	-	-	-	1	-	-	-	-	-	1
21-30	3	3	2	2	11	5	-	-	-	-	26
31-40	9	6	5	1	3	5	-	1	-	-	30

41-50	2	3	3	2	2	5	2	-	-	-	19
51-60	2	1	5	1	2	1	-	-	1	-	13
61-70	-	-	2	2	4	-	-	-	-	-	8
71-80	-	-	1	1	-	1	-	-	-	-	3
TOTAL(%)	16	13	18	9	23	17	2	1	1	-	100
Pvalue	0.046		0.105		0.156		0.51		0.34		

The table 1 shows, the study consists of predominantly of males (60%) when compared to females (40%). Out of 100 patients, majority of them in the study belongs to the age group of 31-40 years (30%) followed by age group of 21- 30 years (26%) and 41-50 years (19%).

Duration of immunosuppression of 1-10 years showed increased incidence of IFI among 86% of patients. Incidence of Proven IFI was 15%. Most of the cases were under the category of Probable IFI (85%).

TABLE-2: Distribution of fungal isolates in clinical samples n=100

Samples	**Growth**	**No growth**	**Total**
Urine	18(43.90%)	31	49
Sputum	6(14.63%)	5	11
Bronchial wash	10(24.39%)	11	21
Pleural fluid	1(2.44%)	2	3
Blood	3(7.32%)	8	11

BAL	3(7.32%)	2	5
TOTAL	41	59	100

Among immunosuppressive patients in the study, the majority of samples were urine (49%) followed by bronchial wash (21%), sputum (11%) and blood (11%). Out of 100 patients in the study, 41 patients showed fungal growth. In the above table, majority of the growth was present in the urine sample (43.90%), followed by bronchial wash (24.39%) and sputum (14.63%).

TABLE-3: Distribution of Candida isolates and filamentous fungal isolates causing IFI

Species	**Renal Transplant (RT)**	**Diabetes Mellitus (DM)**	**Chemo therapy(CT)**	**RT & DM**	**CT & DM**	**Total (%)**
Candida albicans	2	4	2	2	-	10 (24.39%)
Candida non-albicans	3	4	5	-	1	13 (31.70%)
Aspergillus fumigatus	5	4	-	-	-	9(21.95%)
Aspergillus flavus	-	3	2	-	-	5 (12.20%)
Aspergillus niger	-	2	-	-	-	2 (4.88%)
Rhizopus	-	2	-	-	-	2(4.88%)
Total	**10**	**19**	**9**	**2**	**1**	**41**

Above table shows that among 41 isolates , majority of them were Candida non-albicans (31.70%) followed by Candida albicans (24.39%) and Aspergillus fumigatus (21.95%), Aspergillus flavus (12.20%), Aspergillus niger (4.88%) and Rhizopus (4.88%). Among

Candida species majority of them are C.non-albicans (56.5%) followed by C.albicans (43.5%) in clinical samples.

In urine sample, C.tropicalis (14.3%), C.albicans (14.3%) were reported commonly followed by C.parapsilosis (4%), C.glabrata (2%) and C.krusei (2%). In blood culture, C.glabrata (18.2%) was commonly reported followed by C.albicans (9%)**.** Among 100 patients with Proven and Probable IFI, Candidiasis (56.09%) was most commonly encountered followed by Aspergillosis (39.03%) and Zygomycosis (4.88%).

TABLE-4: Antifungal susceptibility testing in candida species by disk diffusion method (n=23)

SPECIES	Fluconazole (25µg)		Itraconazole (10 µg)		Voriconazole (1 µg)	
	S	R	S	R	S	R
C.albicans (10)	3 (30%)	7 (70%)	5 (50%)	5 (50%)	5 (50%)	5 (50%)
C.tropicalis (7)	4 (57.14%)	3 (42.86%)	5 (71.4%)	2 (28.6%)	5 (71.4%)	2 (28.6%)
C.glabrata (3)	- (0%)	3 (100%)	- (0%)	3 (100%)	- (0%)	3 (100%)
C.parapsilosis (2)	2 (100%)	- (0%)	2 (100%)	- (0%)	2 (100%)	- (0%)
C.krusei (1)	- (0%)	1 (100%)	- (0%)	1 (100%)	- (0%)	1 (100%)

In the above table, Antifungal susceptibility testing of Candida albicans showed highly sensitive to Voriconazole (50%) and Itraconazole (50%) followed by a Fluconazole (30%) and highly resistant to Fluconazole (70%) followed by Voriconazole (50%) and Itraconazole (50%) .

