The Ocular Surface 30 (2023) 139–141

Contents lists available at ScienceDirect

The Ocular Surface

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

Diagnostic capacity for fungal keratitis in Africa – Survey in 50 African countries

ARTICLE INFO

Keywords
Microbial keratitis
Corneal scraping
Fungal diseases
Developing countries
Antifungal

Dear Editors:

Corneal blindness is the fourth leading cause of blindness globally, at 4.4 million cases [1]. Fungal keratitis (FK) is a significant cause of corneal visual impairment. The burden of corneal blindness on the individual and the community is substantial. There are estimated to be between 1.1 and 1.4 million cases annually [2]. The younger age groups primarily affected are in their active and productive periods [2,3] and so the socio-economic impact of corneal blindness is greater than cataract in terms of the total blind-person years [3]. In southwestern Nigeria, corneal blindness accounted for 9.6 and 20.4% of bilateral and unilateral blindness, respectively; the major causes of corneal blindness were microbial keratitis (36.4%) and trauma (27.2%) [4]. In low- and middle-income countries, the high risk of ocular trauma from contaminated materials such as vegetative matter is higher and outcomes may be worse because of poor accessibility to good eye care and HIV infection [2]. Early diagnosis is crucial to prevent adverse outcomes in FK, including corneal blindness and ocular perforation. Corticosteroid use is linked to worse ocular outcomes [5].

In Africa, with a significant agrarian and a young population, there is paucity of data on fungal keratitis. In view of this, GAFFI (Global Action For Fungal Infections) conducted a survey in order to identify levels of access to diagnostics for fungal infections for populations across Africa. A survey questionnaire was developed and later iteratively improved. It was sent to healthcare workers to identify levels of access to diagnostics in each African country, with a population >1 million. Full questionnaire details are provided in the formal report of this survey [6]. In terms of the frequency of testing, the term 'often' encompasses frequently indicative of a good and regular diagnostic service. The term 'occasional' refers to intermittent testing, which encompasses infrequent clinical requests as well as patient inability to pay (if charged for) or a combination. Several countries had some diagnostic capacity but testing frequency is classified as 'rare' referring to very infrequent use of a diagnostic.

Corneal scraping is the primary means of diagnosing microbial keratitis in most patients, with samples submitted for direct microscopy and both bacterial and fungal culture [2]. In the public sector, 23.7% of Africa's population (324 million) live in countries which often perform corneal scraping on suspected cases (Table 1). In 8 countries (Burundi, Cameroon Cote d'Ivoire, Kenya Niger, South Africa, Zambia and Zimbabwe), this procedure is frequently undertaken in the private sector. This procedure is performed occasionally in the public sector in 14 countries (625 million Africans (45.6%)). Likewise in Chad, Democratic Republic of Congo (DRC), Madagascar, Mauritius, Puntland, Senegal, Sudan and Tanzania it is occasionally done in the private sector. However, 19.5% (268 million) of Africans live in six countries where the procedure is rarely done and 11.2% (153 million) in 15 countries which never perform corneal scraping in the public sector (including Cameroon and Puntland). Provision is worse in the private sector. Countries with a large population and lower GDP (<$5000) appear to be those which do corneal scraping more frequently. Some wealthier countries appear not to have this diagnostic capability, including Equatorial Guinea and Libya and others undertake the procedure rarely including Botswana, Egypt and Mauritius.

Direct microscopy reported here (Table 1) combines ocular, sputum, bronchoscopy, urine, vaginal and other deep samples such as pleural or peritoneal fluids. We learned that Angola, Equatorial Guinea, Eritrea, Guinea-Bissau, Sierra Leone, Somalia and South Sudan appear to have no microscopy capability in the public sector (64 million). Published literature indicates that the Giemsa stain followed by Calcofluor White fluorescent stain, whether or not done with a KOH stain, are more sensitive than the Gram stain [2,7]. Extending the skills of microscopists to include samples from the cornea is clearly possible in many countries – one such course is free and available online: www.microfungi.net.

The survey found that 748 million (55%) of the African population have access to fungal culture (Table 1). In 10 and 22 countries fungal culture is never performed in the public or private sector respectively, leaving the citizens of Eritrea, Puntland, Sierra Leone, Somalia, Somaliland, South Sudan and Zambia with no access. Many hospitals in both the private and public settings in Africa lack both the capacity and infrastructure to identify unusual fungal pathogens, which are relatively more frequent in fungal keratitis, compared with other fungal diseases (over 350 fungal species are recorded as causative agents of fungal keratitis) [8].

The incidence of and morbidity linked to FK is problematic and may have increased over the last decade. The few recent studies reported

https://doi.org/10.1016/j.jtos.2023.08.010
Received 3 August 2023; Received in revised form 30 August 2023; Accepted 31 August 2023
Available online 1 September 2023

Table 1
Distribution of diagnostic procedures for fungal keratitis in African countries, with a population >1 million, not including Lesotho (no response received), covering 99.65% of the Africa population.

