

A decorative border featuring delicate line drawings of flowers and leaves, primarily in shades of pink and light brown, framing the central text area.

# Fungal Infections:

## The burden, Treatment and Therapeutic Drug Monitoring

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Hospital Sultanah Bahiyah  
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# Disclosure

No conflict in interest



# Outline

Overview of disease burden

Antifungal resistance

Treatment of common IFIs

Case-sharing



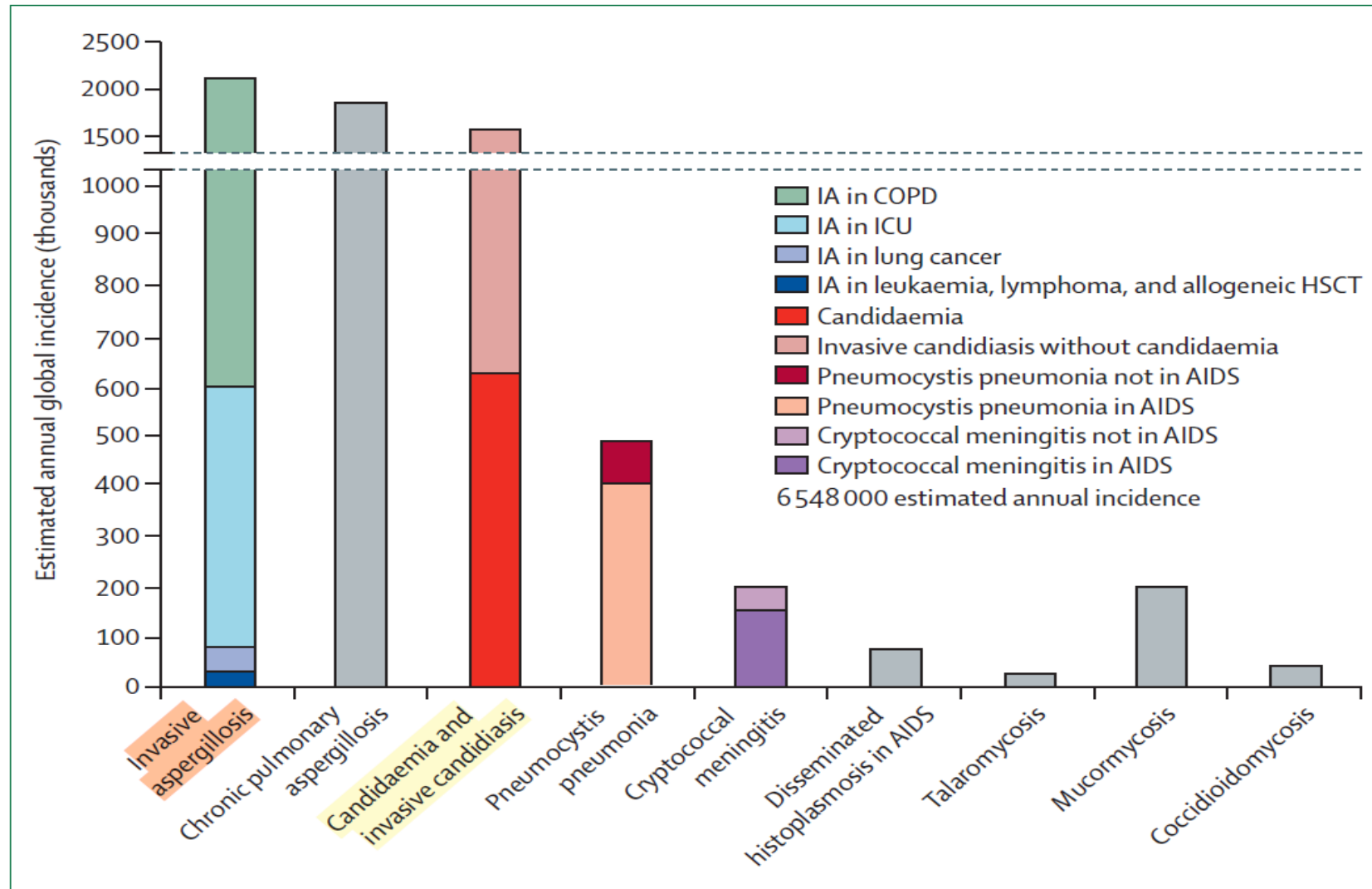
# Burden of invasive fungal infection

Estimated incidence and mortality rates of the most frequent invasive fungal diseases affecting humans

Mycosis	Main aetiologic agent	Cases per year	Mortality rate (%)
Invasive candidiasis	<i>Candida albicans</i>	~ 750,000 <sup>(6)</sup>	~ 40 <sup>(74)</sup>
Invasive aspergillosis	<i>Aspergillus fumigatus</i>	> 300,000 <sup>(6)</sup>	30-70 <sup>(23,24)</sup>
<i>Pneumocystis</i> pneumonia	<i>Pneumocystis jirovecii</i>	> 400,000 <sup>(10)</sup>	10-60 <sup>(38)</sup>
Cryptococcal meningitis	<i>Cryptococcus neoformans</i>	~ 225,000 <sup>(44)</sup>	15 -50 <sup>(74)</sup>
Disseminated histoplasmosis	<i>Histoplasma capsulatum</i>	~ 100,000 <sup>(6)</sup>	10 -60 <sup>(42)</sup>
Mucormycosis	<i>Rhizopus oryzae</i>	> 10,000 <sup>(6)</sup>	35-100 <sup>(49)</sup>



# Estimated Annual Incidence of IFI



♦ Estimation based on > 85 papers from 2010 to 2023 on individual country and global disease burden.

# MALAYSIA

Estimated annual cases and total burden of serious fungal infections in Malaysia.

Fungal Infection	Number of Infections per Underlying Disorder per Year					Total Burden	Rate/100,000
	None	HIV/AIDS	Respiratory	Cancer/Tx	ICU		
Oesophageal candidiasis	-	5850	-	-	-	5850	19
Candidaemia	-	-	-	1073	460	1533	5
<i>Candida</i> peritonitis					230	230	0.8
Recurrent vaginal candidiasis (>4×/year)	501,138	-	-	-	-	501,138	4800 *
ABPA	-	-	30,062	-	-	30,062	98
SAFS	-	-	39,682			39,682	130
Chronic pulmonary aspergillosis	-	-	7635	-	-	7635	24.9
Invasive aspergillosis	-	-		184	834	1018	3.3
Cryptococcal meningitis	47	700	-	108	-	855	2.8
Pneumocystis pneumonia	-	1286	-	-	-	1286	4.2
Histoplasmosis		175				175	0.6
<i>T. marneffe</i> i infection		350				350	1.1
Fungal keratitis	400					400	1.3
Total burden estimated	501,585	8361	77,379	1365	1524	590,214	

# Anti-fungal resistance



# Azoles-resistant aspergillus

- Invasive aspergillosis due to multi-azole-resistant *Aspergillus fumigatus* has emerged in the Netherlands since 1999.
- 6.0–12.8% of patients harbouring resistant isolates.
- **CYP51A mutation**, encodes for the enzyme sterol 14 $\alpha$ -demethylase
- Overexpression of drug targets and efflux pumps

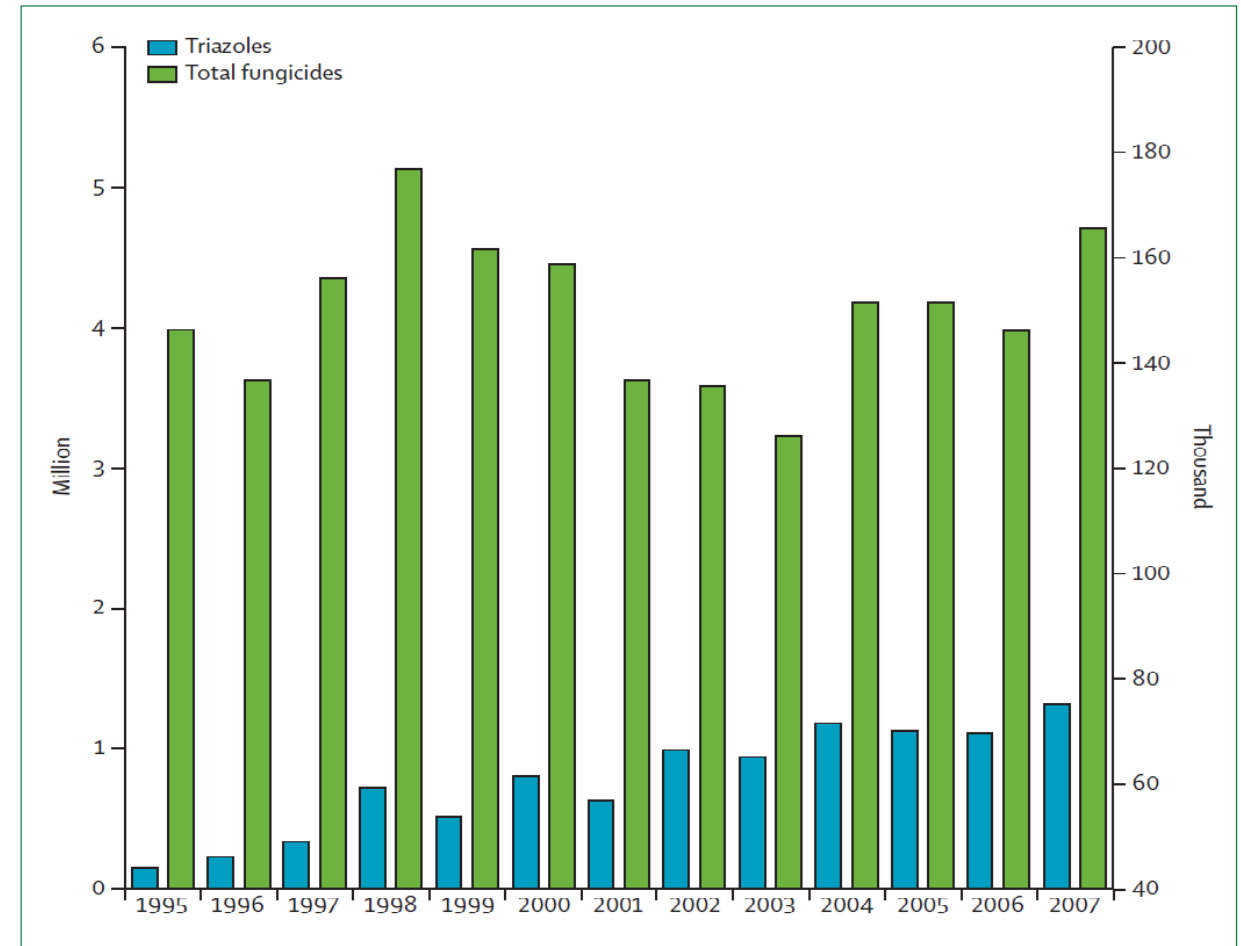


Figure 2: Total volume of fungicides and triazoles sold in the Netherlands between 1995 and 2007  
Data from the Dutch Foundation for Phytofarmacy (Nefyto, Nederlandse Stichting voor Fytofarmacie).

# Antifungal susceptibility of invasive *Candida* bloodstream isolates from the Asia-Pacific region

Increasing azole – resistance *C tropicalis* !