Candida tropicalis showed highly sensitive to Voriconazole (71.4%) and Itraconazole (71.4%) followed by Fluconazole (57.14%) and highly resistant to Fluconazole (42.86%), followed by Voriconazole (28.6%) and Itraconazole (28.6%).

Table-5: Phenotypic characterisation- Phospholipase activity in Candida albicans (n=10)

Phospholipase activity-Pz value	**Number of strains showing Phospholipase activity (Number of strains tested) n=10**
1(Negative)	-
<0.90-0.99(+)	1
0.80-0.89(++)	2
0.70-0.79(+++)	2
<0.70(++++)	5

5 isolates of C.albicans showed Pz value of < 0.70(++++) with high phospholipase activity. 5 isolates of C.tropicalis showed Pz value of <0.70(++++) with high production of phospholipase activity.

Table-6: Phenotypic characterisation-Hemolysin activity in Candida species (n=23)

Candida spp	**Alpha hemolysis**	**Beta hemolysis**	**Gamma hemolysis**
C.albicans n=10	2(20%)	6(60%)	2(20%)
C.non albicans n=13	2(15.38%)	7(53.85%)	4(30.77%)

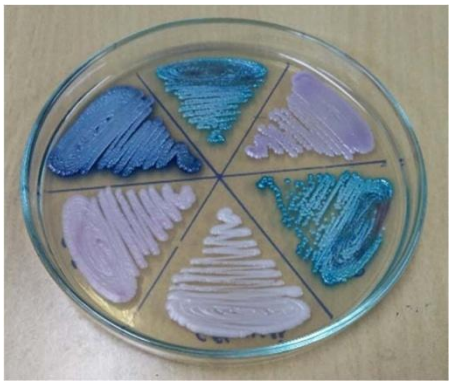
In the above table ,among the Candida species the higher rate of alpha hemolysis, beta hemolysis and gamma hemolysis was observed in C.albicans (20%), C.albicans (60%) and Candida non- albicans (30.77%) respectively.

Fluconazole resistance among Candida species tested by PCR showed the presence of ERG11 gene in 2 isolates of Candida albicans.

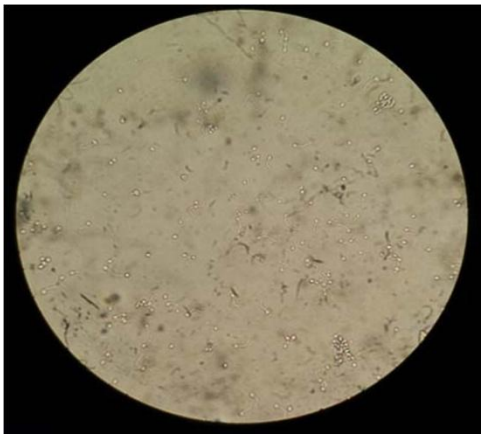
The overall mortality seen in this study was 11% and the cases were proven IFI and probable IFI. Mortality was seen among cancer patients on chemotherapy with neutropenia

due to candidemia, uncontrolled Diabetes mellitus with Rhizopus and invasive Aspergillosis.