	Countries surveyed (n = 50)		Population
	Public sector	Private sector	n (%)
	n (%)	n (%)	
Frequency of corneal scraping			
Often	13 (26%)	8 (16%)	324 million (24%)
Occasional	14 (28%)	9 (18%)	625 million (46%)
Rare	8 (16%)	6 (12%)	268 million (20%)
Never	15 (30%)	27 (52%)	153 million (11%)
Frequency of direct microscopy of non-cutaneous samples			
Often	29 (58%)	25 (50%)	791 million (58%)
Occasional	12 (24%)	10 (20%)	358 million (26%)
Rare	2 (4%)	2 (4%)	156 million (11%)
Never	7 (14%)	13 (26%)	64 million (5%)
Frequency of fungal culture			
Often	22 (44%)	13 (26%)	748 million (55%)
Occasional	7 (14%)	7 (14%)	173 million (13%)
Rare	11 (22%)	7 (14%)	374 million (28%)
Never	10 (20%)	23 (46%)	75 million (5%)

from Africa have demonstrated a significant burden of FK. An Ethiopian study demonstrated that fungi accounted for 69 out of 153 (45%) cases of microbial keratitis investigated [9]. In East Africa, an increased incidence of FK has been attributed to an elevated incidence of people living with HIV [10]. In a study from Egypt [9]; Badawi et al. demonstrated that fungal aetiology was described in 45.6% of 110 positive cultures of corneal scraping samples from 245 patients; main risk factors were trauma (51.4%) and diabetes mellitus (15.1%) [11]. El Shabrawy also in Egypt found a prevalence of 55% of FK among all microbial keratitis [12].

That corneal scraping is performed often in only 23.7% of the African population shows that many African countries lack the necessary skill set/capacity to perform corneal scrapings. We also found more frequent usage in the public than private sector. Whether this deficit is primarily attributable to a lack of trained specialist doctors or laboratory staff (or both) is not clear. Most ophthalmologists in Africa tend to work in tertiary institutions while most cases of FK will likely occur in rural settings. Primary health-care workers who are most likely to be found in rural areas have limited training in the diagnosis and management of microbial keratitis. There are not enough healthcare workers focussed on eye health in Africa [13].

Species of *Aspergillus* and *Fusarium* have been implicated as the predominant agents of keratitis in most reports worldwide. Fungal culture is far from universal in Africa, despite it being listed since 2018 on the WHO's Essential Diagnostic List. In the absence of laboratory diagnosis, the majority of cases of possible fungal keratitis may be misdiagnosed or treated empirically resulting in poor outcomes possibly with progression to endophthalmitis or globe perforation, particularly if left untreated [2]. This is further compounded by the poor availability and accessibility of antifungal agents in the African continent, notably topical natamycin [14].

Fungal keratitis diagnosis remains a major challenge in African countries, with a conservative estimate of 75,200 cases annually, most of which will lead to blindness in that eye [2]. We found gaps in procedures for sample collection to pathogen identification. Confocal microscopy (which the survey did not ask about) is rapid with a sensitivity of which varies between 50% and 86% and specificity 75–86% but it cannot determine the infecting species and is not widely available [2]. Capacity building in diagnostic procedures in Africa is critical to improving the diagnosis of FK. The initial emphasis should be on taking corneal scrapings in the clinic and direct microscopy in the laboratory to ensure early diagnosis of FK and thus reduce the serious public health burden of partial or complete blindness in young people.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Authors signed and approved the publication of this manuscript.

Availability of data and materials

www.gaffi.org/africa-diagnostic-reports

Funding

This survey was wholly funded by GAFFI.

Authors' contributions

JCMC, ROO, DWD: wrote the manuscript; SBK, MB, HMH, VB, GK, SKE, AAM, SIM, FM, MES: reviewed the manuscript, ROSP, EO: Wrote methodology, conducted video meetings and reviewed the manuscript, DWD: Design and conceptualization of the manuscript and publication.

Declaration of competing interest

No conflicts of interest are reported by the authors of this paper.

Acknowledgements

We are indebted to each survey respondent and validator. The full survey has been published by Africa Centres for Disease Control and Prevention and GAFFI online here: https://gaffi.org/africa-diagnostic-reports/.

