



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

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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

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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 n (%)
	Public sector n (%)	Private sector 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 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

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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.

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