

# SARS-CoV-2 et champignons : *association de malfaiteurs*

**Pr Jean-Pierre GANGNEUX**

Parasitologie-Mycologie, CHU de Rennes

Inserm UMR\_S 1085 - Institut de Recherche en Santé Environnement & Travail

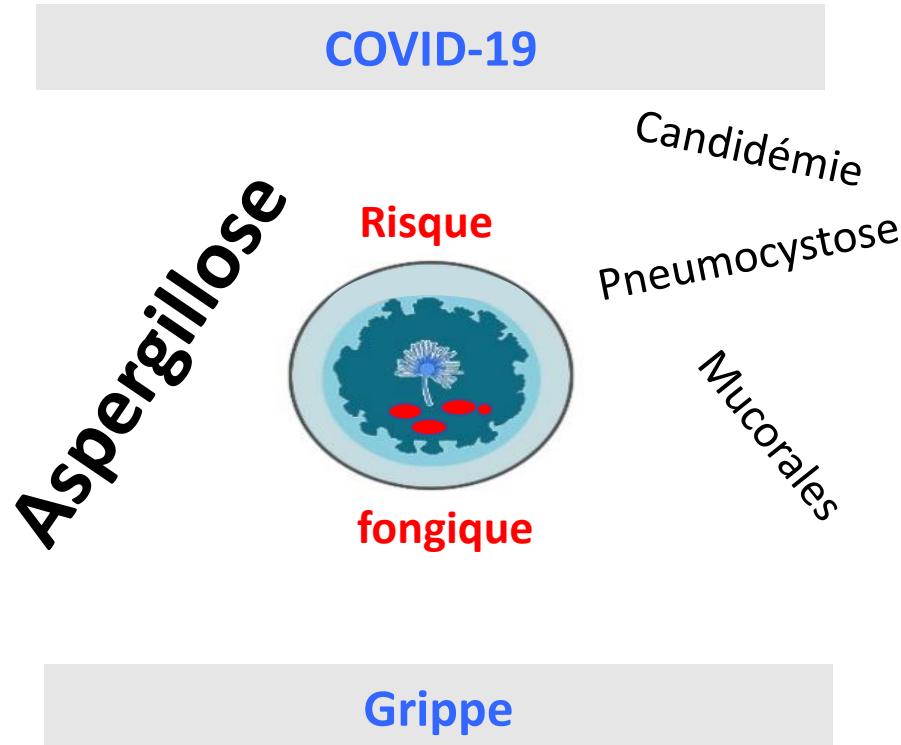
Rennes, FRANCE



European Confederation of Medical Mycology

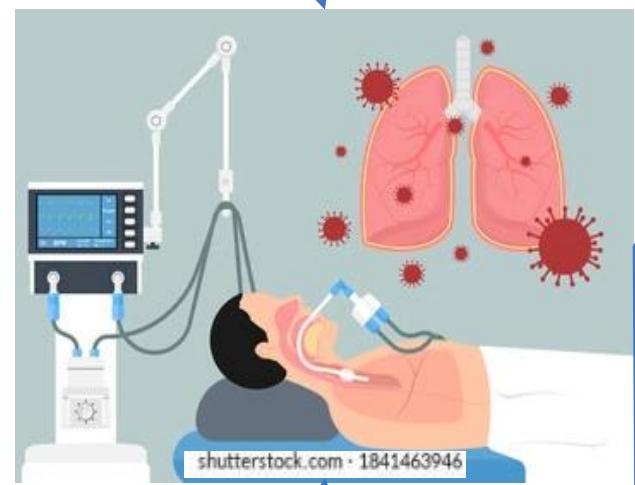


# COVID-19 et infections fongiques : Un air de déjà vu?



- Epidémiologie, incidence ?
- Patients à risque, gravité ?
- Outils diagnostiques ?
- Définitions et prise en charge ?

# Physiopathologie COVID-19 et facteurs de risques d'infections fongiques



5



6

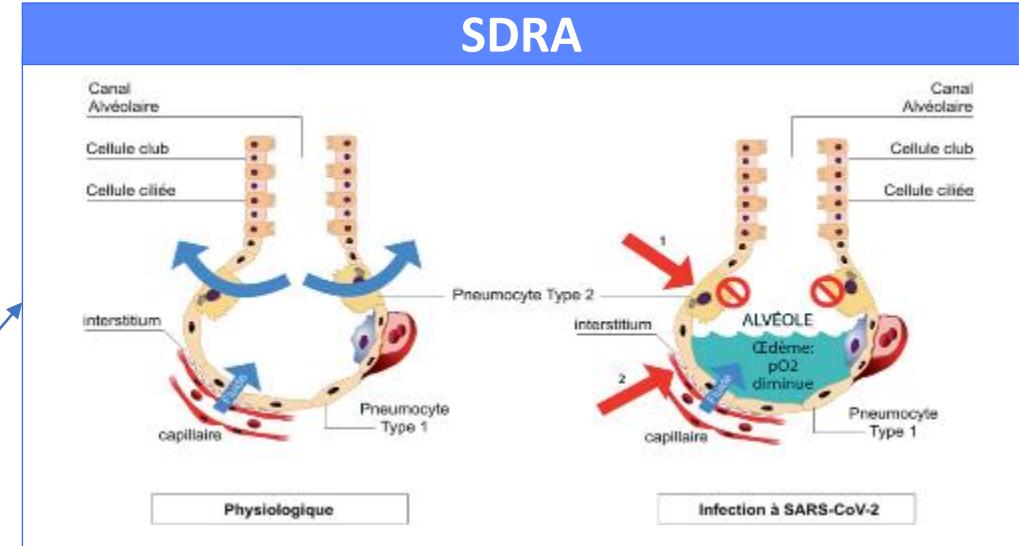
Dysbiose

1

2

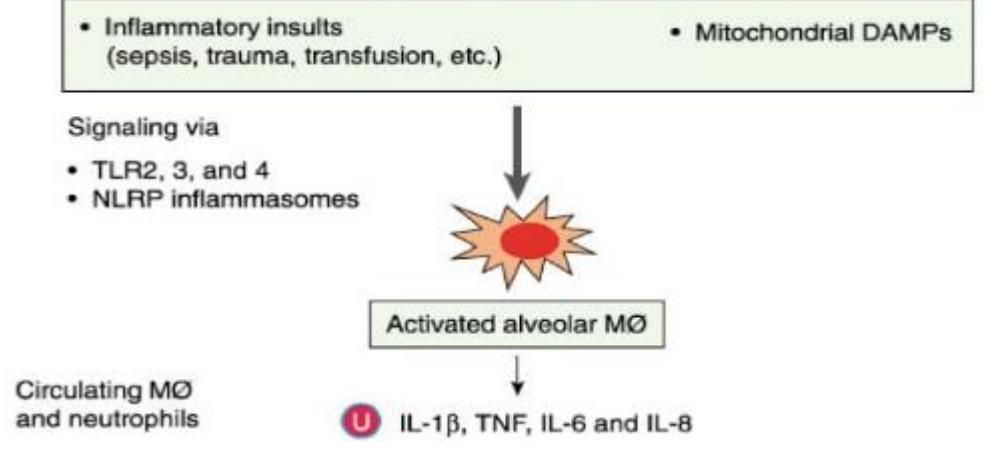
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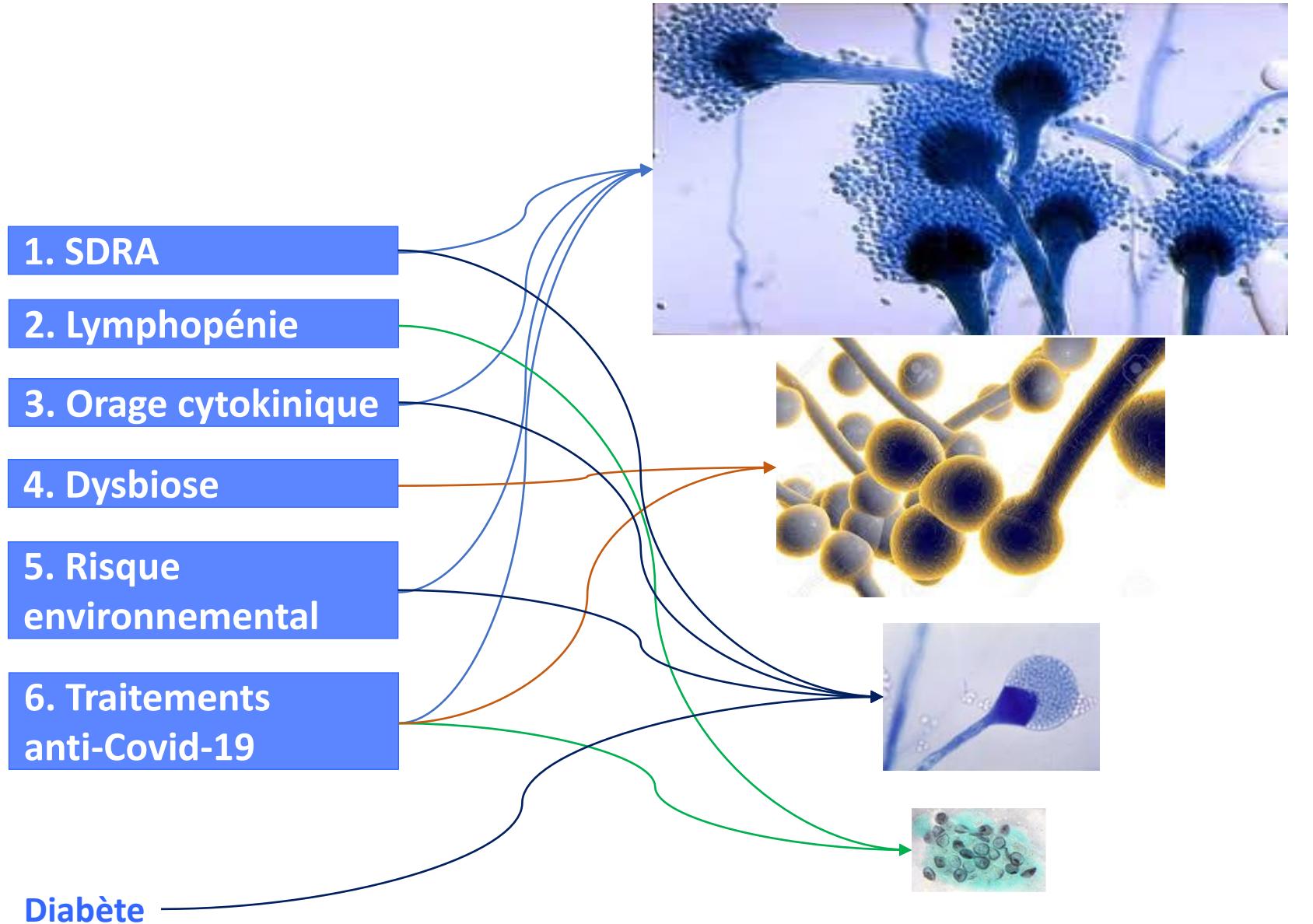