Species	Antifungal name	All countries				Brunei		Korea		Philippines		Taiwan		Thailand		Singapore		Vietnam	
		%I	%S	MIC50 (mg/l)	MIC90 (mg/l)	%I	%S	%I	%S	%I	%S	%I	%S	%I	%S	%I	%S	%I	%S
<i>Candida albicans</i>	Anidulafungin	0	100	0.016	0.064	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	Caspofungin	0	100	0.064	0.064	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	Fluconazole*	0	99.7	0.25	0.5	0	100	0	97.4	0	100	0	100	0	100	0	100	0	100
	Micafungin	0	100	0.008	0.016	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	Voriconazole*	0	100	0.008	0.008	0	100	0	100	0	100	0	100	0	100	0	100	0	100
<i>Candida tropicalis</i>	Anidulafungin	0.4	99.2	0.032	0.125	0	100	0	100	0	100	0	96.6	0	100	2.3	97.7	0	100
	Caspofungin	0.4	99.6	0.064	0.125	0	100	0	100	0	100	0	100	0	100	2.3	97.7	0	100
	Fluconazole*	6.1	75.8	2	32	14.3	85.7	0	100	0	100	6.9	82.8	9.5	70.3	6.8	72.7	3.3	61.7
	Micafungin	0	100	0.032	0.032	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	Voriconazole*	16.7	69.3	0.125	1	7.1	92.9	0	100	3.8	96.2	13.8	82.8	16.2	64.9	25	63.6	25	46.7
<i>Candida parapsilosis</i>	Anidulafungin	0	100	0.5	2	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	Caspofungin	0	100	0.25	0.5	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	Fluconazole*	3.0	94.8	0.5	2	11.1	83.3	3.8	96.2	4.2	87.5	9.0	91.0	0	100	0	95	0	100
	Micafungin	0.8	99.2	1	2	5.6	94.4	0	100	0	100	0	100	0	100	0	100	0	100
	Voriconazole*	0.8	99.2	0.008	0.032	0	100	0	100	4.2	95.8	0	100	0	100	0	100	0	100
<i>Candida glabrata</i>	Anidulafungin	0	99.1	0.032	0.064	0	100	0	100	0	100	0	100	0	96.8	0	100	0	100
	Caspofungin	5.2	93.1	0.125	0.125	0	100	22.2	77.8	0	100	0	100	3.2	93.5	8.2	89.8	0	100
	Fluconazole*	94.8	n/a	8	32	80	n/a	100	n/a	100	n/a	100	n/a	93.5	n/a	93.9	n/a	100	n/a
	Micafungin	1.7	98.3	0.016	0.016	0	100	0	100	0	100	0	100	3.2	96.8	2	98	0	100

# Azole-resistant *C tropicalis*

- ♦ Azole resistance in humans is particularly seen in Asian countries but is emerging in other countries such as Turkey, Spain, and Algeria.
- ♦ Retrospective study : prior azole use increase the risk of Azole –resistant *C tropicalis* ( OR 5.24 ( 2.90-10.10)
- ♦ Thai study : Only 32% of Azole R *C tropicalis* , has recent exposure to Azoles
- ♦ Flu-resistant *C. tropicalis* recovered from aquarium dolphins In Japan and microbiota of healthy animals (goat, sheep, rheas, psittacines, horses, sirenians, shrimp, tortoises, sea turtles) in Brazil.
- ♦ Mutation ERG11 gene, encoding the enzymes involved in ergosterol biosynthesis, 14 $\alpha$ -lanosterol demethylase
- ♦ **Echinocandin-resistant *C tropicalis*** been recovered , after exposure to echinocandin treatment ( China , Singapore, Kuwait)

Chew et al. J. Glob. Antimicrob. Resist., 2018 .16, 105–107

Khan et al. Antimicrob. Agents Chemother. 2018. 62, e01926–e01917. doi: 10.1128/AAC.01926-17

Xiao et al. Infect. Drug Resist.2018, 11, 155–161

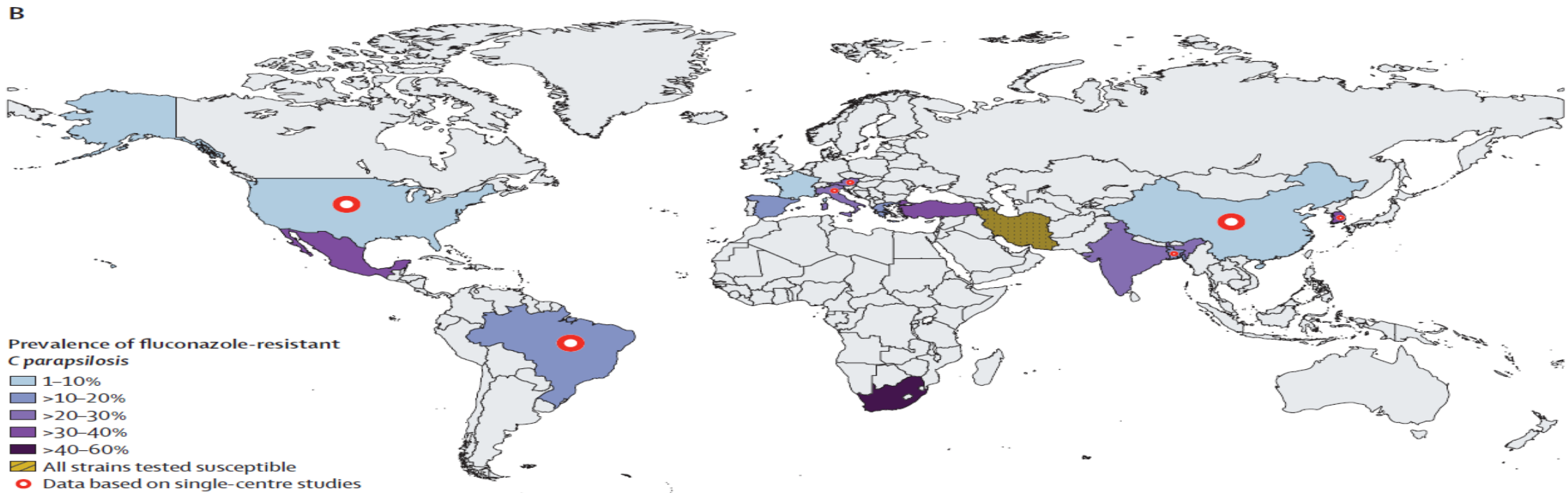
Lima et al., Frontier in Fungal Biology. 2022, [doi.org/10.3389/ffunb.2022.957021](https://doi.org/10.3389/ffunb.2022.957021)

Leepattarakit et al J. Fungi 2022, 8, 983

Rauseo et al . Open Forum Infectious Diseases 2022

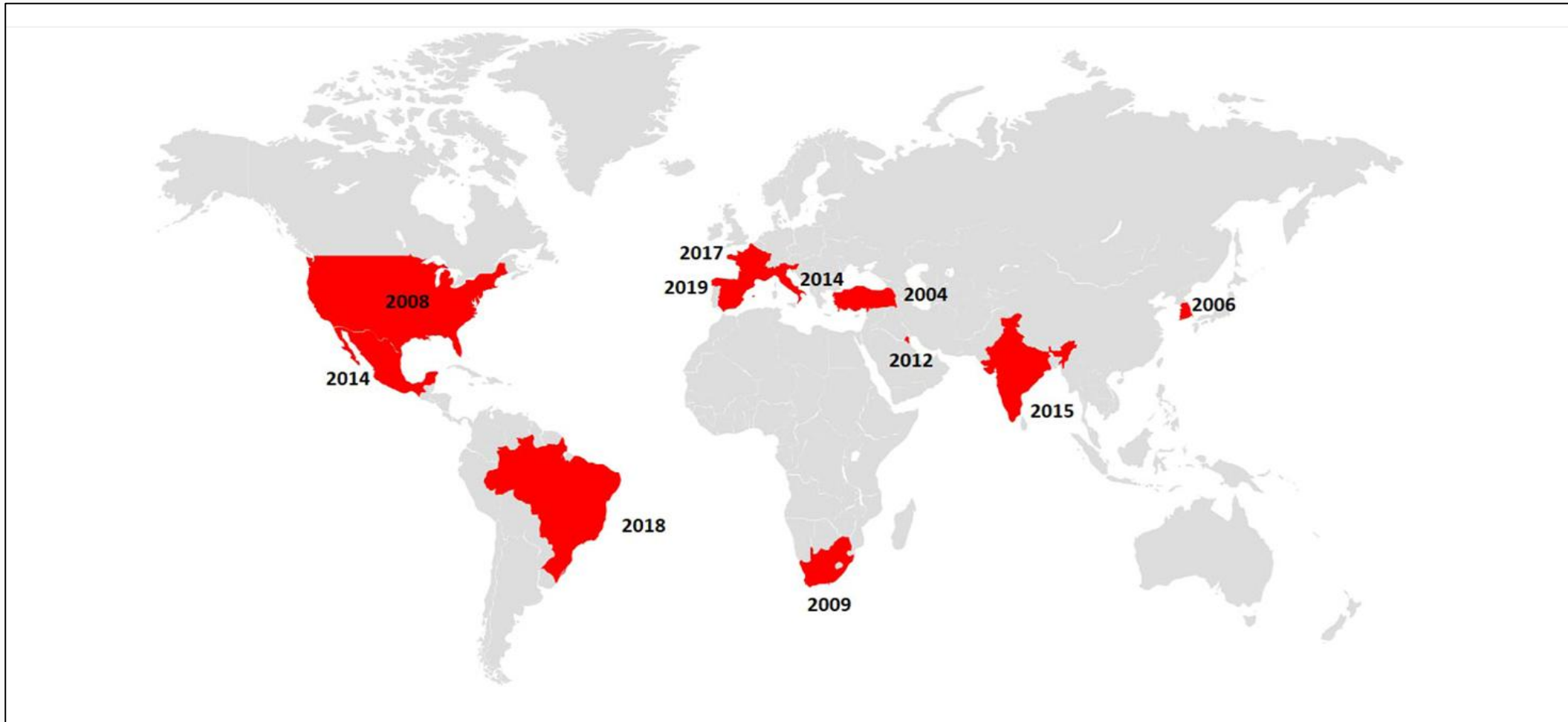
# Azole –resistant *C parapsilsois*

- ♦ Azole- resistant *C. parapsilosis* isolated in azole-naïve patients.
- ♦ In the investigation of fluconazole-resistant *C parapsilosis* outbreak, the phylogenetic clustering of resistant strains show similar genotypes strongly suggests horizontal transmission of infection



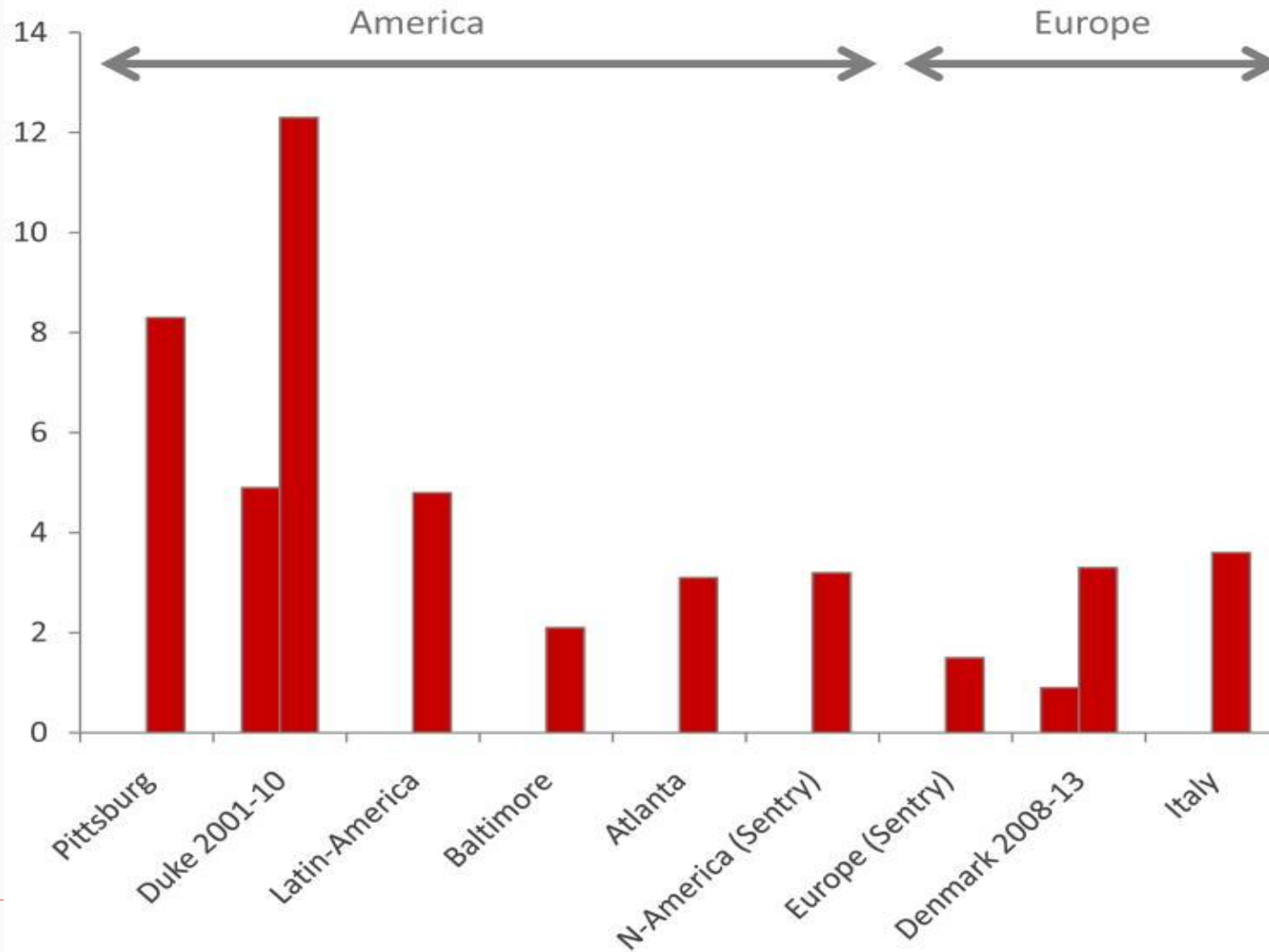
**C** Increase of reported *C parapsilosis* resistance 2012–22





