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Outcomes of Cataract Surgery Performed By Non-Physician Surgeons in Rural Northern Cameroon: Use of the Better Operative Outcomes Software Tool (BOOST) - A Follow-up Study

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Abstract

Purpose: To assess outcomes and reasons for poor results after cataract surgery by non-physician surgeons (NPCS) in North Cameroon using a novel app.

Design: Prospective cohort study.

Participants: Consecutive patients undergoing surgery for age-related cataract between December 2016 and August 2017 at two non-governmental organization (NGO) hospitals (Lagdo and Kousseri) in northern Cameroon.

Methods: The Better Operative Outcome Software Tool (BOOST) app was used to collect data on visual acuity (VA) before and one day after surgery. Reasons for poor visual outcomes were recorded for 20 consecutive patients returning >6 weeks after surgery with VA<6/60.

Main outcome measures: Proportion of patients with good (VA ≥ 6/18), borderline (VA 6/60–6/18), and poor (VA<6/60) results, and cause of poor results: refractive problems, surgical complications or presence of ocular comorbidities.

Results: In total, 148 patients (148 eyes) in Lagdo and 91 patients (91 eyes) in Kousseri were evaluated. Mean (Standard deviation [SD]) age was 62.1 (8.0) years (54.1% male) in Lagdo and 65.7 (11.1) years (56% male) in Kousseri. Most patients (63.4% in Lagdo, 64.9% in Kousseri) were blind in the surgical eye pre-operatively. Good, borderline and poor surgical outcomes were present on Day 1 in 6.8%, 62.1%, and 31.1% in Lagdo (3rd percentile among BOOST users) and 2.2%, 65.9% and 31.9% in Kousseri (2nd percentile). Main reasons for poor surgical outcomes were ocular comorbidities in Lagdo (19 among 21 patients) and refractive errors in Kousseri (8 among 13 patients).

Conclusions: BOOST placed surgical results into context, and identified main causes of poor outcomes in each center.

Keywords: Cataract surgery; Non physician cataract surgeons; BOOST application; Vision 2020; Ophtalmo Sans Frontières

Introduction

In 2015, cataract was the leading cause of blindness worldwide (responsible for 35.1% of vision loss) and the second cause of visual impairment (25.1%), after uncorrected refractive errors (52.3%) [1–4].

In western countries, patients most often undergo surgery before experiencing severe visual impairment [5]. However, cataract remains a major public health problem in many developing countries [3,6]. In 1999, the World Health Organization (WHO) and the International Agency for the Prevention of Blindness launched a program to eliminate avoidable blindness by the year 2020: "VISION 2020, the Right to Sight" [7,8]. Cataract surgery is one of the most cost-effective healthcare interventions, resulting in rapid visual rehabilitation in the large majority of cases [9–11].

Many national plans for preventing blindness in developing countries have led to increased cataract surgical rates [7]. However, a decrease in cataract blindness also depends on surgical quality. Post-operative visual outcomes are often difficult to assess in developing countries because of the low postoperative follow-up rate [12,13]. The WHO recommends that 80% of patients have uncorrected visual acuity (VA) of 6/18 or better in the operated eye at any time between discharge and 12 weeks after cataract surgery [14] Recently, the large-scale multicenter observational study "Prospective Review of Early Cataract Outcomes and Grading (PRECOG)" found a high correlation between visual outcomes at 40 or more days and 3 or fewer days postoperatively [15] raising the prospect that vision outcomes could be measured immediately after surgery, when patient follow-up rates are the highest.

The Better Operative Outcomes Software Tool (BOOST) app [16] was created by a group of non-governmental organizations (NGOs) in collaboration with Aravind Eye Hospital (Madurai, India) to allow users to easily measure and improve surgical outcomes, even where rates of patient follow-up are low. The app, based on protocols from PRECOG, allows users to benchmark their own results against other users in the Cloud anonymously (Phase I), and then suggests specific solutions to improve outcomes on the basis of a directed review of cases with poor results (Phase II).

Since 1987, the non-governmental organization Ophtalmo Sans Frontières (OSF) has been working to improve access to cataract surgery in remote areas in North Cameroon [17]. The local population mostly engages in subsistence farming and herding, and very few ophthalmologists work in the area, due to its remoteness and security issues resulting from border conflicts with neighboring Nigeria and Chad. OSF has been supporting 8 sustainable eye-care centers, staffed solely by non-physician cataract surgeons (NPCSs) trained to perform ophthalmic examinations and cataract surgery. These centers provide comprehensive eye care services to local communities, and in 2016, performed 4262 cataract surgeries.