Lymphopénie

Orage cytokinique



# Physiopathologie COVID-19 et facteurs de risques d'infections fongiques



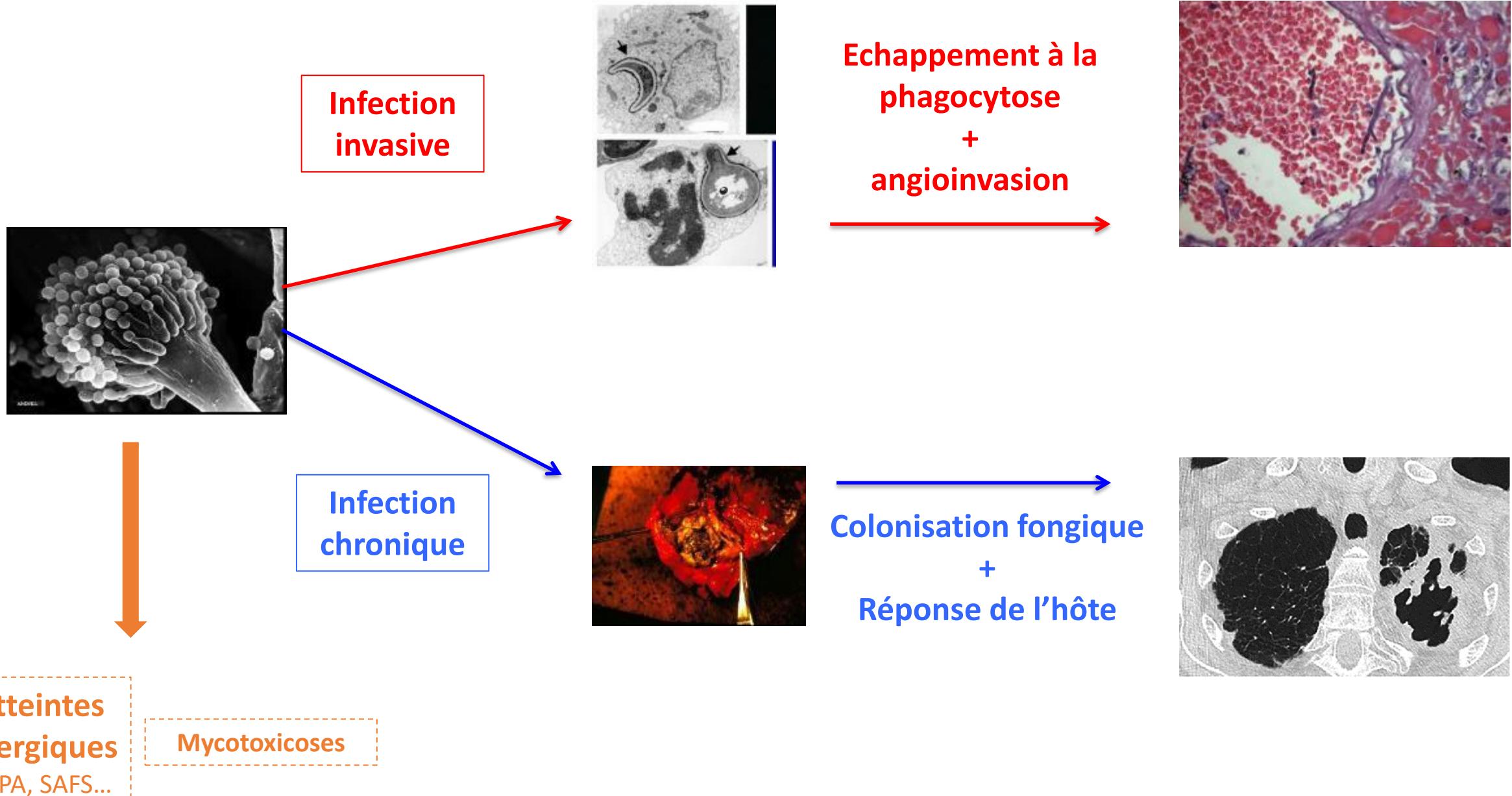
Aspergilloses

Candidémies

Mucormycoses

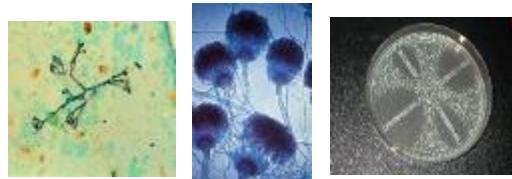
Pneumocystoses

# 1. Aspergillus et aspergilloses

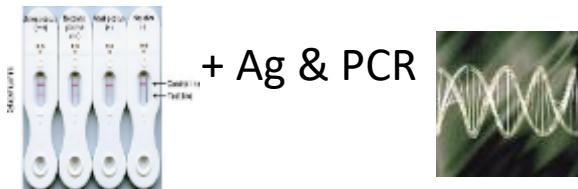


# Les outils diagnostiques des aspergilloses

## Infection invasive



Traquer le champignon  
Examen direct + culture  
+ sensibilité in vitro



Terrains sous-jacents :  
Neutropénie, HSCT, corticostéroïdes...

**Patients de réanimation co-infectés par des virus ?**

Continuum....

Colonisation fongique  
Marqueurs d'invasion

- AI possible
- AI putative
- AI probable
- AI prouvée

IAPA

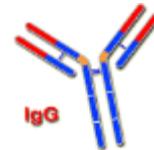


CAPA



## Infection chronique

Etude de la réponse de l'hôte  
Sérologie IgG



+/- mise en évidence d'*Aspergillus*

Terrains sous-jacents:  
Maladies respiratoires chroniques

# Grippe sévère et aspergillose invasive : IAPA

Clinical Infectious Diseases

EDITORIAL COMMENTARY



OXFORD

## Influenza-Associated Pulmonary Aspergillosis: A Local or Global Lethal Combination?

Bart J. A. Rijnders,<sup>1</sup> Alexander F. A. D. Schauwvlieghé,<sup>1,2</sup> and Joost Wauters<sup>3</sup>

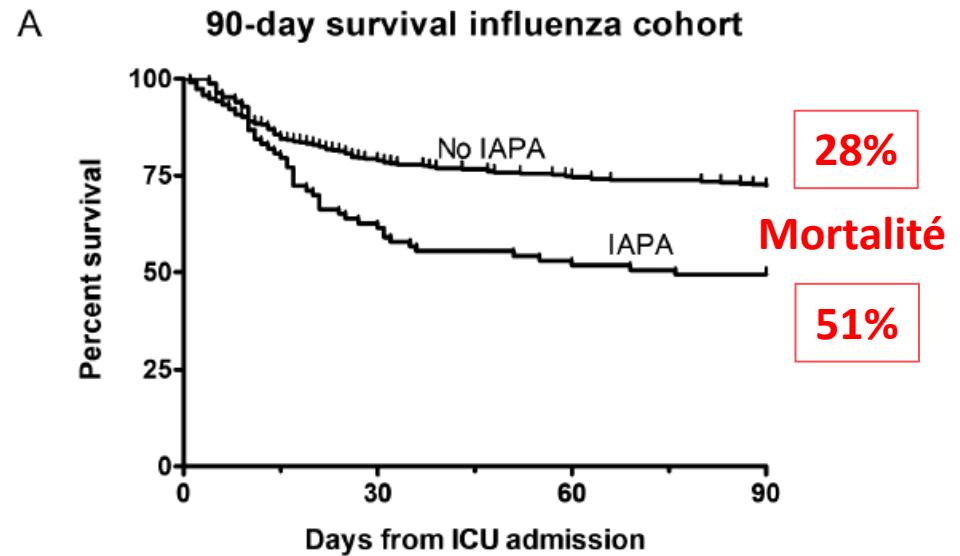
**Let's add invasive aspergillosis to the list of influenza complications**

Since the 1918 pandemic (H1N1), although the causal agent of influenza was not then known, the main cause of death has been suspected as being from secondary infection. Bacterial pneumonia remains a major complication of influenza. Yet, during the past decade, an unexpected mould, *Aspergillus fumigatus*, has emerged as a potential complication.

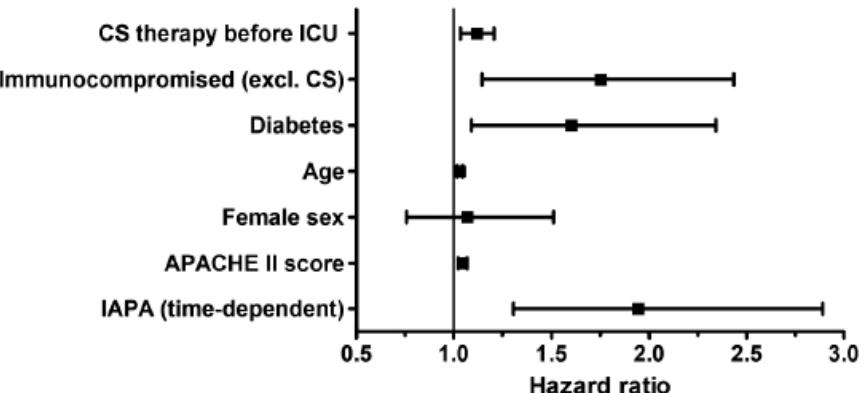
In this issue of *The Lancet Respiratory Medicine*, Alexander Schauwvlieghé and colleagues<sup>1</sup> report a retrospective cohort study assessing patients admitted to seven intensive

care units between Jan 1, 2009, and June 30, 2016, in Belgium and in The Netherlands. They found that invasive pulmonary aspergillosis occurred in 19% of patients with severe influenza requiring admission to the intensive care unit (ICU). Invasive pulmonary aspergillosis also occurred in patients without predisposing host factors according to 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) definition.<sup>2</sup>

Published Online  
July 31, 2018  
[http://dx.doi.org/10.1016/S2213-2600\(18\)30332-1](http://dx.doi.org/10.1016/S2213-2600(18)30332-1)  
See *Articles* page 782



B Effect covariates on 90-day survival



CONFERENCE REPORTS AND EXPERT PANEL

# Review of influenza-associated pulmonary aspergillosis in ICU patients and proposal for a case definition: an expert opinion

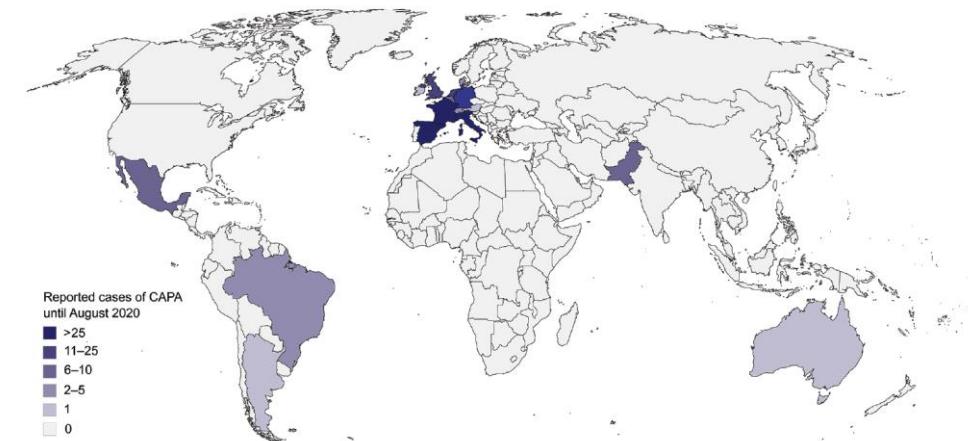
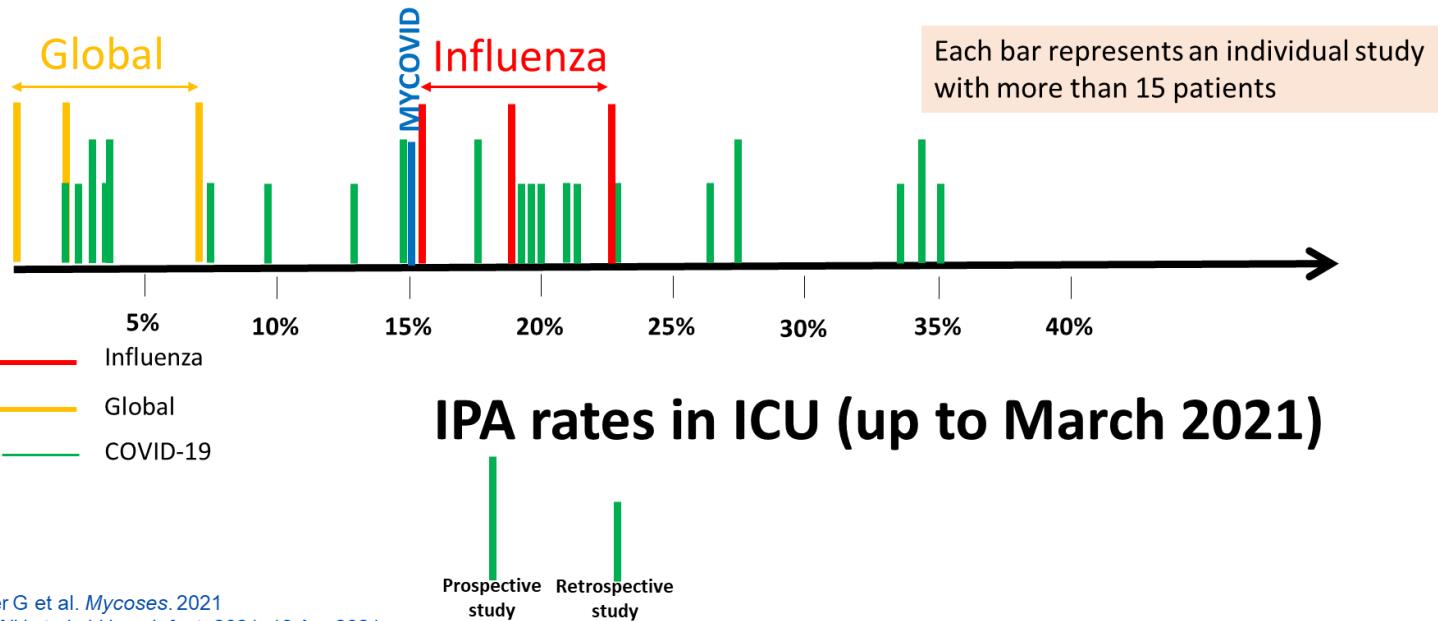


**Table 1 Proposed case definition for IAPA in ICU patients**

Entry criteria: influenza-like illness + positive influenza PCR or antigen + temporally relationship		
	<i>Aspergillus tracheobronchitis</i>	IAPA in patients without documented <i>Aspergillus tracheobronchitis</i>
<b>Proven</b>	Biopsy or brush specimen of airway plaque, pseudomembrane or ulcer showing hyphal elements and <i>Aspergillus</i> growth on culture or positive <i>Aspergillus</i> PCR in tissue	Lung biopsy showing invasive fungal elements and <i>Aspergillus</i> growth on culture or positive <i>Aspergillus</i> PCR in tissue
<b>Probable</b>	Airway plaque, pseudomembrane or ulcer and at least one of the following: Serum GM index > 0.5 <i>or</i> BAL GM index $\geq$ 1.0 <i>or</i> Positive BAL culture <i>or</i> Positive tracheal aspirate culture <i>or</i> Positive sputum culture <i>or</i> Hyphae consistent with <i>Aspergillus</i>	<b>A:</b> Pulmonary infiltrate and at least one of the following: Serum GM index > 0.5 <i>or</i> BAL GM index $\geq$ 1.0 <i>or</i> Positive BAL culture <b>OR</b> <b>B:</b> Cavitating infiltrate (not attributed to another cause) and at least one of the following: Positive sputum culture <i>or</i> Positive tracheal aspirate culture

# Covid-19 et aspergillose invasive : CAPA

- Très nombreuses publications
- Hétérogénéité des critères diagnostiques
- Beaucoup d'études rétrospectives



Salmanton-Garcia et al, Emerging Infectious Diseases 2021

# Le diagnostic de CAPA : pas si facile

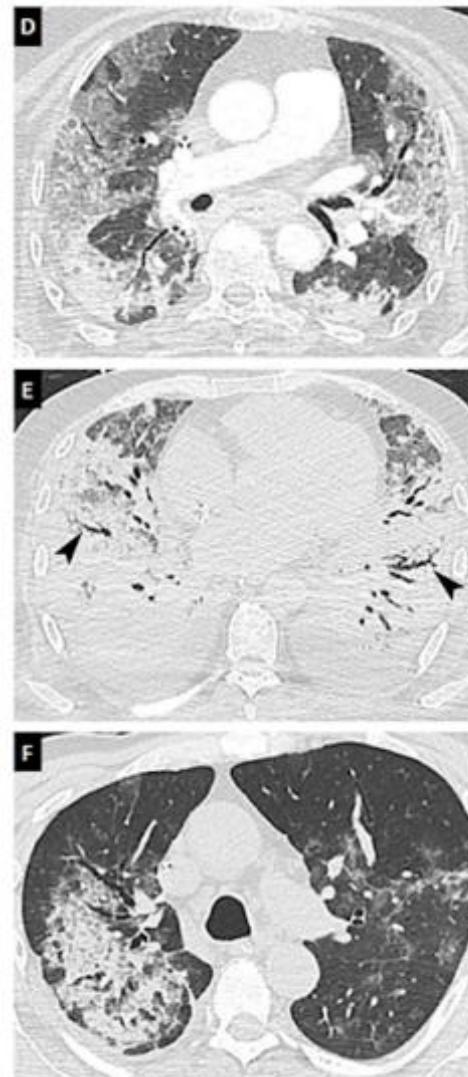
## - Critères d'entrée?