Countries have reported Flu-resistant *C. parapsilosis* isolates with the Y132F substitution in the ERG11p gene.

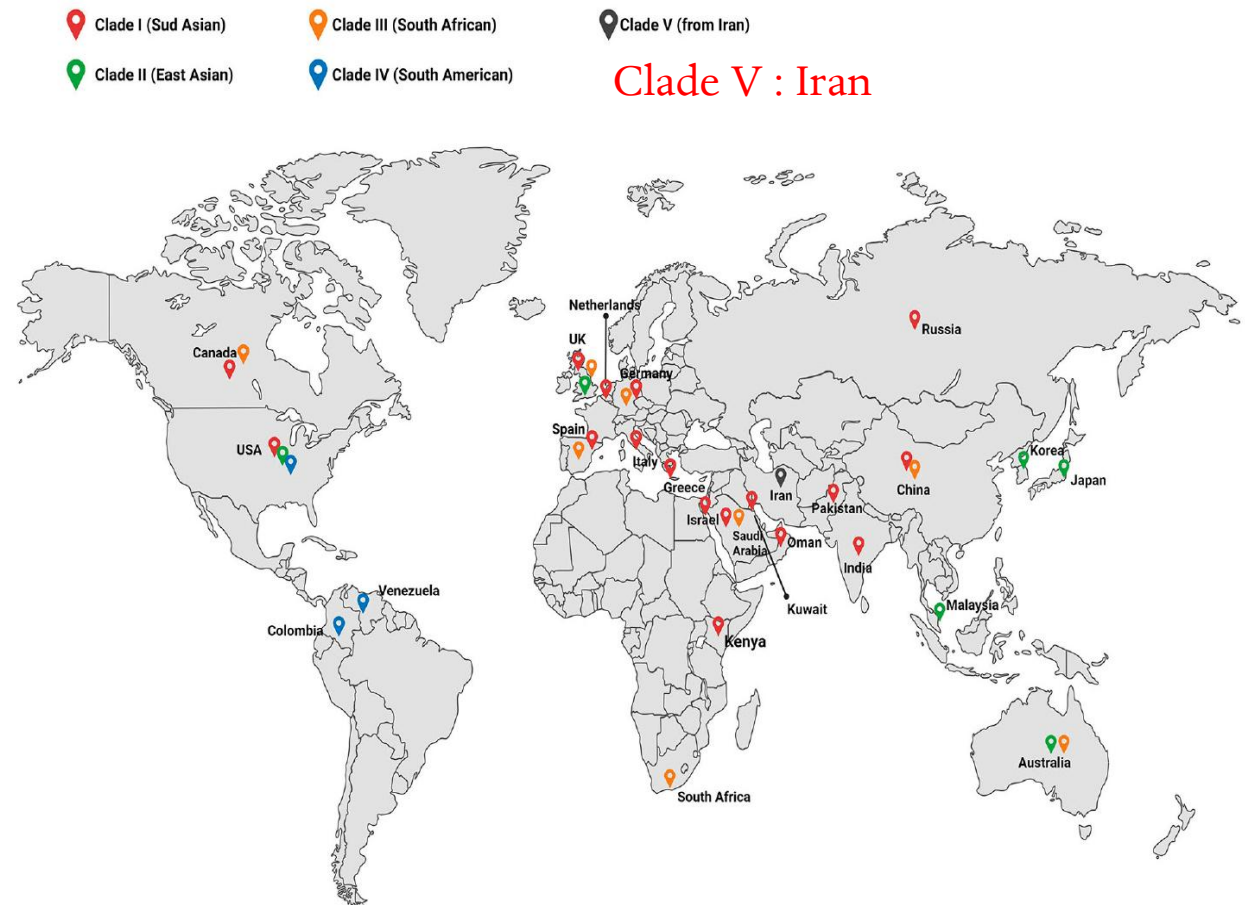
# Echinocandin resistant *C glabrata*



- ♦ Echinocandin resistant *C glabrata* are increasing.
- ♦ FKS gene mutation is associated with echinocandin resistance
- ♦ Echinocandin-R *C. glabrata* isolates have mutations in the FKS1 or FKS2 gene, or both
- ♦ Risk factor for developing breakthrough infections caused by echinocandin-R *C. glabrata* strains with FKS mutations is due to exposure within the preceding month

# *Candida auris* : 5 clades

- ♦ Clade I, III , IV associated with nosocomial outbreak and invasive infection
- ♦ Clade I from the United Kingdom, India, and Pakistan demonstrate the highest resistance levels to fluconazole (97%) and amphotericin B (40–50%) .
- ♦ **Clade II exhibits the highest sensitivity to fluconazole**
- ♦ Clades IV and III : highest levels of resistance to echinocandins, about 7%



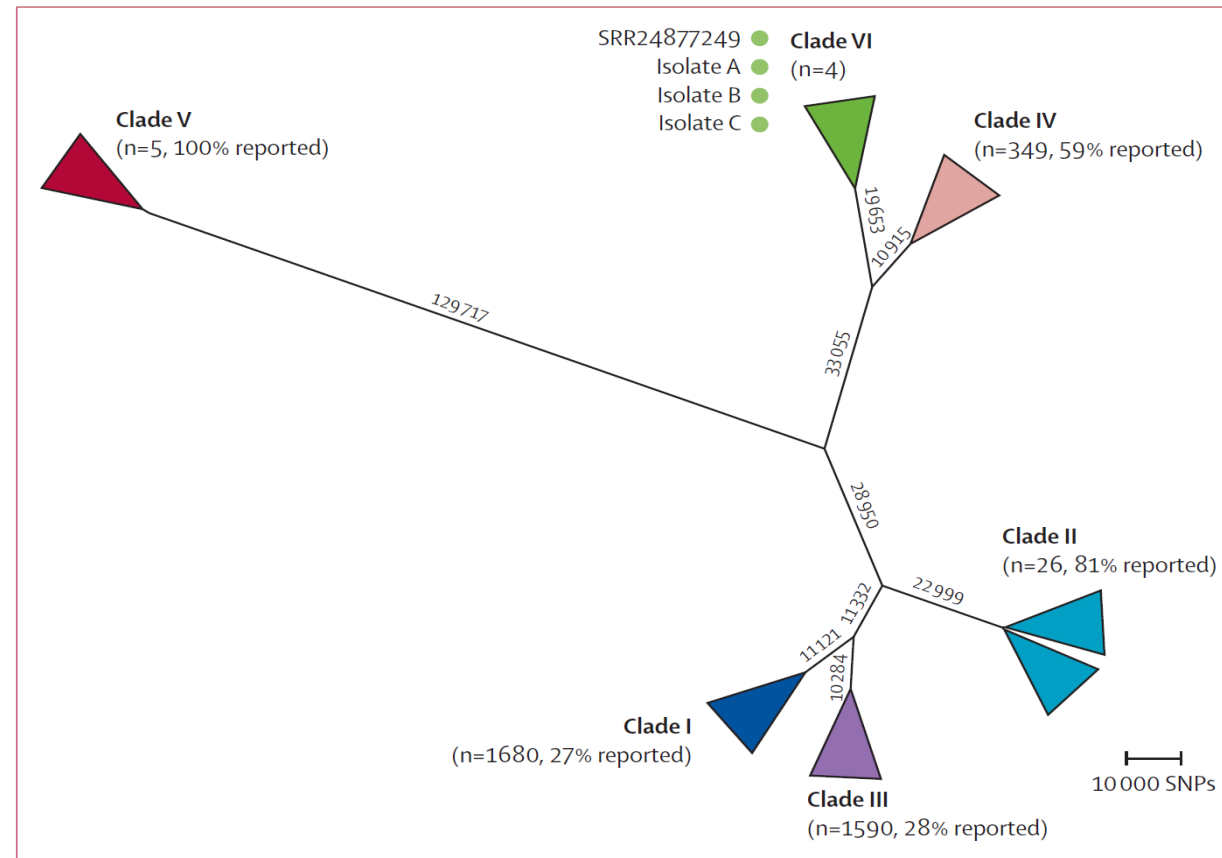
# Detection and characterisation of a sixth *Candida auris* clade in Singapore: a genomic and phenotypic study



Chayaporn Suphavitai\*, Karrie Kwan Ki Ko\*, Kar Mun Lim, Mei Gie Tan, Patipan Boonsimma, Joash Jun Keat Chu, Sui Sin Goh, Prevena Rajandran, Lai Chee Lee, Kwee Yuen Tan, Bushra Binte Shaik Ismail, May Kyawt Aung, Yong Yang, Jean Xiang Ying Sim, Indumathi Venkatachalam,

*Lancet Microbe* 2024; 5: 100878

- Three isolates from Singapore and one from Bangladesh archived sequence data
- Belonging to Clade VI



## MALAYSIA

The most common type of *Candida* species isolated from all samples was: ***Candida tropicalis* in 2018 and 2019**

In 2020 :

