FungiScope

Global Fungal Infection Registry

Initiated in 2003

Interim Report April 2022

Working group of the

ECMM CEMM

ISHAM
INTERNATIONAL SOCIETY FOR HUMAN AND ANIMAL MYCOLOGY

Under the auspices of

The MSG
Mycoses Study Group

AGIHO
INFEKTIONEN IN DER HÄMATOLOGIE UND ONKOLOGIE
FACHGRUPPE DER DGHO

PEG
Paul-Ehrlich-Gesellschaft für Chemotherapie e.V.
www.p-e-g.org

DEUTSCHE GESELLSCHAFT FÜR INFEKTIOLOGIE e.V.

CEL
the CzEch leukemia study group for life

EFISG
ESCMID FUNGAL INFECTION STUDY GROUP

DMYKG

FIMUA
FEDERAZIONE ITALIANA MICOPATOLOGIA UMANA E ANIMALE

ÖGMM Österreichische Gesellschaft für Medizinische Mykologie

NRZMyk

orphanet

Funded by an IRDiRC member

RESEARCH FOR RARE
Forschung für seltene Erkrankungen

Has been and **is** supported by unrestricted grants from **Amplyx Pharmaceuticals**, Astellas, Cidara Therapeutics, Basilea Pharmaceutica, **F2G Ltd.**, Matinas BioPharma, MSD, Pfizer Inc, **Pfizer Pharma GmbH** and Scynexis.

TABLE OF CONTENTS

Introduction

The number of invasive fungal infections (IFI) is increasing worldwide. Medical advances have shaped prevalence and incidences. Major contributing factors are the increasing number of transplantation procedures undertaken around the world, a widening of the indications for intensive chemotherapy, and the growing number of other clinical conditions requiring immunosuppressive treatment.

Candida species and *Aspergillus fumigatus* remain the most frequent cause of IFI in immunocompromised patients but less common IFI caused by rare fungi are reported with increasing frequency. Mucormycosis has been an emerging disease only few decades ago, today it is recognized as a considerable threat in respective patient populations. Therapeutic standards have been developed for the most frequent IFI, i.e. candidiasis, aspergillosis and cryptococcosis, for rarer IFIs less robust treatment strategies or no effective treatment options are available. Clinicians are facing infections due to a variety of different fungi, still without reliable treatment recommendations. In a global effort, guidelines on the clinical management of uncommon IFI are developed, where recommendations - especially for the rarest IFI – are based on expert opinions and single center experiences only [1-3]. Therapeutic decision making on rare IFIs is not evidence-based as comprehensive data are not available to date.

In order to help alleviate the lack of knowledge on epidemiology, clinical course, biology and pathomechanisms, and finally to aid in facilitating an evidence-based diagnostic-therapeutic integrated approach of IFI caused by rare fungi, FungiScope® - A Global Invasive Fungal Infection Registry has been created in 2003. Via a web-based electronic case form (www.clinicalsurveys.net) physicians, scientists and others contribute clinical cases.

With the increasing knowledge on the epidemiology, diagnostics and therapeutic management of fungal infections, improved strategies for early diagnosis and prompt optimized treatment will eventually be identified. Only through this joint and global effort it will be possible to improve patient care.

In this report, an overview on current results, achievements, future goals and ongoing developments of FungiScope are presented.

FungiScope Registry Workflow

Everyone is welcome to join the effort and become a partner within the FungiScope network and actively support our common goal of improving the clinical management patients with invasive fungal infections.

Via a web-based questionaire, anonymized clinical information of proven and probable IFI cases are retrospectively collected [4,5]. Documented data includes information on underlying conditions and risk factors for IFI, diagnostic procdedures (radiological and mycological), clinical manifestation of the IFI, antifungal treatment and response, and outcome. Cases are centralized reviewed by ID specialists of the FungiScope team in Cologne, Germany (Figure 1a).

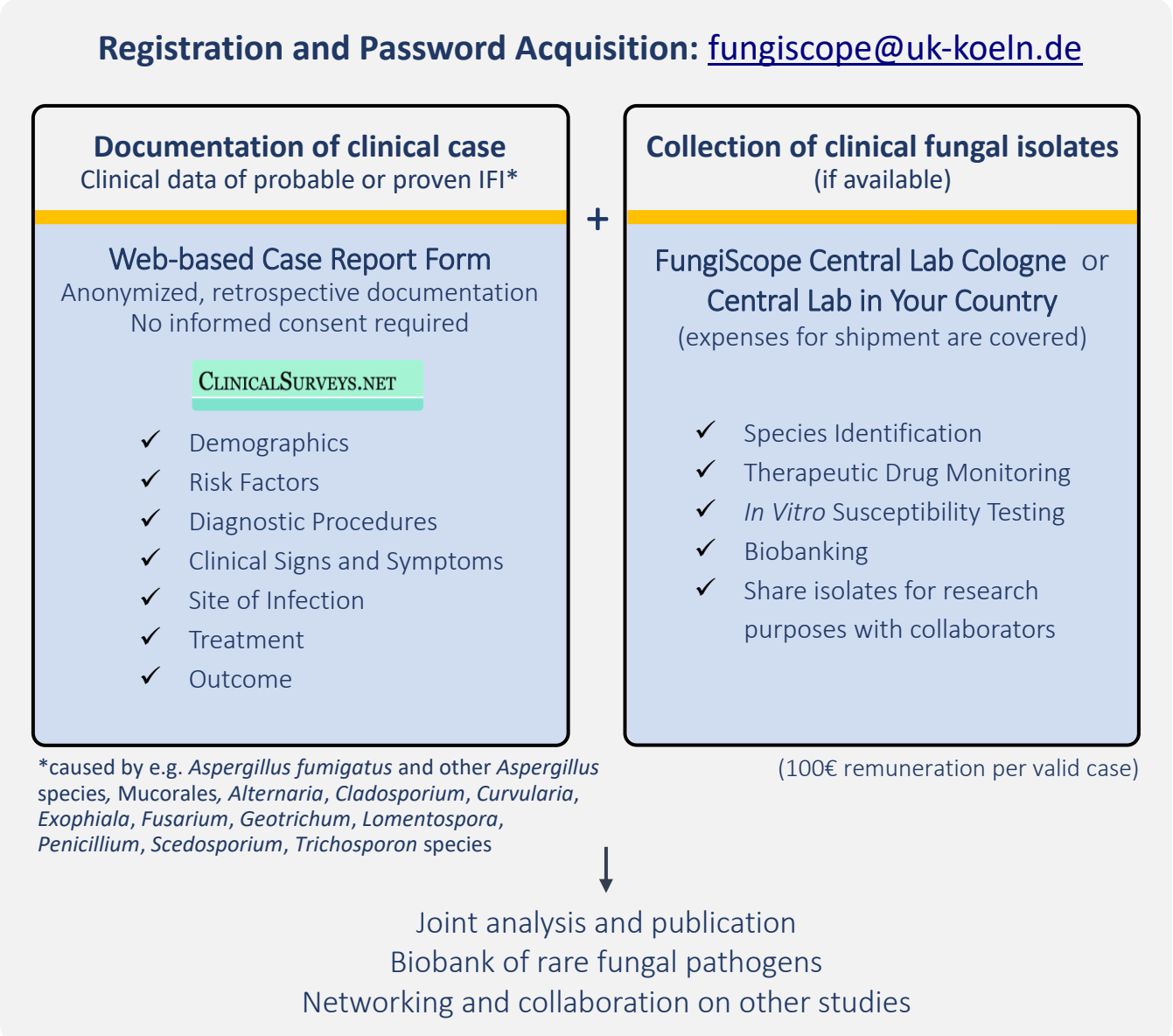


Figure 1a. Project structure

Ideally, the respective clinical fungal isolates are collected, examined and stored in a biobank in Cologne, Germany (Figure 1b). The clinical and biological data are subsequently evaluated and analysed in a joint effort with the partners.

Anonymized data of cases entered in the registry are easily accessible via the web-based search engine FungiQuest (www.fungiquest.net), a tool for clinicians who are confronted with similar cases, to evaluate respective treatment and outcome patterns that may guide individual treatment strategies, where valid recommendations are not available to date (Figure 2).

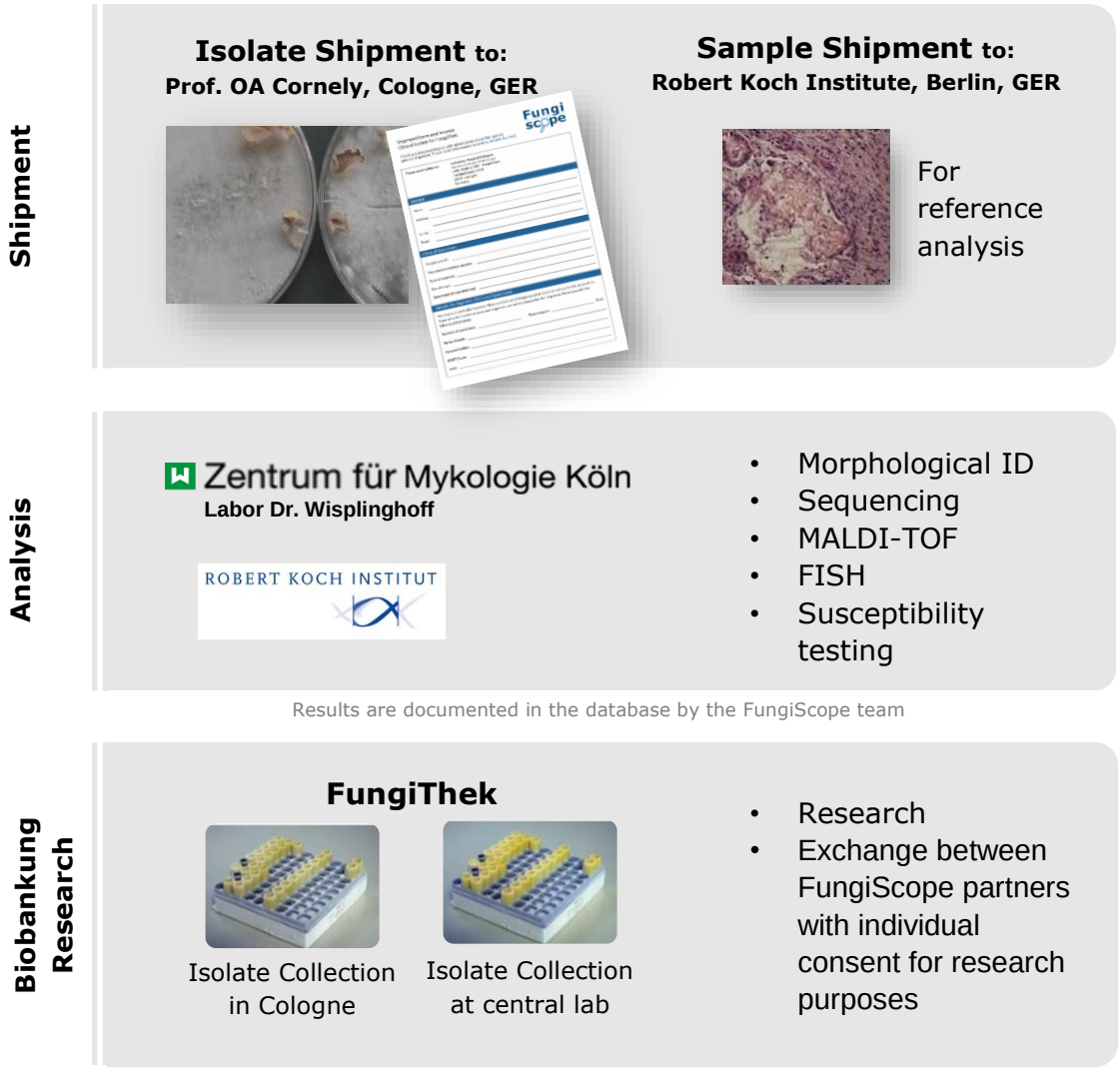


Figure 1b. FungiThek: Clinical fungal isolates can be send 1.) to the FungiScope Central Lab in Cologne, Germany for formal identification and biobanking in the FungiThek or 2.) to the designated reference lab in your country (please see in section Study Coordinators below).