1. PCR Sars-CoV-2 positive+  
détérioration clinique + imagerie

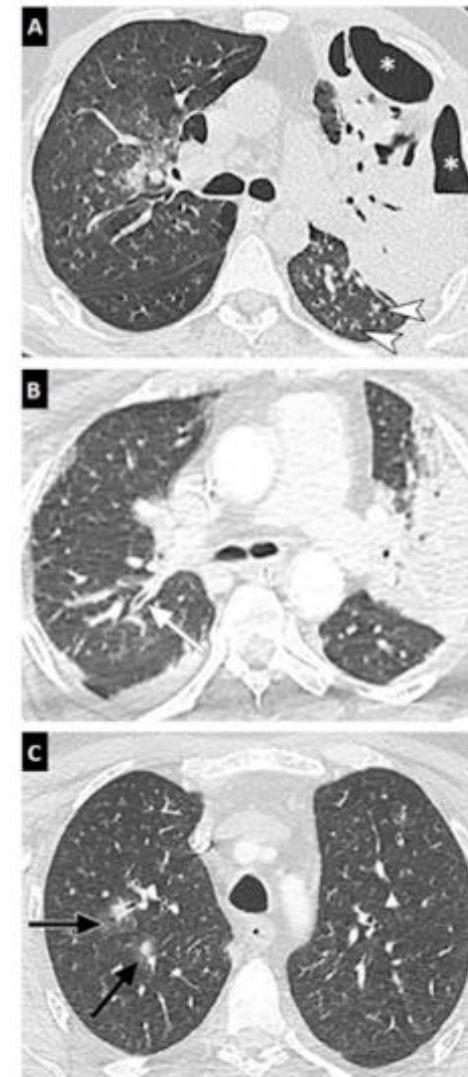
- Verre dépoli/Crazy paving
- Aires de consolidations
- Bronchiectasies

=> Signes non spécifiques

CAPA



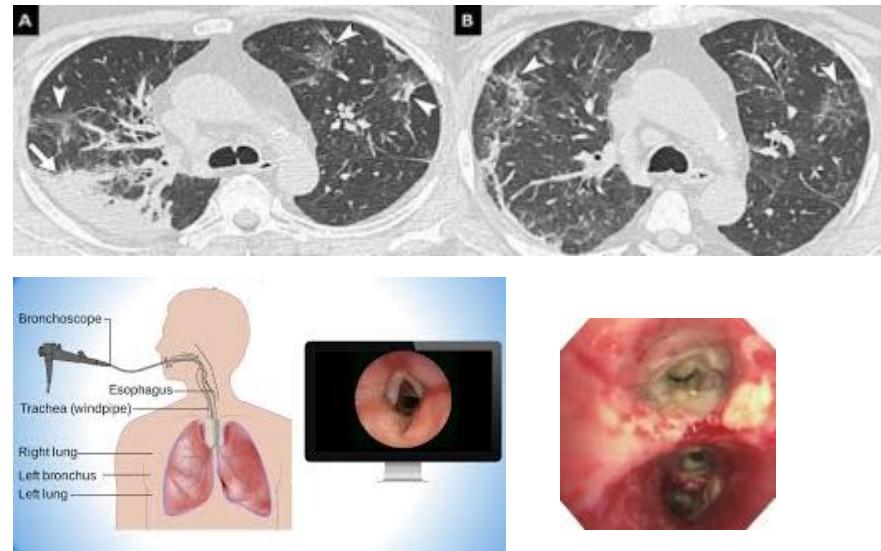
IAPA



# Le diagnostic de CAPA : pas si facile

## - Critères d'entrée?

1. PCR Sars-CoV-2 positive+  
détérioration clinique + imagerie
  
2. Bronchoscopie dès que possible  
**! Protection de l'opérateur !**
  
3. Arguments mycologiques



## - Performances des tests?

Panel: Crucial next research questions for COVID-19 associated invasive pulmonary aspergillosis

### Diagnosis of CAPA

- What is the positive predictive value of culture isolation of *Aspergillus* species in samples from the upper respiratory tract (infection vs colonization)?
  
- In light of low sensitivity of serum galactomannan, are there alternative blood tests for CAPA? What is the performance of *Aspergillus* PCR,  $\beta$ -D-glucan, and the *Aspergillus*-specific lateral flow device and lateral flow assay?

### Diagnosing COVID-19-associated pulmonary aspergillosis



*Lancet Microbe* 2020

Published Online  
May 8, 2020

Paul E Verweij, Jean-Pierre Gangneux, Matteo Bassetti, Roger J M Brüggemann, Oliver A Cornely, Philipp Koehler, Cornelia Lass-Flörl, Frank L van de Veerdonk, Arunabha Chakrabarti, Martin Hoenigl, on behalf of the European Confederation of Medical Mycology, the International Society for Human and Animal Mycology, the European Society for Clinical Microbiology and Infectious Diseases Fungal Infection Study Group, and the ESCMID Study Group for Infections in Critically Ill Patients

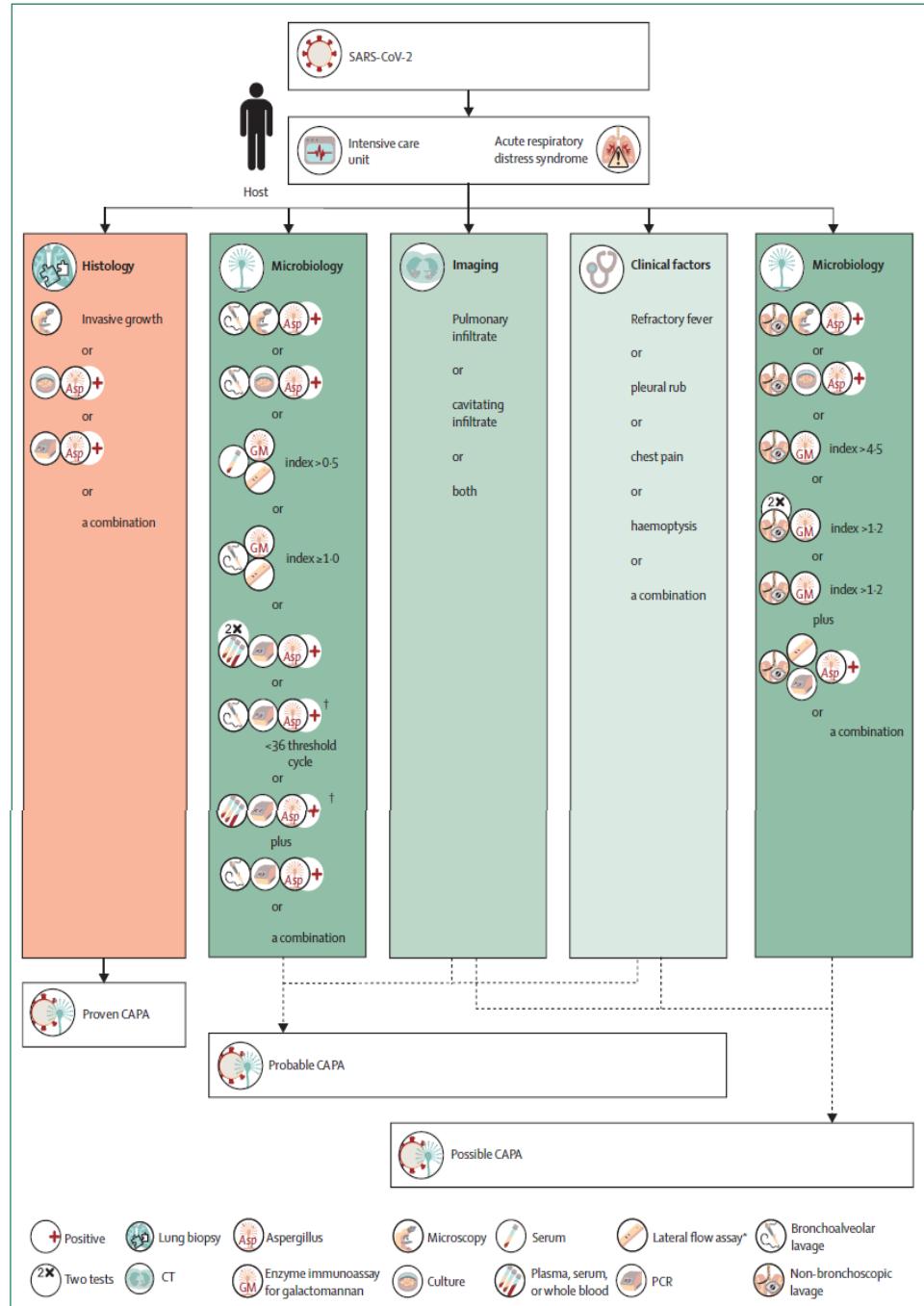
# Quelle définition des CAPA?

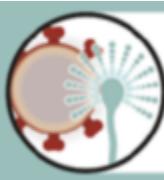
THE LANCET  
Infectious Diseases

Lancet Infect Dis 2021;  
21: e149–62

## Defining and managing COVID-19-associated pulmonary aspergillosis: the 2020 ECMM/ISHAM consensus criteria for research and clinical guidance

Philipp Koehler, Matteo Bassetti, Arunaloke Chakrabarti, Sharon C A Chen, Arnaldo Lopes Colombo, Martin Hoenigl, Nikolay Klimko, Cornelia Lass-Flörl, Rita O Oladele, Donald C Vinh, Li-Ping Zhu, Boris Böll, Roger Brüggemann, Jean-Pierre Gangneux, John R Perfect, Thomas F Patterson, Thorsten Persigehl, Jacques F Meis, Luis Ostrosky-Zeichner, P Lewis White, Paul E Verweij, Oliver A Cornely, on behalf of the European Confederation of Medical Mycology, the International Society for Human and Animal Mycology, the Asia Fungal Working Group, the INFOCUS LATAM/ISHAM Working Group, the ISHAM Pan Africa Mycology Working Group, the European Society for Clinical Microbiology and Infectious Diseases Fungal Infection Study Group, the ESCMID Study Group for Infections in Critically Ill Patients, the Interregional Association of Clinical Microbiology and Antimicrobial Chemotherapy, the Medical Mycology Society of Nigeria, the Medical Mycology Society of China Medicine Education Association, Infectious Diseases Working Party of the German Society for Haematology and Medical Oncology, and Association of Medical Microbiology and Infectious Disease Canada





# Quelle définition des CAPA?

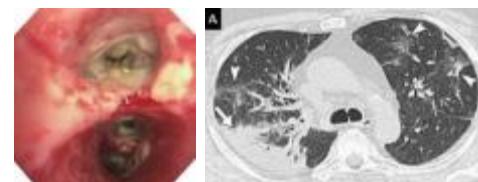
## CAPA prouvée

Examen histo-pathologique ou culture ou PCR positive sur échantillon stérile

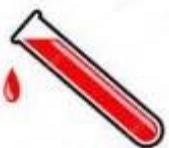


## CAPA Probable (forme pulmonaire)

Critères cliniques  
+ imagerie  
+ mycologiques



LBA : ED+ OU culture+  
OU GM>1  
OU PCR<36CT



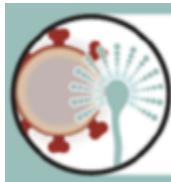
OU Sang : GM > 0,5 OU  $\geq 2$  PCR+



OU 1 PCR+ sang ET 1 PCR+ LBA

Koehler et coll.

The Lancet Infectious Diseases, 14 Dec 2020



# Quelle définition des CAPA?

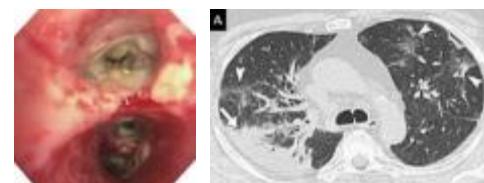
## CAPA prouvée

Examen histo-pathologique ou culture ou PCR positive sur échantillon stérile



## CAPA Probable (forme pulmonaire)

Critères cliniques  
+ imagerie  
+ mycologiques



LBA : ED+ OU culture+  
OU GM>1  
OU PCR<36CT



OU Sang : GM > 0,5 OU  $\geq 2$  PCR+



OU 1 PCR+ sang ET 1 PCR+ LBA

## CAPA possible

Critères cliniques  
+ imagerie  
+ mycologiques

Non broncho-alveolar lavage:  
ED+ OU culture+



OU GM>4,5 (1 fois)  
OU GM>1,2 (2 fois)  
OU GM>1,2 ET PCR+

Koehler et coll.