The aim of the present study is to assess outcomes and reasons for poor results after cataract surgery performed by NPCSs in OSF centers in North Cameroon, using the BOOST app.

Methods

Study design

This was an observational, prospective study of cataract surgical outcomes at the 2 largest OSF centers in North Cameroon, located in Lagdo and Kousseri. The Ethics Committee of North and Extreme North Cameroon approved this study on November 13, 2016 and it was conducted in accordance with the tenets of the Declaration of Helsinki. The ethics committee agreed that written consent for participants was not required, as only fully de-identified data were collected, and the primary aim of the exercise was to improve service delivery.

Setting

Lagdo was the first OSF center, established in 1988, due to the presence of a large population of farmers and fishermen around an artificial lake. The center is centrally-located, integrated into the local District hospital and staffed year-round by 2 NPCSs. It has become a surgical training center for residents in ophthalmology from the faculty of medicine of Yaoundé, the capital city of Cameroon. The main cataract surgical technique used in this center is extracapsular cataract extraction (ECCE) [18,19] and 6440 outpatient visits and 988 cataract surgeries were completed there in 2017 [20]. The Kousseri center opened in 2001, in the extreme North region, near the border with Chad. Many patients from the nearby Chadian capital of N'Djamena attend the center, though since 2013, travel has become increasingly dangerous due to the activities of Boko Haram, a Nigerian terrorist group with Jihadist ideology [21] The main cataract surgery technique used in this center is manual small incision cataract surgery (MSICS) [19,22,23] and 5928 outpatient visits and 960 cataract surgeries were performed in 2017.

Data collection

Data were collected using BOOST in a 2-step approach. Phase I involved recording data for at least 60 consecutive patients at each center one day after cataract surgery, as called for in the PRECOG protocol [15]. All patients who underwent surgery for age-related cataract at the two centers between December 2016 and March 2017 were included, and the only exclusion criteria were presence of congenital and post-traumatic cataracts. It should be noted that PRECOG called for excluding patients with ocular co-morbidities known pre-operatively, but such patients were enrolled in the current study, in order to avoid selection bias. Data collected in Phase I included date of surgery, patients' age and gender, preoperative best-corrected visual acuity (BCVA) in both eyes, laterality of the operative eye, surgical technique and the uncorrected VA one day after surgery in the operative eye.

Phase II involved recording data between December 2016 and August 2017 for 20 consecutive patients with VA ≤ 6/60 who returned 6 weeks or more after surgery. All patients who fulfilled these conditions after age-related cataract surgery performed in Lagdo or Kousseri centers were included, again with the exclusion criteria of congenital and post-traumatic cataracts. The patient groups in Phases I and II were generally different, as is usually the case with BOOST. Data recorded during Phase II included date of follow-up, patient's age and gender, laterality of the operative eye, the uncorrected visual acuity (UCVA), BCVA and reason for poor outcome, which the BOOST app prompted users to select for each patient from among three possibilities: refractive problems, surgical complications or presence of ocular comorbidities. More detailed information on causes of poor outcomes, such as the exact diagnosis in the case of co-morbidities, was also collected outside of the BOOST app.

Measurement of vision

Visual acuity was recorded separately for each eye at each visit with Tumbling E Snellen charts freshly printed for the study and designed for use at a distance of 5 meters. After correctly identifying the direction of more than half of the optotypes on the uppermost line

(equivalent to a VA of 6/60), patients moved to the next and then to successively lower lines. The lowest line on which more than half of the optotypes were correctly read was recorded as the patient's VA. For patients unable to read the top line at the standard distance, we considered "count fingers at 3 to 5 meters" as equivalent to 3/60 and "count fingers at 1 meter" as equivalent to 1/60. Throughout testing, the examiner ensured that the fellow eye remained fully occluded, and that the patient maintained the proper distance from the chart and did not squint (which creates an optical pinhole effect that may improve vision). VA was recorded in Monnoyer notation, and then converted to Snellen 6 meters notation. The WHO definitions of blindness (VA<3/60) and severe visual impairment (VA 3/60–6/60) were used throughout [24].