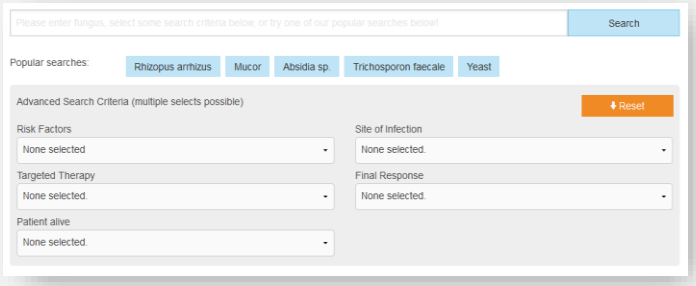
Reference analyses from biopsies will be performed at the Robert Koch Institute in Berlin, Germany.

FungiQuest

Check for similar cases at www.fungiquest.net

Go to www.fungiquest.net

Type the name of the fungus and specify your search



Browse through FungiScope cases with the same kind of fungal infection

Culture	PCR	Species	Risk Factors	Site	Empiric Therapy	Targeted Therapy	Surgery IFD	Final Response	Patient alive	Last Observed
✔		Mucor sp.	Chemotherapy, ICU, Neutropenia	Paranasal sinus(es)		Amphotericin B deoxycholate, Posaconazole solution	Sinosotomy	Stable Disease	Yes	2013
✔		Mucor sp.	HSCT, ICU	Lungs	Ca			Deterioration or failure	No	2013
✔		Mucor sp.	Chronic renal disease, HSCT, ICU	Lungs	Posaconazole solution, Voriconazole	Liposomal amphotericin B, Posaconazole solution		Deterioration or failure	No	2011
✔		Mucor sp.	Chronic pulmonary disease, ICU	Lungs		Posaconazole solution		Partial Response	Yes	2013
✔		Mucor sp.	Chemotherapy, HSCT, ICU, Neutropenia	Lungs	Amphotericin B lipid complex, Caspofungin	Amphotericin B lipid complex, Caspofungin		Deterioration or failure	No	2002

Figure 2. FungiQuest database search engine.

Results

In the FungiScope® registry, 2,413 cases of invasive fungal infection (IFI) diagnosed between 1997 and 2022 have been documented, 1,961 cases of these are already finalized and considered valid for analysis. Eighty-five percent of cases were diagnosed in 2010 or later.
Main causative pathogens registered were Mucorales (n=847, 43,2%), yeasts (n=252, 12,9%), dematiaceae (n=201, 10.2%), and *Fusarium* spp. (n=161, 8,2%) followed by *Scedosporium* spp. (n=145, 7.4%) and *Penicillium, Paecilomyces, Purpureocillium* spp. (n=75, 3.8%) (Figure 3a). Between 11% (Dematiaceae) and 20.0% (*Scedosporium*) of the cases had concomittant infections with other fungal pathogens (not shown).
Mucormycosis is the most frequent IFI in FungiScope, with *Rhizopus*, *Mucor*, *Lichtheimia*, and *Rhizomucor* species being the main causative pathogens in this group (Figure 3a and b).
Aspergillosis with galactomannan follow up and non-*fumigatus Aspergillus*-related infections as well as COVID-19-associated fungal infections have been a focus of research since 2019 and 2020, respectively. Currently, 222 (11.3%) cases of *Aspergillus*-related infections are included, about 200 more cases are related to mixed fungal infections. One-hundred cases were associated to COVID-19, most of them COVID-19-associated aspergillosis (CAPA).
The majority of cases (71.5%) were contributed from partners in Germany, Spain, the United States, France, Russia, India, the Czech Republic, and Japan. The contribution of cases by country is shown in Figure 4.

Main sites of infection differed between fungal pathogens (Figure 5) but also between risk groups and geographical regions (data not shown). Patients with invasive mucormycosis most commonly had lung infection (57%), but also frequent involvement of paranasal sinuses (25%) and central nervous system (15%). Lung was also commonly affected in infections caused by *Fusarium* and *Scedosporium and Aspergillus*-associated infections (30.4%, 43.4% and 78.4%, respectively) but sinuses were comparably less frequently involved (13%, 8.3% and 12.2%, respectively). *Fusarium* and *Scedosporium* were commonly identified in blood (36.6% and 20.7%, respectively), for mucormycosis and aspergillosis only rare cases of blood stream infections were noted (<2% and <5%, respectively).
Yeasts were most often diagnosed from blood cultures (74.6%), 25% of those with lung involvement. Infections due to dematiaceae mostly involved deep soft tissue and skin, lungs, paranasal sinuses, and the central nervous system (range between 15% and 26%).

Frequent risk factors for the development of IFI are presented for the main fungal groups in Figure 6. Chemotherapy and allogeneic haematopoetic stem cell

transplantation (HSCT) for treamtent of underlying malignancy and intensive care unit (ICU) stay were the most common risk factors for Mucorales, *Fusarium* and yeast-related infections. Diabetes mellitus was frequently reported as a comorbidity overall (20.5%) and was the most common underlying condition in Dematiaceae-associated infections (29%). Chronic renal disease was comparably frequent in patients with yeast, Aspergillus and Dematiaceae-associated infections (12% each).

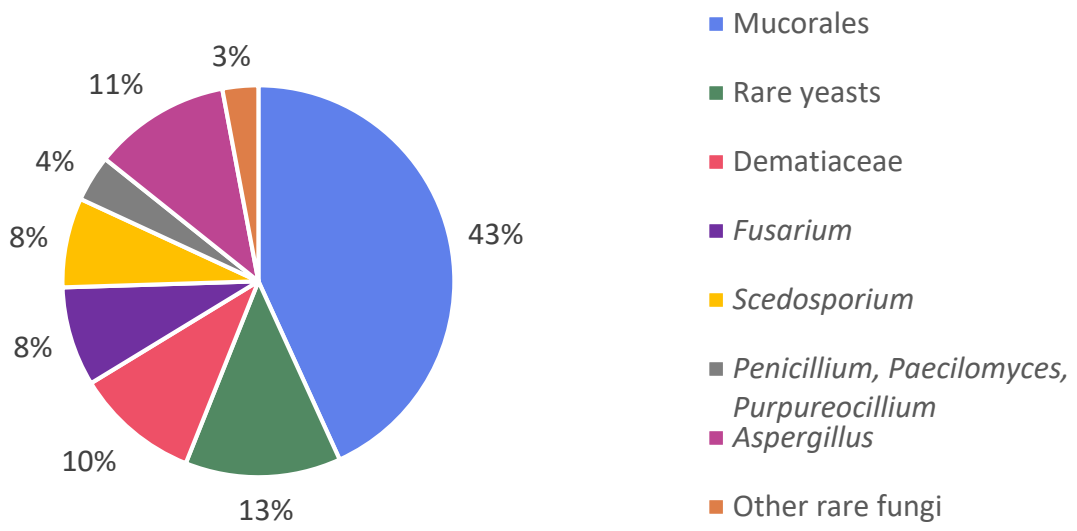


Figure 3a. Distribution of main fungal pathogens causing invasive infections in FungiScope (including mixed infections).

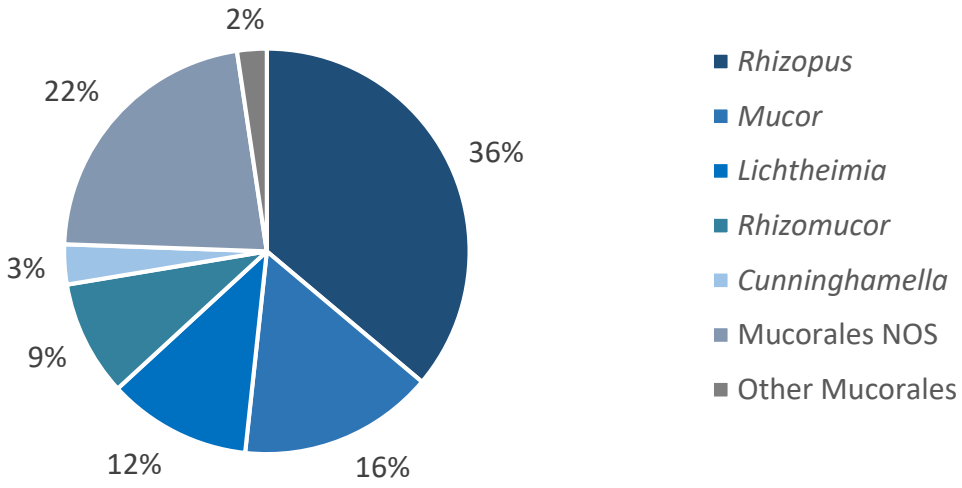


Figure 3b. Distribution of pathogens causing mucormycosis by genera.

