

### Delay along the care seeking journey of patients with Microbial Keratitis in Uganda

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12 **4 Uganda**

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42  
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3 40 **ABSTRACT**  
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6 41 **Purpose:** To describe the care seeking journey and causes of delay among patients with  
7  
8 42 Microbial Keratitis in Uganda.

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11 43 **Methods:** A prospective cohort of patients presenting with microbial keratitis at the two main  
12  
13 44 eye units in Southern Uganda (2016-2018). We collected information on demographics, home  
14  
15 45 address, clinical history and presentation pathway ~~including:including,~~ order of facilities where  
16  
17 46 patients went to seek care, treatment advice, cost of care and use of Traditional Eye Medicine.  
18  
19 47 Presentation time was noted. We compared “direct” presenters versus “indirect” presenters  
20  
21 48 and analysed predictors of delay.  
22  
23

24  
25 49 **Results:** 313 patients were enrolled. All were self-referred. Only 19% of the patients presented  
26  
27 50 directly to the eye hospital. Majority (52%) visited one facility before presenting, 19% visited 2  
28  
29 51 facilities, 9% visited 3 facilities and 2% visited 4 facilities. The cost of care increased with  
30  
31 52 increase in the number of facilities visited. People in a large household, further distance from  
32  
33 53 the eye hospital and those who used Traditional Eye Medicine ~~were~~ less likely to come directly  
34  
35 54 to the eye hospital. Visiting another facility prior to the eye hospital and use of Traditional Eye  
36  
37 55 Medicine aOR 1.58 (95%CI 1.03-2.43), p=0.038 were associated with delayed presentation  
38  
39 56 to the eye hospital.  
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42  
43 57 **Conclusion:** This study provided information on ~~care-seekingpatient~~ journeys to seek care.  
44  
45 58 Delay was largely attributable to having visited ~~another~~ health facility: a referral mechanism  
46  
47 59 for microbial keratitis was non-existent. There is need to explore how these ~~gaps~~-health  
48  
49 60 system gaps can be strengthened.  
50  
51

52  
53 61 **Keywords**  
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56 62 Microbial Keratitis, Bacterial keratitis, Fungal keratitis, Keratitis, Blindness, Uganda  
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## 64 INTRODUCTION

65 Microbial keratitis (MK) can be caused by a range of pathogens, including bacteria, viruses,  
66 protozoa (e.g. *acanthamoeba*), and fungi (yeasts, moulds and microsporidia). It is  
67 characterised by an acute or sub-acute onset of pain, conjunctival hyperemia and corneal  
68 ulceration with a stromal inflammatory cell infiltrate. MK frequently leads to sight-loss from  
69 dense corneal scarring, or even loss of the eye, especially when the infection is severe and/or  
70 appropriate treatment is delayed.<sup>1</sup> MK is important because it is a leading causes of unioocular  
71 blindness worldwide.<sup>2,3</sup>

72 In Sub Saharan Africa, the incidence of MK has been suggested to be around  
73 180/100,000/year.<sup>4</sup> Bacterial (*staphylococcus*, *streptococcus* and *pseudomonas*) and fungal  
74 (*fusarium* and *aspergillus*) are the most common with an almost 50:50 proportion.<sup>5-11</sup>

75 In Lower and Middle-Income Countries (LMIC), MK management is often more challenging  
76 because of late presentation, use of Traditional Eye Medicine (TEM), insufficient diagnostic  
77 support, lack of effective drugs and keratoplasty services.<sup>11,12</sup>

78 A critical step in effectively managing MK is ensuring that patients start appropriate treatment  
79 as early as possible. This is because once the infection is well established, there is little that  
80 can be done to change its course.<sup>13</sup> It is believed that many MK start following corneal  
81 abrasions. Studies in Burma and Bhutan showed that if people with a simple corneal abrasion  
82 applied antibacterial or antifungal medication responded within the first 24-48 hours, ~~to a~~  
83 ~~simple corneal abrasion by applying antibacterial or antifungal medication,~~ there was full  
84 recovery without any infectious sequelae.<sup>14-16</sup>

85 Delayed presentation of patients is a key determinant of outcomes.<sup>12</sup> Patients typically present  
86 at least two weeks after the onset of the first symptoms.<sup>12</sup> There are a number of factors that  
87 could contribute to this delay such as: distance from the hospital, transportation costs, poverty,  
88 self-medication and tortuous referral pathways through the health system.<sup>17-19</sup> Prior visit to a

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3 89 non-specialist health facility has been implicated as a cause of delay in other eye  
4  
5 90 conditions.<sup>18,20</sup>  
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8 91 In Uganda, the public health system has six levels, with the lowest point of care being at the  
9  
10 92 village level (Village Health Committee).<sup>21</sup> However, physically, a Health Centre II (HC II) is  
11  
12 93 the lowest unit and is located at a parish level, HC III at sub-county level, HC IV at county  
13  
14 94 level, district hospital (HC V), and referral hospital (HC VI). These units have quite different  
15  
16 95 staffing and capacity in terms of service provision. There are several different levels of private  
17  
18 96 health care providers as well. Patients are referred up this tier system depending on the  
19  
20 97 complexity of their condition.  
21  
22

23  
24 98 Therefore, to investigate the role of the health system in providing care and onward referral of  
25  
26 99 people with MK, here we describe the presentation pathway and factors associated with  
27  
28 100 delayed presentation, among patients with microbial keratitis in Uganda.  
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30