The Lancet Infectious Diseases, 14 Dec 2020

# Facteurs associés aux CAPA dans la littérature



## ORIGINAL ARTICLE

### Occurrence of Invasive Pulmonary Fungal Infections in Patients with Severe COVID-19 Admitted to the ICU

Amaud Fekkar<sup>1,2</sup>, Alexandre Lampros<sup>1</sup>, Julien Mayaux<sup>2</sup>, Corentin Poignon<sup>1</sup>, Sophie Demeret<sup>4</sup>, Jean-Michel Constantin<sup>5</sup>, Anne-Geneviève Marcellin<sup>6</sup>, Antoine Monse<sup>7,8,9</sup>, Charles-Edouard Luyt<sup>10,11</sup>, and Marion Blaize<sup>1</sup>

→ Immunodépression/Transplantation d'organes solides

Clinical Microbiology and Infection 27 (2021) 790.e1–790.e5



Contents lists available at ScienceDirect  
Clinical Microbiology and Infection  
journal homepage: [www.clinicalmicrobiologyandinfection.com](http://www.clinicalmicrobiologyandinfection.com)



Research Note

Risk factors associated with COVID-19-associated pulmonary aspergillosis in ICU patients: a French multicentric retrospective cohort

Sarah Delliére<sup>1,2,†</sup>, Emmanuel Dudoignon<sup>3,†</sup>, Sofiane Fodil<sup>4,†</sup>, Sebastian Voicu<sup>5,†</sup>, Magalie Collet<sup>3,†</sup>, Pierre-Antoine Ollic<sup>6</sup>, Maud Salmona<sup>7</sup>, François Dépret<sup>3,8,9</sup>, Théo Ghelfenstein-Ferreira<sup>1</sup>, Benoit Plaud<sup>3</sup>, Benjamin Chousterman<sup>3</sup>, Stéphane Bretagne<sup>1,2</sup>, Elie Azoulay<sup>4,†</sup>, Alexandre Mebazaa<sup>3,8,9,†</sup>, Bruno Megarbane<sup>5,†</sup>, Alexandre Alainio<sup>1,2,\*,†</sup>

→ Azithromycine  
Dexamethasone (tendance si forte dose)

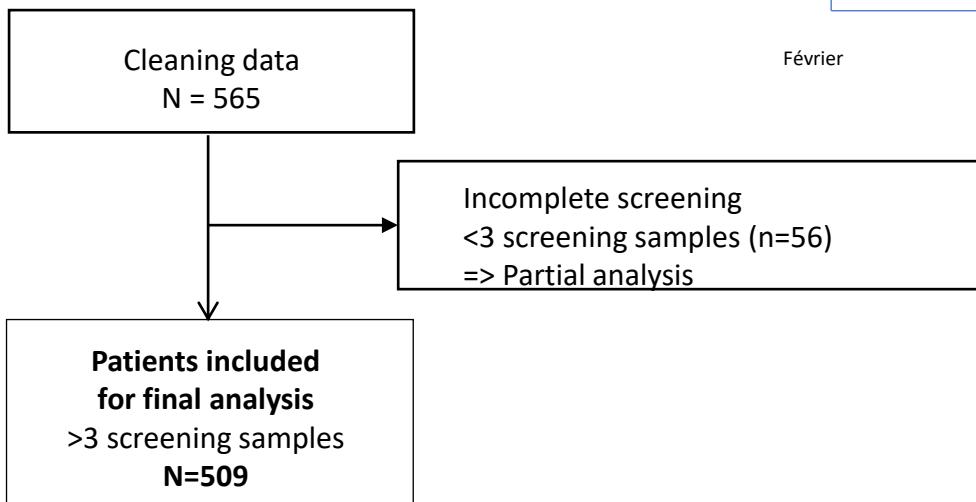
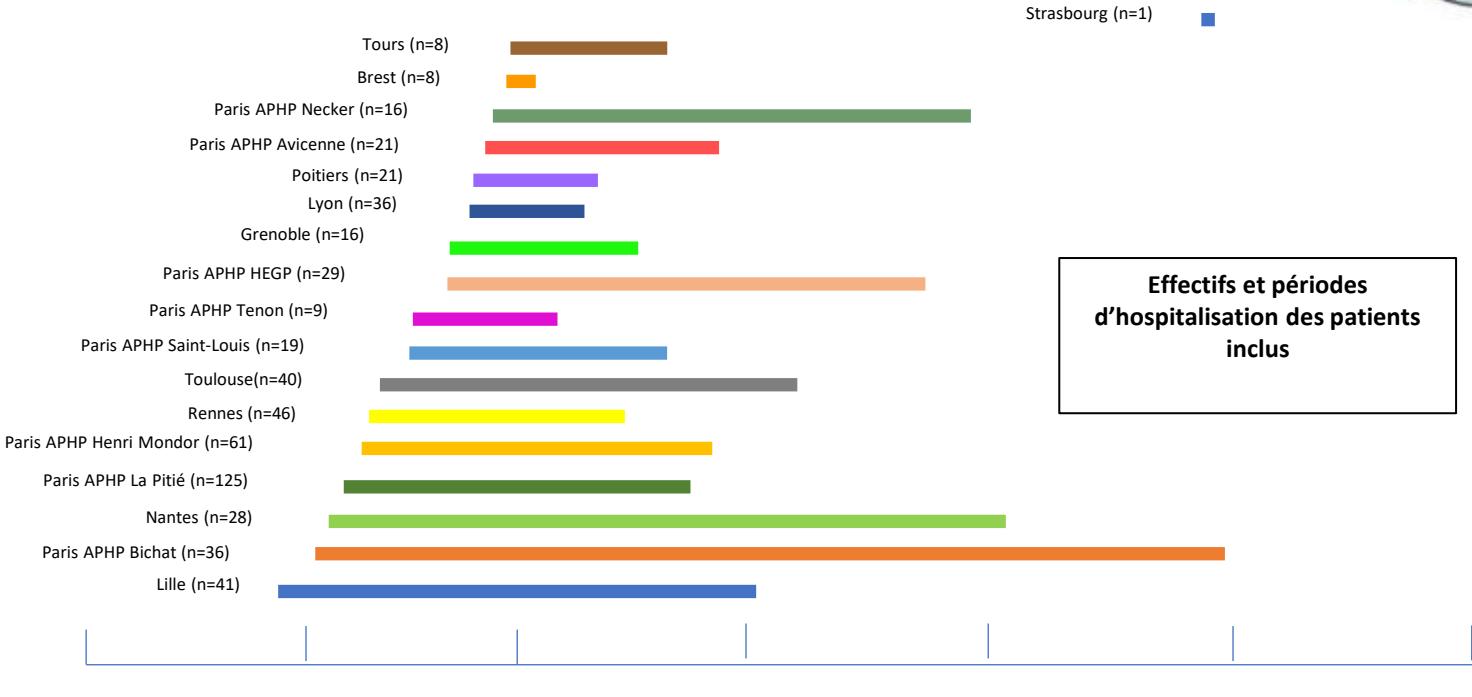
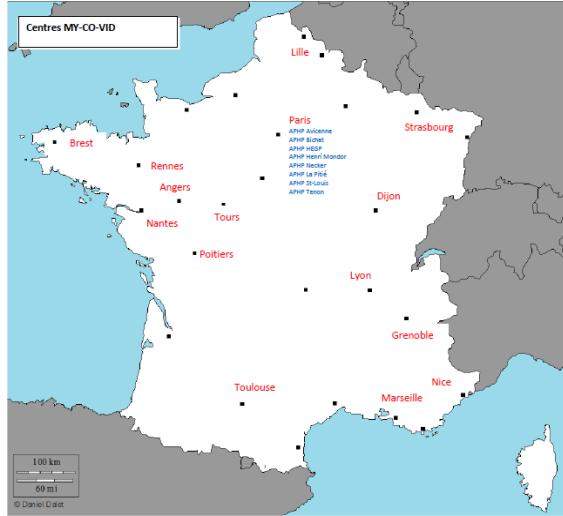
### COVID-19 Associated Pulmonary Aspergillosis in Mechanically Ventilated Patients

Nitipong Permpalung MD, MPH<sup>1,2</sup>, Teresa Po-Yu Chiang MD, MPH<sup>3</sup>, Allan B. Massie PhD<sup>3,4</sup>, Sean X. Zhang MD, PhD<sup>5</sup>, Robin K. Avery MD<sup>1</sup>, Saman Nematollahi MD<sup>1</sup>, Darin Ostrander PhD<sup>1</sup>, Dorry L. Segev MD, PhD<sup>3,4</sup>, and Kieren A. Marr MD, MBA<sup>1</sup>

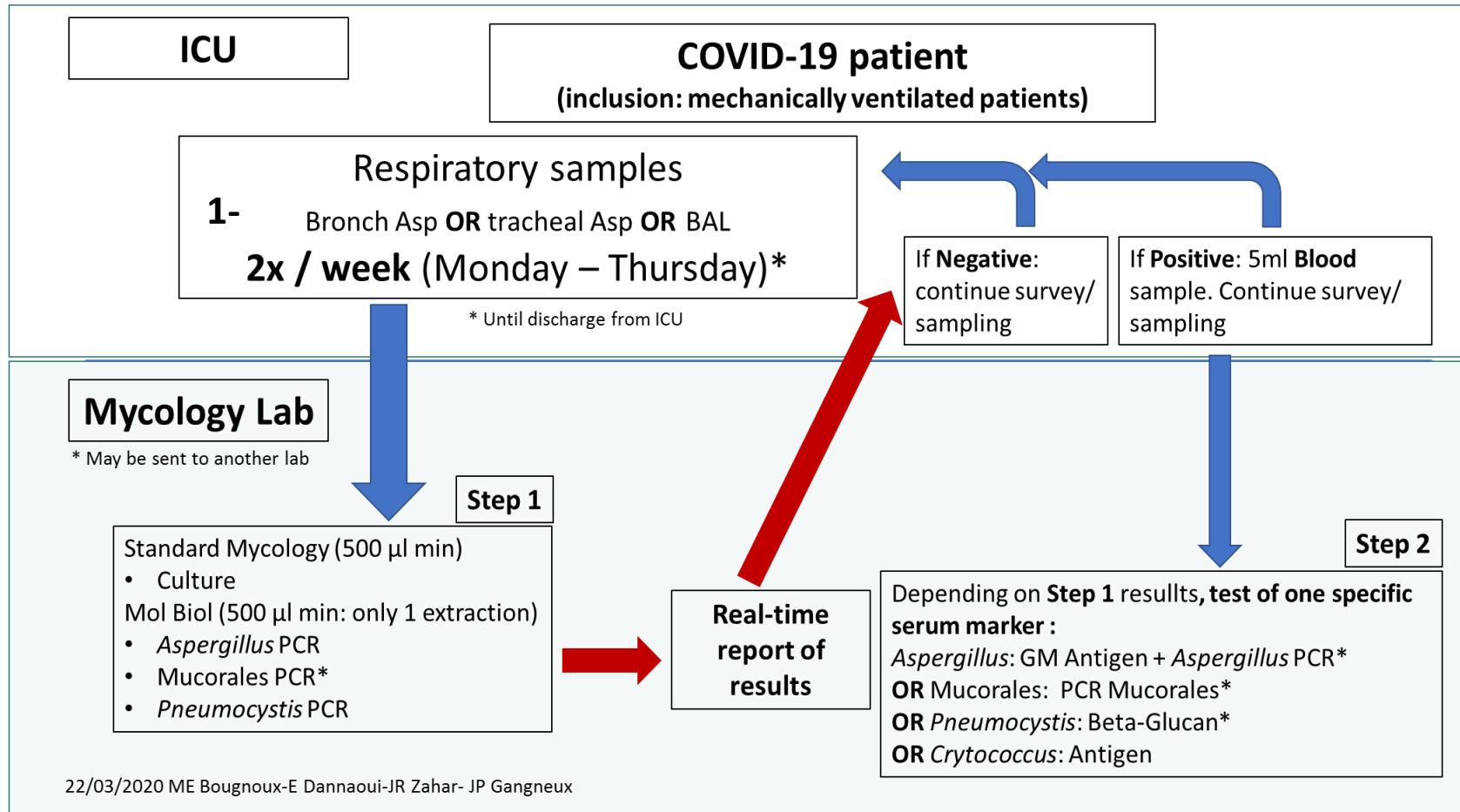
→ Maladies hépatiques  
Maladies vasculaires pulmonaires  
Coagulopathies, tumeurs solides, myélomes  
Hydrocortisone



# MYCOVID : Characterization of fungal infections in COVID-19 infected and mechanically ventilated patients in ICU



# MYCOVID : Characterization of fungal infections in COVID-19 infected and mechanically ventilated patients in ICU



22/03/2020 ME Bougnoux-E Dannaoui-JR Zahar- JP Gangneux

E-CRF

Nombre d'infections déclarées : filamenteux, candidémies, PAVM et co-infections HSV1 et CMV