References

[1] Mundial da Saude Organização. Blindness and vision impairment. 2018. p. 1–5. 2018;11(2018, https://www.who.int/en/news-room/fact-sheets/detail/blindness-and-visual-impairment.
[2] Brown L, Leck AK, Gichangi M, Burton MJ, Denning DW. The global incidence and diagnosis of fungal keratitis. Lancet Infect Dis 2020;3099(20):1–9. https://doi.org/10.1016/S1473-3099(20)30448-5.
[3] Deorukhkar S, Katiyar R, Saini S. Epidemiological features and laboratory results of bacterial and fungal keratitis: a five-year study at a rural tertiary-care hospital in western Maharashtra, India. Singapore Med J 2012;53:264–7.
[4] Seidu M, Olusanya B, Ogundipe A. Prevalence and determinants of corneal blindness in a Semi-Urban population of southwest Nigeria. Niger J Ophthalmol 2017;25(1):18. https://doi.org/10.4103/njo.njo_34_16.
[5] Li Z, Denning DW. The impact of corticosteroids on the outcome of fungal disease: a systematic review and meta-analysis. Curr Fungal Infect Rep 2023;17:54–70. https://doi.org/10.1007/s12281-023-00456-2.
[6] Global Action For Fungal Disease. Diagnostics for fungal disease in Africa; A GAFFI survey. https://gaffi.org/africa-diagnostic-reports/Launched in Kigali; 2022. Rwanda December 12th 2022.
[7] Bagga B, Vishwakarma P, Sharma S, Jospeh J, Mitra S, Mohamed A. Sensitivity and specificity of potassium hydroxide and calcofluor white stain to differentiate between fungal and Pythium filaments in corneal scrapings from patients of Pythium keratitis. Indian J Ophthalmol 2022;70(2):542–5. https://doi.org/10.4103/ijo.IJO_1880_21.
[8] Bartimote C, Foster J, Watson S. The spectrum of microbial keratitis: an updated review. Open Ophthalmol J 2019;13:100–30. https://doi.org/10.2174/1874364101913010100.
[9] Kibret T, Bitew A. Fungal keratitis in patients with corneal ulcer attending minilik II memorial hospital, addis ababa, Ethiopia. BMC Ophthalmol 2016;16(1):1–6. https://doi.org/10.1186/s12886-016-0330-1.
[10] Arunga S, Kyomugasho N, Kwaga T, et al. The management of microbial keratitis within Uganda's primary health system: a situational analysis. Wellcome Open Res 2019;4:187. https://doi.org/10.12688/wellcomeopenres.15463.1.
[11] Badawi AE, Moemen D, El-Tantawy NL. Epidemiological, clinical and laboratory findings of infectious keratitis at mansoura ophthalmic center, Egypt. Int J Ophthalmol 2017;10(1):61–7. https://doi.org/10.18240/ijo.2017.01.10.
[12] Shabrawy RMEL. The incidence of fungal keratitis in Zagazig University Hospitals, Egypt and the value of direct microscopy and PCR technique in rapid diagnosis. J Microbiol Infect Dis 2013:186–91. https://doi.org/10.5799/ahinjs.02.2013.04.0106. 03(04).

[13] Graham R. Facing the crisis in human resources for eye health in sub-Saharan Africa. Commun Eye Health 2017;30(100):85–7.
[14] GAFFI. Antifingal availability. https://gaffi.org/antifungal-drug-maps/. Accessed 10th July 2023.

Jean Claude Makangara Cigolo
Microbiology Service, Kinshasa University Hospital, Democratic Republic of the Congo
National Institute for Biomedical Research (INRB), Democratic Republic of the Congo

Rita O. Oladele
Department of Medical Microbiology and Parasitology, College of Medicine, University of Lagos, Nigeria

Stephen B. Kennedy
UL-PIRE Africa Center, An Infectious Disease Research Center, University of Liberia, Ground Floor, Graduate Education Building, Monrovia, Liberia

Michelle Bignoumba
International Centre of Medical Research of Franceville (CIRMF), Gabon

Hassane Mahamat Hassane
Chad Agricultural, Medical and Veterinary Services, N'Djamena, Chad

Victor Bucumi
Programme National Integré de Lutte contre les Maladies Tropicales Négligées et la Cécité, Burundi

Guyguy Kamwiziku
Microbiology Service, Kinshasa University Hospital, Democratic Republic of the Congo

Stephen Kojo Eduful
Medland Hospital, Tema, Ghana

Alice Afonso Manjate
Department of Microbiology, Faculty of Medicine, University Eduardo Mondlane, Mozambique

Sahra Isse Mohamed
National Public Health Laboratory, Mogadishu, Somalia

Furahini Mbise
National Institute for Medical Research (NIMR) - Muhimbili Center, Tanzania
E-mail address: furahinjapherson@gmail.com.

Mutinta E. Shisholeka
National Quality Management Systems, Ministry of Health, Lusaka, Zambia

Richard O.S. Penney, Emma Orefuwa
Global Action for Fungal Infections, Geneva, Switzerland

David W. Denning*
Global Action for Fungal Infections, Geneva, Switzerland
Manchester Fungal Infection Group, Faculty of Medicine, Biology and Health, The University of Manchester, United Kingdom

* Corresponding author. Infectious Diseases in Global Health, Manchester Fungal Infection Group, CTF building, Grafton Street, Manchester, M13 9NT, United Kingdom.
E-mail address: ddenning@manchester.ac.uk (D.W. Denning).