## 31 101 **METHODS**

### 32 102 **Ethical statement**

33  
34  
35 103 This study followed the tenets of the Declaration of Helsinki. It was approved by the London  
36  
37 104 School of Hygiene & Tropical Medicine Ethics Committee (Ref 10647), Mbarara University  
38  
39 105 Research Ethics Committee (Ref 10/04-16) and Uganda National Council for Science and  
40  
41 106 Technology (Ref HS-2303). Written informed consent in “*Runyankore*” the local language was  
42  
43 107 obtained before enrolment. If the participant was unable to read, the information was read to  
44  
45 108 them ~~any by the research assistant. The participant was~~ they were asked to place a  
46  
47 109 thumbprint on the consent form, which was independently witnessed.  
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### 53 110 **Study design and setting**

54  
55  
56 111 This was part of a study where we prospectively enrolled patients with MK that presented to  
57  
58 112 Ruharo Eye Centre (REC) and Mbarara University and Referral Hospital Eye Centre  
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2  
3 113 (MURHEC) from December 2016 to March 2018. MURHEC is a government owned tertiary  
4  
5 114 eye unit established in 2013. It provides mostly free services and sees about 6,000 - 10,000  
6  
7 115 patients/year. REC is a church-based, fee-paying tertiary eye hospital founded in the 1960s.  
8  
9 116 It sees about 20,000 - 25,000 patients/year. Both hospitals are in Mbarara Municipality, South-  
10  
11 117 Western Region, Uganda, approximately four hours' drive from Kampala. The two units are  
12  
13  
14 118 about 5km apart and work closely together.

### 16 17 119 **Participants**

18  
19  
20 120 All patients that were enrolled into the cohort study were included. In that cohort study, we  
21  
22 121 aimed to recruit all MK cases presenting during a year in order to have a powerful sample set  
23  
24 122 to answer detailed questions around the seasonal microbiological patterns. It was important  
25  
26 123 to recruit for a full year as MK had been shown in other parts of the world to have seasonal  
27  
28 124 variations in its' epidemiology.<sup>22</sup>

### 30 31 125 **Study participants**

32  
33  
34 126 The inclusion criteria for the bigger prospective study was the presence of acute MK at  
35  
36 127 presentation to the hospital defined as EITHER (i) corneal epithelial ulceration ( $\geq 1$ mm  
37  
38 128 diameter) AND corneal stromal infiltrate AND evidence of acute ocular inflammation (e.g.  
39  
40 129 Conjunctival injection / anterior chamber inflammatory cells / hypopyon); OR (ii) a corneal  
41  
42 130 abscess ( $\geq 1$ mm diameter) AND evidence of acute ocular inflammation. We excluded those  
43  
44 131 not willing to participate, those not willing to return for follow-up, pregnant women, lactating  
45  
46 132 mothers, those aged below 18 years.

### 47 48 49 50 133 **Data collection procedures**

51  
52  
53 134 Patients presenting with MK were introduced to the study and the informed consent processes  
54  
55 135 followed. They were assigned a unique study number and their age, sex, occupation and place  
56  
57 136 of residence recorded. A history was taken of the circumstances in which their eye became  
58  
59 137 infected, the predisposing factors (such as trauma and use of Traditional Eye Medicine [TEM]).

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2  
3 138 A meticulous “journey” history was taken to document the date when they developed  
4  
5 139 symptoms, where and when they sought treatment (name and level of the health centre), what  
6  
7 140 medical advice and treatment was given (including whether they were referred to the eye  
8  
9 141 hospital or not), how much each step cost them in Uganda shillings (transportation,  
10  
11 142 consultation fees, medicines). The total amount of money recorded was for all the costs  
12  
13  
14 143 incurred before patients were enrolled into the study.

15  
16  
17 144 The place where they first received any form of treatment was denoted as “Facility 1”, the  
18  
19 145 second place visited (either as a result of formal referral or self-initiated referral) was denoted  
20  
21 146 “Facility 2” and so on. GPS coordinates were generated for the patients’ addresses (to the  
22  
23 147 nearest village, parish, county school or health centre-depending on what was available on  
24  
25 148 Google maps). Presenting Log MAR (Logarithm of Minimum Angle of Resolution) visual acuity  
26  
27 149 at 2 metres in a dark room was measured using Peek Acuity software.<sup>23</sup> For visual acuities of  
28  
29 150 counting fingers or less, Log MAR values were attributed as follows: counting fingers, 2.0;  
30  
31 151 hand movements, 2.5; perception of light, 3.0; and no perception of light, 4.0.<sup>24</sup> The patients  
32  
33 152 were then examined on a slit lamp and clinical signs carefully recorded. Infiltrate size was  
34  
35 153 measured as the greatest diameter of the infiltrate (dimension 1) and the diameter of an  
36  
37 154 imaginary line perpendicular to the widest axis (dimension 2). The final infiltrate size was then  
38  
39 155 derived as the geometrical mean of the two diameters.<sup>25</sup> The same was repeated after  
40  
41 156 fluorescein staining of the ulcer to measure the epithelial defect sizes. Corneal specimens  
42  
43 157 were obtained for microbiological testing at Mbarara University Microbiology Department.  
44  
45 158 Patients were treated as per the hospital treatment protocol and followed up periodically for  
46  
47 159 up to 3 months to determine their outcome.