1.CHROM agar showing Candida species



2.Germ tube test- C.albicans showing Germ tube

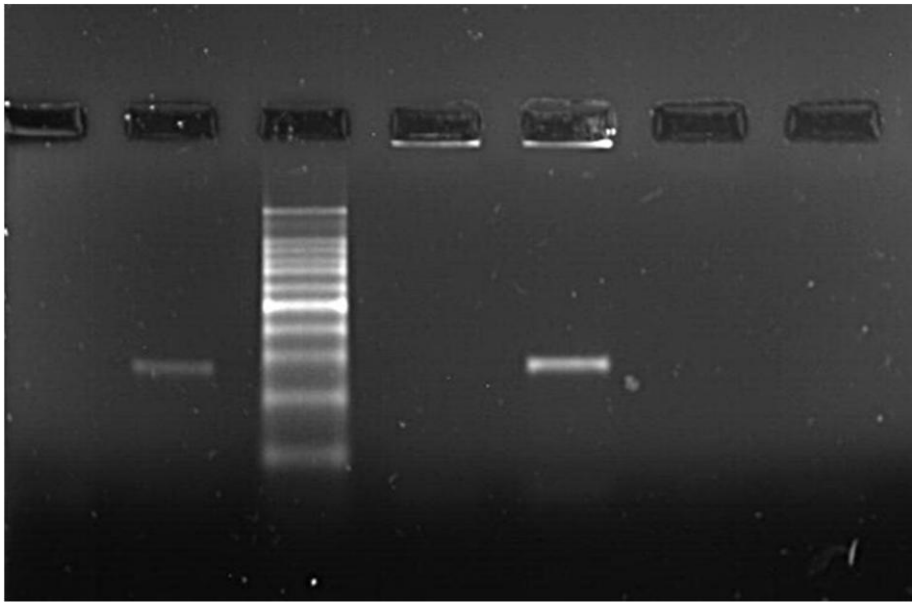


3.Assimilation test- C.albicans

4.Phospholipase activity in Egg Yolk Medium–Candida species

5. Hemolysin activity in Blood Agar Plate-Candida species

6. Molecular analysis-Identification of ERG11 gene among Fluconazole resistance Candida species



DISCUSSION

Invasive Fungal Infections (IFIs) are increasing in incidence among patients with immunocompromised state[8]. The morbidity and mortality is caused by IFIs.

100 immunocompromised patients with clinical suspicion of having fungal infections were included in the study. Immunocompromised patients selected under the study were acute hematological malignancy with intensive chemotherapy, cancer patients, complicated intensive care patients, patients on long term steroids and antibiotic therapy, Renal transplant recipients on immunosuppressive therapy and Diabetes mellitus.

Most of the patients affected by IFI in this study were in the age group of 31-40 years (30%) followed by age group of 21-30 years (26%). Among the study population, majority of the patients were males (60%). Similar findings have been recorded by Milton camplesi junior et al[9] . The mean age of the patients was 35.7 years, with a range of 21-60 years.

Patients with duration of immunosuppression of 1-10 years showed increased incidence of IFI in this study. As the duration of immunosuppressed state increases, susceptibility of infection also increases. Similar findings have been recorded by Kontoyiannis et al, who found a median duration for development of IFI in transplant recipients was more than 1 year[10].

Among 100 cases in the present study, 41 patients showed fungal growth. According to European Organisation for Research and Treatment of Cancer (EORTC) criteria, among these 100 patients ,15% were Proven and 85% were Probable IFI. Kontoyiannis et al ,studied on patients with IFI for a period of 5 years reported 56% were Proven and 44% were probable IFI [10].

In the present study, majority of patients of IFI presented with symptoms of urinary tract infections, sepsis and respiratory infections. So, most of the samples collected were urine, bronchial wash, sputum, blood and bronchoalveolar lavage. Pagano et al studied patients with IFI and reported most common system involved was respiratory tract [11].

In the present study, among the 41 fungal isolates, majority of them were Candida non-albicans (31.70%) followed by Candida albicans (24.39%), Aspergillus fumigatus (21.95%), Aspergillus flavus (12.20%), Aspergillus niger (4.88%) and Rhizopus (4.88%). Pfaller et al also reported increase in Candida non-albicans species and higher mortality among the patients[2].

Candida species are usually colonizers. So, if isolated their significance should be defined. Candida species from blood or on repeated isolation is taken as pathogen. In the present study, among invasive candidiasis, majority of them were Candida non-albicans (56.5%) followed by Candida albicans (43.5%) in clinical samples. In this study, in urine samples, among candida species, majority of them were Candida tropicalis (14.3%), Candida albicans

(14.3%) followed by Candida parapsilosis (4%), Candida glabrata (2%) and Candida krusei (2%). Chakrabarti et al [12] showed high rate of isolation of Candida tropicalis in intensive care unit patients.

