Supplemental Table 2: Characteristics and risk factors of COVID-associated pulmonary aspergillosis (CAPA), COVID-associated mucormycosis (CAM), and COVID-associated candidiasis (CAC).

= particularly relevant for low- and middle-income countries (LMICs)

= relevant also for *C. auris*

	CAPA	**CAM**	**CAC**
Prevalence	Prevalence about 10% among invasive ventilated COVID-19 patients[1-3]	Prevalence of 0.27% among hospitalized COVID-19 patients in India[4]	Unknown, outbreaks reported from 12 countries in the Americas, Europe and Middle East
Infectious agents	*A. fumigatus* predominant ! Azole resistant *A. fumigatus*	*Rhizopus* spp. predominant[4]	*C. albicans* predominant ! *C. auris*
Shared risk factors	Male sex[4-9] Older age[1,4,10-14] Systemic corticosteroids Severe COVID-19, ARDS ICU treatment		
Risk factors	Dexamethasone, Tocilizumab and their combination[1,2,13-19] (**Major!**) (Prolonged) mechanical ventilation[20] Environmental exposure/hospital air exposure/ventilation systems/building renovation work[16,21] Chronic obstructive pulmonary disease[2,12,13,16,17] Greater extend of lung damage caused by COVID-19[12]	Uncontrolled Diabetes Mellitus[4,6,7,10,23-27] Newly diagnosed Diabetes Mellitus[10] Diabetic ketoacidosis[27] Hyperglycaemia[27] Systemic Corticosteroids[4,6,7,10,23,25,27-31] (overuse) COVID-19 related hypoxemia[4,7]	Indwelling devices (CVC, urinary catheter, prosthetic device Prolonged ICU stay[20,35-37] 11,38,39 CVCs[36,40,41] 11,38 More severe disease/higher organ failure assessment score[20,42] Corticosteroids and other immunosuppressants[20,35,40,41,43]

	Potential Minor Risk factors Negative air pressure in ICU rooms[22] Azithromycin[15] HIV/AIDS[2] Solid cancer[17,19] Pulmonary vascular disease[19] Liver disease[19] Multiple myeloma[19] Diabetes[9]	Iron overload[10,32] Environmental exposure/hospital air exposure[10,32] $ Prolonged use of masks[33] $ Occupation farmer[6] $ ICU admission and mechanical ventilation[27,30] Underlying malignancies or SOT[27,30] Repeated nasopharyngeal swab testing[33] $ Exocrine damage Endothelial damage Overexpression of glucose regulated protein (GRP78)[4] **Potential Minor Risk factors** Broad-spectrum antibiotics[25,34] $	Tocilizumab[20,37,44] Prior antifungal exposure[39] including *C. auris* Lack of hygiene plans/ABS program $ Broad spectrum antibiotics[36,41,45] including *C. auris* Malignancies[20] **Potential Minor Risk factors** Mechanical ventilation[38,40,41,46]
Sites of infection	Lungs	ROM, ROCM[4,47,48] $ Pulmonary[27,30,49] Gastrointestinal[27] Disseminated	Bloodstream
Diagnostics	Imaging: halo sign, multiple pulmonary nodules or lung cavitation (alone not sufficient)[50] Bronchoscopy, including tracheobronchial inspection and BAL sampling	RO(C)M: Nasal endoscopy[29] Sinus debridement[29] Cranial CT/MRI[29]	Blood cultures[51] Imaging (abdomen)[52]

	Culture, microscopy and PCR from BAL and lung biopsy samples[50] Galactomannan from BAL[50] Biopsy	Pulmonary: Imaging: Halo sign or reversed halo sign, vascular occlusion sign[29] Culture Direct microscopy using fluorescent brightener[29] Histopathology	
Therapy	Voriconazole or isavuconazole as first line for possible, probable, and proven CAPA [50] Amphotericin B, posaconazole or echinocandins as second line[50]	Surgical debridement[29] Liposomal amphotericin B[29] If renal compromise isavuconazole iv or posaconazole iv[53]	Caspofungin or micafungin as first line[51,54,55] Liposomal amphotericin B as second line[55]
Follow up	Repeated susceptibility testing for resistance[50]		Repeated blood cultures until clearance[51]
Clinical outcome	About 50% mortality rate at 12 weeks, 17.2% attributed[2,9,13,56]	Case-fatality rate at 12 weeks 45.7%[4] Age, rhino-orbital-cerebral involvement, and intensive care unit admission were associated with increased mortality rates[4] Mortality lower for RO(C)M 37.3% (22/59) versus 81% (17/21) for pulmonary, gastro-intestinal and disseminated mucormycosis ($P<0.001$)[27]	
Challenges in LMICs	Countries with lower socioeconomic status are likely to have inadequate resources available to diagnose and treat patients with CAPA	Disfiguring surgeries may be the first option for RO(C)M before considering expensive antifungals	Resource-limitation to run and repeat susceptibility tests