## 50 51 160 **Analysis**

52  
53  
54 161 Data were analysed in STATA v14. “direct” presenters were defined as participants whose  
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56 162 first point of care was the eye hospital (MURHEC or REC). “Indirect” presenters are those who  
57  
58 163 first went to other health centres before presenting to the eye hospital. Summary frequency  
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1  
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3 164 tables of demographics and clinical presentation of “direct” versus “indirect” presenters were  
4  
5 165 generated with appropriate statistical tests for each variable (Wilcoxon rank sum for the  
6  
7 166 continuous variables and  $\chi^2$  test for the categorical variables). To determine where the  
8  
9 167 participants came from, Google maps was used to pinpoint to the addresses of the  
10  
11 168 participants. The presentation journey was described using interval times in days from home  
12  
13 169 to Facility 1 or from Facility 1 to Facility 2 and so on (presented as median time in days with  
14  
15 170 Inter Quartile Ranges [IQRs]). To describe the cost of care, the total patient expenditure at  
16  
17 171 different facilities were summarised and cumulative expenditure derived depending on how  
18  
19 172 many facilities an individual visited. Costs are presented as median expenditure in Uganda  
20  
21 173 shillings with IQRs.

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24  
25 174 Presentation time was defined as the time in days it took a patient to come to the eye hospital  
26  
27 175 after onset of symptoms. For analysis of delay, presentation time was divided into quartiles as  
28  
29 176 “early” (0-7days), “intermediate” (8-14days), “late” (15-30days) and “very late” (>30days).  
30  
31 177 Ordinal logistic regression was performed to determine the factors associated with these four  
32  
33 178 quartiles of “delay”, while logistic regression was performed to determine factors associated  
34  
35 179 with direct presentation. Univariable regression was performed to generate crude Odds Ratios  
36  
37 180 (OR). After assessing for collinearity, variables with a p-value less than 0.1 were introduced  
38  
39 181 in the multivariable model. A backward stepwise approach was then used, until only the  
40  
41 182 variables with a p-value <0.05 were retained. Adjusted OR were reported for the final model.  
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44

## 45 183 **RESULTS**

### 46 47 48 184 **Demographic features**

49  
50  
51 185 During the study period, 313 patients were enrolled into this study. The baseline  
52  
53 186 characteristics of direct versus indirect presenters are shown in Table 1. Overall, the direct and  
54  
55 187 indirect presenters were similar for many variables. However, the direct presenters lived closer  
56  
57 188 to the eye hospital (median 58km vs. 87km;  $p=0.0001$ ), had fewer household members  
58  
59 189 (median 5 people vs. 7 people;  $p=0.006$ ) and fewer were farmers (59% vs. 73%,  $p=0.031$ ).  
60

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3 190 Table 2 shows some select clinical history and signs of direct versus indirect presenters.  
4  
5 191 Compared to indirect presenters, direct presenters had a shorter presentation time (median 8  
6  
7 192 days vs. 17 days;  $p < 0.0001$ ), had slightly better presenting vision (median Log MAR 0.65 vs.  
8  
9 193 1.3;  $p = 0.075$ ), a smaller infiltrate size (median 4.2 mm vs. 5.5 mm;  $p = 0.025$ ) and a smaller  
10  
11 194 epithelial defect (median 3.5 mm vs. 4.1 mm;  $p = 0.048$ ). The proportion of people who had  
12  
13 195 used TEM was higher among the indirect (63%) versus direct presenters (46%),  $p = 0.020$ . The  
14  
15 196 direct and indirect presenters had similar proportions with a history of trauma, hypopyon, an  
16  
17 197 opaque stromal opacity and perforation.  
18  
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20

### 21 198 **Factors associated with direct presentation**

22  
23  
24 199 On univariable and multivariable analysis summarised in Table 3. People who lived far from  
25  
26 200 the eye hospital (overall  $p = 0.003$ ), those from large households OR 0.53 (95%CI 0.32-0.85),  
27  
28 201  $p = 0.0080$  and those who had used TEM OR 0.48 (95% CI 0.25-0.90),  $p = 0.020$  were less likely  
29  
30 202 to be direct presenters.  
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### 33 203 **Care seeking pathway**

34  
35  
36 204 Figure 1 shows where the patients came from in relation to the eye hospital (MURHEC or  
37  
38 205 REC). Most came from the South Western region of Uganda and a handful from Northern  
39  
40 206 Tanzania. Figure 2 shows the place where patients were first treated. Majority (46%) sought  
41  
42 207 treatment at a nearby clinic/pharmacy/drug-shop, 19% presented directly to the eye hospital,  
43  
44 208 15% were initially treated at home (either used TEM or an old eye drop) and 17% were treated  
45  
46 209 at various levels of the health system (HC II, HC III, HC IV and district hospital). Some patients  
47  
48 210 (2%) did not know the type of facility where they first sought care and only 1% went to a  
49  
50 211 traditional healer's shrine for treatment.  
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52

53  
54 212 Figure 3 illustrates the pathway patients took to come to the eye hospital and the different  
55  
56 213 times spent on each stage. Only 55 (20%) patients presented directly to the eye hospital,  
57  
58 214 majority (134, 51%) visited one facility before presenting to the eye hospital, another 43 (19%)  
59  
60

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3 215 visited two facilities, 24 (9%) visited three facilities and 5 (2%) visited four facilities. On  
4  
5 216 average, patients took about a week to move from one facility to the next. The shortest  
6  
7 217 response time was from onset of symptoms to Facility 1 and was even shorter among indirect  
8  
9 218 presenters, median 2 days (IQR 0-5) versus direct presenters, median 8 (IQR 2-18),  
10  
11 219  $P < 0.0001$ . The longest interval time was from Facility 4 to the eye hospital, median 13 (IQR  
12  
13 220 10-33). The choice of the first facility did not affect overall presentation time. All the patients  
14  
15  
16 221 were self-referred.