***C. albicans***

***C.tropicalis***

***C.glabrata***

***(Nakaseomyces glabrata)***

***C.parapsilosis* complex**

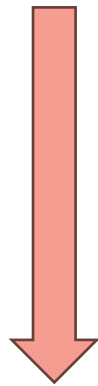
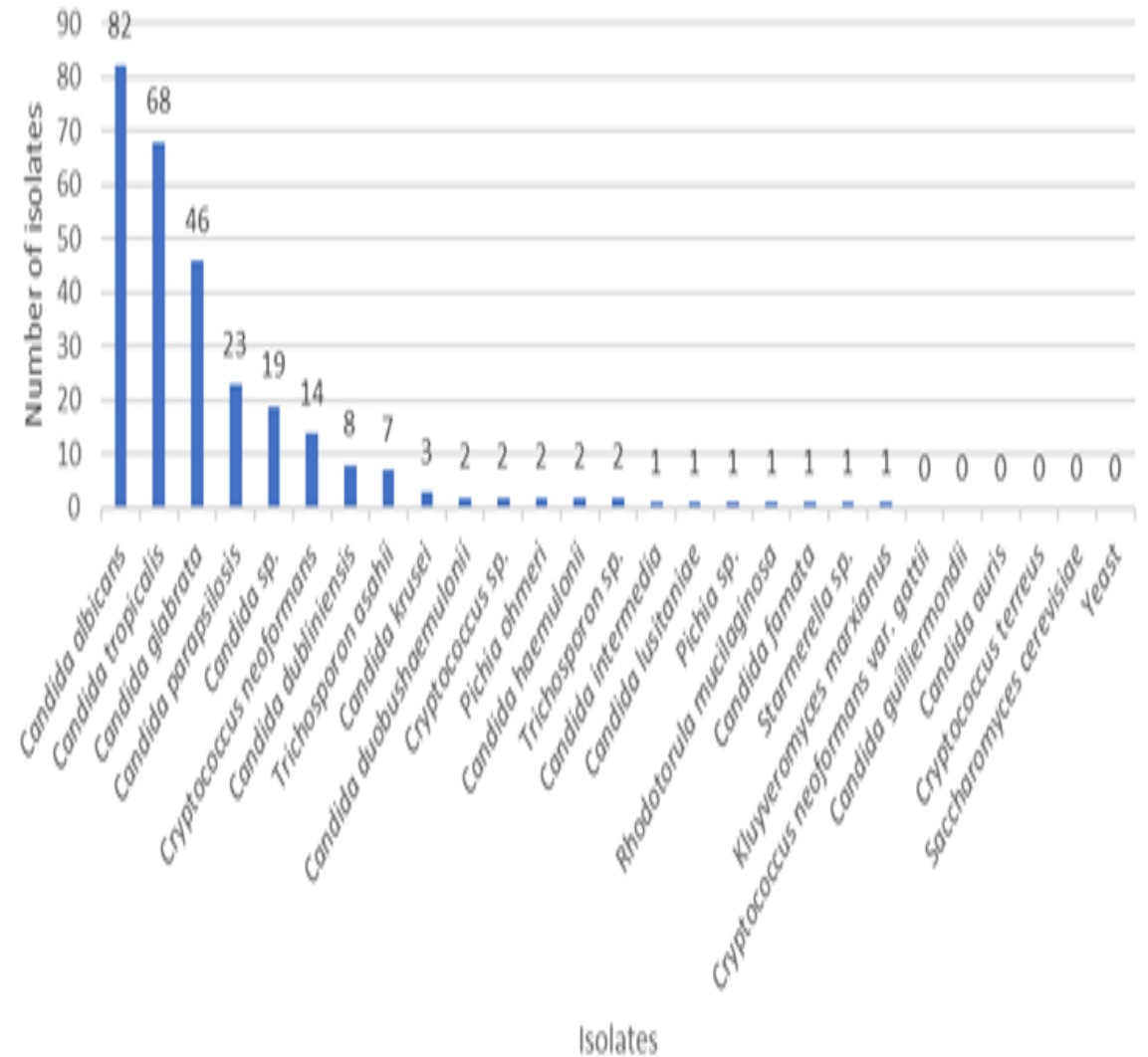


Figure 3: Distribution by species for 287 isolates in 2020



Source : unpublished data from IMR

# Hospital Sultanah Bahiyah :

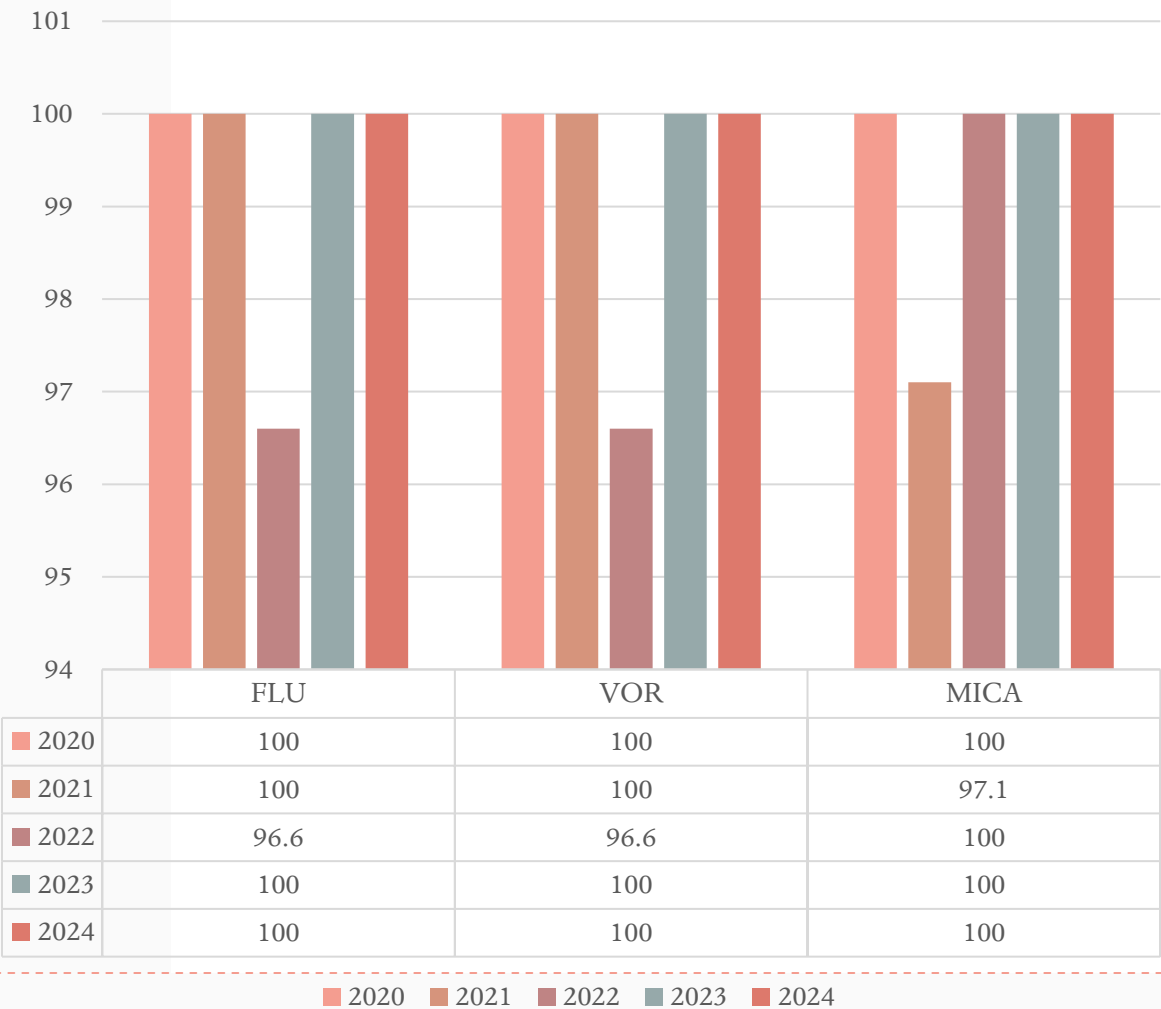
## *Candida* spp isolated from blood samples

Ranking	2020	2021	2022	2023	2024
1	C albicans ( 29.5%)	C tropicalis (37.4%)	C tropicalis ( 30.7%)	C albicans (32%)	C. tropicalis ( 29.1%)
2	C parapsilosis ( 19.6%)	C albicans ( 35%)	C. albicans C. parapsilosis ( 22.8%)	C tropicalis (25%)	C. parapsilosis ( 18.6%)
3	C tropicalis ( 17.9%) C glabrata ( 17.9%)	C glabrata ( 31%)	C. glabrata ( 15.7%)	C parapsilosis ( 19%)	C.albicans C glabrata ( 17.4%)
Increasing trend					C haemulonii complex 10.4%

*Candida haemulonii* complex : High MIC to Ampho B and Fluconazole

# HSB : Antifungal susceptibility patterns of *Candida* spp

*C. albicans*



*C. tropicalis*





# Susceptibility to antifungals

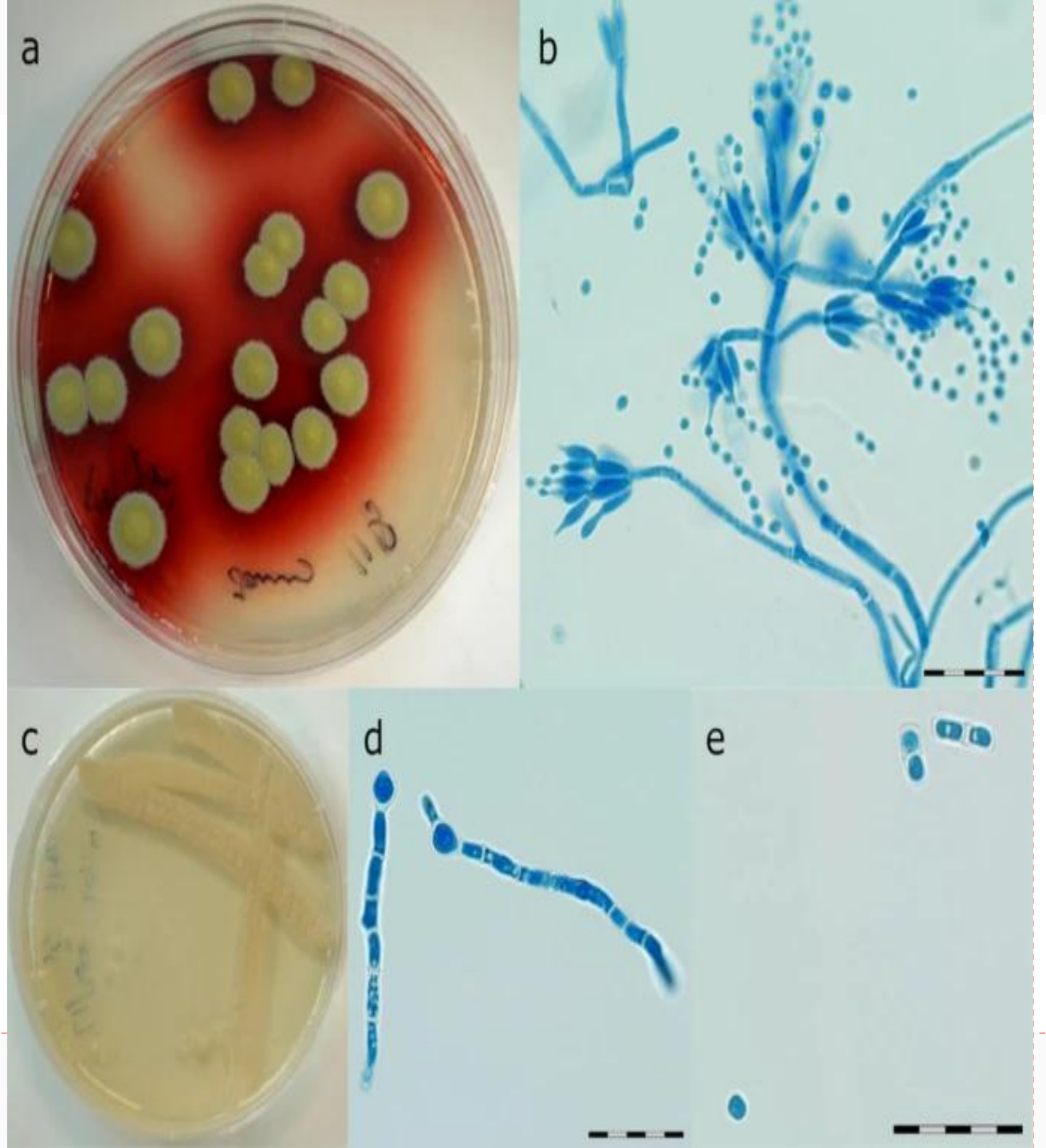
## ***C. parapsilosis***

	2020 (%)	2021 (%)	2022 (%)	2023 ( %)	2024 ( %)
FLU	100	90.9	88.9	93	85
VOR	100	95.5	94.6	93	85
MICA	100	100	89.3	93.3	100

## ***C. glabrata***

	2022 (%)	2021 (%)	2022 ( %)	2023 (%)	2024 (%)
MICA	92.9	100	100	92.3	82
Amp B	100	100	100	100	100