Cataract surgical technique was recorded as either ECCE or MSICS [19,20,22]. A one-piece posterior chamber intraocular lens (PCIOL) made with poly methyl methacrylate material was used (Aurolens®, Aurolab, Madurai, India) for all surgeries.

Outcomes and statistical methods

The primary outcome was UCVA in the operative eye one day after cataract surgery. Surgical outcome was categorized according to the WHO classification as good (UCVA ≥ 6/18), borderline (UCVA 6/60–6/18), or poor (UCVVA < 6/60).14 The BOOST app then calculated a single outcome for each facility: the proportion with good vision outcomes subtracting the proportion with bad outcomes. This value was then benchmarked against results from 4000 cases at 40 hospitals from the PRECOG study,15 and a percentile score delivered to users with a simple explanation ("Outstanding result" for ≥ 90th percentile, "Very good result for 75-89th percentile, "Good result" for 50–74th percentile, "Fair result" for 25-49th percentile," and "Capable of being improved" for < 25th percentile.) The secondary outcome was the reason for poor surgical outcome at 6 weeks or more after surgery, assessed as described above.

Results

At day 1 after surgery, UCVA was recorded for 148 patients (148 eyes, mean age [SD] 62.1 [8.0 years, 54% male) at Lagdo and 91 patients (91 eyes, 65.7 [11.1] years, 56% male) at Kousseri. All patients at Lagdo underwent surgery with ECCE and PCIOL, and all patients at Kousseri received MSICS with PCIOL. At 6 weeks or more after surgery, 21 patients (21 eyes, 68.6 [9.6] years, 57% male) with VA<6/60 in the operative eye were enrolled at Lagdo and 13 (68.1 [13.2] years, 54% male) in Kousseri.

At Lagdo, among 148 patients, preoperative BCVA in the surgical eye was < 6/60 for 137 (92.4%), between 6/60 and 3/18 for 9 (6.2%) and ≥ 6/18 for 2 patients (1.4%). The corresponding figures at Kousseri among 91 patients were 80 (87.9%), 11 (12.1%) and 0 patients (0%). One day after surgery, the majority of patients had borderline surgical outcome (92/148 [62.1%] at Lagdo and 60/91 [65.9%] at Kousseri). Surgical outcome was good for 10 patients (6.8%) in Lagdo and 2 patients (2.2%) in Kousseri, and poor for 46 patients (31.1%) at Lagdo and 29 patients (31.9%) at Kousseri (Table 1). The BOOST app in Phase I indicated that results should be considered as "capable of being improved" in Lagdo (Figure 1) and Kousseri.

BOOST application then suggested some changes in order to improve surgical outcomes. In Lagdo, advices were to improve preoperative examination: better recording patients ocular and systemic history, better examining front and back of the eye by slit lamp, checking pupillary reflex and presence of strabismus, performing B-scan ultrasound if available before operating white cataract. In Kousseri, advices were to improve uncorrected post-operative VA: better IOL power calculation, increasing range of IOL powers, decreasing wound astigmatism (by avoiding overly tight sutures or preferring suture less surgery).

WHO VA classification	Lagdo (n=148)		Kousseri (n=91)	
	Pre-operative BCVA	Day 1 PVA	Pre-operative BCVA	Day 1 PVA
Good: VA ≥ 6/18	2 (1.4)	10 (6.8)	0 (0)	2 (2.2)
VA 6/12	1 (0.7)	5 (3.4)	0 (0)	0 (0)
VA 6/18	1 (0.7)	5 (3.4)	0 (0)	2 (2.2)
Borderline: VA–6/18	9 (6.2)	92 (62.1)	11 (12.1)	60 (65.9)
VA 6/24	2 (1.4)	6 (4.1)	0 (0)	1 (1.1)
VA 6/36	2 (1.4)	34 (23.0)	0 (0)	14 (15.4)
VA 6/60	5 (3.4)	52 (35.0)	11 (12.1)	45 (49.5)
Poor: VA <6/60	137 (92.4)	46 (31.1)	80 (88)	29 (31.9)
VA 3/60	43 (29.0)	40 (27.0)	21 (23.1)	24 (26.4)
VA 1/6	52 (35.0)	6 (4.1)	42 (46.2)	5 (5.5)
VA <1/60	42 (28.4)	0 (0)	17 (18.7)	0 (0)

Note: Data are n (%).Abbreviations: WHO = World Health Organization; VA = visual acuity; BCVA = best corrected VA; PVA = presenting VA

Table 1: Best corrected pre-operative visual acuity and presenting visual acuity at day 1 examination in the surgical eye.