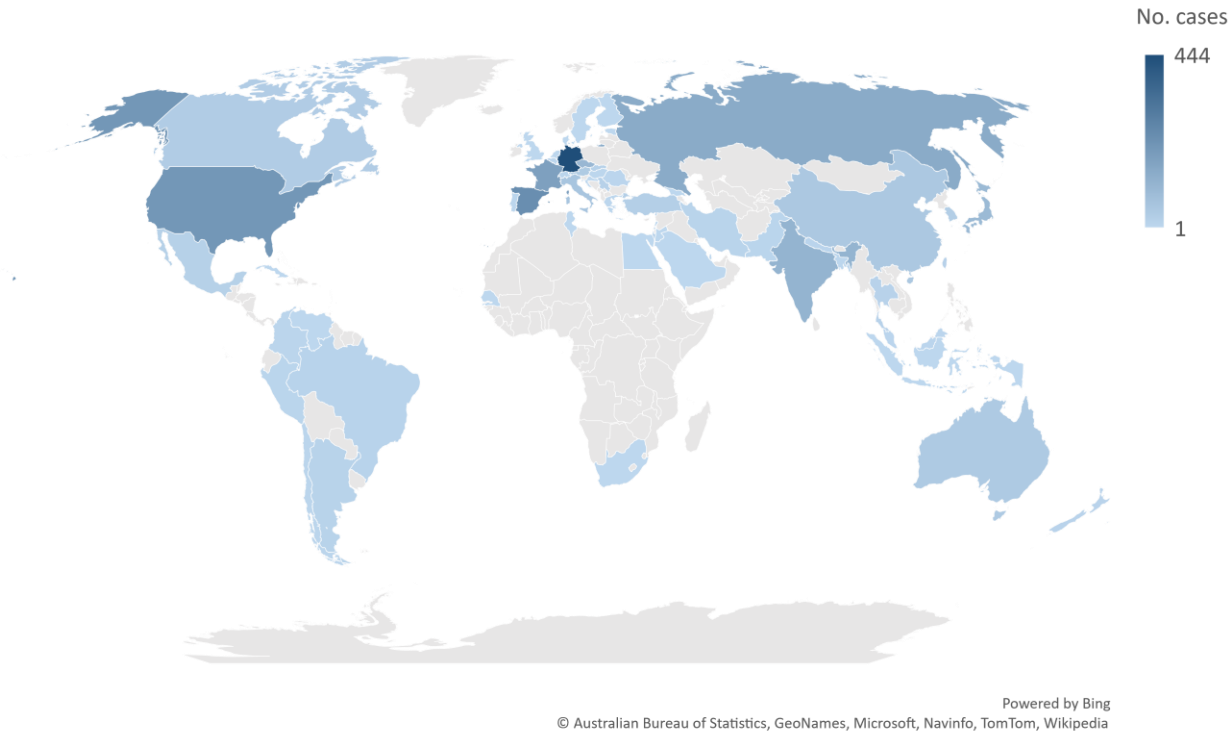


Figure 4. Number of cases per country contributed by FungiScope partners.

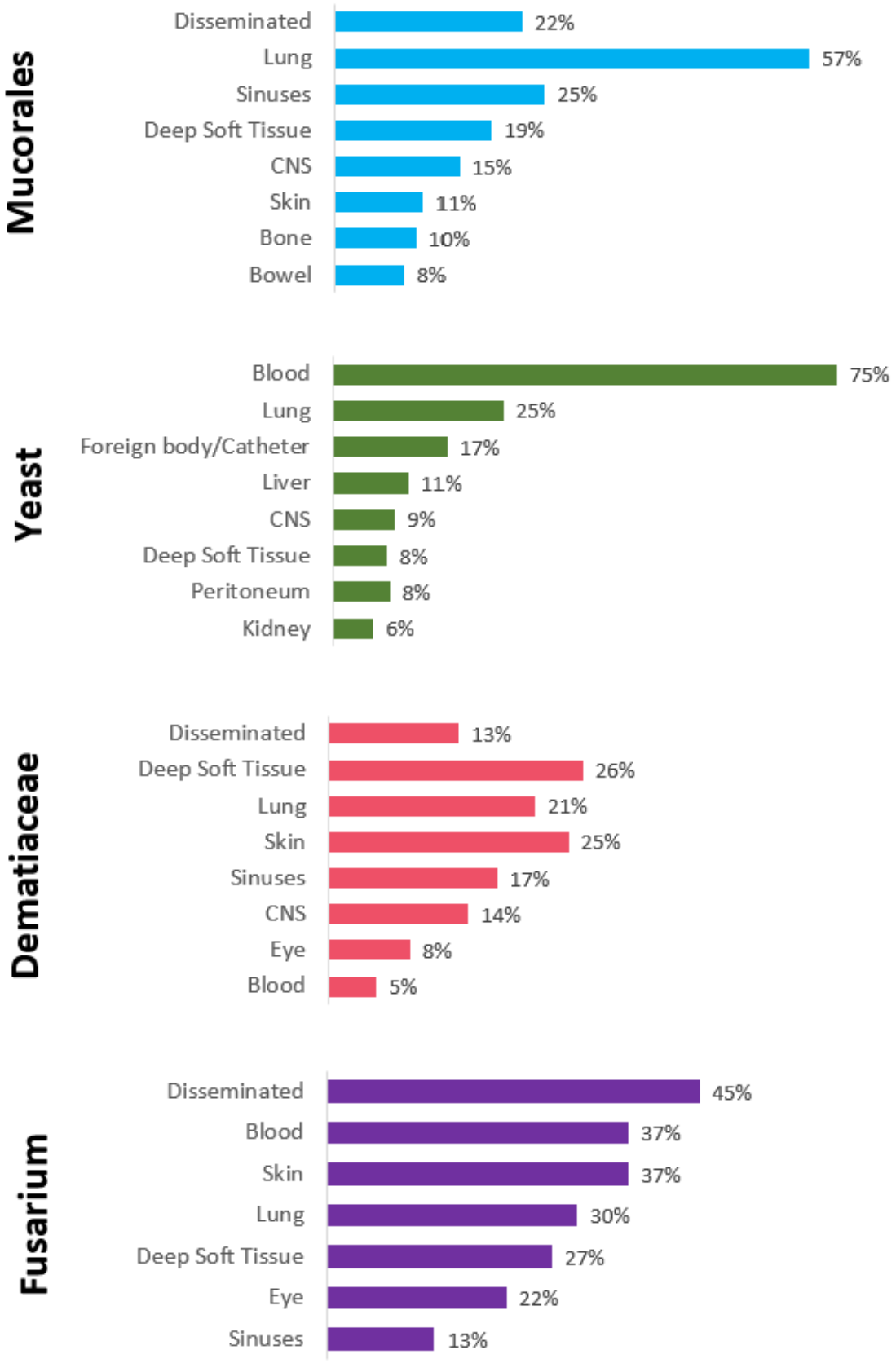


Figure 5. Main sites of infection for major groups of fungi.

CNS, Central Nervous System

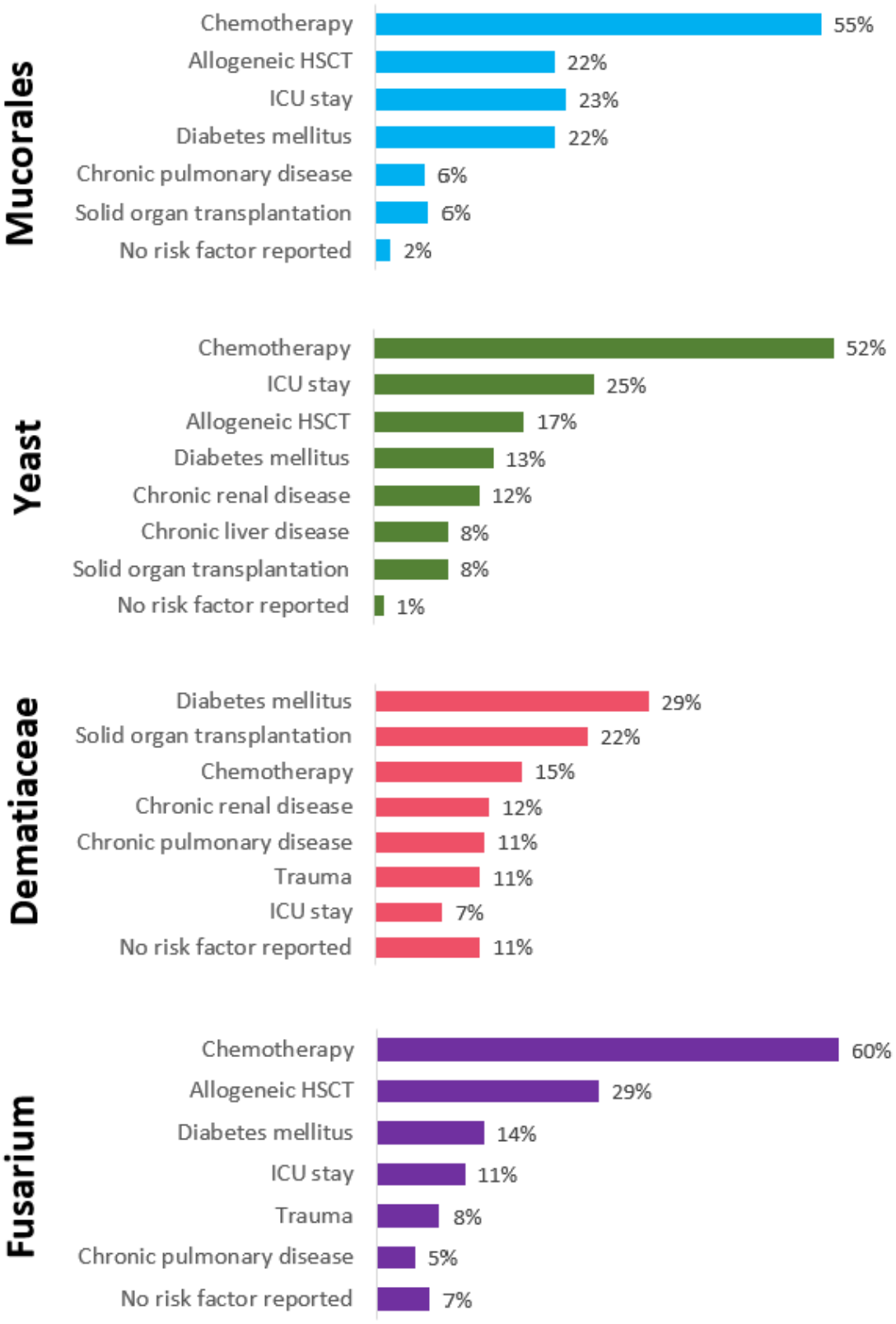


Figure 6. Main risk factors for major groups of fungi.

HSCT Hematopoietic stem-cell transplantation, **ICU** Intensive Care Unit

All-cause-mortality, mortality due to fungal infection and response to treatment differed among individual pathogens and are shown in Figure 7. The highest all-cause-mortality was observed in patients with infection caused by Mucorales (55.6%). Similar mortality was reported for patients with aspergillosis (48.6%, not shown), yeast (52.4%), and *Scedeosporium*-related infections (47.6%, not shown). Reported mortality attributable to fungal infections was highest in patients with mucormycosis (32,2%), similar for scedosporiosis (31%, not shown), and fusariosis (28%). Dematiaceae infection was associated with the lowest all-cause and attributable mortality (21.9% and 11,4%, respectively).

Favorable outcome considering partial and complete response to antifungal therapy was achieved in two thirds of patients with Dematiaceae-associated infections. Fungal infections caused by any other fungal pathogen, including *Aspergillus* and *Scedosporiumi*, was associated with less favorable outcome overall, half of the patients in each group had partial or complete response at day of final assessment (Figure 7).