In this study, in blood culture samples, the most common Candida species isolated were Candida glabrata (18.2%) followed by Candida albicans (9%). Candida glabrata has emerged as potentially resistant invasive fungal infection [13]. Trick et al [14] in United states have demonstrated C.glabrata has increased incidence in intensive care unit patients. Two prospective studies by Tortorano et al [15] also reported C.glabrata in blood culture.

In the present study, Invasive Candidiasis was present in 56.09% of patients followed by Aspergillosis (39.03%) and Zygomycosis (4.88%). Similar findings are observed by Chakrabarti et al [12].

In the present study Antifungal susceptibility testing was performed in candida species by Disk diffusion method. Among 10 Candida albicans, Fluconazole resistance was 70% followed by Itraconazole (50%) and Voriconazole (50%). Among 7 Candida tropicalis, Fluconazole resistance was 42.86% followed by Itraconazole (28.6%) and Voriconazole (28.6%). Brekow et al [16] showed increase in Fluconazole resistance in Candida albicans and Candida non-albicans.

In the present study, the virulence characters of Candida species such as Phospholipase activity and hemolysin activity were determined. 5 isolates of C.albicans showed Pz value of < 0.70(++++) with high phospholipase activity. 5 isolates of C.tropicalis showed Pz value of <0.70(++++) with high production of phospholipase activity. Dasetal [17] showed similar finding with high production of phospholipase activity among C.albicans.

In the present study, among the Candida species, the higher rate of alpha hemolysis, beta hemolysis and gamma hemolysis was observed in C.albicans (20%), C.albicans (60%) and Candida non-albicans (30.77%) respectively. Nader Davari et al[18] showed similar production of alpha hemolysis, beta hemolysis and gamma hemolysis among the Candida isolates.

In the present study, Fluconazole resistance among the Candida species tested by PCR showed the presence of ERG11 gene in 2 isolates of C.albicans. Berkow et al[16]showed the presence of ERG11 gene in C.albicans.

The overall mortality seen in this study was 11% and the cases had Proven IFI and Probable IFI. Mortality was seen among cancer patients on chemotherapy with neutropenia due to candidemia caused by drug resistant C.albicans, uncontrolled Diabetes mellitus with Rhizopus and Aspergillosis. Fleveri et al[20] showed mortality rate of 30-60% in patients with candidemia.

CONCLUSION

Invasive fungal infections are a major cause of morbidity and mortality in

immunocompromised patients. The patients with suspected IFI in the study population was in the age group of 31-40 years and they were predominantly males. Etiological agent was identified in 41% of infected patients. On categorization, 15% had Proven IFI and 85% had Probable IFI. The leading cause of IFI was invasive Candidiasis followed by Aspergillosis. Invasive Candidiasis was mainly caused by Candida non-albicans followed by Candida albicans. Aspergillus fumigatus was the commonest species causing Aspergillosis in IFI. Virulence characters such as Phospholipase and hemolysin activity were found among Candida isolates. Higher production of Phospholipase and hemolysin activity was shown in Candida albicans. Candida non-albicans also showed higher level of Phospholipase and hemolysin activity.

Antifungal susceptibility testing for Candida species by Disk diffusion method showed higher resistance to fluconazole in C.albicans followed by C.tropicalis. Fluconazole resistance tested by PCR in Candida albicans showed the presence of ERG11 gene.

Increasing rate of Fluconazole resistance among C.albicans may be due to frequent use of these agents in the prophylaxis of fungal infections in immunocompromised patients. So, the best approach to the optimal management of fungal infection is early detection and identification of the causal agent, so that appropriate treatment can be initiated as soon as possible in immunocompromised patients.