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18  
19 222 We found in our study that most patients used TEM after having been to a health facility  
20  
21 223 (secondary use). Out of the 188 who used TEM, only 51 used TEM as primary treatment (47  
22  
23 224 at home and 4 at the traditional healers' shrine). The rest (137/188) had secondary TEM  
24  
25 225 application.

#### 26 27 28 226 **Cost of care**

29  
30  
31 227 The cost of care in Uganda shillings (UGX) is presented in Table 4. The cost of care increased  
32  
33 228 with increase in the number of facilities visited. There was evidence (Cuzick test for trend  
34  
35 229  $p < 0.0001$ ), of an association between expenditure and number of facilities visited prior to  
36  
37 230 presentation. The lowest spend was for direct presenters where the median expenditure was  
38  
39 231 UGX 30,000 (IQR 7,000-63,000, total range 0-385,000) and the largest spend was among  
40  
41 232 patients who had visited 4 facilities before presentation with a median expenditure of UGX  
42  
43 233 284,000 (IQR 118,000-439,500, total range 96,000-864,000). Across the different expenditure  
44  
45 234 lines, medicines were the most expensive followed by transportation, consultation fees were  
46  
47 235 the least expensive.

#### 48 49 50 51 236 **Factors associated with delay**

52  
53  
54 237 We tested for associations with delay in presenting to the eye hospital, (Table 5). After  
55  
56 238 adjusting for distance, visiting another facility prior to the eye hospital was strongly associated

239 with delay but no obvious trend. Previous use of TEM was also found to be associated with  
240 delay OR 1.58 (IQR 1.03-2.43), p=0.038

## 241 **DISCUSSION**

242 This study aimed to describe the presentation journey and factors associated with delay.  
243 Factors associated with delay were having visited another health facility and prior use of  
244 Traditional Eye Medicine (TEM). This supported our hypothesis that an initial visit to a health  
245 facility introduced delay as had been reported previously for other eye conditions.<sup>18,20,26</sup> After  
246 onset of symptoms, the majority of patients quickly visited a health facility to seek treatment.

247 This was an impressive median response time (within 48 hours). Although we did not explicitly  
248 ask their reasons for presenting early to these facilities, the painful nature of MK, proximity of  
249 the facilities and trauma (for those who had it) could have played a role. Perhaps, if appropriate  
250 treatment had been given or rapid referral made at this stage, the outcomes might have been  
251 better.<sup>13,14,16</sup>

252 At the first point of contact with the health system, there were three missed opportunities that  
253 we identified in our study, these were: to promptly initiate appropriate treatment; to triage and  
254 urgently refer; and health education advice against TEM use. We discuss these below.

255 Firstly, the health facility where most patients presented first were usually a nearby pharmacy  
256 /clinic. These are mostly private clinics that have sprouted up in many parts of Uganda. They  
257 are loosely regulated, manned by primary health workers and do not require a doctor's  
258 prescription to dispense treatment. Effective anti-microbial medication such as Natamycin and  
259 Ciprofloxacin eye drops are not available in such units. These could be potential stakeholders  
260 to target in promotion of triage and referral mechanisms for MK. We found that there was no  
261 referral mechanism for MK: all patients who came to the eye hospital were self-referred.

262 Secondly, all the patients who visited a health facility we given some treatment but none of  
263 the patients was ever referred for specialist care. Most of the health centres (II and III) are

1  
2  
3 264 managed by mid-level cadres, who may not have the necessary skills and tools to appreciate  
4  
5 265 the urgency and seriousness of MK. General eye health training has been previously reported  
6  
7 266 to be limited among mid-level cadres in the region.<sup>27</sup> In addition, Uganda is still grappling with  
8  
9 267 a major shortage of human resources for eye health. An eye specialist is found at some level  
10  
11 268 six facilities and a mid-level ophthalmic cadre might be available in some level IV onwards.<sup>28</sup>  
12  
13 269 We plan to conduct a study into factors around the health system that could be developed to  
14  
15 270 strengthen treatment, triage and referral.  
16  
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18

19 271 Thirdly, we found in our study that most patients used TEM after having been to a health facility  
20  
21 272 (secondary use). This is worrying because these were patients who could have been  
22  
23 273 sensitised against TEM use at the health facilities where they first presented. This was a  
24  
25 274 missed opportunity that needs to be addressed.  
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27

28 275 Fifty-Eight (19%) of the patients were direct presenters. As expected, people who had large  
29  
30 276 households, those who lived far from the eye hospital and those who used TEM were less  
31  
32 277 likely to present directly to the eye hospital. Understandably, use of TEM and having a large  
33  
34 278 household were negative predictors for being a direct presenter. Most of the people who used  
35  
36 279 TEM used it at home and this was marked as a treatment event in our study design. Many  
37  
38 280 patients in our cohort were heads of households and the sole bread winners, they might have  
39  
40 281 preferred to first seek treatment at a place near home.  
41  
42  
43

44 282 The cost of care was variable depending on the number of facilities visited. Most of the money  
45  
46 283 was spent on drugs, and transportation. The public health system in Uganda is largely free or  
47  
48 284 highly subsidised. Expenses are incurred on transportation and sometimes medicines when  
49  
50 285 they are out of stock. For the case of MK, drugs such as Natamycin have only been erratically  
51  
52 286 and expensively supplied by select private pharmacies and not available in the public health  
53  
54 287 system. We anticipate this to change as Natamycin was recently added on the WHO essential  
55  
56 288 medicines list.<sup>29</sup>  
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## 289 **Strengths/limitations**