Discussion

BOOST software allowed us to assess outcomes and reasons for poor results after cataract surgery performed by NPCSs in a remote rural area in North Cameroon. We compared our data to that recorded in the PRECOG study 15, which evaluated cataract surgery outcomes at 40 centers in 10 developing countries, using principally MSICS surgery (63%), with smaller proportions of phacoemulsification (21%) and ECCE (16%) cases. When comparing our centers to those with similar preoperative VA in PRECOG, the proportion of participants with poor visual outcome at day 1 were similar in our study to summary findings for several regions and countries in PRECOG (31.1% in Lagdo, 31.9% in Kousseri, 39% in Vietnam, 67% in Indonesia, 29% in Latin America, 40% in Africa). However, the proportion of participants with good visual outcomes at day 1 was markedly lower in our study (6.8% in Lagdo, 2.2% in Kousseri, 47% in Vietnam, 22% in Indonesia, 39% in Latin America, 26% in Africa). The BOOST app calculated a single outcome for each facility: the proportion with good vision outcomes subtracting the proportion with poor outcomes. This figure was then used to calculate a single percentile value ranking our two hospitals against the 40 facilities in

PRECOG, making the process of benchmarking much easier. The figure for both facilities in the current study was below the 5th percentile, underscoring the need to improve outcomes. It should be noted that one potential reason for the comparatively low number of good outcomes at these facilities was their policy of operating on and enrolling those patients with known co-morbidities, contrary to the practice in PRECOG and recommended use of the BOOST app, where such patients would be excluded. The main surgical technique used in Lagdo was ECCE, and sutures remaining at early follow-up may have induced significant astigmatism [25]. Though this may in theory have contributed to worse results, the PRECOG study showed that early measurement of visual outcomes was just as accurate in assessing surgical quality in ECCE cases [15].

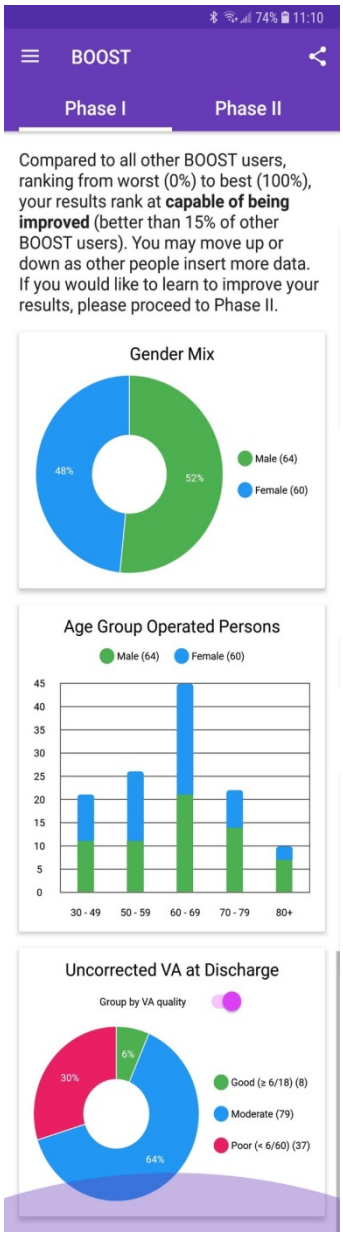

Figure 1: Phase I results in Lagdo as presented in BOOST app.

The main reason for poor surgical outcomes at 6 weeks or more after surgery was ocular comorbidity at Lagdo (19 patients out of 21 [90.5%]) (Figure 2) and refractive error at Kousseri (8 patients out of 13 [61.5%]). Surgical complications were responsible for a similar low proportion of poor outcomes at both Lagdo and Kousseri (2/19 patients [10.5%] and 1/13 patient [7.69%], respectively). Specific causes of co-morbidity are summarized in Table 2.