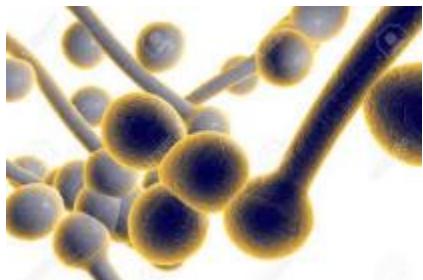
+

Screening des *Aspergillus*, mucorales et *Pneumocystis*

# MYCOVID : Characterization of fungal infections in COVID-19 infected and mechanically ventilated patients in ICU



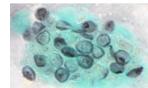
CAPA probables : 14,9%



Candidémies : 6,3%



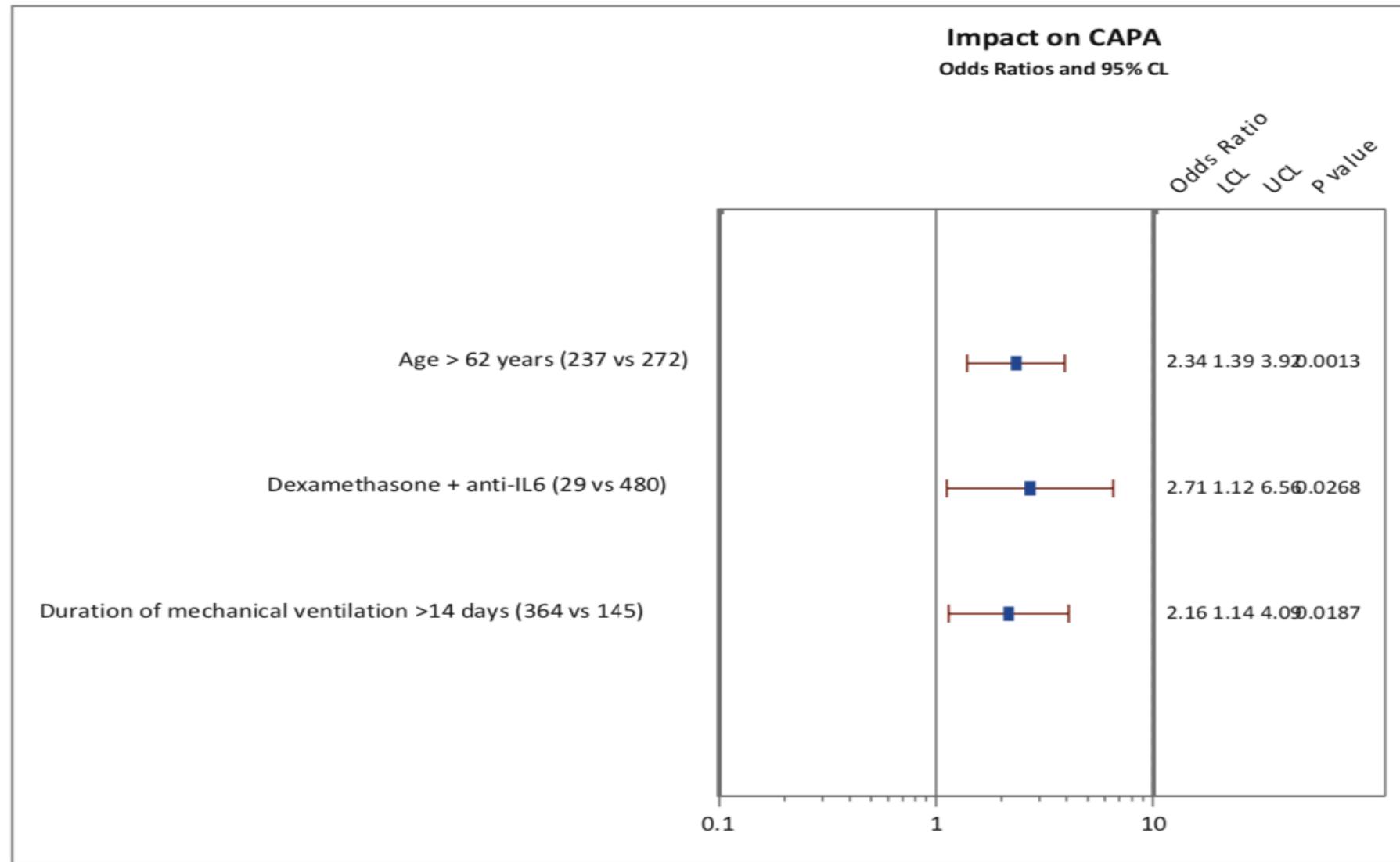
Mucormycoses : 1,2%



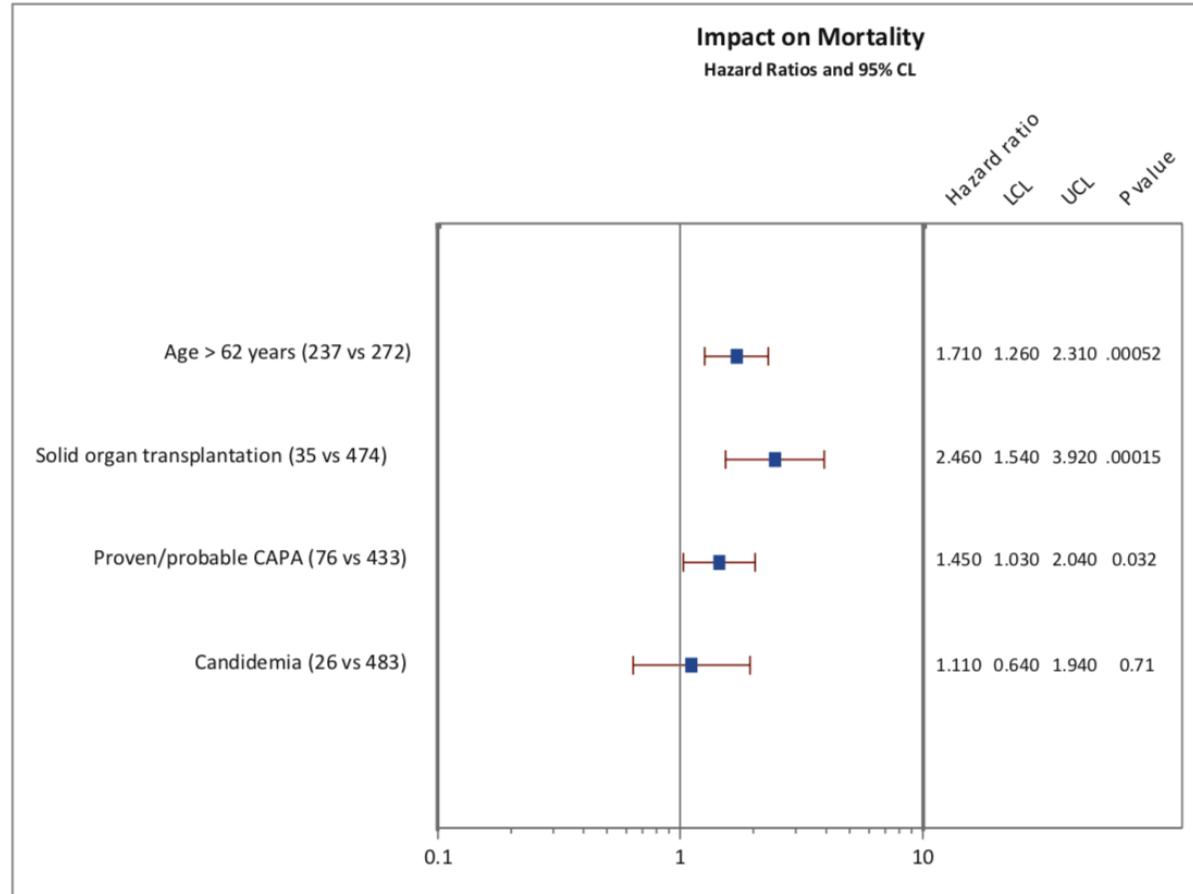
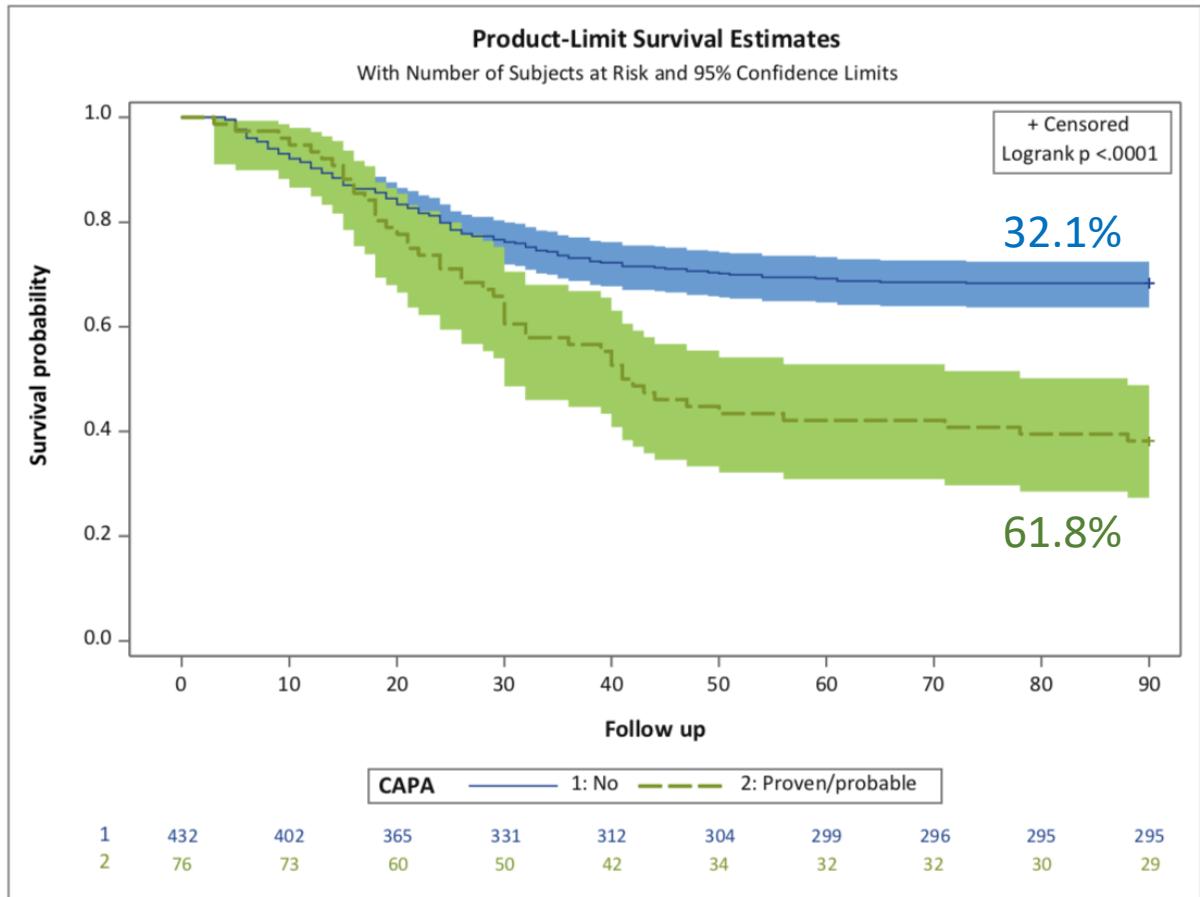
Pneumocystoses (PCR positives) : 0,8%



# MYCOVID : Characterization of fungal infections in COVID-19 infected and mechanically ventilated patients in ICU



# MYCOVID : Characterization of fungal infections in COVID-19 infected and mechanically ventilated patients in ICU



CAPA, aussi grave que IAPA ?

... mais angioinvasion plus tardive

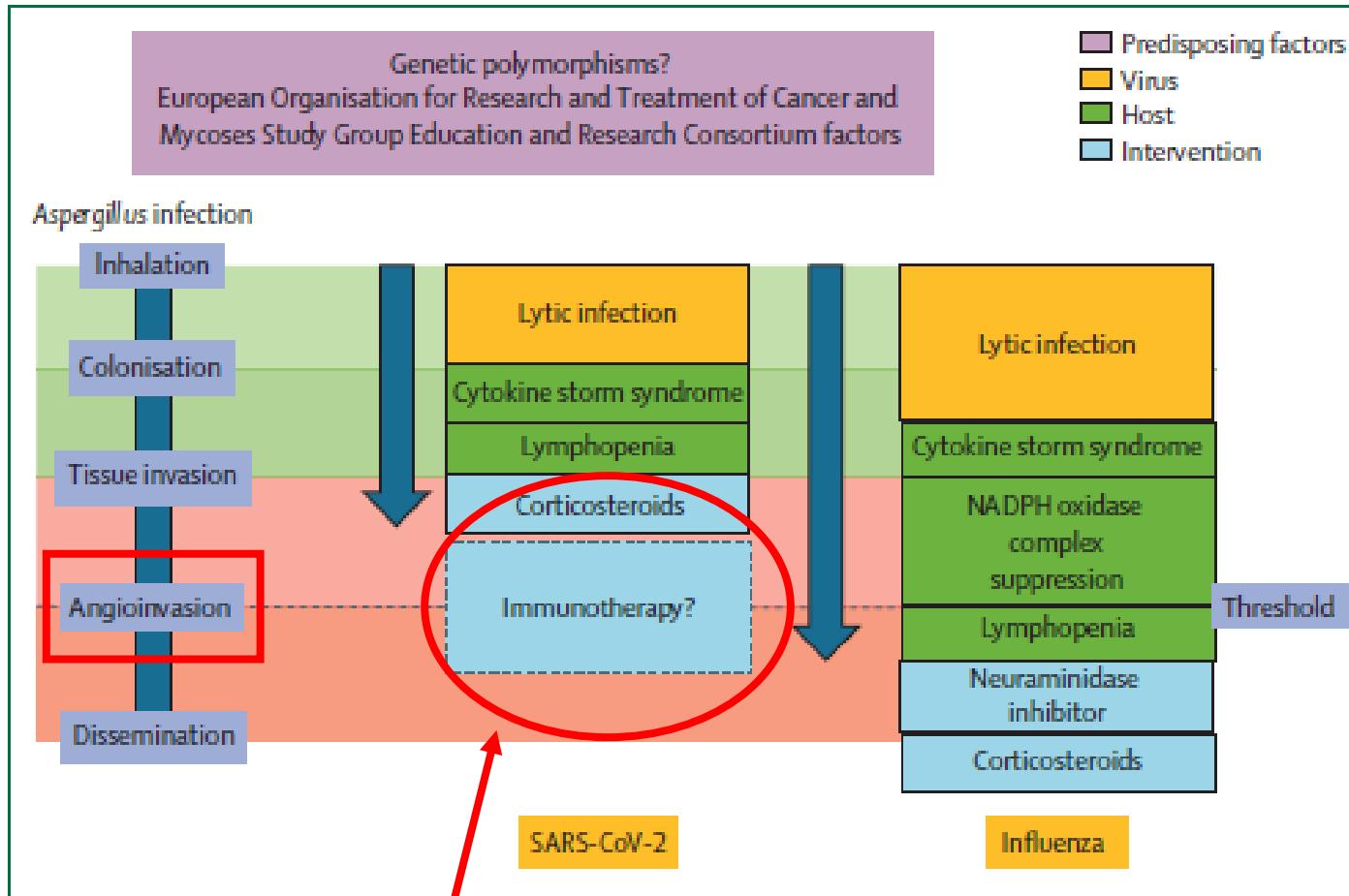


Figure 3: The angioinvasion threshold model (Van de Veerdonk et al., Lancet 2021)