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2  
3 290 This study was the first in SSA to systematically collect information on how MK patients seek  
4  
5 291 care and what influences their pattern. It provides useful information on key health system  
6  
7 292 gaps that need strengthening. Before this study, it had been thought that patients had poor  
8  
9 293 health seeking behaviour, however, what we found was that majority of people presented to a  
10  
11 294 health facility quite early after the onset of symptoms. Secondly, although TEM use was a  
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13 295 known problem, this study showed that the bigger problem was secondary TEM use, that is  
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15 296 patients who opted to use TEM even after they had been to a health facility.  
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19 297 Although we collected information on distance covered and treatment given at each level, it  
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21 298 was difficult to analyse for these because most patients did not come to the eye hospital with  
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23 299 their medicine and could not recall the names. There were many circular movements that  
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25 300 made it complicated to analyse total distance covered by each patient. A qualitative approach  
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27 301 in discussing with patients what informed their choice of self-referral or direct presentation  
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29 302 would have strengthened the evidence in this study.  
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## 32 **CONCLUSION**

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36 304 Delayed presentation to a specialist eye hospital is a problem in the care of MK, and that this  
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38 305 appears to be largely attributable to slow referral through the health system. There are  
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40 306 opportunities for health education, early referral, appropriate treatment and sensitization  
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42 307 against TEM use that could be utilized to improve care of MK. This important insight highlights  
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44 308 the missed opportunities in the health system that need to be addressed to improve a triage  
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46 309 and referral mechanism for MK, prompt appropriate treatment and sensitisation against TEM  
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48 310 use. More needs to be done to understand what goes on in the health system and how this  
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51 311 can be strengthened.  
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Table 1: Baseline characteristics of direct versus indirect presenters (n=313)

Variable	Direct presenters (n=58)			Indirect presenters (n=255)			P-value
	Median	(IQR)	(Total range)	Median	(IQR)	(Total range)	
Age	47	(35-60)	(18-96)	47	(35-60)	(18-87)	0.772
Distance to Eye Units	58	(16-85)	(0.2-244)	87	(57-131)	(2-378)	0.0001
Household population	5	(3-7)	(1-14)	7	(4-8)	(1-28)	0.006
Distance to nearest Health Centre in Km*	2	(1-3)	(0-14)	3	(1-4)	(0-45)	0.174
Variable	Category	count	(%)	count	(%)	P value	
Gender	Female	22	(38%)	117	(46%)	0.271	
	Male	36	(62%)	138	(54%)		
Occupation	Farmer	34	(59%)	186	(73%)	0.031	
	Non-farmer	24	(41%)	69	(27%)		
Marital status	Unmarried †	18	(31%)	77	(30%)	0.900	
	Married	40	(69%)	178	(70%)		
Education status	None	15	(26%)	69	(27%)	0.407	
	Primary	29	(50%)	133	(52%)		
	Secondary	7	(12%)	38	(15%)		
	Tertiary	7	(12%)	15	(6%)		
Being head of household	Yes	42	(72%)	170	(67%)	0.398	
	No	16	(28%)	85	(33%)		
Needed an escort to hospital*	Yes	24	(41%)	49	(20)	<0.0001	
	No	34	(59%)	202	(80)		

\*Variables with some missing data: distance to nearest health centre was measured in km (n=312, [direct 57]) needed an escort (n=309, [direct 58]). † Unmarried included single, divorced and widowed,

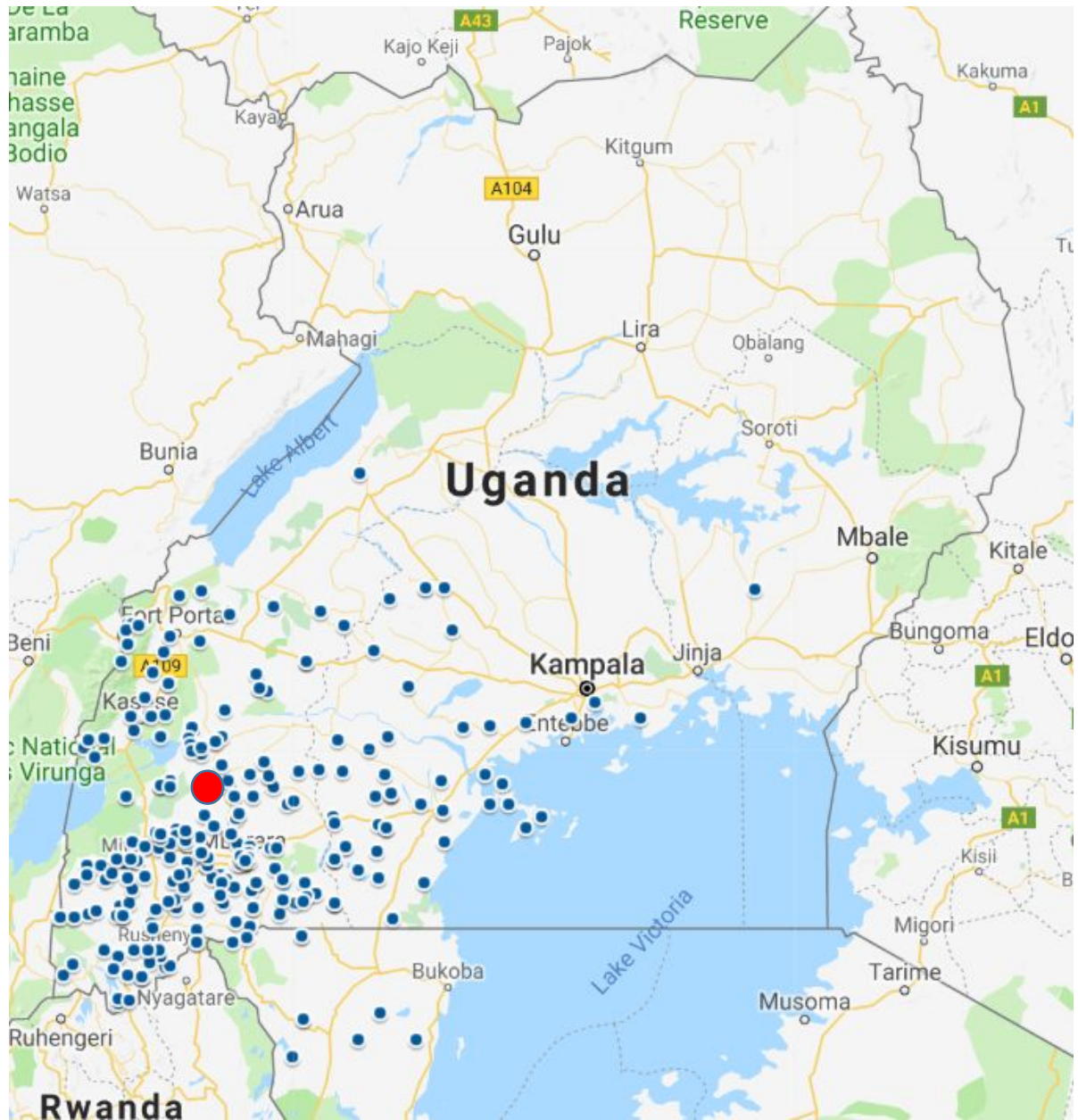
Table 2: Clinical history and clinical signs of direct versus indirect presenters (n=313)