	Lagdo n = 21 (%)	Kousseri n = 13 (%)
Ocular comorbidity	19 (90)	4 (31)
Glaucomatous optic nerve atrophy	5 (26)	1 (25)
Corneal dystrophy	6 (32)	0
Retinopathy	4 (21)	1 (25)
Posterior capsular opacification still present after surgery	1 (5.2)	1 (25)
Unknown	3 (15.8)	1 (25)
Optical correction	0 (0)	8 (61)
Surgical complication	2 (10)	1 (8)

Table 2: Reasons for poor visual outcome at 6 weeks or more after cataract surgery.

Results of the current study are consistent with another recent [26] on surgical outcomes at day 1 and day 7-30 for cataract surgery in Lagdo. Among 474 patients, the majorities of surgical cases were white cataracts (87.3%), and had poor preoperative VA (88.4%). Good outcome was achieved by only 3.2% of patients at day 1 after surgery. By post-operative day 7-30, this figure had risen to 41.2% among 414 returning patients (87.3%), which remained well below the 25th percentile for facilities participating in PRECOG [15].

Phase II of BOOST is concerned with improving cataract surgical outcomes by helping users to pinpoint the main cause of poor visual outcome at late follow-up. In Lagdo, 90% of poor visual outcomes were attributed to ocular comorbidity, a documented frequent cause in low and middle-income countries [27,28]. Ocular comorbidity could be recognized pre-operatively in some cases (corneal dystrophy) but was less evident in others (glaucomatous optic neuropathy), which could potentially remain un-detected in this setting given the preponderance of white cataracts obscuring a view of the posterior pole. However, recommendations by the BOOST app potentially useful in improving results in this setting include assessment for relative afferent pupillary defect and light perception with projection, both of which could help to defect cases of glaucoma. These changes have been instituted at Lagdo.

In Kousseri, ocular comorbidity explained only 31% of poor visual outcomes. Most eyes (61%) were affected by refractive issues, and could achieve good surgical outcomes after correction. The BOOST app recommends proven solutions to such facilities, including improvement of pre-operative biometry [29], maintaining an adequate range of intra-ocular lenses to avoid the necessity of using incorrect powers, and correctly assessing refractive errors at postoperative visits [4]. Measures such as the routine use of biometry have now been instituted at Kousseri.