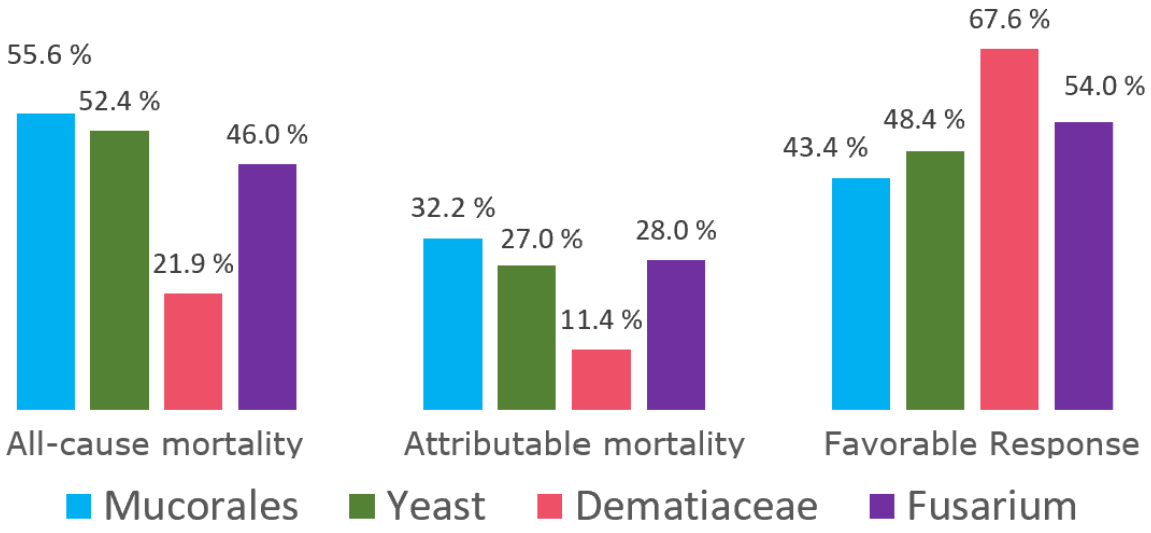


Figure 7. Mortality rates and clinical response at final assessment for major causative pathogen groups in FungiScope. Favorable response is defined by complete or partial response assessed by the treating physician.

Achievements and Goals

Project presentations

Mar 10, 2022	Live Webinar, Pfizer Ireland 'Recent Publication on Covid-19 - Associated Pulmonary Aspergillosis', Virtual Event (Talk)
Oct 12, 2021	Zealands University Hospital Roskilde, Denmark, Virtual Event (Talk)
Oct 8 - 11, 2021	10th Trends in Medical Mycology (TIMM), Aberdeen, United Kingdom (Talk, Poster)
Jul 9 – 12, 2021	31st European Congress of Clinical Microbiology & Infectious Diseases (ECCMID) (Talk, Poster)
Jun 16 – 19, 2021	15. Kongress für Infektionskrankheiten und Tropenmedizin (KIT), Virtual Event (Talk, Poster)
Feb 24 – Mar 3	Pan American Health Organization: PAHO/WHO, Virtual Events (Talk)
Oct 21-25, 2020	IDWeek Virtual Event (Poster)
Sep 23 – 25, 2020	ECCVID ESCMID Conference on Coronavirus Disease, Virtual Event (Poster)
Sep 23, 2020	Mycology Week 2020, Antioquía University, Medellín, Colombia, Virtual Event (Talk)
Sep 16-18, 2020	54. Wissenschaftliche Tagung der Deutschsprachigen Mykologischen Gesellschaft e.V. (Talk)
Apr 2020 - Canceled	30th European Congress of Clinical Microbiology & Infectious Diseases (ECCMID) (Poster)
Nov 16 – 19, 2019	17th INFOCUS and 1st ISHAM – LATAM Congress, Salvador, Brazil (Poster)
Oct 11 – 14, 2019	9th Trends in Medical Mycology (TIMM), Nice, France (Oral, Poster)
Oct 2 – 6, 2019	IDWeek 2019, Advancing Science, Improving Care, Washington, DC, USA (Poster)
Sep 26, 2019	IPHS Day 2019, University of Cologne, Germany (Talk)
Jun 20 – 24, 2019	ASM Microbe 2019, San Francisco, USA (Poster)
May 23 – 25, 2019	XXIII National Congress of the Spanish Society of Infectious Diseases and Clinic Microbiology, Madrid, Spain (Talk, Poster)
Apr 13 – 16, 2019	29th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID), Amsterdam, Netherlands (Poster)

Apr 13 – 16, 2019	ECCMID - ESCMID Networking Corner 2019, Amsterdam, Netherlands (Poster)
Dec 3 - 4, 2018	German Center for Infection Research (DZIF) Annual Meeting, Heidelberg, Germany (Talk, Poster)
Oct 3 - 7, 2018	IDWeek 2018, San Francisco, USA (Poster)
Sep 25 – 28, 2018	2018 MSG-ERC Biennial Meeting, Big Sky, MT, USA (Poster)
Jun 30 – Jul 4, 2018	20th ISHAM, Amsterdam, Netherlands (Talk)
Apr 21 – 24, 2018	28th European Congress of Clinical Microbiology and Infectious Diseases (ECCMID), Madrid, Spain (Mini-oral ePoster)
Oct 10, 2017	ECMM Excellence Center Symposium, Cologne, Germany (Posters, Oral)
Oct 6 – 9, 2017	8th Trends in Medical Mycology (TIMM), Belgrade, Serbia (Talk, Poster)
Sep 28 – 30, 2017	Joint DGI and DZIF Annual Meeting, Hamburg, Germany (Talk)
Aug 31 – Sep 02, 2017	51. Wissenschaftliche Tagung der Deutschsprachigen Mykologischen Gesellschaft e. V., Münster, Germany (Talk)

Full Publications

Oct 2021 Seidel D, Simon M, Sprute R, Lubnow M, Evert K, Speer C, Seeßle J, Khatamzas E, Merle U, Behrens C, Blau IW, Enghard P, Haas CS, Steinmann J, Kurzai O, Cornely OA. *Results from a national survey on COVID-19-associated mucormycosis in Germany: 13 patients from six tertiary hospitals.* **Mycoses**. 2021

May 2021 Sprute R, Salmanton-García J, Sal E, Malaj X, Ráčil Z, Ruiz de Alegría Puig C, Falces-Romero I, Barać A, Desoubeaux G, Kindo AJ, Morris AJ, Pelletier R, Steinmann J, Thompson GR, Cornely OA, Seidel D, Stemler J. *Invasive infections with Purpureocillium lilacinum: clinical characteristics and outcome of 101 cases from FungiScope and the literature*. **J Antimicrob Chemother**. 2021

Feb 2021 Salmanton-García J, Sprute R, Stemler J, Bartoletti M, Dupont D, Valerio M, García-Vidal C, Falces-Romero I, Machado M, de la Villa S, Schroeder M, Hoyo I, Hanses F, Ferreira-Paim K, Giacobbe DR, Meis JF, Gangneux JP, Rodríguez-Guardado A, Antinori S, Sal E, Malaj X, Seidel D, Cornely OA, Koehler P; FungiScope European Confederation of Medical Mycology/The International Society for Human and Animal Mycology Working Group*. COVID-19-Associated Pulmonary Aspergillosis, March-August 2020*. **Emerg Infect Dis**. 2021 Feb 4;27(4)

Feb 2021 Sprute R, Salmanton-García J, Sal E, Malaj X, Falces-Romero I, Hatvani L, Heinemann M, Klimko N, López-Soria L, Meletiadis J, Shruti M, Steinmann J, Seidel D, Cornely OA, Stemler J. *Characterization and outcome of invasive infections due to Paecilomyces variotii: analysis of patients from the FungiScope registry and literature reports.* **J Antimicrob Chemother**. 2021 Feb 11;76(3):765-774

Nov 2020 Salmanton-García J, Koehler P, Kindo A, Falces-Romero I, García-Rodríguez J, Ráčil Z, Chen SC, Klimko N, Desoubeaux G, Thompson GR , III, Benítez-Peñuela MÁ, Rodríguez JY, Sheppard DC, Hoenigl M, Le Govic Y, Badali H, Baddley JW, Chander J, Ingram PR, Pakstis DL, Mellinghoff SC, Atıcı S, Cesaro S, Chakrabarti A, Dupont D, González GM, Hatvani L, Herbrecht R, Klyasova G, Lass-Flörl C, Mareș M, Mullane K, Vinh DC, Wisplinghoff H, Lackner M, Cornely OA, Seidel D; *ECMM/ISHAM working group. Needles in a haystack: Extremely rare invasive fungal infections reported in FungiScope®-Global Registry for Emerging Fungal Infections*. **J Infect**. 2020 Nov;81(5):802-815

Oct 2020 Stemler J, Hamed K, Salmanton-García J, Rezaei-Matehkolaei A, Gräfe SK, Sal E, Zarrouk M, Seidel D, Abdelaziz Khedr R, Ben-Ami R, Ben-Chetrit E, Roth Y, Cornely OA. *Mucormycosis in the Middle East and North Africa: Analysis of the FungiScope® registry and cases from the literature*. **Mycoses**. 2020 Oct;63(10):1060-1068

Apr 2020 Jenks JD, Seidel D, Cornely OA, Chen S, van Hal S, Kauffman C, Miceli MH, Heinemann M, Christner M, Jover Sáenz A, Burchardt A, Kemmerling B, Herbrecht R, Steinmann J, Shoham S, Gräber S, Pagano L, Deeren D, Slavin MA, Hoenigl M. *Clinical characteristics and outcomes of invasive Lomentospora prolificans infections: Analysis of patients in the FungiScope® registry.* **Mycoses**. 2020 May;63(5):437-442. Epub 2020 Apr 15.

Jan 2020 Jenks JD, Seidel D, Cornely OA, Chen S, van Hal S, Kauffman C, Miceli MH, Heinemann M, Christner M, Jover Sáenz A, Burchardt A, Kemmerling B, Herbrecht R, Steinmann J, Shoham S, Gräber S, Pagano L, Deeren D, Aslam S, Taplitz R, Revankar SG, Baddley J, Mehta SR, Reed S, Slavin MA, Hoenigl M. *Voriconazole plus terbinafine combination antifungal therapy for invasive Lomentospora prolificans infections: analysis of 41 patients from the FungiScope® registry 2008-2019*. **Clin Microbiol Infect.** 2020 Jan 20. pii: S1198-743X(20)30037-9. [Epub ahead of print]

Dec 2019 Seidel D, Hassler A, Salmanton-García J, Koehler P, Mellinghoff SC, Carlesse F, Cheng MP, Falces-Romero I, Herbrecht R, Jover Sáenz A, Klimko N, Mareş M, Lass-Flörl C, Soler-Palacín P, Wisplinghoff H, Cornely OA, Pana Z, Lehrnbecher T. Invasive Scedosporium spp. and Lomentospora prolificans infections in pediatric patients: Analysis of 55 cases from FungiScope® and the literature. **Int J Infect Dis.** 2020 Mar;92:114-122. doi: 10.1016/j.ijid.2019.12.017. Epub 2019 Dec 19.