Variable	Direct presenters (n=58)			Indirect presenters (n=255)			P value
	Median	(IQR)	(Total range)	Median	(IQR)	(Total range)	
<b>Presentation time <u>in days</u>*</b>	8	(2-18)	(0-116)	17	(8-32)	(0-370)	<0.0001
<b>Presenting Vision (Log MAR)</b>	0.65	(0.1-2.5)	(0-4)	1.3	(0.3-2.5)	(0-4)	0.072
<b>Infiltrate size in mm <u>‡</u>*</b>	4.2	(2.5-7.1)	(0.9-11)	5.5	(3.5-8)	(0.5-13)	0.025
<b>Epithelial defect size in mm <u>‡</u>*</b>	3.5	(1.8-5.8)	(0-11)	4.1	(2.5-6.9)	(0-13)	0.048
Variable	Category	count	(%)	count	(%)	P value	
<b>History of trauma (overall 29%) <u>‡‡</u></b>	Yes	14	(25%)	77	(30)	0.388	
	No	43	(75)	177	(70)		
<b>Used Traditional Eye Medicine (overall 61%)</b>	Yes	27	(46)	161	(63)	0.020	
	No	31	(53)	94	(37)		
<b>Pain being the main complaint</b>	Yes	26	(45%)	112	44	0.121	
	No	32	55	143	56		
<b>Opaque stromal opacity <u>‡‡</u></b>	Yes	25	(43)	107	(44)	0.918	
	No	33	(57)	137	(56)		
<b>Hypopyon <u>‡‡</u></b>	Yes	13	(22)	81	(32)	0.151	
	No	45	(78)	172	(68)		
<b>Perforated at admission</b>	Yes	10	(17)	66	(26)	0.166	
	No	48	(83)	189	(74)		

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3 | \*Presentation time was measured as duration in days it took to come to the eye hospital after onset of symptoms. †geometrical of the largest  
4 diameter and the diameter perpendicular to the largest diameter. ‡ variables that had less than 313 observations due to missing data (trauma  
5 n=311 [direct57] , opaque stromal opacity n=302 [direct 58], hypopyon n=311 [direct 58]).  
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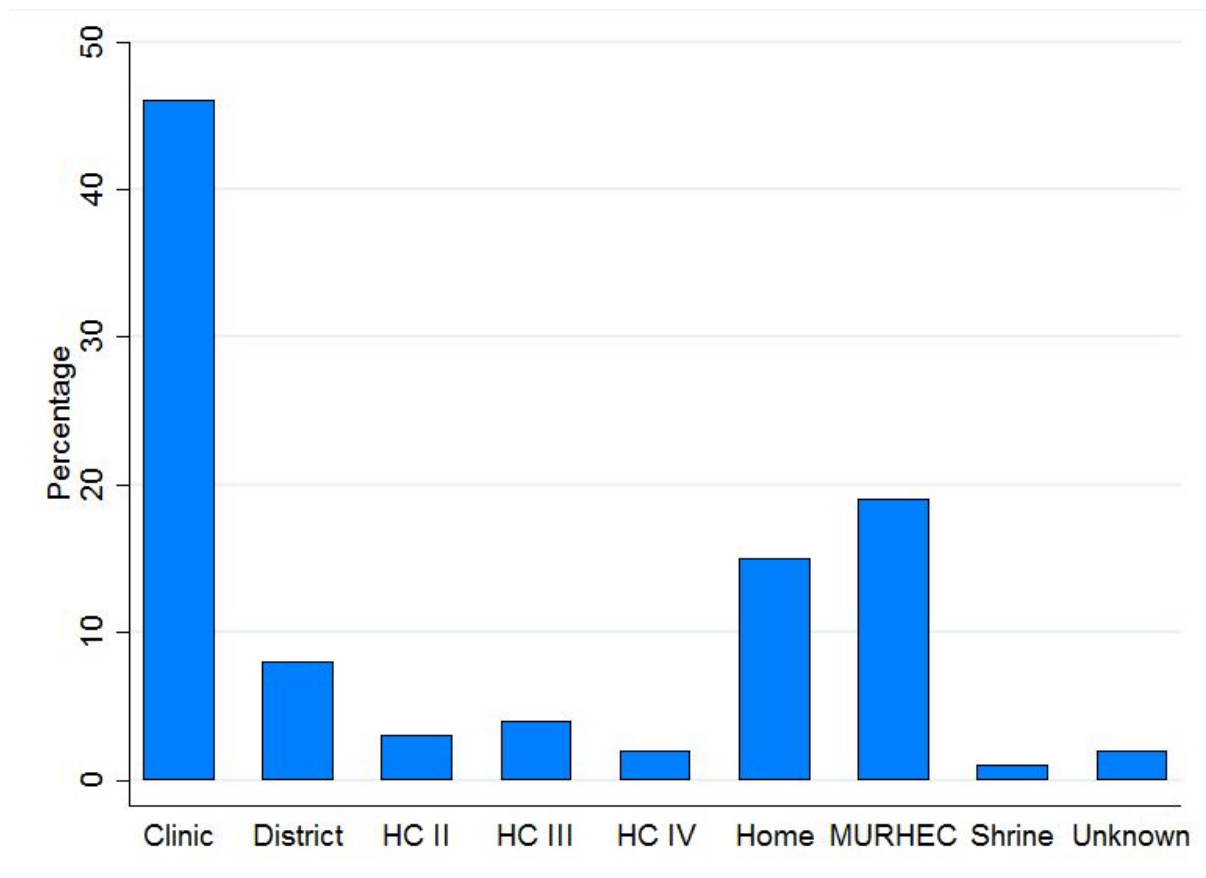
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Figure 1 A map of Uganda showing patients homes