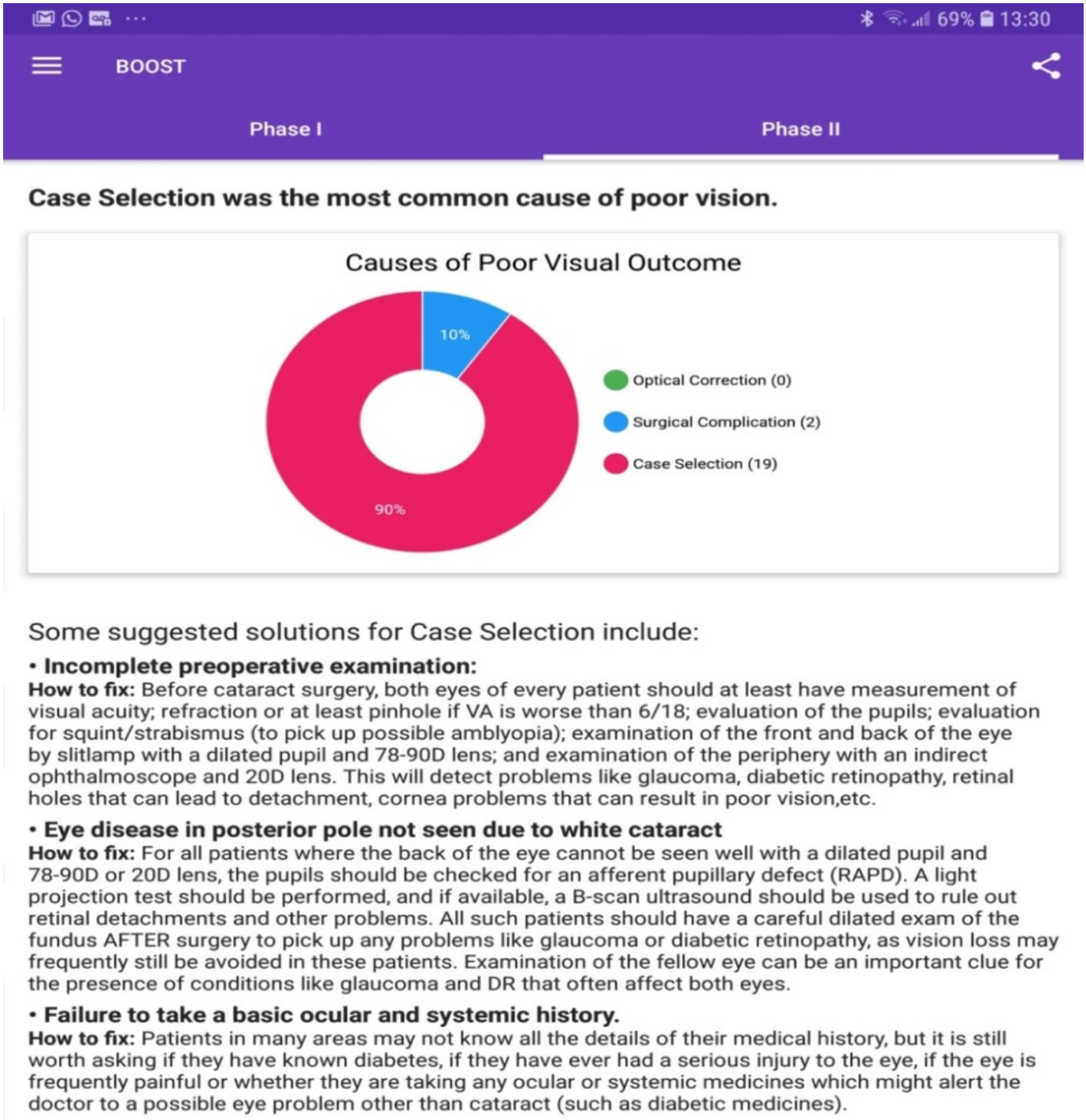

Figure 2: Phase II results in Lagdo as presented in BOOST app.

Collection of data for the second phase of BOOST was a major challenge in our study. In Kousseri, only 13 patients could be recruited over the 9 months between December 2016 and August 2017. This was due in part to low (20-30%) follow-up rates secondary to cost, poor transportation infrastructure and failure to communicate the benefits of returning after surgery, as has been reported in other areas of limited resources [12,13]. In Kousseri, the situation is further complicated by Boko Haram activity in the area.

Surgeons may be wary of monitoring their outcomes, due to fears of being judged by administrators or other practitioners. BOOST allows fully anonymous self-evaluation of individual surgical results, which

may help to overcome resistance to monitoring, and lead to improvement of postoperative visual outcomes [30].

Limitations of our study should also be recognized. In the first place, we did not extend our follow-up prospectively to collect data on the impact of interventions prompted by BOOST on the quality of surgical outcomes, though we hope to report on this in the future. Secondly, objective measurement of post-operative visual acuity does not tell the whole story about the impact of surgery on patients' lives. Even borderline visual outcomes can lead to a meaningful reduction in activity limitations [31] and consequent improvement in quality of life, especially in the setting of pre-operative severe visual impairment or blindness, as was the case here. In Lagdo, 91.1% of patients presented with blindness or severe VI in their affected eye before cataract surgery and this figure was reduced to 29.8% at day 1 after surgery. (The corresponding figures were 87.9% and 31.9% in Kousseri). These improvements likely represent a positive, qualitative change in patients' lives, even if the WHO definition of "good outcome" is not reached.

It should also be emphasized that our study is specifically limited to cataract surgery performed by NPCSs. Use and acceptance of NPCSs varies greatly in different countries [32–34], and so the applicability of our results to these different settings will vary as well. Reasonable visual outcomes were achieved in our study, and BOOST identified ways to further improve them. Encouraging NPCS to use tools like BOOST can allow the eye care community to better understand cataract surgery outcomes in cases performed by NPCSs, as part of finding solutions to the critical lack of ophthalmologists in poor and rural areas in low and middle-income countries.

Conclusion

BOOST software allowed us to assess outcomes and reasons for poor results after cataract surgery performed by NPCSs in a remote rural area in North Cameroon. Blindness and severe visual impairment were decreased at day 1 after surgery. Poor visual outcomes at late follow-up were rarely associated with surgical complications, and in many cases could be improved by optical correction. Many poor results were due to ocular comorbidities, pinpointing the need to improve patient selection in this low-resource setting. BOOST is a suitable tool to evaluate outcomes in areas where cataract surgery is performed by NPCSs, and can be part of improving postoperative outcomes in such settings.

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