Nov 2019 Stemler J, Salmanton-García J, Seidel D, Alexander B, Bertz H, Hoenigl M, Herbrecht R, Meintker L, Meißner A, Mellinghoff SC, Sal E, Zarrouk M, Koehler P, Cornely OA. *Risk factors and mortality in invasive Rasamsonia spp. infection: Analysis of cases in the FungiScope® registry and from the literature*. **Mycoses**. 2019 Nov 26. [Epub ahead of print].

Nov 2019 Salmanton-García J, Seidel D, Koehler P, Mellinghoff SC, Herbrecht R, Klimko N, Ráčil Z, Falces-Romero I, Ingram P, Benítez-Peñuela MÁ, Rodríguez JY, Desoubeaux G, Barać A, García-Vidal C, Hoenigl M, Mehta SR, Cheng MP, Klyasova G, Heinz WJ, Iqbal N, Krause R, Ostermann H, Penack O, Schalk E, Sheppard DC, Willinger B, Wisplinghoff H, Vehreschild JJ, Cornely OA, Vehreschild MJGT; FungiScope® ECMM/ISHAM Working Group. *Matched-paired analysis of patients treated for invasive mucormycosis: standard treatment versus posaconazole new formulations (MoveOn)*. **J Antimicrob Chemother**. 2019 Nov 1;74(11):3315-3327.

Oct 2019 Buchta V, Bolehovská R, Hovorková E, Cornely OA, Seidel D, Žák P. *Saprochaete clavata Invasive Infections - A New Threat to Hematological-Oncological Patients*. **Front Microbiol**. 2019 Oct 29;10:2196.

Jun 2019 Verhasselt HL, Radke J, Schmidt D, Killengray D, Scharmann U, Rickerts V, Hansen W, Seidel D, Falces-Romero I, Buer J, Rath P-M,

Steinmann J. *Comparison of genotyping methods for Cunninghamella bertholletiae*. **Mycoses**. 2019 Jun;62: 519–525.

Feb 2019 Seidel D, Meißner A, Lackner M, Piepenbrock E, Salmanton-García J, Stecher M, Mellinghoff S, Hamprecht A, Durán Graeff L, Köhler P, Cheng MP, Denis J, Chedotal I, Chander J, Pakstis DL, Los-Arcos I, Slavin M, Montagna MT, Caggiano G, Mares M, Trauth J, Aurbach U, Vehreschild MJGT, Vehreschild JJ, Duarte RF, Herbrecht R, Wisplinghoff H, Cornely OA. *Prognostic factors in 264 adults with invasive Scedosporium spp. and Lomentospora prolificans infection reported in the literature and FungiScope®*. **Crit Rev Microbiol**. 2019 Feb;45(1):1-21.

Sep 2017 Revankar SG, Baddley JW, Chen SC, Kauffman CA, Slavin M, Vazquez JA, Seas C, Morris MI, Nguyen MH, Shoham S, Thompson GR 3rd, Alexander BD, Simkins J, Ostrosky-Zeichner L, Mullane K, Alangaden G, Andes DR, Cornely OA, Wahlers K, Lockhart SR, Pappas PG. *A Mycoses Study Group International Prospective Study of Phaeohyphomycosis: An Analysis of 99 Proven/Probable Cases*. **Open Forum Infect Dis**. 2017 Sep 26;4(4):ofx200.

Nov 2018 Heimann SM, Vehreschild MJGT, Cornely OA, Heinz WJ, Grüner B, Silling G, Kessel J, Seidel D, Vehreschild JJ. Healthcare burden of probable and proven invasive mucormycosis: a multi-centre cost-of-illness analysis of patients treated in tertiary care hospitals between 2003 and 2016. **J Hosp Infect**. 2019 Mar; 101(3):339-346.

Aug 2017 Seidel D, Durán Graeff LA, Vehreschild MJGT, Wisplinghoff H, Ziegler M, Vehreschild JJ, Liss B, Hamprecht A, Köhler P, Racil Z, Klimko N, Sheppard DC, Herbrecht R, Chowdhary A, Cornely OA, FungiScope Group. *FungiScope™-Global Emerging Fungal Infection Registry*. **Mycoses**. 2017 Aug;60(8):508-516.

Jan 2017 Durán Graeff L, Seidel D, Vehreschild MJGT, Hamprecht A, Kindo A, Racil Z, Demeter J, De Hoog S, Aurbach U, Ziegler M, Wisplinghoff H, Cornely OA; FungiScope Group. *Invasive infections due to Saprochaete and Geotrichum species: Report of 23 cases from the FungiScope Registry*. **Mycoses**. 2017 Apr;60(4):273-279.

Nov 2016 Hassler A, Lieb A, Seidel D, Simone Cesaro S, Greil J, Klimko N, Khostelidi S, Solopova G, Ogunc D, Durán Graeff L, Cornely OA, Vehreschild MJGT, Lehrnbecher T. *Disseminated Fusariosis in Immunocompromised Children - Analysis of Recent Cases Identified in the Global FungiScope Registry*. **Pediatr Infect Dis J**. 2016 Nov 11.

Nov 2016 Pana ZD, Seidel D, Skiada A, Groll AH, Petrikkos G, Cornely OA, Roilides E; Collaborators of Zygomyco.net and/or FungiScope™ Registries. *Invasive mucormycosis in children: an epidemiologic study in European and non-European countries based on two registries*. **BMC Infect Dis**. 2016 Nov 10;16(1):667.

Aug 2016 Cornely OA, Maher RM, Marty FM, Lee M, Vehreschild JJ, Vehreschild MJ. *The VITAL study: case control studies are hypothesis-generating*. **Lancet Infect Dis**. 2016 Aug;16(8):886-7.

Mar 2016 Marty FM, Ostrosky-Zeichner L, Cornely OA, Mullane KM, Perfect JR, Thompson GR 3rd, Alangaden GJ, Brown JM, Fredricks DN, Heinz WJ, Herbrecht R, Klimko N, Klyasova G, Maertens JA, Melinkeri SR, Oren I, Pappas PG, Ráčil Z, Rahav G, Santos R, Schwartz S, Vehreschild JJ, Young JA, Chetchotisakd P, Jaruratanasirikul S, Kanj SS, Engelhardt M, Kaufhold A, Ito M, Lee M, Sasse C, Maher RM, Zeiher B, Vehreschild MJ; VITAL and FungiScope Mucormycosis Investigators. *Isavuconazole treatment for mucormycosis: a single-arm open-label trial and case-control analysis.* **Lancet Infect Dis**. 2016 Jul;16(7):828-37. Epub 2016 Mar 9.

Nov 2013 Nucci M, Marr K, Vehreschild M, de Souza C, Velasco E, Cappelano P, Carlesse F, Queiroz-Telles F, Sheppard D, Kindo A, Cesaro S, Hamerschlak N, Solza C, Heinz W, Schaller M, Atalla A, Arikan-Akdagli S, Bertz H, Castro Jr C, Herbrecht R, Hoenigl M, Härter G, Hermansen NE, Josting A, Pagano L, Salles M, Mossad SB, Ogunc D, Pasqualotto A, Araujo V, Troke P, Lortholary O, Cornely O, Anaissie E. *Improvement in the outcome of invasive fusariosis in the last decade.* **Clin Microbiol Infect**. 2014 Jun; 20(6):580-5. Epub 2013 Nov 18.

May 2013 Pagano L, Cornely O, Caira M, Cesaro S, Gasbarrino C, Girmenia C, Heinz WJ, Herbrecht R, Lass-Flörl C, Nosari A, Potenza L, Racil Z, Rickerts V, Sheppard DC, Simon A, Ullmann AJ, Valentini CG, Vehreschild JJ, Candoni A, Vehreschild MJ*. Combined antifungal approach for the treatment of invasive mucormycosis in patients with hematological diseases: a report from the SEIFEM and FUNGISCOPE registries.* **Haematologica**. 2013 Oct; 98(10):e127-30. Epub 2013 May 28.

Jan 2013 Christopeit M, Lindner A, Surov A, Weber T, Vehreschild MJ, Bialek R, Schmoll HJ. *Right flank pain and high fever in a neutropenic patient with acute lymphoblastic leukaemia.* **Mycoses** 2013, Jan; 56(1):90-92

Oct 2011 de Hoog GS, Robert V, Lackner M, Vehreschild MJ, Vehreschild JJ, Symoens F, Göttlich-Fligg E, Garcia-Hermoso D, Harun A, Meyer W, Chen SC, Hamprecht A, Fischer G, Buzina W, Cornely OA, Guarro J, Cano J, Horré R. *Making moulds meet. Information retrieval as a basis for understanding Pseudallescheria and Scedosporium*. **Mycoses**. 2011 Oct;54 Suppl 3:1-4

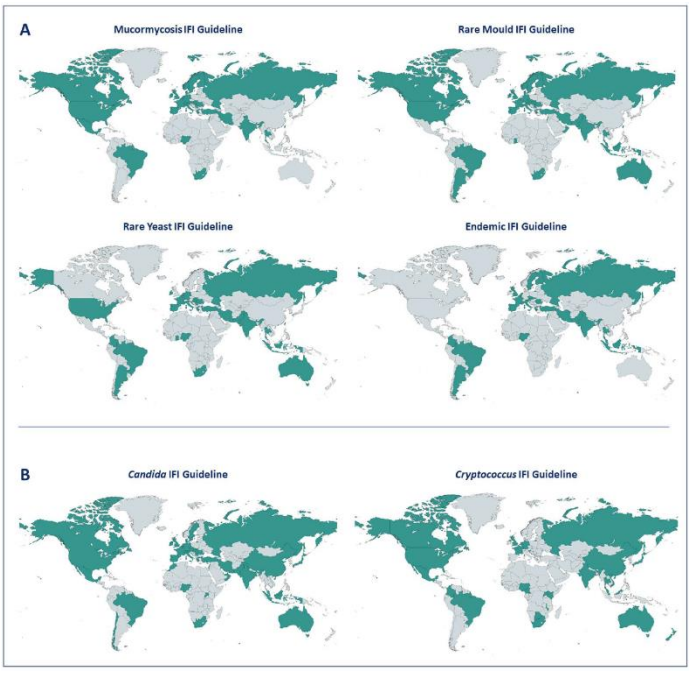
Dec 2009 Rüping MJGT, Heinz WJ, Kindo AJ, Rickerts V, Lass-Flörl C, Beisel C, Herbrecht R, Roth Y, Silling G, Ullmann AJ, Borchert K, Egerer G, Maertens J, Maschmeyer G, Simon A, Wattad M, Fischer G, Vehreschild JJ, Cornely OA. Forty-one Recent Cases of *Invasive Zygomycosis from a Global Clinical Registry.* **J Antimicrob Chemother**. 2010 Feb;65(2):296-302