DXM + anti-IL6

# Virus et aspergillose invasive : quelles différences?

Clinical Infectious Diseases

EDITORIAL COMMENTARY



IDSA  
Infectious Diseases Society of America



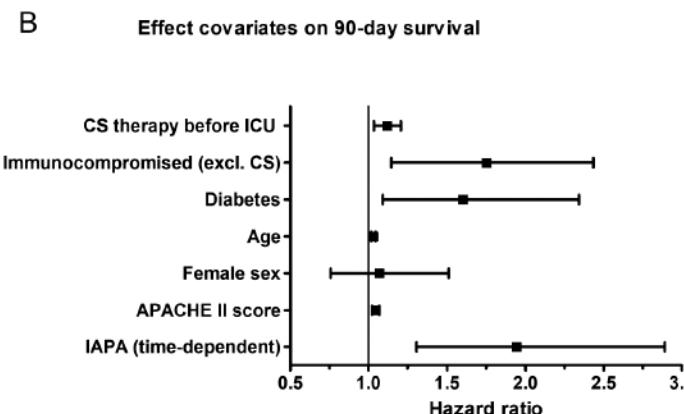
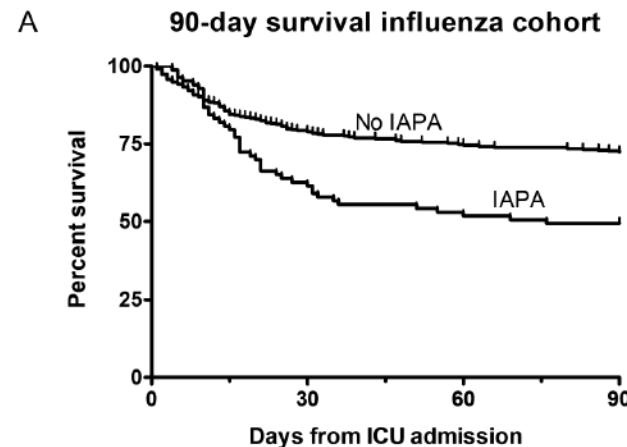
hivma  
hiv medicine association



OXFORD

## Influenza-Associated Pulmonary Aspergillosis: A Local or Global Lethal Combination?

Bart J. A. Rijnders,<sup>1</sup> Alexander F. A. D. Schauvlieghe,<sup>1,2</sup> and Joost Wauters<sup>3</sup>



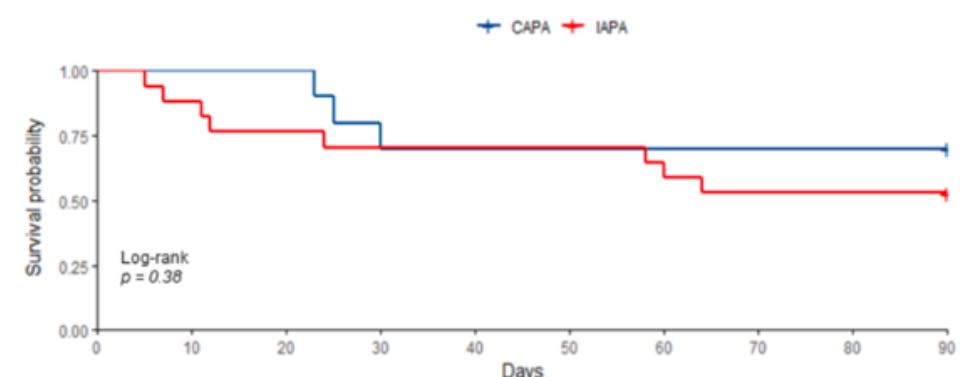
Article

## Influenza- and COVID-19-Associated Pulmonary Aspergillosis: Are the Pictures Different?

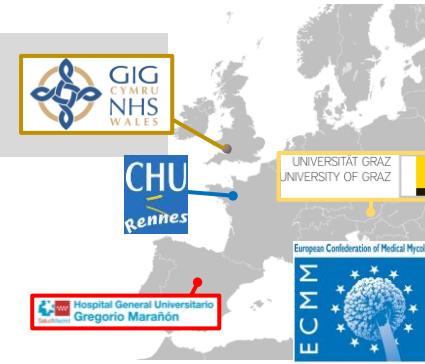
Florian Reizine <sup>1,\*</sup>, Kieran Pinceaux <sup>1</sup>, Mathieu Lederlin <sup>2</sup>, Brice Autier <sup>3,4</sup>, Hélène Guegan <sup>3,4</sup>, Arnaud Gacoin <sup>1</sup>, David Luque-Paz <sup>1</sup>, Christelle Boglione-Kerrien <sup>5</sup>, Astrid Bacle <sup>4,6</sup>, Brendan Le Daré <sup>6</sup>, Yoann Launey <sup>7</sup>, Mathieu Lesouhaitier <sup>1</sup>, Benoit Painvin <sup>1</sup>, Christophe Camus <sup>1</sup>, Alexandre Mansour <sup>1</sup>, Florence Robert-Gangneux <sup>3,4</sup>, Sorya Belaz <sup>3</sup>, Yves Le Tulzo <sup>1</sup>, Jean-Marc Tadié <sup>1</sup>, Adel Maamar <sup>1</sup> and Jean-Pierre Gangneux <sup>3,4,\*</sup>

Similitudes : prévalence, mortalité, peu de facteurs de risque sous-jacents

Differences : IAPA plus précoces et chez des patients plus sévères, CAPA avec signes radio moins spécifiques et difficulté pour atteindre la concentration efficace de voriconazole



# Quels défis pour l'avenir ?



## A/ Diagnostic précoce

### Aspergillus Lateral Flow Assay with Digital Reader for the Diagnosis of COVID-19 Associated Pulmonary Aspergillosis (CAPA): A multicenter study

Brice Autier<sup>a\*</sup>, Juergen Prattes<sup>b\*</sup>, P. Lewis White<sup>c\*</sup>, Maricela Valerio<sup>d</sup>, Marina Machado<sup>d</sup>, Jessica Price<sup>c</sup>, Matthias Egger<sup>b</sup>, Jean-Pierre Gangneux<sup>a†</sup>, Martin Hoenigl<sup>b,e,f†</sup>

<sup>a</sup>Univ Rennes, CHU Rennes, Inserm, EHESP, Irset (Institut de recherche en santé, environnement et travail), UMR\_S 1085, F-35000 Rennes, France; <sup>b</sup>Division of Infectious Diseases, Medical University of Graz, Graz, Austria; <sup>c</sup>Public Health Wales Mycology Reference Laboratory, UHW, Cardiff, UK; <sup>d</sup>Hospital General Universitario Gregorio Marañón, Madrid, Spain; <sup>e</sup>Division of Infectious Diseases and Global Public Health, University of California San Diego, San Diego, CA, United States; <sup>f</sup>Clinical and Translational Fungal-Working Group, University of California San Diego, San Diego, CA, United States

- **344 samples**
  - **196 respiratory samples**
    - 90 BALF
    - 72 NBL
    - 34 TA
  - **148 serum samples**
- From **239 patients**
  - **1 Proven CAPA**
  - **47 Probable CAPA**
  - **19 Possible CAPA**
  - **172 No CAPA**



Picture from IMMY website  
<https://www.immy.com/asp>

### Proven/probable CAPA vs possible/no CAPA

	0.5 ODI cutoff		1.0 ODI cutoff	
	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
<b>Non-directed bronchial lavage (<math>N_{\text{CAPA}}=4</math>; <math>N_{\text{ØCAPA}}=68</math>)</b>	4/4 100% (40-100)	45/68 66% (54-77)	4/4 100% (40-100)	50/68 74% (61-84)
<b>Bronchoalveolar lavage fluid (<math>N_{\text{CAPA}}=26</math>; <math>N_{\text{ØCAPA}}=64</math>)</b>	20/26 77% (56-91)	51/64 80% (68-89)	15/26 58% (37-77)	63/64 98% (92-100)
<b>All combined (<math>N_{\text{CAPA}}=39</math>; <math>N_{\text{ØCAPA}}=146</math>)</b>	33/39 85% (69-94)	100/146 68% (60-76)	26/39 67% (50-81)	121/146 83% (76-89)
<b>Serum samples (<math>N_{\text{CAPA}}=37</math>; <math>N_{\text{ØCAPA}}=111</math>)</b>	8/37 22% (10-38)	103/111 93% (86-97)	4/37 11% (3-25)	110/111 99% (95-100)

## B/ Surveillance de la biodiversité

- *Aspergillus fumigatus* : espèce la plus fréquente en Europe > 65%

Salmanton-Garcia J et al. *Emerg Infect Dis.* 2021;27(4):107

- Risque de résistance aux azolés?



Case Report

### Azole-Resistant COVID-19-Associated Pulmonary Aspergillosis in an Immunocompetent Host: A Case Report

Eelco F. J. Meijer <sup>1,2,3</sup>, Anton S. M. Dofferhoff <sup>3,4</sup>, Oscar Hoiting <sup>5</sup>, Jochem B. Buil <sup>1,2</sup>, and Jacques F. Meis <sup>1,2,3,6,\*</sup>



Table 1. Patient characteristics

Gender	Female
Age (years)	74
Medical history	Reflux, polyarthrosis, stopped smoking 20 years ago
Medication	Pantoprazol (PPI) and Etoricoxib (NSAID)
Underlying immuno-compromising condition	None
Initial symptoms	Fever, dry cough, dyspneic, diarrhea
ARDS	Prone positioning vvECMO
Acute renal failure	Yes, continuous venovenous hemofiltration (CVVH)
IPA definition	EORTC/MSG criteria (modified) AspICU algorithm
	N/A
	N/A

⇒ Netherlands

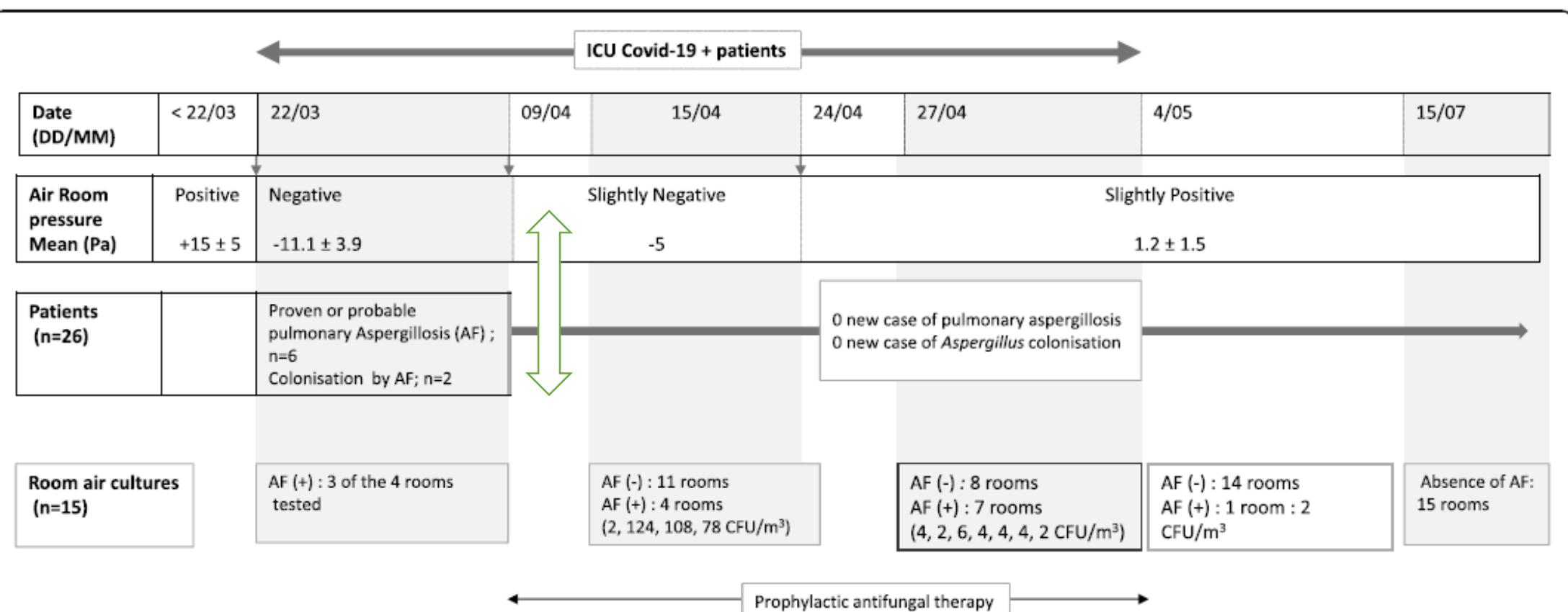
- Immunocompetent
- No chronic respiratory diseases - No CPA
- No prior antifungal therapy



*A. fumigatus*  
*cyp51A* sequencing  
⇒ TR34/L98H mutation  
⇒ Environmental origin

## C/ Gestion du risque environnemental

### Impact of negative air pressure in ICU rooms on the risk of pulmonary aspergillosis in COVID-19 patients



Ichai et al, Crit Care Med 2020

\*AF, *Asp. fumigatus*, AF (+); presence of *Asp. fumigatus*, AF (-); absence of *Asp. fumigatus*

## Quels défis pour l'avenir ?

### D/ Faut-il discuter une chimioprophylaxie antifongique comme pour les IAPA?

Posaconazole for prevention of invasive pulmonary aspergillosis in critically ill influenza patients (POSA-FLU): a randomised, open-label, proof-of-concept trial. **Intensive Care Med.** 2021 Jun;47(6):674-686.