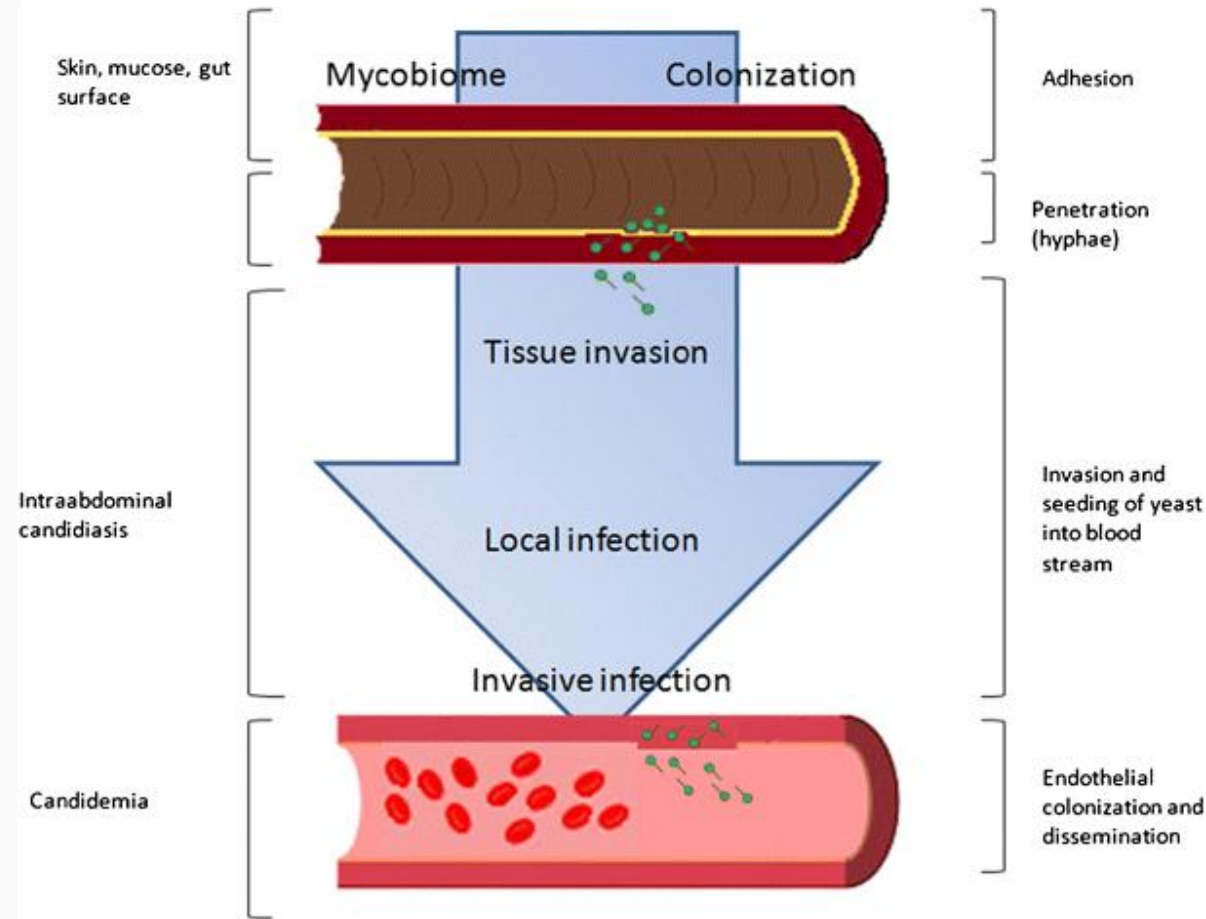
# Treatment of Invasive Fungal Infections



# Antifungal treatment strategy

Therapy	
Prophylaxis	Risk factor driven
Empirical	Risk factor + Fever driven
Pre-emptive	Risk factor + Clinical or radiological evidence + Fungal biomarker driven
Targeted	Microbiology diagnostic driven

# Invasive candidiasis



**Critically ill patients**

Candida colonization

Broad spectrum antibiotics

Breach of skin barrier :  
indwelling catheter

Bowel perforation

# Critically ill patients: Risk factors for Invasive candidiasis (IC)

## Specific risk factors

- Recurrent gastrointestinal perforation ( higher risk Upper GIT )
- Anastomotic leakage
- Recurrent abdominal surgery

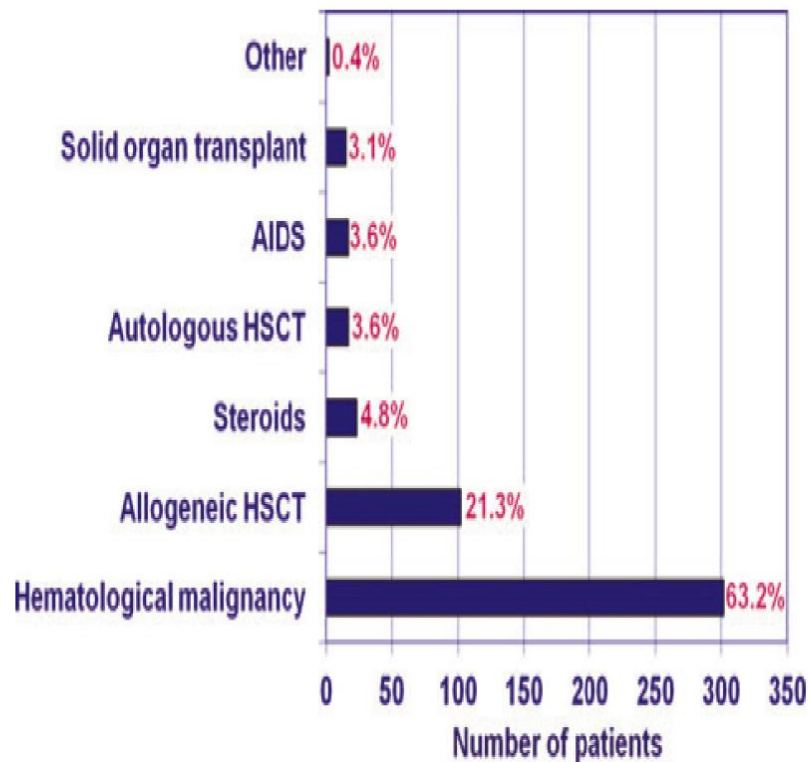
## Non specific risk factors

- Central venous catheter
- Candida colonization
- TPN
- Prolonged ICU stay
- broad spectrum antibiotics

Critically ill patients with candida colonization  $\geq 2$  sites ( 80% of ICU patients are colonized with *Candida spp* > 1 week in ICU)

# Invasive aspergillosis

Landmark trials of Lipo-ampho B and Voriconazole in IA



Cornely et al, CID 2007  
Herbrecht NEJM 2002

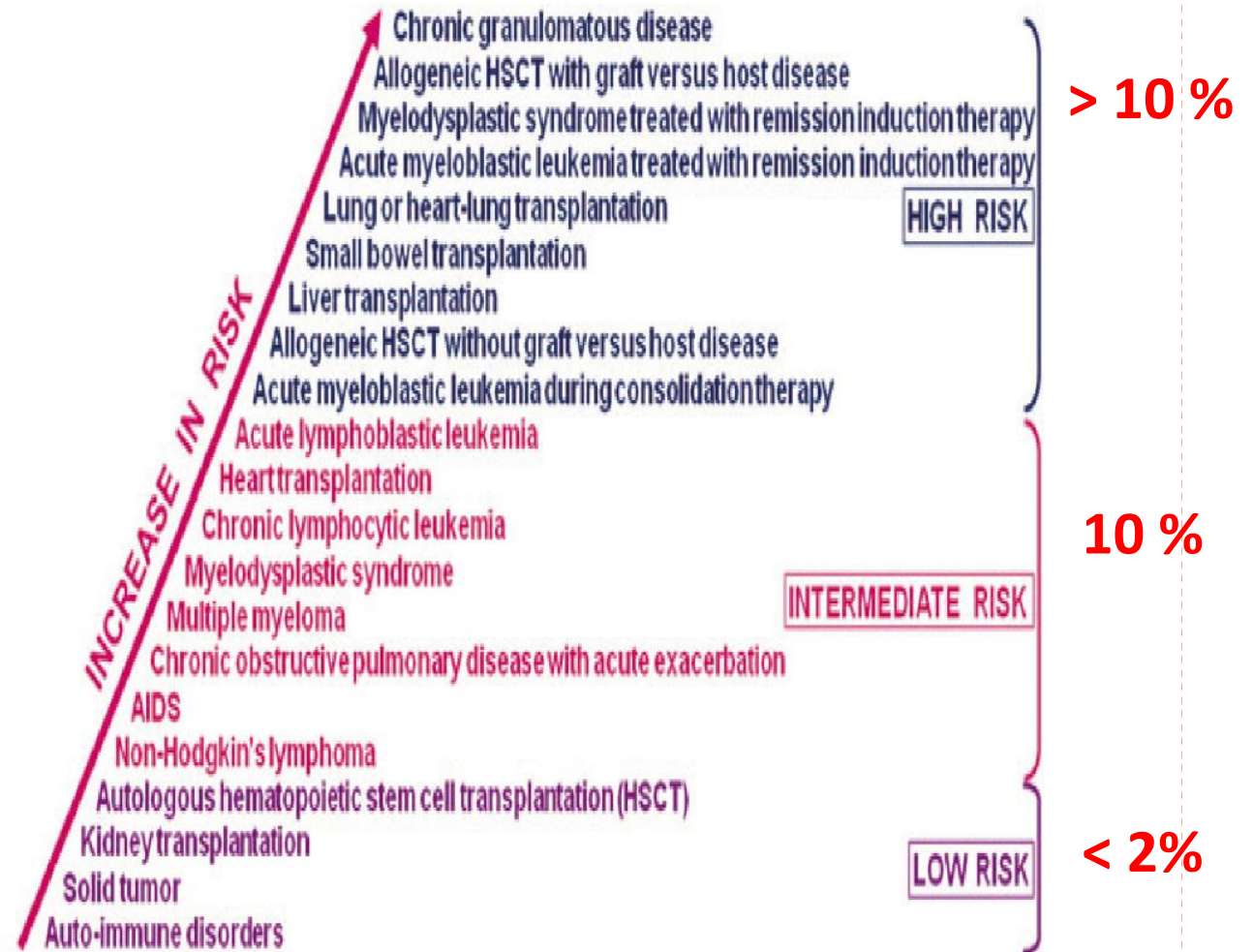


Figure 3. Risk of invasive aspergillosis based on the primary host factor.