Each point represents a patient. The red circle is the eye hospital where these patients presented.

Figure 2 showing where patients first accessed treatment (n=309)



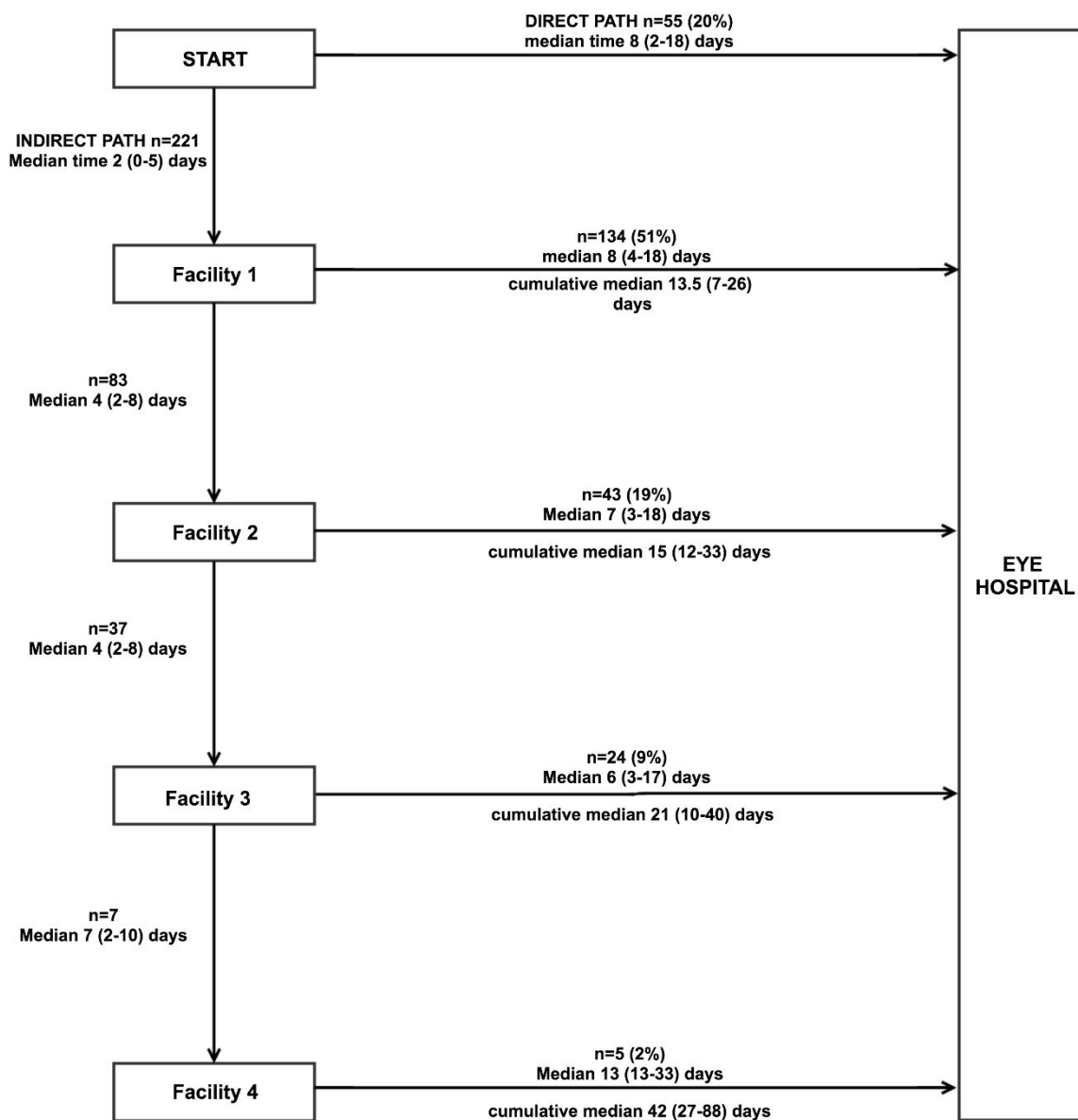
**Key:** Clinic refers to clinic/pharmacy/drug shop, District is district hospital, MURHEC is the main eye hospital (Mbarara University and Referral Hospital Eye Centre and Ruharo Eye Centre)