*Vanderbeke L, Janssen NAF, Bergmans DCJJ, Bourgeois M, Buil JB, Debaveye Y, Depuydt P, Feys S, Hermans G, Hoiting O, van der Hoven B, Jacobs C, Lagrou K, Lemiale V, Lormans P, Maertens J, Meersseman P, Mégarbane B, Nseir S, van Oers JAH, Reynders M, Rijnders BJA, Schouten JA, Spiet I, Thevissen K, Thille AW, Van Daele R, van de Veerdonk FL, Verweij PE, Wilmer A, Brüggemann RJM, Wauters J; Dutch-Belgian Mycosis Study Group.*

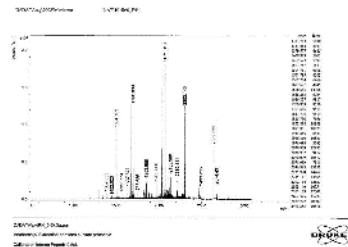
- ⇒ Incidence élevée : IAPA occurred in 21 cases (24%), the majority of which (71%, 15/21) were diagnosed within 48 h of ICU admission
- ⇒ Pas de différence significative : The incidence of IAPA was not significantly reduced in the POS arm (5.4%, 2/37) compared with SOC (11.1%, 4/36; between-group difference 5.7%; 95% CI - 10.8 to 21.7; p = 0.32).
- ⇒ Mortalité reste très élevée : ICU mortality of early IAPA was high (53%), despite rapid antifungal treatment.

# Les autres IFI associées au SARS-CoV-2

## Candidoses invasives

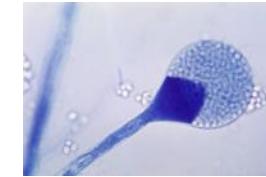


Détection par hémocultures  
+ identification et sensibilité in vitro



## Autres IFI

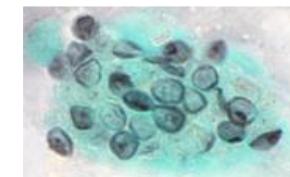
### Mucorales



### FusarioSES



### Pneumocystoses



→ pulmonaires et rhino-orbitaires



# Candidémies et COVID-19

## Etude MYCOVID

Incidence : 6.3% (32/509 patients)

Mortalité Candidémie : 56 %

Mortalité globale MYCOVID : 36, 5 %

	Death in the ICU (n=186)	Survival (n=323)	p
Mean ± SD, median, and (95% CI)			
Candidemia (32, 6·3%)	18 9·7% (5·8-14·9)	14 4·3% (2·4-7·2)	0·017

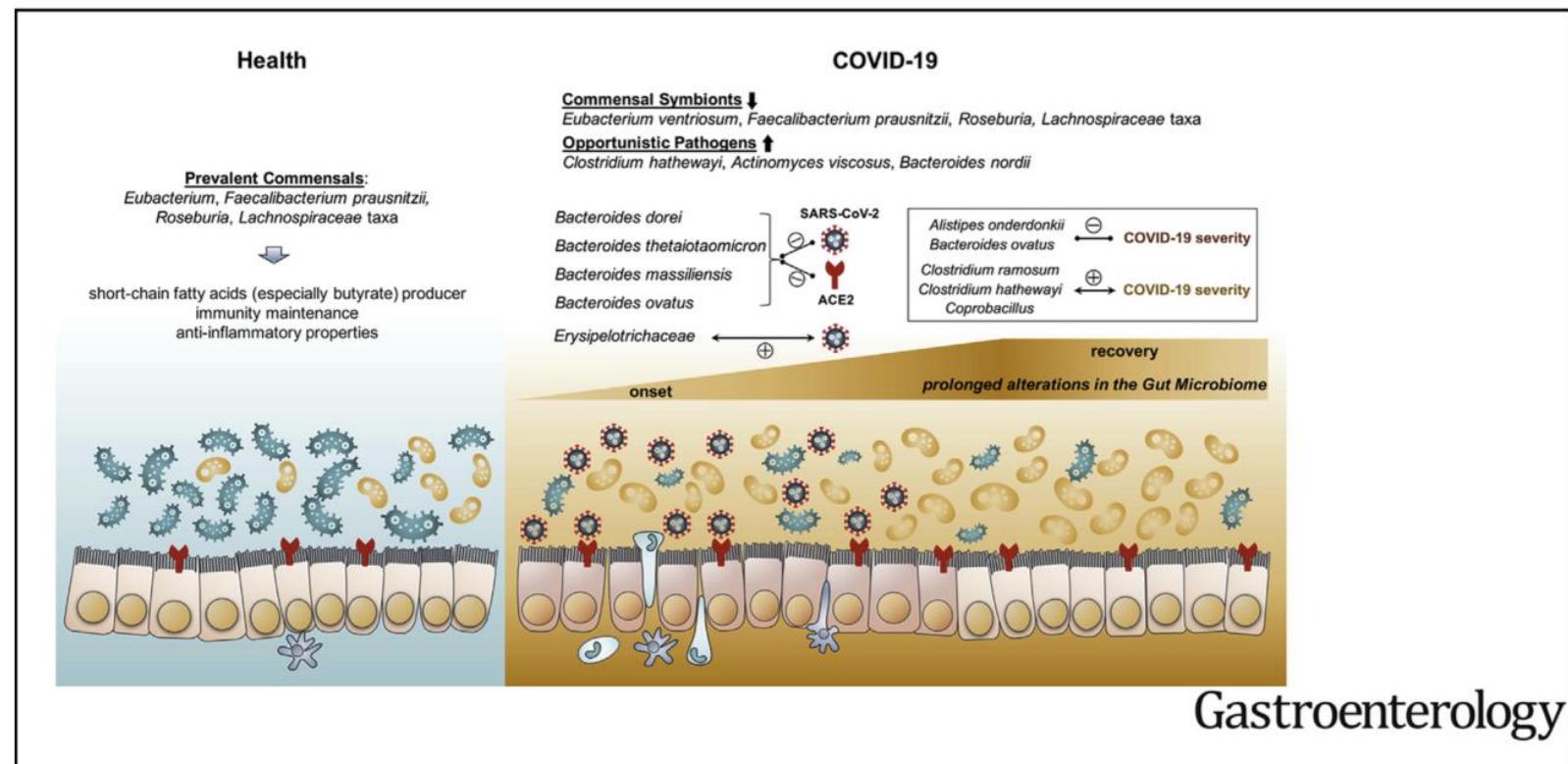
Ref	COVID-19	Non COVID	Remarques
Mastrangelo et al.	10.97 /10000 Patient-jour	1.48 10000 Patient-jour	Tout hôpital → Incidence X 7. Non Covid = série historique.
Mastrangelo et al.	81.68 10000 Patient-jour	14.5 10000 Patient-jour	Réa → Incidence X6
Macauley et al.	51/1000 admissions	11/1000 admissions	Réa
Agrifoglio et al., J Mycol Med, 2020	15/139 COVID-19		Mortality 40%

# Candidémies et COVID-19

## FDR :

- Augmentation de la translocation intestinale?
- Modification du microbiote?
- Alterations immunologiques liées au COVID-19
- Facteurs non liés au COVID-19? (age, gravité, durée de réa...)

Dysbiose?



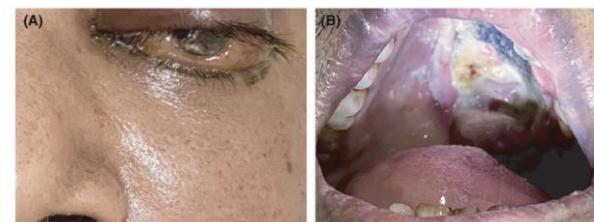
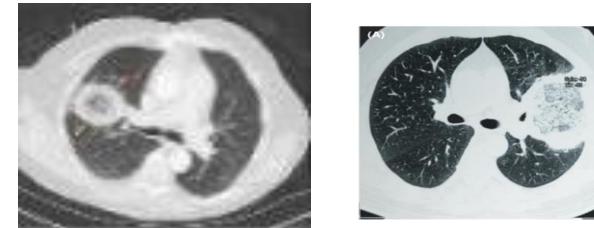
# Mucormycoses et COVID-19

- Phénomène majeur en Inde > 30.000 cas



On Saturday morning, a Dr Akshay Nair, a Mumbai-based eye surgeon, was waiting to operate on a 25-year-old woman who had recovered from a bout of Covid-19 three weeks ago.

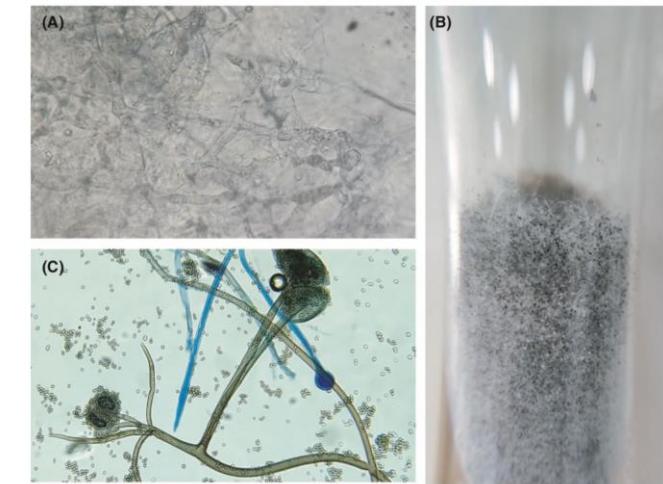
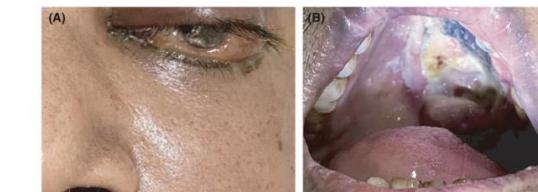
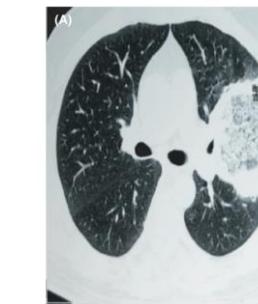
- Etude MYCOVID : 1,2% (6)



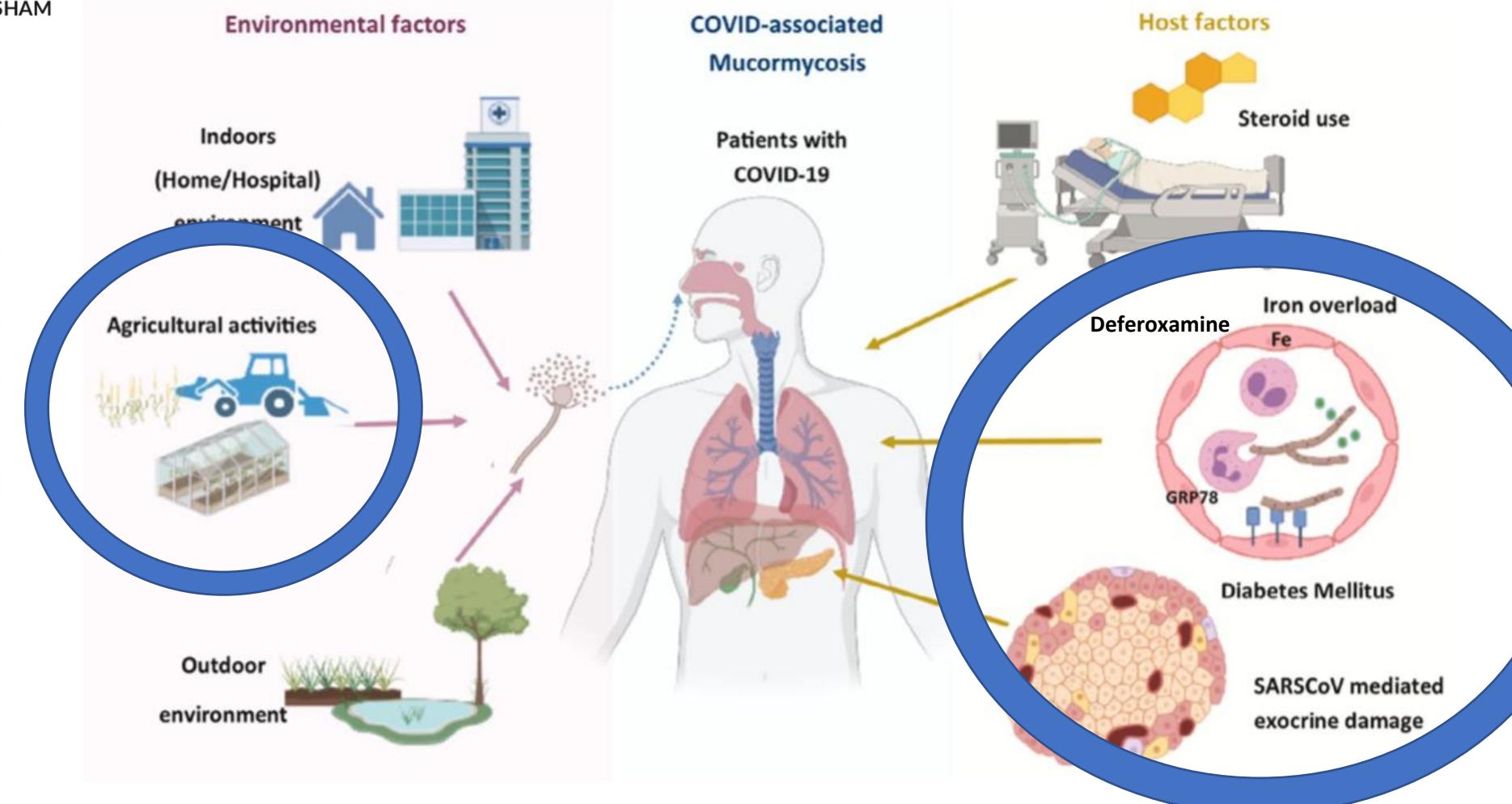
Mucormycoses pulmonaires et rhino-orbito-cérébrales