Herbrecht , Ann. N.Y. Acad. Sci. 2012



# Established risk groups recommended antifungal prophylaxis in haematological patients

Risk level	Risk groups	Recommended prophylaxis†	SoR	QoE
High risk >10% incidence of IFD	Neutrophil $<0.1 \times 10^9/L$ for >3 weeks or $<0.5 \times 10^9/L$ for >5 weeks (e.g. allogeneic HSCT) Corticosteroids >1 mg/kg prednisolone equivalent and neutrophils $<1 \times 10^9/L$ for >1 week Corticosteroids >2 mg/kg prednisolone equivalent >2 weeks Unrelated, mismatched or cord blood allogeneic HSCT GVHD – extensive or severe AML – induction/reinduction ALL – induction/reinduction MDS	First line: Posaconazole Alternate agents: Voriconazole Itraconazole Micafungin Liposomal amphotericin Isavuconazole	A	I

Risk > 10 %



# Non-conventional risk factors for IA

Neutropenic Hosts

Including Non-neutropenic Hosts

1940s  
leukaemia

1960s  
Transplant

1990  
Biologicals

2001  
ICU

2009  
Influenza

2016  
SMKI

2018  
CART cell

2020  
Covid-19

Influenza asso pulmonary aspergillosis ( incidence 16-23 %, Mortality 50% )

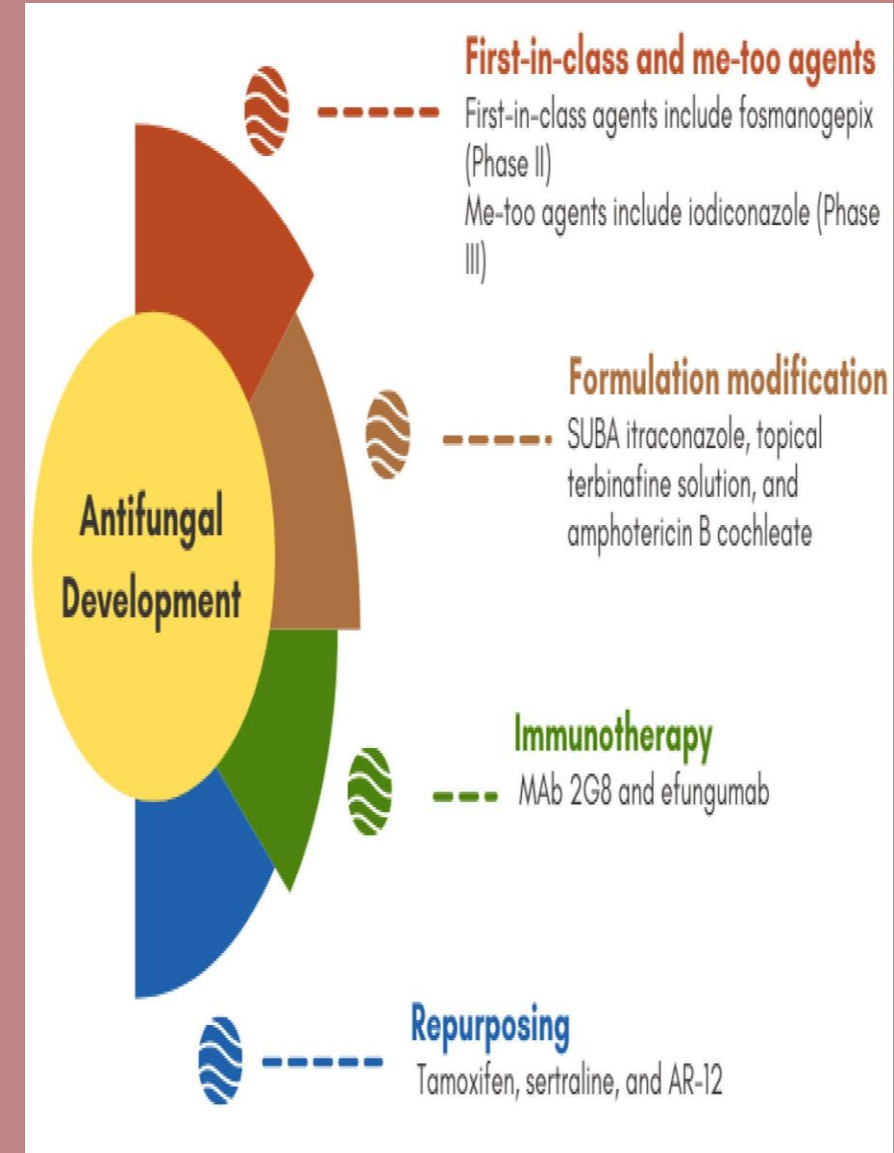
Covid-19 asso pulmonary aspergillosis ( incidence 18-29 %, Mortality 50% )

Chronic lung diseases : COAD

Immunosuppressive therapy / Steroid

Cardiovascular diseases, DM

# Antifungal therapy for IFIs



# Global guideline for the diagnosis and management of candidiasis: an initiative of the ECMM in cooperation with ISHAM and ASM

*Lancet Infect Dis 2025*

## Preferred

- Anidulafungin
- Micafungin
- Caspofungin
- Rezafungin



After > 5 days , switch to oral FLU or VOR, if is susceptible to azole

## Alternative

- Fluconazole
- Voriconazole
- Liposomal amphotericin B



Fluconazole :  
concern of increased azole -resistance, refer to local antibiogram

Voriconazole:  
risk of Azole-resistance, drug–drug interactions, and the need for therapeutic monitoring

## Other alternative

- Lipid complex Amphotericin B
- Isavuconazole

# Clinical Practice Guideline for the Management of Candidiasis: 2016 Update by the Infectious Diseases Society of America ( IDSA)

## Preferred

- Echinocandin

## Alternative

- Liposomal amphotericin B

## Other alternative

- Fluconazole in selected patients
- Not critically ill
- patients who is Azole -naïvé and are not colonized with azole-resistant Candida species

# Australasian Consensus guidelines for the diagnosis and management of invasive candidiasis in haematology, oncology and intensive care settings, 2021

## Preferred

- Echinocandin

## Alternative

Liposomal amphotericin B

Azole as first line if :

- No previous exposure to AFT
- Not Suspecting azole-resistance
- No delay in AFT initiation

## Stepdown

- Oral azole if susceptible
- Stable, culture clearance
- Azole susceptible Candida spp

# ECIL-6 guidelines for the treatment of invasive candidiasis, aspergillosis and mucormycosis in leukemia and hematopoietic stem cell transplant patients 2017

Haematologica 2017

**Table 4.** ECIL-6 recommendations for initial first-line treatment of candidemia.

	Overall population	Hematologic patients
Antifungal therapy		
Micafungin <sup>a</sup>	A I	A II
Anidulafungin	A I	A II <sup>b</sup>
Caspofungin	A I	A II
Liposomal amphotericin B	A I	A II
Amphotericin B lipid complex	B II	B II
Amphotericin B colloidal dispersion	B II	B II
Amphotericin B deoxycholate <sup>c</sup>	C I	C II
<u>Fluconazole<sup>d,e</sup></u>	<u>A I</u>	<u>C III</u>
<u>Voriconazole<sup>d</sup></u>	<u>A I</u>	<u>B II</u>
Catheter removal <sup>f</sup>	A II	B II

## Stepdown therapy

- When *Candida* species is azole-susceptible, step-down to fluconazole can be considered in stable patients after five days of intravenous (iv) therapy.
- In patients with *C.krusei* infection, switch to oral voriconazole is an option.

# Invasive aspergillosis

First line * Caution if on mould active Azole prophylaxis	Voriconazole
	Isavuconazole
	Posaconazole * ( Australian consensus)
Alternative	Liposomal Amphotericin B

IDSA guidelines 2016

ESCMID / ECMM / 2017

ECIL-6 guidelines 2017

Australasian Guidelines 2021

**TDM is recommended :**

**Voriconazole and**

**Posaconazole**



## Prophylaxis

Playford et al : recommended prophylaxis only be given to high risk group in an ICU with candidiasis **incidence > 10%**

An average incidence of invasive candidiasis of ICU around 1–2% :

To achieve 50% reduction of risk, need provide prophylaxis for 100–200 patients to prevent one infection.

Prophylaxis to a higher risk group with  $\geq 10\%$  incidence, the number needed to treat is 20 to prevent one infection

	IDSA	ECCM	Australasia
Prophylaxis	NICU Low birth weight neonats, with NICU IC rates > 10%	patients with recent abdominal surgery and recurrent gastrointestinal perforations or anastomotic leakages	NICU : Low birth weight infant with high incidence of IC  ICU: NOT recommended
Pre-emptive	NA	NA	ICU : not recommended
Empirical	Critically ill, with risk factors for IC or Positive fungal marker or candida colonization	with septic shock or patients with deteriorating health with additional risk factors of candidaemia, such as prolonged stay at an intensive care unit, an indwelling vascular catheter, or <i>Candida</i> spp colonisation.	Septic shock with multiorgan failure + $\geq$ candida colonisation

# Mucormycosis

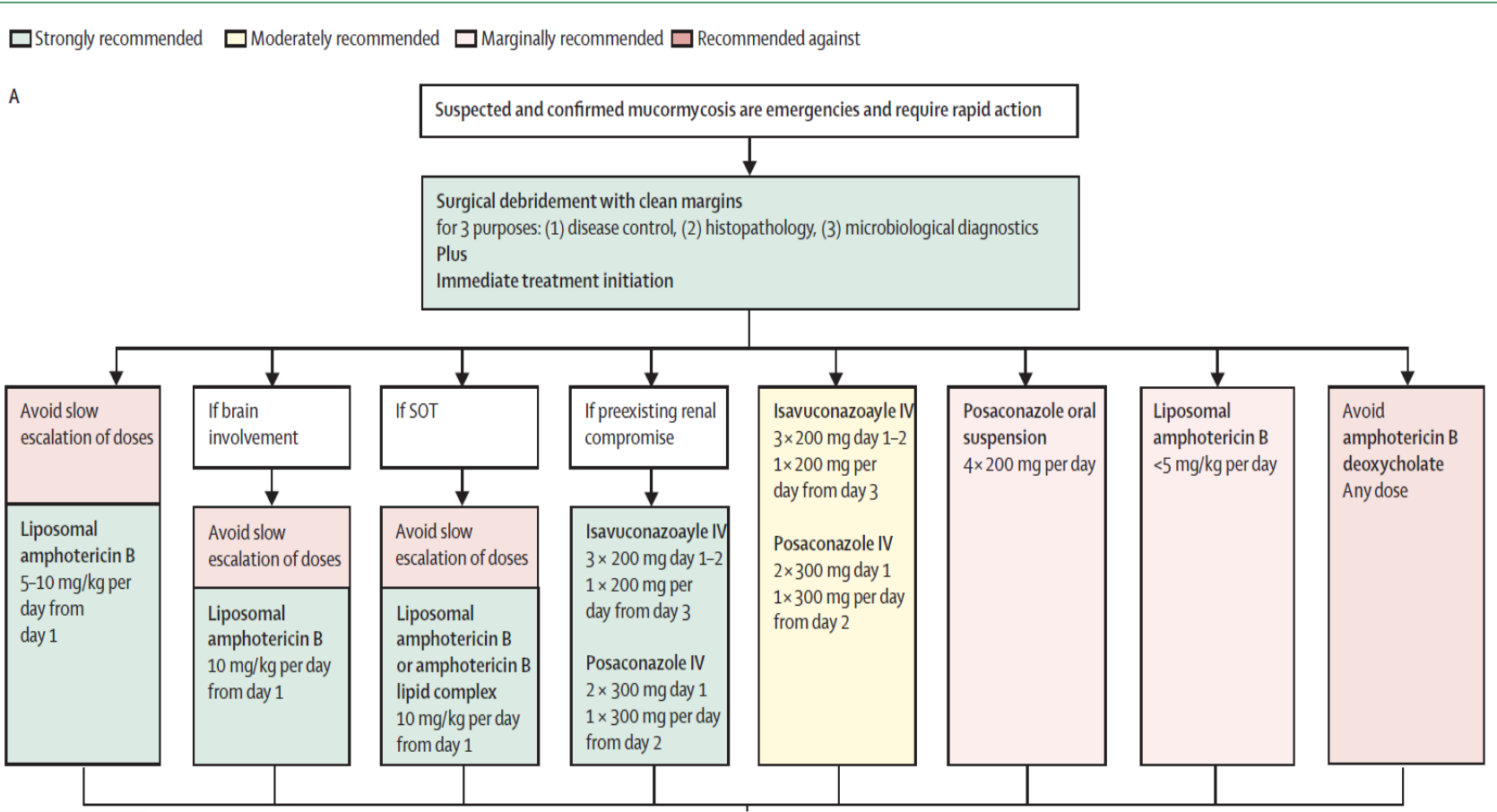
Mucorales

Non-septate hyphae that exhibit irregular branching, often at right angles, and can invade blood vessels, leading to tissue damage.