5

References

1. Prattes J, Wauters J, Giacobbe DR, et al. Risk factors and outcome of pulmonary aspergillosis in critically ill coronavirus disease 2019 patients-a multinational observational study by the European Confederation of Medical Mycology. *Clin Microbiol Infect* 2021.
2. Janssen NAF, Nyga R, Vanderbeke L, et al. Multinational Observational Cohort Study of COVID-19-Associated Pulmonary Aspergillosis(1). *Emerg Infect Dis* 2021; **27**(11): 2892-8.
3. Fekkar A, Neofytos D, Nguyen MH, Clancy CJ, Kontoyiannis DP, Lamoth F. COVID-19-associated pulmonary aspergillosis (CAPA): how big a problem is it? *Clin Microbiol Infect* 2021; **27**(9): 1376-8.
4. Patel A, Agarwal R, Rudramurthy SM, et al. Multicenter Epidemiologic Study of Coronavirus Disease-Associated Mucormycosis, India. *Emerg Infect Dis* 2021; **27**(9): 2349-59.
5. Narayanan S, Chua JV, Baddley JW. COVID-19 associated Mucormycosis (CAM): risk factors and mechanisms of disease. *Clin Infect Dis* 2021.
6. Gupta S, Ahuja P. Risk Factors for Procurence of Mucormycosis and its Manifestations Post Covid-19: a Single Arm Retrospective Unicentric Clinical Study. *Indian J Otolaryngol Head Neck Surg* 2021: 1-8.
7. Sen M, Honavar SG, Bansal R, et al. Epidemiology, clinical profile, management, and outcome of COVID-19-associated rhino-orbital-cerebral mucormycosis in 2826 patients in India - Collaborative OPAI-IJO Study on Mucormycosis in COVID-19 (COSMIC), Report 1. *Indian J Ophthalmol* 2021; **69**(7): 1670-92.
8. Muthu V, Kumar M, Paul RA, et al. Is there an association between zinc and COVID-19-associated mucormycosis? Results of an experimental and clinical study. *Mycoses* 2021; **64**(10): 1291-7.
9. Salmanton-García J, Sprute R, Stemler J, et al. COVID-19-Associated Pulmonary Aspergillosis, March-August 2020. *Emerg Infect Dis* 2021; **27**(4): 1077-86.
10. Bhanuprasad K, Manesh A, Devasagayam E, et al. Risk factors associated with the mucormycosis epidemic during the COVID-19 pandemic. *Int J Infect Dis* 2021; **111**: 267-70.
11. Chowdhary A, Tarai B, Singh A, Sharma A. Multidrug-Resistant Candida auris Infections in Critically Ill Coronavirus Disease Patients, India, April-July 2020. *Emerg Infect Dis* 2020; **26**(11): 2694-6.
12. Arastehfar A, Carvalho A, van de Veerdonk FL, et al. COVID-19 Associated Pulmonary Aspergillosis (CAPA)-From Immunology to Treatment. *J Fungi (Basel)* 2020; **6**(2).
13. Chong WH, Saha BK, Neu KP. Comparing the clinical characteristics and outcomes of COVID-19-associate pulmonary aspergillosis (CAPA): a systematic review and meta-analysis. *Infection* 2021: 1-14.
14. Gangneux JD, E; Fekkar, A; Luyt, CE; Botterel, FDe Prost, N. Fungal infections in mechanically ventilated COVID-19 patients in the ICU during the 1 first wave: The French multicenter MYCOVID study. *Lancet Resp Med* 2021.
15. Dellière S, Dudoignon E, Fodil S, et al. Risk factors associated with COVID-19-associated pulmonary aspergillosis in ICU patients: a French multicentric retrospective cohort. *Clin Microbiol Infect* 2020; **27**(5): 790.e1-5.
16. Montrucchio G, Lupia T, Lombardo D, et al. Risk factors for invasive aspergillosis in ICU patients with COVID-19: current insights and new key elements. *Ann Intensive Care* 2021; **11**(1): 136.