Jul 2008 Rüping M.J.G.T., Albermann N., Ebinger F., Burckhard I., Beisel C., Müller C., Vehreschild J.J., Kochanek M., Fätkenheuer G., Bangard C., Ullmann A.J., Herr W., Kolbe K., Hallek M., Cornely O.A. *Posaconazole concentrations in the central nervous system.* **J Antimicrob Chemother.** 2008 Dec;62 (6):1468-70

Presentation of recent publications

- Overview of the main projects regarding Medical Mycology at the University Hospital Cologne (ECMM Excellence Center)
- One World One Guideline Project – Summary

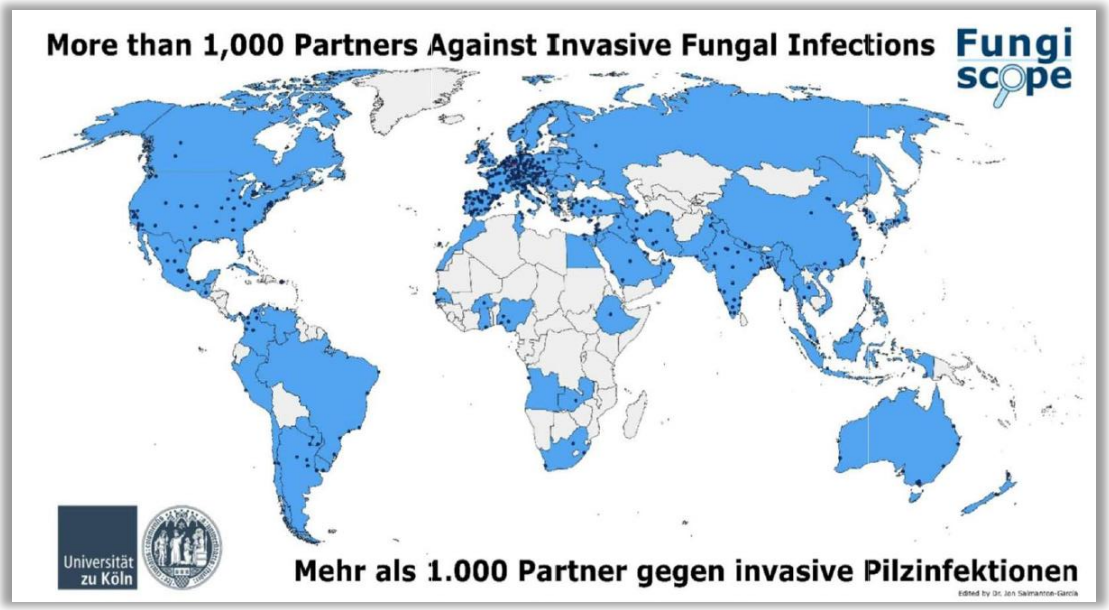
Year of publication	Guideline
2019	Mucormycosis (with MSG-ERC)
2022	CAPA (adapted methology)
2021	Rare Molds Endemic Mycoses Rare Yeast
~2022	*Cryptococcus*
	Candida
~2023	*Aspergillus*



- Overview of Treatment Algorithms throughout the University Hospital of Cologne

- Presentation of EQUAL Score Cards and translations

- Clinical Trials at the ECMM EC Cologne
- YoungECMM
- YouTube Channel "IDIM – Infectious Diseases in Motion" and YouKu Channel
- ECMM Consulting Service
- Overview on Publications



Link:

https://www.ecmm.info/wp-content/uploads/ECMM-Progress-Report-EC-Cologne.pdf

Danila Seidel, PhD

Danila.Seidel@uk-koeln.de

Received: 27 September 2021 | Revised: 9 October 2021 | Accepted: 11 October 2021
DOI: 10.1111/myc.13379

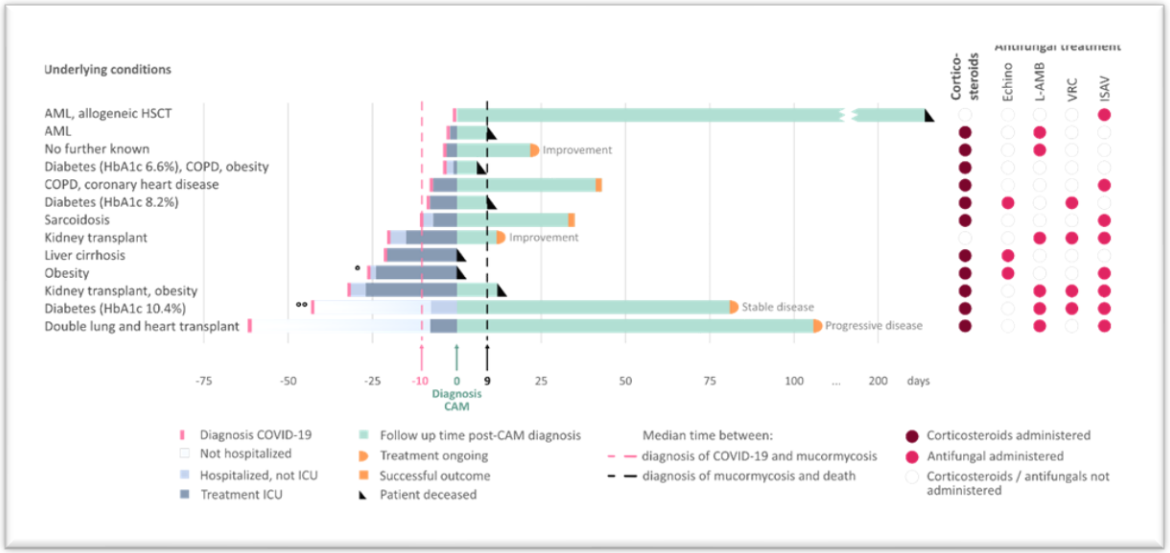
ORIGINAL ARTICLE

mycoses WILEY

Results from a national survey on COVID-19-associated mucormycosis in Germany: 13 patients from six tertiary hospitals

Danila Seidel[1,2,3] | Michaela Simon[4] | Rosanne Sprute[1,2,3] | Matthias Lubnow[5] | Katja Evert[6] | Claudius Speer[7] | Jessica Seeßle[8] | Elham Khatamzas[9] | Uta Merle[8] | Christopher Behrens[10] | Igor Wolfgang Blau[11] | Philipp Enghard[12] | Christian S. Haas[13] | Joerg Steinmann[14,15] | Oliver Kurzai[16,17] | Oliver A. Cornely[1,2,3,18,19]

- Most CAM presented as pulmonary infection (11/13)
- Most had severe/critical COVID-19 (12/13), 11 required intensive care involving mechanical ventilation
- Median time between diagnosis of COVID-19 and CAM: 10 (range 0 – 62) days
- All-cause mortality: 53.8%



Link:

Seidel et al. Mycoses. 2021 Oct 16.

Danila Seidel, PhD

Danila.Seidel@uk-koeln.de

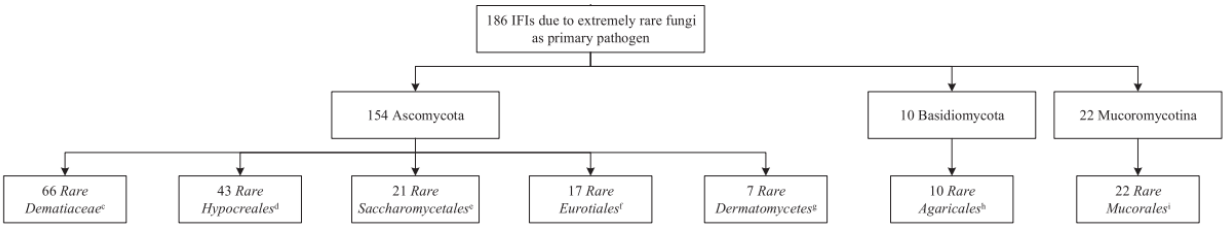
Contents lists available at ScienceDirect

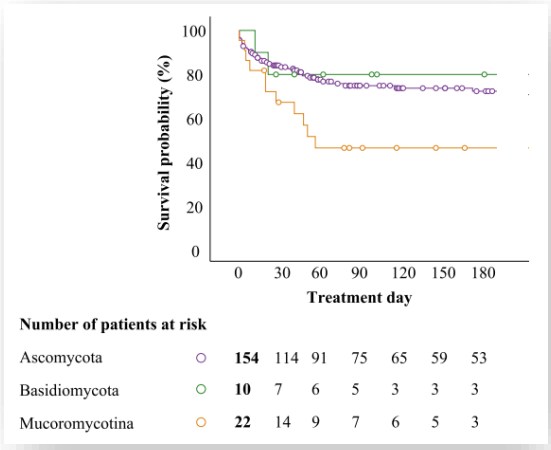
Journal of Infection

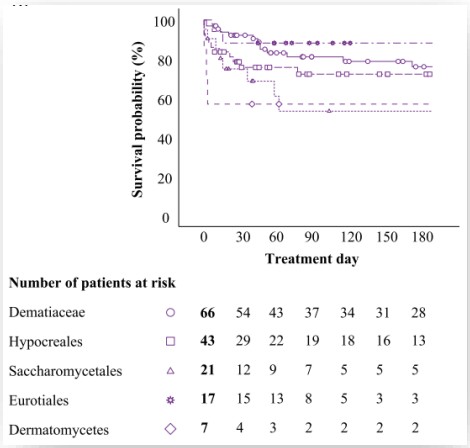
journal homepage: www.elsevier.com/locate/jinf

Needles in a haystack: Extremely rare invasive fungal infections reported in FungiScope®—Global Registry for Emerging Fungal Infections

Jon Salmanton-García[a], Philipp Koehler[a,b], Anupma Kindo[c], Iker Falces-Romero[d], Julio García-Rodríguez[d], Zdeněk Ráčil[e,f,g], Sharon C.-A. Chen[h,i], Nikolai Klimko[j], Guillaume Desoubeaux[k,l], George R. Thompson, III[m,n], Miguel-Ángel Benítez-Peñuela[o], José-Yesid Rodríguez[o], Donald C. Sheppard[p], Martin Hoenigl[q,r,s], Yohann Le Govic[t], Hamid Badali[u], John W. Baddley[v,w,x], Jagdish Chander[y], Paul R. Ingram[z,aa], Diana L. Pakstis[bb], Sibylle C. Mellinghoff[a], Serkan Atıcı[cc], Simone Cesaro[dd], Arunaloke Chakrabarti[ee], Damien Dupont[ff,gg], Gloria M. González[hh], Lóránt Hatvani[ii,jj], Raoul Herbrecht[kk], Galina Klyasova[ll], Cornelia Lass-Flörl[mm], Mihai Mareş[nn], Kathleen Mullane[oo], Donald C. Vinh[pp], Hilmar Wisplinghoff[qq,rr,ss], Michaela Lackner[mm], Oliver A. Cornely[a,tt,uu,vv], Danila Seidel[a,*], The FungiScope® ECMM/ISHAM working group[1]







Link:

Salmanton-García et al. J Infect. 2020 Nov;81(5):802-815.