# Global guideline for the diagnosis and management of mucormycosis: an initiative of the European Confederation of Medical Mycology in cooperation with the Mycoses Study Group Education and Research Consortium

Lancet infect Dis , 2019



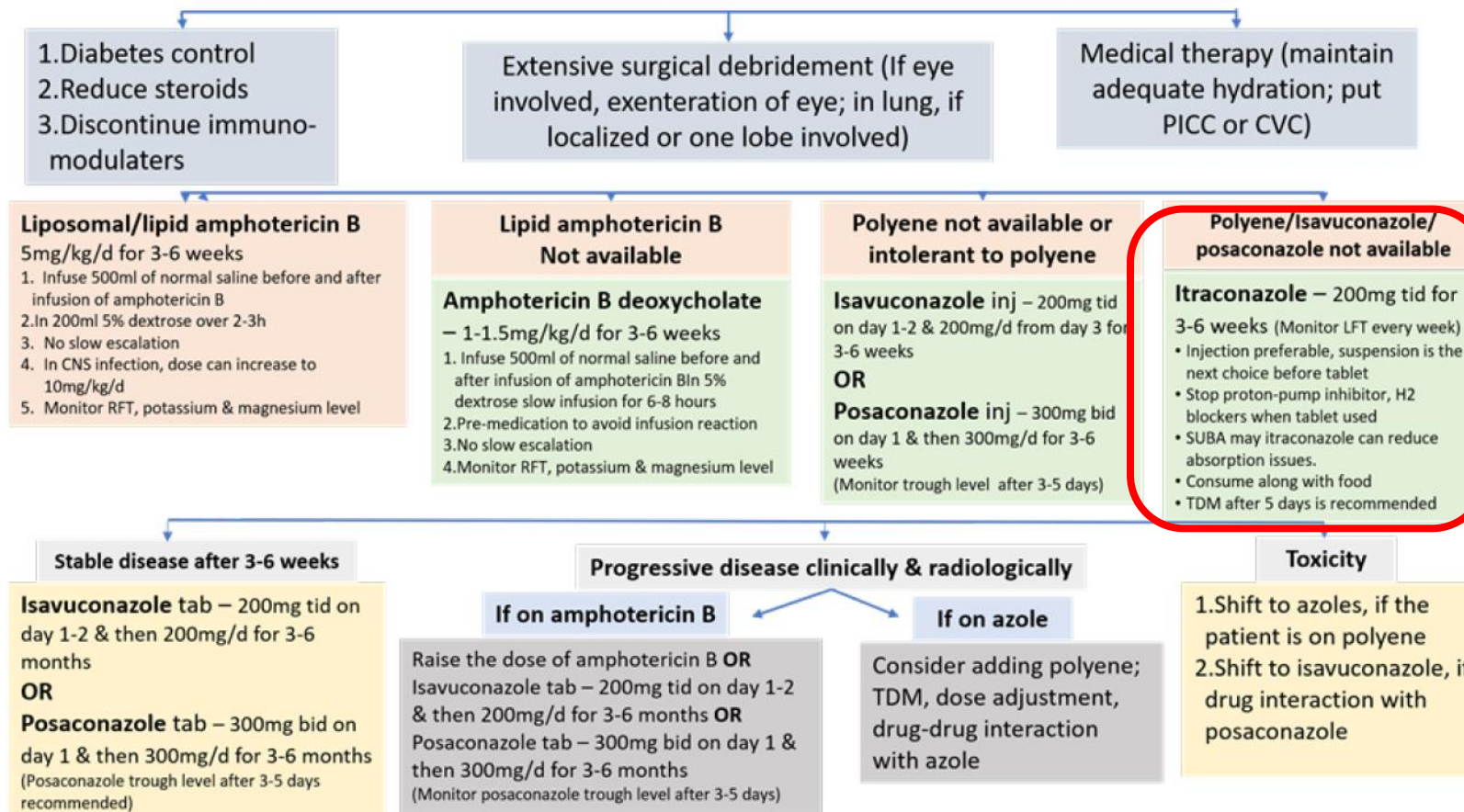
Liposomal AMP B

Alternative :   
Isavuconazole   
Posaconazole

AVOID D-AMP B

# ECMM/ISHAM recommendations for clinical management of COVID -19 associated mucormycosis in low- and middle-income countries

Mycoses 2021



In Vitro study in India,

All Mucorales spp have demonstrated low MIC to Itraconazole



50 years old

Myelofibrosis transformed AML

At presentation BMAT : 50% blast

Multiple cycles of chemo : not in remission

On Itraconazole as prophylaxis

3rd cycle of HIDAC ( 17/2)

WBC 3.86, Hb 10.3, platelet 236

Post chemo day 14 : Neutropenic Fever

WBC nadir 0.25 , HB 7.9, platelet 5

Febrile , on Low dose NA

on RA

Not responding to antibiotics

Started on micafungin empirically

Blood culture from lumens : **yeast cells**



## FLU-resistant *Trichosporon asahii*

Ampho B

Eventually the catheter was removed

Repeated blood culture : negative

US abd and kidneys : no collections

ECHO no vegetation

Day 20 post chemo :

WBC 2.03 (1.15) Hb 8.6, Platelet 66

Azoles are the best options for treatment, but resistance emerges worldwide.

Continuous exposure to azoles can induce mutations in *ERG11* resulting in resistance.

Hyperactive efflux pumps also play a role as drug transporters in FLC resistant *T. asahii* strains.

Blood culture form lumens :

## *Trichosporon asahii*

	MIC µg/ mL	ECV
Flu	> 64	8
VOR	1	0.5
Mica	8	--
Ampho B	0.5	4

*Trichosporon* spp. exhibit an intrinsic resistance to echinocandin and poor susceptibility to the polyenes



20 years old  
ALL/ B myeloid  
- received 1<sup>st</sup> cycle MIDAC, not in remission  
subsequently declined chemotherapy

Fever , frontal headache  
SpO2 : 92 % on RA

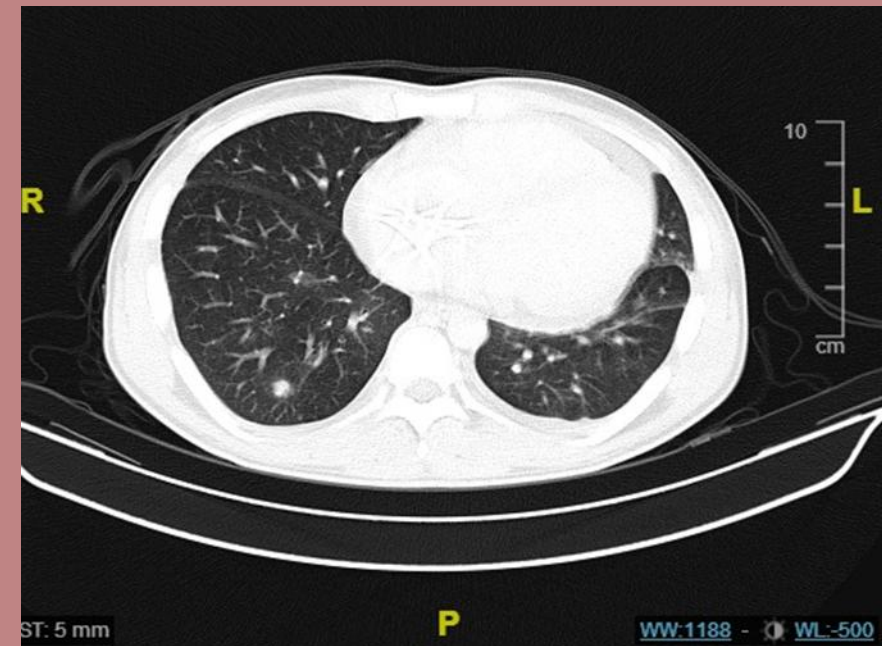
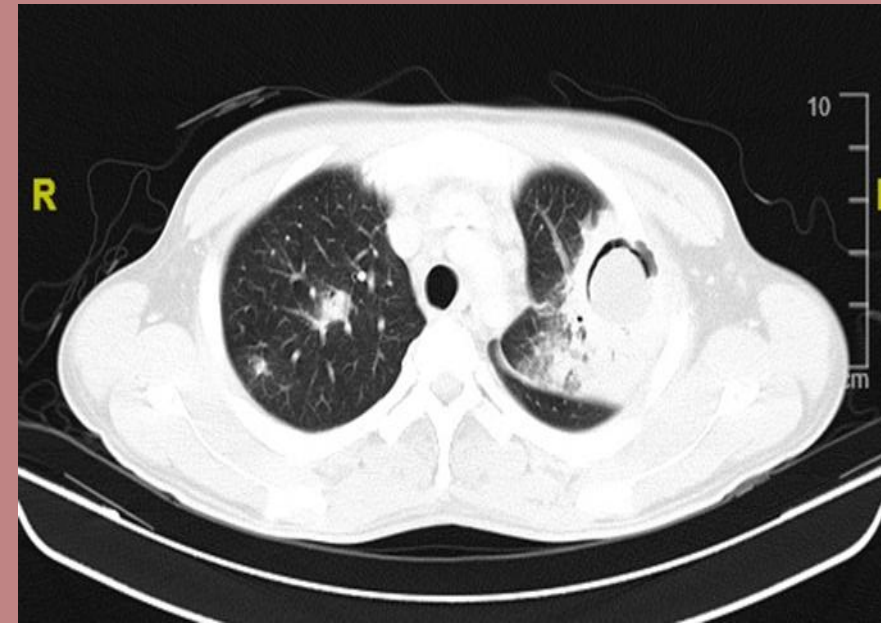
WBC 1.05, HB 7.0, Platelet 23

Se GM :1.11

CT Thorax : Soft tissue mass with air crescent within  
cavity , multiple nodules with surround halos of  
ground glass ( haemorrhage )

CT paranasal : mucosal thickening both sphenoid,  
ethmoid, maxillary, no bony erosion

Started on Amphotericin B



31/07 Nasal rigid scope :