17. White PL, Dhillon R, Cordey A, et al. A National Strategy to Diagnose Coronavirus Disease 2019-Associated Invasive Fungal Disease in the Intensive Care Unit. *Clin Infect Dis* 2021; **73**(7): e1634-e44.
18. Meijer EFJ, Dofferhoff ASM, Hoiting O, Meis JF. COVID-19-associated pulmonary aspergillosis: a prospective single-center dual case series. *Mycoses* 2021; **64**(4): 457-64.
19. Permpalung N, Chiang TP, Massie AB, et al. COVID-19 Associated Pulmonary Aspergillosis in Mechanically Ventilated Patients. *Clin Infect Dis* 2021.
20. Segrelles-Calvo G, de SAGR, Llopis-Pastor E, et al. Candida spp. co-infection in COVID-19 patients with severe pneumonia: Prevalence study and associated risk factors. *Respir Med* 2021; **188**: 106619.
21. Soriano MC, Narváez-Chávez G, López-Olivencia M, Fortún J, de Pablo R. Inhaled amphotericin B lipid complex for prophylaxis against COVID-19-associated invasive pulmonary aspergillosis. *Intensive Care Medicine* 2022; **48**(3): 360-1.
22. Ichai P, Saliba F, Baune P, Daoud A, Coilly A, Samuel D. Impact of negative air pressure in ICU rooms on the risk of pulmonary aspergillosis in COVID-19 patients. *Crit Care* 2020; **24**(1): 538.
23. Pradhan P, Shaikh Z, Mishra A, et al. Predisposing factors of rhino-orbital-cerebral mucormycosis in patients with COVID 19 infection. *Indian J Otolaryngol Head Neck Surg* 2021: 1-7.
24. Pakdel F, Ahmadikia K, Salehi M, et al. Mucormycosis in patients with COVID-19: A cross-sectional descriptive multicentre study from Iran. *Mycoses* 2021; **64**(10): 1238-52.
25. Selarka L, Sharma S, Saini D, et al. Mucormycosis and COVID-19: An epidemic within a pandemic in India. *Mycoses* 2021; **64**(10): 1253-60.
26. Avatef Fazeli M, Rezaei L, Javadirad E, et al. Increased incidence of rhino-orbital mucormycosis in an educational therapeutic hospital during the COVID-19 pandemic in western Iran: An observational study. *Mycoses* 2021; **64**(11): 1366-77.
27. Hoenigl MS, D; Carvalho, Ag; Rudramurthy, SM; Arastehfar, A; Gangneux, JP; Nasir, N; Bonifaz, A; Araiza, J; Klimko, N; Serris, A; Lagrou, K; Meis, JF; Cornely, OA; Perfect, JR; White, PL; Chakrabarti, A; and Group, ECMM and ISHAM Collaborators. The Emergence of COVID-19 Associated Mucormycosis: Analysis of Cases From 18 Countries. *Available at SSRN: https://ssrncom/abstract=3844587 or http://dxdoiorg/102139/ssrn3844587* 2021.
28. Garg D, Muthu V, Sehgal IS, et al. Coronavirus Disease (Covid-19) Associated Mucormycosis (CAM): Case Report and Systematic Review of Literature. *Mycopathologia* 2021: 1-10.
29. Rudramurthy SM, Hoenigl M, Meis JF, et al. ECMM/ISHAM recommendations for clinical management of COVID -19 associated mucormycosis in low- and middle-income countries. *Mycoses* 2021.
30. Seidel D, Simon M, Sprute R, et al. Results from a national survey on COVID-19 associated mucormycosis in Germany: 13 patients from six tertiary hospitals. *Mycoses* 2021.
31. Ramaswami A, Sahu AK, Kumar A, et al. COVID-19-associated mucormycosis presenting to the Emergency Department-an observational study of 70 patients. *Qjm* 2021; **114**(7): 464-70.
32. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; **395**(10223): 507-13.
33. Arora U, Priyadarshi M, Katiyar V, et al. Risk factors for Coronavirus disease-associated mucormycosis. *J Infect* 2022; **84**(3): 383-90.
34. Arora S, Hemmige VS, Mandke C, et al. Online Registry of COVID-19-Associated Mucormycosis Cases, India, 2021. *Emerg Infect Dis* 2021; **27**(11): 2963-5.