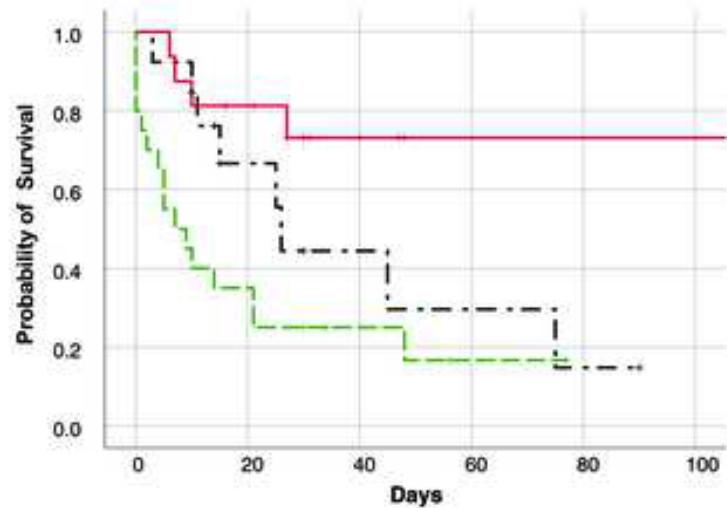
# ECMM/ISHAM recommendations for clinical management of COVID-19 associated mucormycosis in low- and middle-income countries

Shivaprakash M. Rudramurthy<sup>1</sup> | Martin Hoenig<sup>2,3</sup> | Jacques F. Meis<sup>4</sup> | Oliver A. Cornely<sup>5,6,7</sup> | Valliappan Muthu<sup>8</sup> | Jean Pierre Gangneux<sup>9</sup> | John Perfect<sup>10</sup> | Arunaloke Chakrabarti<sup>1</sup> | ECMM and ISHAM

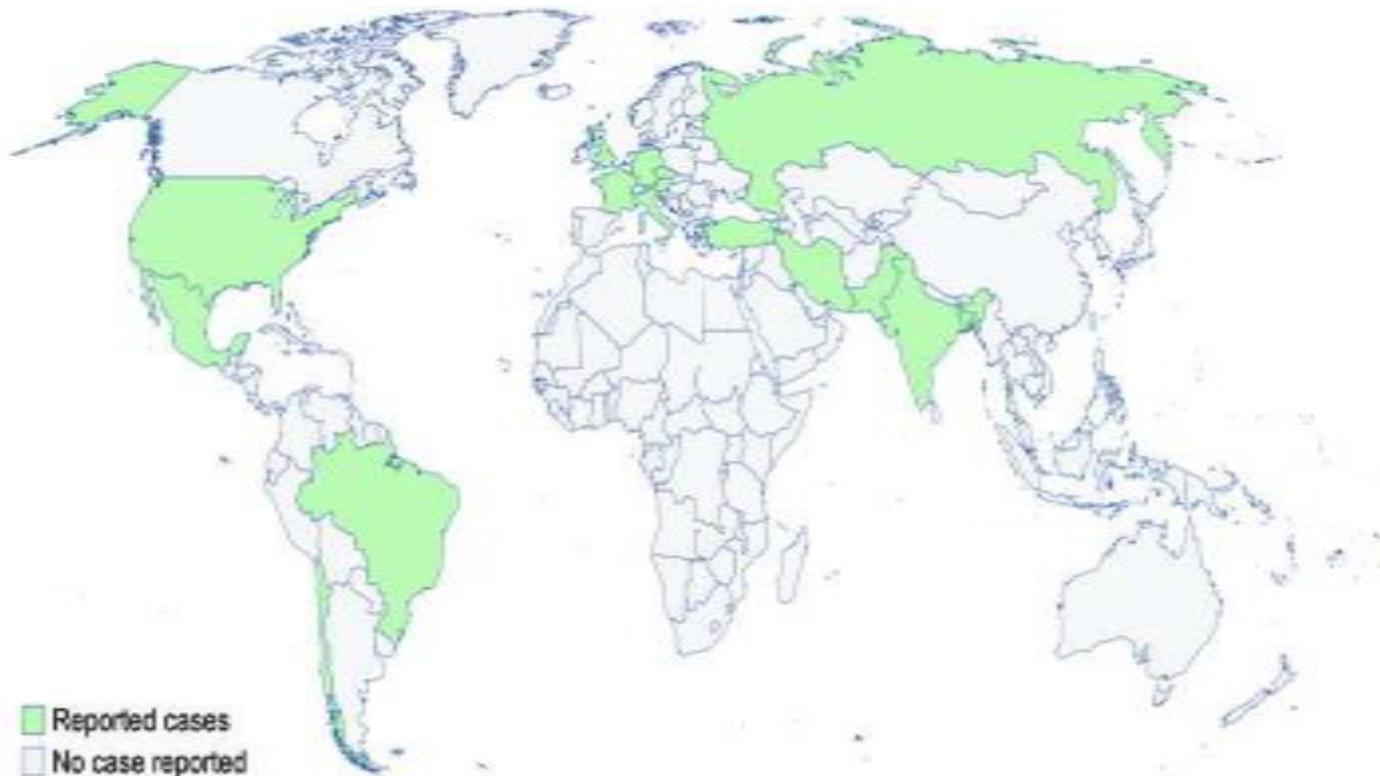


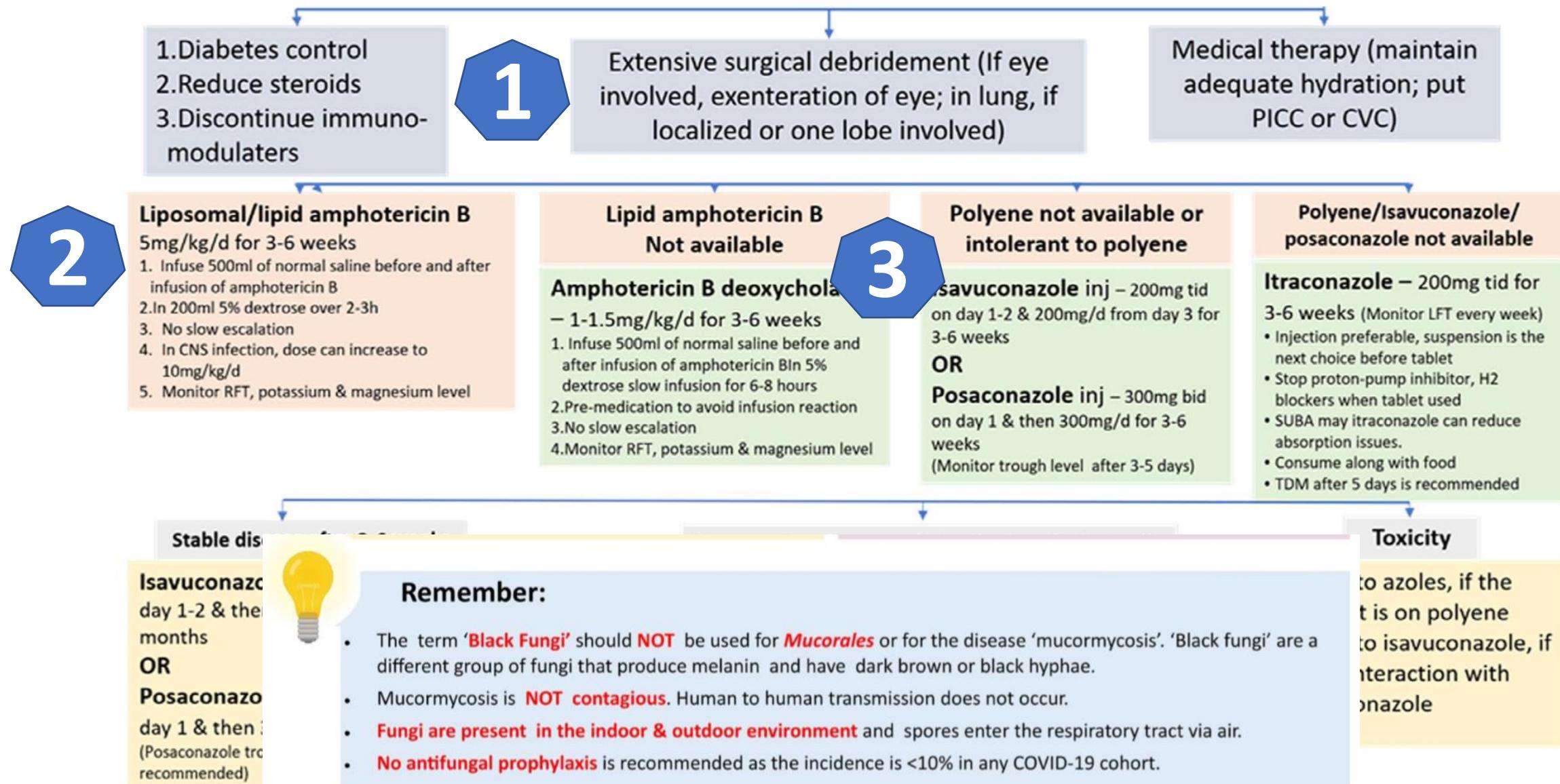
*Rhizopus arrhizus*





ROCM with vs without CNS  $P=0.074$   
 ROCM with CNS vs Other  $P=0.116$   
 ROCM without CNS vs Other  $P=0.001$





**FIGURE 5** Treatment algorithm for CAM prepared by the Fungal Infections Study Forum (modified)<sup>51</sup> [CVC, central venous catheter; PICC, peripherally inserted central catheter; TDM, therapeutic drug monitoring]



## Principal Investigators MYCOVID

Jean Pierre Gangneux, CHU de Rennes

Eric Dannaoui, CHU HEGP, Paris

Jean- Ralph Zahar, CHU Avicenne, Bobigny

Marie-Elisabeth Bougnoux, CHU de Necker & Institut Pasteur, Paris



## + 58 Associated Investigators MYCOVID

Under the auspices of



## Academic Promotion by CHU de Rennes

With industrial grant from : Pfizer Laboratory

### **Methodologist**

Bruno Laviolle, DRC Rennes



### **Biostatisticien**

Jeff MORCET – CIC Rennes

<b>BREST</b>	Cécile AURBON Gilles NEVEZ, Solène LE GAL, Dorothée QUINIO
<b>GRENOBLE</b>	Nicolas TERZI, Carole SCHWEBEL Muriel CORNET, Céline GARNAUD
<b>LILLE</b>	Saadalla NSEIR Boualem SENDID, Jordan LEROY, Nadine FRANCOIS
<b>LYON</b>	Florent WALLET, Jean-Christophe RICHARD, Sylvie PAULUS, Laurent ARGAUD Florence PERSAT, Damien DUPONT, Jean MENNOTI
<b>NANTES</b>	Emmanuel CANET Patrice LE PAPE, Florent Morio
<b>PARIS APHP - Avicenne</b>	Yves COHEN, Marie SOULIE Jean-Ralph ZAHAR, Sophie BRUN
<b>PARIS APHP - Bichat</b>	Jean-François TIMSIT Sandrine HOUZE, Christine BONNAL
<b>PARIS APHP - HEGP</b>	Ana NOVARA Eric DANNAOUI, Melek MANAI
<b>PARIS APHP - Henri Mondor</b>	Nicolas DE PROST, Frédérique BOQUEL Françoise BOTTEREL
<b>PARIS APHP - La Pitié</b>	Charles-Edouard LUYT, Julien MAYAUX, Antoine MONSEL Arnaud FEKKAR, Marion BLAIZE
<b>PARIS APHP - Necker</b>	Lionel LAMHAUT Marie-Elisabeth BOUGNOUX, Estelle SABOURIN
<b>PARIS APHP - Saint Louis</b>	Bruno MEGARBANE Alexandre ALANIO
<b>PARIS APHP - Tenon</b>	Guillaume VOIRIOT Christophe HENNEQUIN, Juliette GUITARD
<b>POITIERS</b>	Arnaud W. THILLE Estelle CATEAU
<b>RENNES</b>	Jean-Marc TADIE, Florian REIZINE, Philippe SEGUIN, Yves LE TULZO, Matthieu LE SOUAHITIER Jean-Pierre GANGNEUX, Florence ROBERT-GANGNEUX, Hélène GUEGAN, Sorya BELAZ, Jeff MORCET, Bruno LAVIOLE
<b>STRASBOURG</b>	Feraht MEZIANI Valérie LETSCHER-BRU
<b>TOULOUSE</b>	Béatrice RIU-POULENC Xavier IRIART, Antoine BERRY
<b>TOURS</b>	Stephan EHRMANN Guillaume DESOUBEAUX

*Merci de votre attention*



[Jean-pierre.gangneux@chu-rennes.fr](mailto:Jean-pierre.gangneux@chu-rennes.fr)