Table 3: Univariable and multivariable logistic regression analysis of factors associated with direct presentation to the eye hospital (n=309)

Variable	Univariable analysis			Multivariable analysis		
	cOR	(95% CI)	p-value	aOR	(95% CI)	p-value
<b>Age in years</b>	1.004	(0.987-1.022)	0.576			
<b>Sex (being male)</b>	1.38	(0.77-2.48)	0.273			
<b>Marital status (being married)</b>	0.96	(0.52-1.78)	0.900			
<b>Occupation (being a farmer)</b>	0.52	(0.29-0.94)	0.033			
<b>Being head of household</b>	1.31	(0.69-2.46)	0.399			
<b>Number of people in household (increase/one person)</b>	0.59	(0.38-0.90)	0.015	0.53	(0.32-0.85)	0.008
<b>Distance to the eye hospital</b>						
0-50km	1		0.001			0.003
50-100km	0.52	(0.26-1.01)		0.62	(0.30-1.27)	
100-150km	0.16	(0.05-0.44)		0.16	(0.06-0.48)	
>150km	0.42	(0.17-1.03)		0.52	(0.19-1.34)	
<b>Distance from nearest health centre (increase per 1km)</b>	0.92	(0.822-1.029)	0.146			
<b>Positive history of trauma</b>	0.74	(0.38-1.44)	0.389			
<b>Positive history of TEM Use</b>	0.50	(0.28-0.90)	0.021	0.48	(0.25-0.90)	0.020
<b>Education status</b>						
None	1		0.462			
Primary	1.00	(0.50-1.99)				
Secondary	0.84	(0.31-2.25)				
Tertiary	2.14	(0.74-6.17)				

\*patients with missing data were dropped from the model. OR less than 1 means they were less likely to come directly to the eye hospital

Figure 3: The care seeking journey of patients with Microbial keratitis and the time taken at each step (n=276)



In this analysis, only patients with complete data were included. START refers to when the symptoms started. Facility refers to a health centre or clinic/pharmacy and not necessarily the hierarchy of the health centres

Table 4: Money spent by patients per number of facilities visited before coming to the eye hospital

Facility	n (%)	Cost of Care Median (IQR) in Uganda Shillings*							
		Transportation		Consultation		Medicine		Total expenditure	
0	58 (18.5%)	11,000	(4,000-20,000)	15,000	(0-15,000)	0	(0-27,000)	30,000	(7,000-63,000)
1	147 (52%)	19,500	(10,000-33,000)	15,000	(15,000-15,000)	19,800	(2,750-99,500)	52,000	(31,000-142,000)
2	58 (18.5%)	22,000	(15,000-37,000)	15,000	(0-15,000)	25,750	(6,000-80,000)	67,750	(34,250-142,500)
3	29 (9%)	30,000	(19,000-51,000)	15,000	(0-15,000)	28,500	(3,000-70,000)	78,250	(32,000-209,000)
4	6 (2%)	62,500	(33,000-143,000)	12,500	(10,000-30,000)	170,500	(78,000-343,500)	284,000	(118,000-439,500)
<b>P value of test for trend</b>								<0.0001	

\*All money is quoted in Uganda shillings. The US \$ exchange rate was US \$1: Uganda shillings 3,700 (2017). †0-direct presenters who did not visit any other facility before coming to the eye hospital. Patients with incomplete data were not included in this analysis



Table 5: Univariable and multivariable ordinal logistic regression analysis of factors associated with delay among patients with Microbial Keratitis (n=309)

Variable	Univariable analysis			Multivariable analysis		
	cOR	(95% CI)	p-value	aOR	(95% CI)	p-value
<b>Age in years</b>	1.009	(0.994-1.019)	0.140			
<b>Sex (being male)</b>	1.06	(0.71-1.58)	0.792			
<b>Marital status (being married)</b>	0.86	(0.55-1.33)	0.316			
<b>Occupation (being a farmer)</b>	1.24	(0.80-1.93)	0.339			
<b>Being head of household</b>	0.83	(0.54-1.27)	0.394			
<b>Number of people in household (increase/one person)</b>	1.14	(0.85-1.51)	0.365			
<b>Distance to the eye hospital (every 10km increase)</b>	1.036	(1.003-1.)	0.034			
<b>Distance from nearest health centre (increase per 1km)</b>	1.01	(0.97-1.06)	0.501			
<b>Positive history of trauma</b>	0.96	(0.62-1.49)	0.860			
<b>Positive history of TEM Use</b>	1.73	(1.14-2.62)	0.010	1.58	(1.03-2.43)	0.038
<b>Other facilities visited before eye hospital</b>						
Nil (direct presenters)	1		0.0002	1		0.001
One facility	2.95	(1.63-5.38)		2.74	(1.53-4.92)	
Two facilities	3.62	(1.74-7.52)		2.58	(1.30-5.15)	
Three facilities	4.12	(1.82-9.34)		3.26	(1.42-7.45)	
Four facilities*	15.5	(2.65-90)		14.3	(2.45-83.7)	

\*2 patients had visited 5 facilities and one patient 6 facilities, these were dropped from the analysis