necrotic and whitish patch at middle turbinate

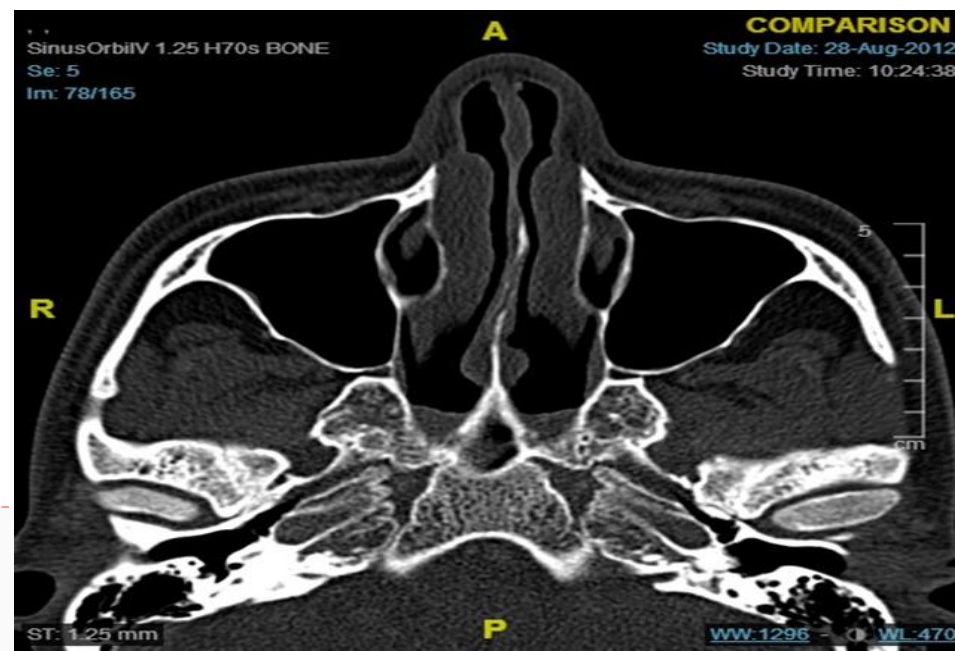
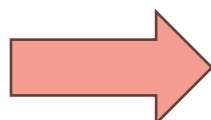
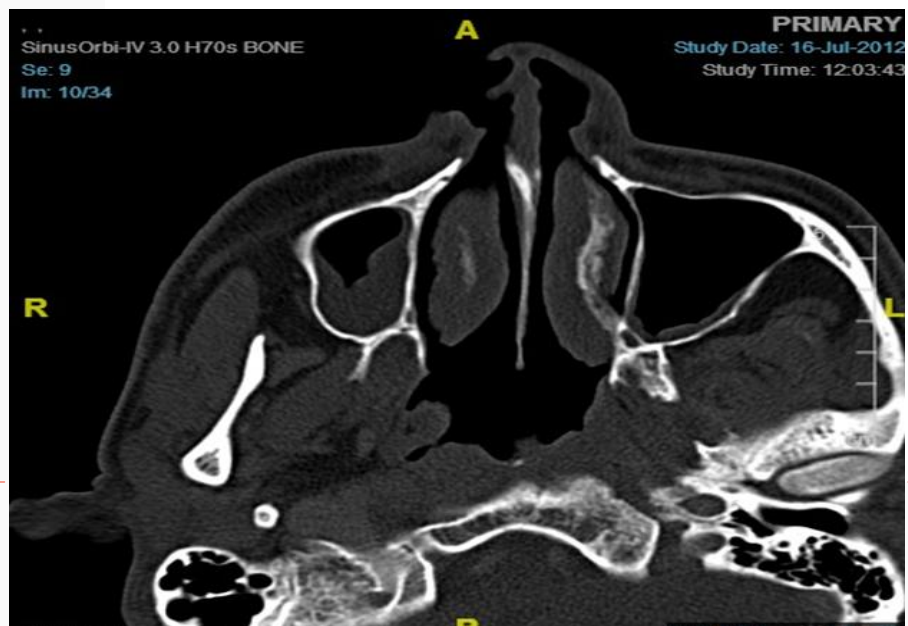
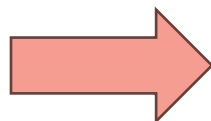
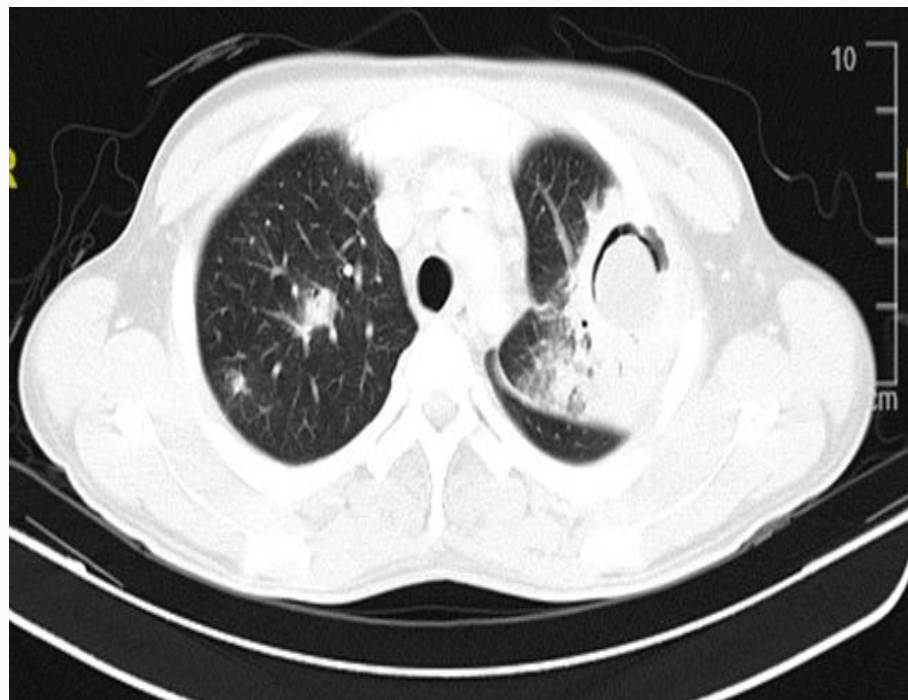
HPE : Middle meatus biopsy :

Necrotic material, two fungal hyphae :

*Aspergillus* spp and unidentifiable spp

Tissue culture :

*Aspergillus flavus* and *Fusarium* spp



■ Strongly recommended   
 ■ Moderately recommended   
 ■ Marginally recommended   
 ■ Recommended against

	First-line	First-line alternative	Second-line	Treatments to avoid	Salvage treatments
<b>Fusariosis</b>	Voriconazole, or voriconazole plus L-AmB, or voriconazole plus ABLC	L-AmB, or ABLC	Isavuconazole, or posaconazole	D-AmB	Posaconazole
Lomentosporosis	Voriconazole plus terbinafine	Voriconazole	Isavuconazole, or posaconazole	L-AmB	Voriconazole
Scedosporiosis	Voriconazole	Voriconazole in combination with L-AmB, ABLC, echinocandins, or terbinafine	Isavuconazole, or posaconazole, or itraconazole	L-AmB	Voriconazole echinocandins, or posaconazole
Phaeohyphomycosis: localised infection	Voriconazole	L-AmB with or without echinocandins, or triazole	Isavuconazole	D-AmB	Isavuconazole, or posaconazole, or voriconazole
Phaeohyphomycosis: cutaneous or subcutaneous infection	Itraconazole or voriconazole	L-AmB with or without echinocandins, or triazole	Isavuconazole	D-AmB	Isavuconazole, or posaconazole, or voriconazole
Phaeohyphomycosis: disseminated infection	Posaconazole, or voriconazole plus echinocandins, or voriconazole plus terbinafine	L-AmB with or without echinocandins, or triazole	Isavuconazole	D-AmB	Isavuconazole, or posaconazole, or voriconazole
Phaeohyphomycosis: <i>Exserohilum rostratum</i>	Voriconazole with or without L-AmB	..	L-AmB plus triazoles other than voriconazole	D-AmB	..
<i>Rasamsonia</i> spp	Caspofungin, or micafungin	Caspofungin plus L-AmB or posaconazole, or micafungin plus L-AmB or posaconazole	..	Azole monotherapy	..
<i>Schizophyllum commune</i>	L-AmB; stepdown to posaconazole	..	Voriconazole	..	..
<i>Schizophyllum</i> spp other than <i>S commune</i> and other basidiomycetes (eg, <i>Coprinopsis cinerea</i> , <i>Hormographiella aspergillata</i> )	L-AmB with or without inhaled L-AmB, or L-AmB with or without voriconazole	..	Voriconazole	Echinocandins	L-AmB, or voriconazole
<i>Scopulariopsis</i> spp	Isavuconazole, or voriconazole	L-AmB with or without voriconazole	..	..	Posaconazole with or without micafungin with or without terbinafine
<i>Penicillium</i> spp: disseminated infection	L-AmB with or without other antifungals	..	..	..	Voriconazole
<i>Penicillium</i> spp: lung infection	Posaconazole	..	..	..	Voriconazole
Non-marneffe <i>Talaromyces</i> spp	L-AmB	..	..	..	Voriconazole, or echinacondine plus terbinafine
<i>Paecilomyces</i> spp	L-AmB	..	..	..	Itraconazole, or posaconazole
<i>Purpureocillium</i> spp	Voriconazole	..	Itraconazole or L-AmB or posaconazole	..	Itraconazole, or L-AmB, or posaconazole
<i>Purpureocillium</i> spp: cutaneous or subcutaneous infection	Voriconazole plus terbinafine	..	Itraconazole or L-AmB or posaconazole	..	Itraconazole, or L-AmB, or posaconazole



# Role of antifungal TDM

Improve efficacy

Prevent toxicity

Improve compliance

★ Prevent development of resistance

## Therapeutic drug monitoring

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Clinical scenarios where antifungal therapeutic drug monitoring may be indicated

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Populations with increased pharmacokinetic variability

Changing pharmacokinetics

Interacting medications

Poor prognosis disease

Compliance concerns

Suspected breakthrough infection

Suspected drug toxicity, especially neurotoxicity (voriconazole)

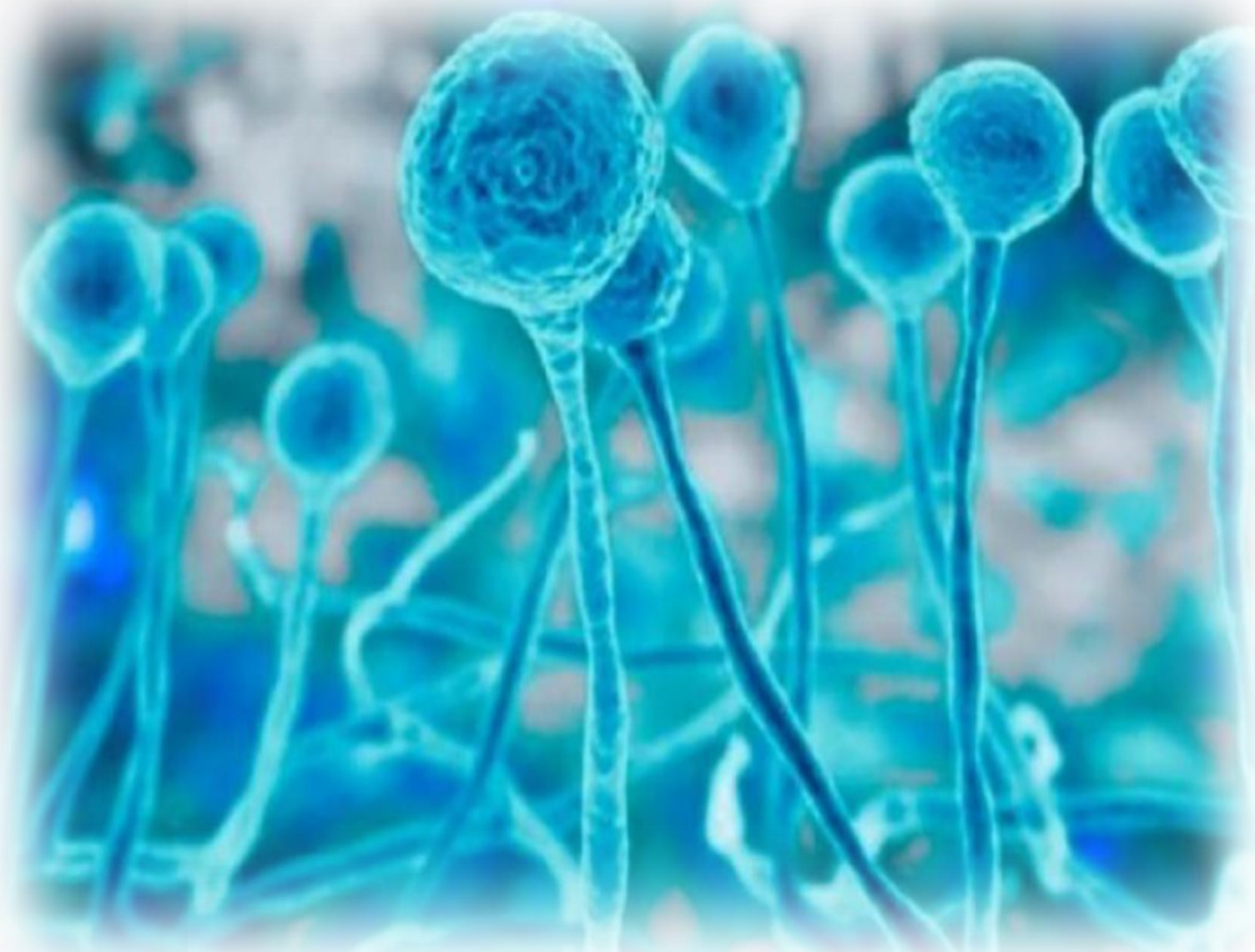
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# ISHAMASIA 2026

## SEE YOU IN MALAYSIA







# THANK YOU

## ACKNOWLEDGEMENT

Microbiology Unit  
Department of  
Pathology  
Hospital Sultanah  
Bahiyah