35. Mastrangelo A, Germinario BN, Ferrante M, et al. Candidemia in Coronavirus Disease 2019 (COVID-19) Patients: Incidence and Characteristics in a Prospective Cohort Compared With Historical Non-COVID-19 Controls. *Clin Infect Dis* 2021; **73**(9): e2838-e9.
36. Al-Hatmi AMS, Mohsin J, Al-Huraizi A, Khamis F. COVID-19 associated invasive candidiasis. *J Infect* 2021; **82**(2): e45-e6.
37. Ezeokoli OT, Gcilitshana O, Pohl CH. Risk Factors for Fungal Co-Infections in Critically Ill COVID-19 Patients, with a Focus on Immunosuppressants. *J Fungi (Basel)* 2021; **7**(7).
38. Villanueva-Lozano H, Treviño-Rangel RJ, González GM, et al. Outbreak of Candida auris infection in a COVID-19 hospital in Mexico. *Clin Microbiol Infect* 2021; **27**(5): 813-6.
39. Moin S, Farooqi J, Rattani S, Nasir N, Zaka S, Jabeen K. C. auris and non-C. auris candidemia in hospitalized adult and pediatric COVID-19 patients; single center data from Pakistan. *Med Mycol* 2021.
40. Seagle EE, Jackson BR, Lockhart SR, et al. The landscape of candidemia during the COVID-19 pandemic. *Clin Infect Dis* 2021.
41. Arastehfar A, Carvalho A, Nguyen MH, et al. COVID-19-Associated Candidiasis (CAC): An Underestimated Complication in the Absence of Immunological Predispositions? *J Fungi (Basel)* 2020; **6**(4).
42. Omrani AS, Koleri J, Abid FB, et al. Clinical Characteristics and Risk Factors for COVID-19-associated Candidemia. *Med Mycol* 2021.
43. Kayaaslan B, Eser F, Kaya Kalem A, et al. Characteristics of candidemia in COVID-19 patients; increased incidence, earlier occurrence and higher mortality rates compared to non-COVID-19 patients. *Mycoses* 2021; **64**(9): 1083-91.
44. Antinori S, Bonazzetti C, Gubertini G, et al. Tocilizumab for cytokine storm syndrome in COVID-19 pneumonia: an increased risk for candidemia? *Autoimmun Rev* 2020; **19**(7): 102564.
45. Allaw F, Kara Zahreddine N, Ibrahim A, et al. First Candida auris Outbreak during a COVID-19 Pandemic in a Tertiary-Care Center in Lebanon. *Pathogens* 2021; **10**(2).
46. Nucci M, Barreiros G, Guimarães LF, Deriquehem VAS, Castiñeiras AC, Nouér SA. Increased incidence of candidemia in a tertiary care hospital with the COVID-19 pandemic. *Mycoses* 2021; **64**(2): 152-6.
47. Singh Y, Ganesh V, Kumar S, et al. Coronavirus Disease-Associated Mucormycosis from a Tertiary Care Hospital in India: A Case Series. *Cureus* 2021; **13**(7): e16152.
48. Alfishawy M, Elbendary A, Younes A, et al. Diabetes mellitus and Coronavirus Disease (Covid-19) Associated Mucormycosis (CAM): A wake-up call from Egypt. *Diabetes Metab Syndr* 2021; **15**(5): 102195.
49. Fekkar A, Lampros A, Mayaux J, et al. Occurrence of Invasive Pulmonary Fungal Infections in Patients with Severe COVID-19 Admitted to the ICU. *Am J Respir Crit Care Med* 2021; **203**(3): 307-17.
50. Koehler P, Bassetti M, Chakrabarti A, et al. Defining and managing COVID-19-associated pulmonary aspergillosis: the 2020 ECMM/ISHAM consensus criteria for research and clinical guidance. *The Lancet Infectious Diseases* 2020.
51. Mellinghoff SC, Hoenigl M, Koehler P, et al. EQUAL Candida Score: An ECMM score derived from current guidelines to measure QUAlity of Clinical Candidaemia Management. *Mycoses* 2018; **61**(5): 326-30.
52. Bassetti M, Peghin M, Carnelutti A, et al. Clinical characteristics and predictors of mortality in cirrhotic patients with candidemia and intra-abdominal candidiasis: a multicenter study. *Intensive care medicine* 2017; **43**(4): 509-18.

53. Cornely OA, Alastruey-Izquierdo A, Arenz D, et al. 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.
54. Seagle EE, Jackson BR, Lockhart SR, et al. The Landscape of Candidemia During the Coronavirus Disease 2019 (COVID-19) Pandemic. *Clinical Infectious Diseases* 2022; **74**(5): 802-11.
55. Cornely OA, Bassetti M, Calandra T, et al. ESCMID* guideline for the diagnosis and management of Candida diseases 2012: non-neutropenic adult patients. *Clin Microbiol Infect* 2012; **18 Suppl 7**: 19-37.
56. Prattes J, Wauters J, Giacobbe DR, et al. Risk factors and outcome of pulmonary aspergillosis in critically ill coronavirus disease 2019 patients- a multinational observational study by the European Confederation of Medical Mycology. *Clin Microbiol Infect* 2021.