Jon Salmanton-García, PhD

Jon.Salmanton-Garcia@uk-koeln.de

Received: 17 March 2020 | Revised: 15 May 2020 | Accepted: 18 May 2020

DOI: 10.1111/myc.13123

ORIGINAL ARTICLE

mycoses WILEY

Mucormycosis in the Middle East and North Africa: Analysis of the FungiScope® registry and cases from the literature

Jannik Stemler[1,2,3] | Kamal Hamed[4] | Jon Salmanton-García[1,2] | Ali Rezaei-Matehkolaei[5] | Stefanie K. Gräfe[1,2,6] | Ertan Sal[1,2] | Marouan Zarrouk[1,2] | Danila Seidel[1,2] | Reham Abdelaziz Khedr[7] | Ronen Ben-Ami[8] | Eli Ben-Chetrit[9] | Yehudah Roth[10] | Oliver A. Cornely[1,2,3,11]

Patients: 310 cases of mucormycosis in the MENA region

Risk: Diabetes mellitus (49.7%)
Conditions associated with immunosuppression (46.5%)

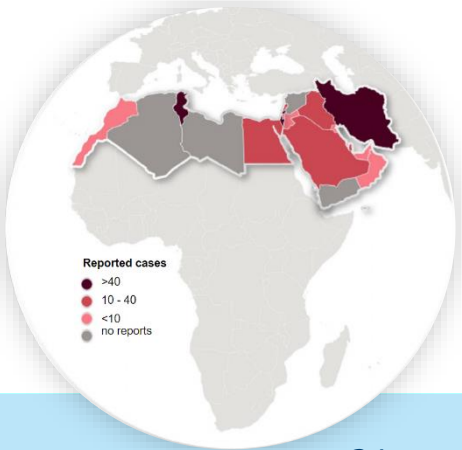
Mortality:

	N (%)	Mortality (%)
Rhino-orbital-cerebral	145 (46.8)	56 (38.6)
Pulmonary	38 (12.3)	17 (44.7)
Curaneous	35 (11.3)	8 (22.9)
Gastrointestinal	6 (1.9)	5 (83.3)
Disseminated	59 (19.0)	36 (61.0)

Conclusions: Increase of reports of mucormycosis in the MENA region over the past few decades

Treatment with antifungals and surgery is associated with improved outcome

Mortality rates decreased from 47.8% before 1990 to 32.3% in the 2010s

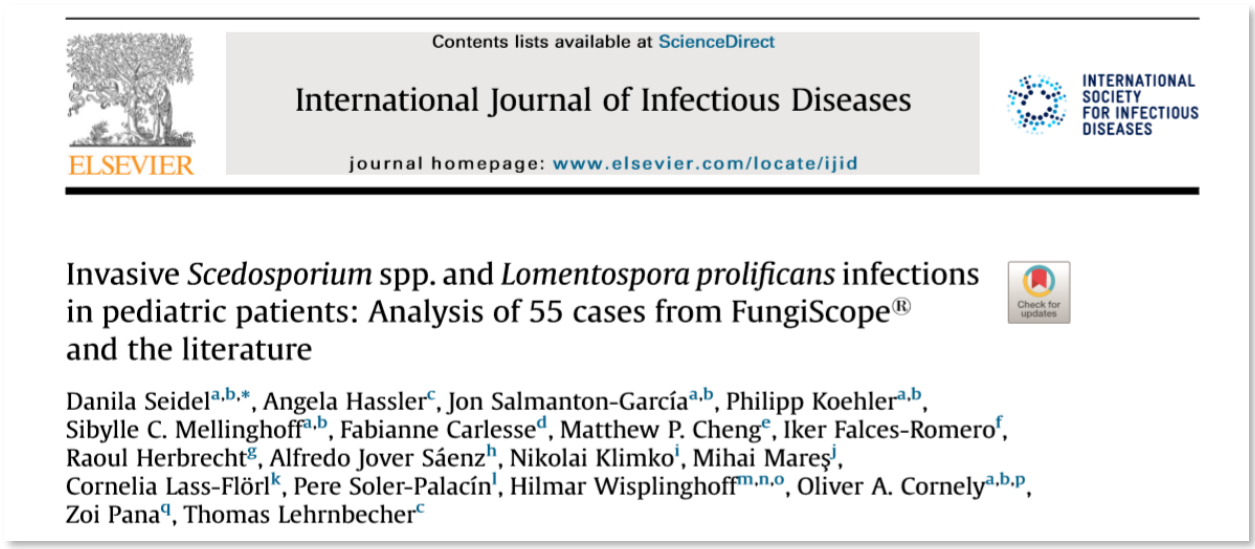


Link:

Stemler et al. Mycoses. 2020 Oct;63(10):1060-1068.

Jannik Stemler, MD

Jannik.Stemler@uk-koeln.de



Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Invasive *Scedosporium* spp. and *Lomentospora prolificans* infections in pediatric patients: Analysis of 55 cases from FungiScope® and the literature

Danila Seidel[a,b,*], Angela Hassler[c], Jon Salmanton-García[a,b], Philipp Koehler[a,b], Sibylle C. Mellinghoff[a,b], Fabianne Carlesse[d], Matthew P. Cheng[e], Iker Falces-Romero[f], Raoul Herbrecht[g], Alfredo Jover Sáenz[h], Nikolai Klimko[i], Mihai Mareş[j], Cornelia Lass-Flörl[k], Pere Soler-Palacín[l], Hilmar Wisplinghoff[m,n,o], Oliver A. Cornely[a,b,p], Zoi Pana[q], Thomas Lehrnbecher[c]

Patients: 55 children with *Scedosporium* and *Lomentospora*-related infections

Risk: Immunosuppression, malignancy, allogeneic HSCT, trauma, near drowning

Mortality:

	Overall	Immuno-compromised	Immuno-competent
Scedosporium spp.	42%	46%	85%
Lomentospora spp.	50%	40%	0%

Conclusions: Severity of infection predicts worse outcome irrespective of immune status - Localized infection predicts good outcome

Voriconazole use and surgical treatment are associated with improved outcome in children

Link:

Seidel et al. International Journal of Infectious Diseases. 2019 Dec.

Danila Seidel, PhD

Danila.Seidel@uk-koeln.de

ORIGINAL ARTICLE | Open Access

Risk factors and mortality in invasive *Rasamsonia* spp. infection: Analysis of cases in the FungiScope® registry and from the literature

Jannik Stemler, Jon Salmanton-García, Danila Seidel, Barbara Alexander, Hartmut Bertz, Martin Hoenigl , Raoul Herbrecht, Lisa Meintker, Arne Meißner, Sibylle C. Mellinghoff, Ertan Sal, Marouan Zarrouk, Philipp Koehler, Oliver A. Cornely ... See fewer authors

First published: 26 November 2019 | https://doi.org/10.1111/myc.13039

Patients: 23 *Rasamsonia* spp. cases

Risk: Chronic granulomatous disease, immunosuppression, malignancy, HSCT

In vitro susceptibility:

Amphotericin B (S/R)
Caspofungin (S)
Micafungin (S)
Posaconazole (R)
Voriconazole (R)

Mortality: 39%

Conclusions: No predictors of mortality identified, but
Frequently misidentified as *Paecilomyes* spp. (48%)
Frequently BT-IFI (56.5%)
Species identification by PCR necessary

Link:

Stemler et al. Mycoses. 2019 Nov 26.

Jannik Stemler, MD

Jannik.Stemler@uk-koeln.de

Matched-paired analysis of patients treated for invasive mucormycosis: standard treatment versus posaconazole new formulations (MoveOn)

Jon Salmanton-García [1], Danila Seidel[1,2], Philipp Koehler[1,2], Sibylle C. Mellinghoff[1], Raoul Herbrecht[3], Nikolai Klimko[4], Zdeněk Ráčil[5,6], Iker Falces-Romero [7], Paul Ingram[8,9], Miguel-Ángel Benítez-Peñuela[10], José Yesid Rodríguez[10], Guillaume Desoubeaux[11,12], Aleksandra Barać[13], Carolina García-Vidal[14], Martin Hoenigl[15,16], Sanjay R. Mehta[15,17], Matthew P. Cheng [18], Galina Klyasova[19], Werner J. Heinz[20], Nousheen Iqbal[21], Robert Krause[16], Helmut Ostermann[22], Olaf Penack[23], Enrico Schalk[24], Donald C. Sheppard[18], Birgit Willinger[25], Hilmar Wisplinghoff[26–28], J. Janne Vehreschild[1,29,30], Oliver A. Cornely [1,2,29,30–32] and Maria J. G. T. Vehreschild[1,29,30,33]* on behalf of The FungiScope® ECMM/ISHAM Working Group†

Patients: First-POS*new* (*n=5*) vs First-AMB (*n=15*)
First-AMB+POS*new* (*n=18*) vs First-AMB (*n=50*)
Salvage-POS*new* (*n=22*) vs Salvage-POS*susp* (*n=42*)

Matching: Malignancy, Surgery, Severity, Renal dysfunction

Mortality:

First-POS*new*	40%	vs First-AMB	60%
First-AMB+POS*new*	50%	vs First-AMB	60%
Salvage-POS*new*	18%	vs Salvage-POS*susp*	33%

Conclusion: Posaconazole tablet or iv is effective against mucormycosis with regard to treatment response and mortality

Link:

Salmanton-García et al. J Antimicrob Chemother. 2019 Nov 1;74(11):3315-3327.

Jon Salmanton-García, MPH, PHD
Jon.Salmanton-Garcia@uk-koeln.de

Prognostic factors in 264 adults with invasive *Scedosporium* spp. and *Lomentospora prolificans* infection reported in the literature and FungiScope®

Danila Seidel[a,b*], Arne Meißner[a,c*], Michaela Lackner[d], Ellen Piepenbrock[e], Jon Salmanton-García[a], Melanie Stecher[a,f], Sibylle Mellinghoff[a], Axel Hamprecht[d], Luisa Durán Graeff[a], Philipp Köhler[a,b,f], Matthew P. Cheng[g], Julie Denis[h], Isabelle Chedotal[i], Jagdish Chander[j], Diana Lynn Pakstis[k], Ibai Los-Arcos[l], Monica Slavin[m], Maria Teresa Montagna[n], Giuseppina Caggiano[n], Mihai Mares[o], Janina Trauth[p], Ute Aurbach[q], Maria J. G. T. Vehreschild[a,f,r], Jörg Janne Vehreschild[a,f,r], Rafael F. Duarte[s], Raoul Herbrecht[i], Hilmar Wisplinghoff[e,q,t] and Oliver A. Cornely[a,b,f,r,u,v]

Patients: 208 Scedosporium spp., 56 Lomentospora prolificans cases
(34 *Scedosporium* and 7 *Lomentospora* cases from FungiScope)
Male 60.6 %; Median age 57 years (IQR 40 – 65)

Risk: Malignancy, HSCT, solid organ transplantation

Sites: Fungemia, lung, CNS, heart

In vitro susceptibility:

Scedosporium spp.: Voriconazole (S)
Lomentospora prolificans: All (R)

Mortality: **Solid organ transplantation**
Scedosporium spp.: 40% vs *Lomentospora prolificans*: 57%
Malignancy
Scedosporium spp.: 55% vs *Lomentospora prolificans*: 86%

Conclusions: Predictors for mortality (-) and survival (+):

***Scedosporium* spp.**

Solid organ transplantation: (-) CNS, disseminated disease
Malignancy: (-) Lung

Lomentospora prolificans

(-) Disseminated disease
(+) Surgery

Link:

Seidel et al. Crit Rev Microbiol. 2019 Feb;45(1):1-21.