REFERENCES

1. Fungal infections in immunocompromised patients Article in Mycoses · December 2011 DOI: 10.1111/j.1439-0507.2011.02134.xGabriela Sganga - 2011 Blackwell Verlag Gmbh -Mycoses 54(suppl.4)1-3
2. Pfaller MA, Diekema DJ. Rare and emerging opportunistic fungal pathogens: concern for resistance beyond Candida albicans and Aspergillus fumigatus. J Clin Microbiol 2004; 42: 4419-31
3. Meersseman W, Lagrou K, Maertens J, Van Wijngaerden E Invasive aspergillosis in the intensive care unit. Clin Infect Dis 2007: 45: 205-16
4. D. A. Enoch, H. A. Ludlam and N. M. Brown Invasive fungal infections: a review ofepidemiologyand management optionsJournalofMedicalMicrobiology(2006), 55, 809–818
5. Opportunisticinvasivefungalinfections:diagnosis&clinicalmanagement Parisa BadieeandZahra Hashemizadeh Indian J Med Res. 2014 Feb; 139(2): 195–204.
6. OverviewoftreatmentoptionsforinvasivefungalinfectionsMelanieW. Pound Mary L. TownsendVincent DimondiDustin WilsonRichard H. Drew Medical Mycology, Volume 49, Issue 6, 1 August 2011, Pages 561–580,

7. Godoy, P.; Almeida, L.P.; Colombo, A.L. (2001). Identificación deCandida albicansutilizandoel mediocromogénicoAlbicans ID.Rev Iberoam Micol18: 197-9.

8. F 1000 Med Rep. 2011; 3: 14.Published online 2011 Jul 1. doi: 10.3410/M3-14 PMCID: PMC3155160PMID: 21876720Emergingfungalinfectionsin immunocompromised patientsChian-Yong Low[1,2] and Coleman Rotstein[1]

9. Invasive fungal infection in patients with hematologic disorders in a Brazilian tertiary care hospital., MiltonCamplesiJunior[1]Hildene MenesesSilva[2]Adriano MoraesArantes[3]Carolina RodriguesCosta[2]Fábio SilvestreAtaides[2]Thaisa CristinaSilva[2]Maysa de PaulaCosta dosReis[2] Maria do Rosário RodriguesSilva[21]Departamento de Biomedicina, Universidade Paulista, Goiânia, GO, Brasil. [2]Departamento de Microbiologia, Imunologia, Parasitologia e Patologia, Instituto de Patologia Tropical, Universidade Federal de Goiás, Goiânia, GO, Brasil. [3]Hospital Araújo Jorge, Goiânia, GO, Brasil.

10. Clin Infect Dis 2010 Apr 15;50(8):1091-100. doi: 10.1086/651263. Prospective surveillance for invasive fungal infections in hematopoietic stem cell transplant recipients, 2001-2006: overview of the Transplant-Associated Infection Surveillance Network (TRANSNET) Database. Kontoyiannis DP[1],Marr KA,Park BJ, Alexander BD, Anaissie EJ, Walsh TJ, Ito J,Andes DR, Baddley JW, Brown JM, BrumbleLM, FreifeldAG, HadleyS, HerwaldtLA, KauffmanCA, KnappK, LyonGM, MorrisonVA, PapanicolaouG, PattersonTF, PerlTM, Schuster MG, Walker

11. FungalInfections in Recipients ofHematopoietic StemCellTransplants: Results of theSEIFEMB-2004 Study—SorveglianzaEpidemiologicaInfezioniFungineNelle Emopatie Maligne L. Pagano M. CairaA. NosariM. T. Van Lint A. CandoniM. OffidaniT. AloisiG. IrreraA. BoniniM. Picardi...Show more Clinical Infectious Diseases, Volume 45, Issue 9, 1 November 2007, Pages 1161–1170,

12. Intensive Care Med DOI 10.1007/s00134-014-3603-2 Incidence, characteristicsand outcome ofICU-acquired candidemia in India Arunaloke ChakrabartiPrashant Sood Shivaprakash M. Rudramurthy Sharon Chen Harsimran Kaur Malini Capoor Deepinder Chhina Ratna Rao Vandana Kalwaje Eshwara Immaculata Xess Anupama J. Kindo P. Umabala JayanthiSavio AtulPatelUjjwayini RaySangeetha Mohan Ranganathan Iyer Jagdish Chander Anita Arora Raman Sardana Indranil Roy B. Appalaraju Ajanta Sharma Anjali Shetty Neelam Khanna Rungmei Marak Sanjay Biswas Shukla Das B. N. Harish Sangeeta Joshi Deepak Mendiratta

13. Pfaller, M. A., S. A. Messer, L. Boyken, S. Tendolkar, R. J. Hollis, and D. J. Diekema. 2004.Geographicvariationinthesusceptibilitiesofinvasiveisolates ofCandida glabrata to seven systemically active antifungal agents: a global

assessment from the ARTEMIS Antifungal Surveillance Program conducted in 2001 and 2002. J. Clin. Microbiol. 42:3142-3146

14. Trick, W. E., S. K. Fridkin, J. R. Edwards, R. A. Hajjeh, R. P. Gaynes, and the National Nosocomial Infections Surveillance System Hospitals. 2002. Secularтrend of hospital-acquired candidemia among intensive care unit patients in the United States during 1989-1999. Clin. Infect. Dis. 35:627-630.