Danila Seidel, PhD

Danila.Seidel@uk-koeln.de

Healthcare burden of probable and proven invasive mucormycosis: a multi-centre cost-of-illness analysis of patients treated in tertiary care hospitals between 2003 and 2016

S.M. Heimann [a,*], M.J.G.T. Vehreschild [a,b], O.A. Cornely [a,b,c], W.J. Heinz [d], B. Grüner [e], G. Silling [f], J. Kessel [g], D. Seidel [a], J.J. Vehreschild [a,b]

Patients: 46 Mucorales
Male 67%; Median age 53 years (range 11 – 88)

Risk: Malignancy, HSCT

Mortality: 41%

Extra costs:

	Invasive Mucormycosis FungiScope n=46	Control German central health care database	Difference	
Length of stay median days (IQR)	46.5 (30.3 – 83.3)	25.6 (17.9 – 40.4)	+ 20.9 (1.9 – 49.1)	days
direct treatment costs €; median (IQR)	35,765 (18,090 – 69,350)	12,587 (6,601 – 30,762)	**+ 23,178** (11,489 – 38,588)	€

Conclusions: Lower overall costs if

- No chemotherapy
- Surgical treatment of mucormycosis
- Antifungal prophylaxis

Link:

Heimann et al. J Hosp Infect. 2019 Mar;101(3):339-346.

Sebastian Wingen-Heimann, PhD
Sebastian.Wingen-Heimann@uk-koeln.de

Invasive infections due to *Saprochaete* and *Geotrichum* species: Report of 23 cases from the FungiScope Registry

Luisa Durán Graeff[1] | Danila Seidel[1] | Maria J. G. T. Vehreschild[1] | Axel Hamprecht[2] | Anupma Kindo[3] | Zdenek Racil[4] | Judit Demeter[5] | Sybren De Hoog[6] | Ute Aurbach[7] | Maren Ziegler[7] | Hilmar Wisplinghoff[2,7,8] | Oliver A. Cornely[1,9,10,11] | FungiScope Group†

Patients: 23 cases, Female 48%, Median age 49 years (18 -78)

Risk: Malignancy, HSCT, diabetes mellitus, treatment in ICU

Sites: Fungemia, lung, liver, spleen, CNS

In vitro susceptibility:

Amphotericin B (I)
Echinocandins (R)
Triazoles (S)

Mortality: 65%

Conclusions: Treatment with echinocandins predicts worse outcome

Link:

Durán Graeff L et al. Mycoses. 2017 Apr;60(4):273-279.

Luisa Durán Graeff, MD

Invasive mucormycosis in children: an epidemiologic study in European and non-European countries based on two registries

Zoi Dorothea Pana[1], Danila Seidel[2], Anna Skiada[3], Andreas H. Groll[4], Georgios Petrikkos[5], Oliver A. Cornely[2], Emmanuel Roilides[1*] and Collaborators of Zygomyco.net and/or FungiScope™ Registries*

Patients: 63 children: 34 girls, Median age: 13 years

Risk: Malignancy, HSCT, solid organ transplantation, trauma/surgery, diabetes mellitus

Treatment: 31% monotherapy AMB
48% combination AMB
14% no systemic antifungals
54% + surgery

Mortality: 33%

Conclusions: Predictor for mortality (-) and survival (+)
(-) HSCT
(-) Disseminated IFI
(+) Combination antifungal therapy + surgery

Link:

Pana Z et al. BMC Infect Dis. 2016 Nov 10;16(1):667.

Zoi Pana, MD

Current Activities

- FungiScope expanded its inclusion criteria to invasive *Aspergillus* spp. infections
- COVID-19 associated fungal infections are enrolled
- Publication on *Purpureocillium* and *Paecilomyces*-associated infections, on COVID-19 associated aspergillosis and mucormycosis
- Participation in global guidelines on clinical management of mold and yeast infections
- Prof. Yingchun Xu and Prof. Yao Wang at the Peking Union Medical College Hospital joint FungiScope as the reference lab for the People's Republic of China
- Extending and renewal of the FungiQuest® platform www.fungiquest.net
- Web presence on the Research for Rare website www.research4rare.de
- Web presence as an Expert center for rare mycosis on the Orphanet - The portal for rare diseases and orphan drugs website www.orpha.net

ECMM Excellence Center Symposium October 10th, 2017

The University Hospital of Cologne was awarded with the ECMM Excellence Center Diamond status in2017, certifying *Excellence* in the mycological fields of clinical microbiology and infectious diseases and acknowledging participation in ECMM endorsed clinical and epidemiological studies. The *Excellence Diamond status* was reevaluated in 2021.

Central Laboratories

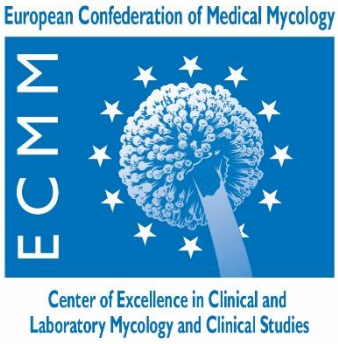
Australia	
Sharon Chen, MD, PhD Westmead Hospital Centre for Infectious Diseases and Microbiology Laboratory Services, ICPMR Darcy Road ICPMR Building Level 3 Westmead NSW 2145 Sharon.Chen@health.nsw.gov.au	
People's Republic of China	
Yingchun Xu, MD Yao Wang, MD Peking Union Medical College Hospital Chinese Academy of Medical Sciences Department of Clinical Laboratory Beijing 100730	
Czech Republic	
Zdeněk Ráčil, MD, PhD Institute of Hematology and Blood Transfusion U Nemocnice 1 128 20 Praha 2 Racil.Zdenek@fnbrno.cz	Barbora Weinbergerová, MD University Hospital Brno Dept. of Internal Medicine Hematology-Oncology Jihlavska 20 62500 Brno weinbergerova.barbora@fnbrno.cz
Germany	
Hilmar Wisplinghoff, MD Klinikum der Universität Institut für Mikrobiologie, Immunologie und Hygiene Goldenfelsstr. 19-2 50935 Köln H.Wisplinghoff@wisplinghoff.de	
India	
Anuradha Chowdary, MD Vallabhbhai Patel Chest Institute Department of Medical Mycology University of Delhi Delhi 110 007 drAnuradha@hotmail.com	Anupma Jyoti Kindo, MD Sri Ramachandra Medical College/Research Institute Department of Microbiology No.1, Ramachandra Nagar Porur, Chennai, 600 116 Anupmalakra@yahoo.com

Russia	
Nikolai Klimko, MD North Western State Medical University Santiago De Cuba Street 1/28 194295 St.Petersburg N_Klimko@mail.ru	

Spain	
Ana Alastruey-Izquierdo, PhD National Centre for Microbiology, Instituto de Salud Carlos III Carretera Majadahonda- Pozuelo km. 2. Majadahonda, 28220 Madrid, Spain AnaAlastruey@isciii.es	

Contact Information

University Hospital Cologne
Dept. I for Internal Medicine
Infectious Diseases
Herderstrasse 52-54
50931 Cologne
Germany
✆ +49 221 478 85523
+49 221 478 1426929
www.fungiscope.net



Chair

Prof. Oliver A. Cornely MD, FACP, FIDSA, FAAM, FECMM, Cologne
Oliver.Cornely@uk-koeln.de
✆ +49 221 478 88795

Scientific Lead

Danila Seidel PhD, FECMM, Cologne
Danila.Seidel@uk-koeln.de
✆ +49 221 478 97343

Project Management

Natalia Vasenda
Natalia.Vasenda@uk-koeln.de

Coordinating physicians and Quality Control Team, Cologne

Philipp Köhler MD, FECMM
Philipp.Koehler@uk-koeln.de

Jon Salmanton-García, MPH, PhD
Jon.Salmanton-Garcia@uk-koeln.de

Rosanne Sprute MD
Rosanne.Sprute@uk-koeln.de

Jannik Stemler MD
Jannik.Stemler@uk-koeln.de

Andrea Will
Andrea.Will@uk-koeln.de

Epidemiology, IT and Statistics

Prof. J. Janne Vehreschild MD, FECMM, Cologne
Janne.Vehreschild@uk-koeln.de

Microbiology and Sample Storage

Hilmar Wisplinghoff MD, Cologne
H.Wisplinghoff@wisplinghoff.de

Molecular Identification

Volker Rickerts MD, Berlin
RickertsV@rki.de

Histopathology

Birgid Schömig-Markiefka MD, Cologne
birgid.markiefka@uk-koeln.de

Thoracic Surgery

Khosro Hekmat MD, Cologne
Khosro.Hekmat@uk-koeln.de

Therapeutic Drug Monitoring

Carsten Müller MD, Cologne
C.Mueller@uni-koeln.de

References

1. Hoenigl M, Salmanton-Garcia J, Walsh TJ, et al. Global guideline for the diagnosis and management of rare mould infections: an initiative of the European Confederation of Medical Mycology in cooperation with the International Society for Human and Animal Mycology and the American Society for Microbiology. *Lancet Infect Dis* 2021.
2. 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; **19**(12): e405-e21.
3. Chen SC, Perfect J, Colombo AL, et al. Global guideline for the diagnosis and management of rare yeast infections: an initiative of the ECMM in cooperation with ISHAM and ASM. *Lancet Infect Dis* 2021; **21**(12): e375-e86.
4. Donnelly JP, Chen SC, Kauffman CA, et al. Revision and Update of the Consensus Definitions of Invasive Fungal Disease From the European Organization for Research and Treatment of Cancer and the Mycoses Study Group Education and Research Consortium. *Clin Infect Dis* 2020; **71**(6): 1367-76.
5. Bassetti M, Scudeller L, Giacobbe DR, et al. Developing definitions for invasive fungal diseases in critically ill adult patients in intensive care units. Protocol of the FUNgal infections Definitions in ICU patients (FUNDICU) project. *Mycoses* 2019; **62**(4): 310-9.