15. mycoses.2012Jan;55(1):73-9.doi:10.1111/j.1439-0507.2011.02044.x.Epub2011

Jun 12. Invasive fungal infections in the intensive care unit: a multicentre, prospective,observationalstudyinItaly(2006-2008).TortoranoAM[1], DhoG, PrigitanoA, BredaG, GranciniA, EmmiV, CavannaC, MarinoG, Morero S, OssiC, DelvecchioG, PasseraM, CusumanoV, DavidA, Bonaccorso G, CoronaA, FavaroM, VismaraC, GarauMG, Falchi S, TejadaMR;ECMM-FIMUA Study Group

16. InfectDrugResist.2017Jul31;10:237-245.doi:10.2147/IDR.S118892.eCollection 2017. Fluconazole resistance inCandidaspecies: a current perspective Berkow EL[1], Lockhart SR[1].
17. Detection of phospholipase activity ofCandida albicansand nonalbicans isolated from women ofreproductive age with vulvovaginal candidiasis in rural area Year : 2015|Volume:33| Issue:1| Page:92-95SRFule, DDas, RPFule Department of Microbiology , Jawaharlal Nehru Medical College, Sawangi,Meghe, Wardha, Maharashtra, India

18. Curr Med Mycology.2017 Dec; 3(4): 1–5. Evaluation of esterase and hemolysin activities of different **Candida** species isolated from vulvovaginitis cases in Lorestan Province, Iran. Maryam Noori,[1] Mohammad Dakhili,[1] Asghar Sepahvand,[2,*] and Nader Davari[3]

19. Invasive Fungal Infections among Organ Transplant Recipients: Results of the Transplant-Associated Infection Surveillance Network (TRANSNET) Peter G. PappasBarbaraD.Alexander DavidR.AndesSusanHadleyCarolA. KauffmanAlisonFreifeldEliasJ.AnaissieLisaM.BrumbleLoreen HerwaldtJames Ito Clinical Infectious Diseases, Volume 50, Issue 8, 15 April2010, Pages 1101–1111,https://doi.org/10.1086/651262

20. Flevari A, Theodorakopoulou M, Velegraki A, Armaganidis A, Dimopoulos G. Treatmentofinvasivecandidiasisintheelderly:areview.ClinInterv Aging. 2013;8:1199–1208

21. Revised definitions of invasive fungal disease from the European Organization for Research and Treatment of Cancer/Invasive Fungal Infections Cooperative Group and the National Institute of Allergy and Infectious Diseases Mycoses Study Group (EORTC/MSG) Consensus Group. De Pauw B[1], Walsh TJ, Donnelly JP, Stevens DA, Edwards JE, Calandra T, Pappas PG, Maertens J, Lortholary O, Kauffman CA, Denning DW, Patterson TF, Maschmeyer G,

Bille J, Dismukes WE, Herbrecht R, Hope WW, Kibbler CC, Kullberg BJ, Marr KA, Muñoz P, Odds FC, Perfect JR, Restrepo A, Ruhnke M, Segal BH, Sobel JD, Sorrell TC, Viscoli C, Wingard JR, Zaoutis T, Bennett JE; European Organization for Research and Treatment of Cancer/Invasive Fungal Infections Cooperative Group; National Institute of Allergy and Infectious Diseases Mycoses Study Group (EORTC/MSG) Consensus Group. Clin Infec Dis 2008 Jun 15;46(12):1813-21

22. Koneman 's Color Atlas and Textbook of Diagnostic Microbiology- 7th edition Pg 1390-1391,1350-1351,1323,1330-1332.