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A cost analysis of pediatric cataract surgery at two child eye health tertiary facilities in Africa

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Abstract

Purpose—To determine the direct cost of pediatric cataract surgery at two child eye health tertiary facilities (CEHTFs) in Africa.

Methods—The direct cost of pediatric cataract surgery was determined by reviewing data collected from two CEHTFs in Zambia and Malawi. Inventory, cost, and usage data of all durable medical equipment, consumable equipment, personnel, and medications were collected and the direct cost per child calculated.

Results—For cataract surgery and related treatment during 2011, the total cost per child was calculated to be $202 for Malawi and $277 for Zambia using figures derived from estimating labor cost allocation proportional to employee time devoted to pediatric cataract management. The onetime equipment cost totaled $178,121 for Malawi and $179,832 for Zambia.

Conclusions—These cost estimates may serve as a basis for economic decisions aimed at improving access to care, management, and follow-up for children with cataract and provide

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useful insights for programs dedicated to promoting organizational and financial sustainability for CEHTFs in Africa.

Childhood blindness presents a significant problem because of the well-established morbidity and mortality associated with visual impairment.[1] Worldwide, there are an estimated 19 million children with visual impairment.[2] Of these, an estimated 1.4 million children are irreversibly blind and another 17.5 million have low vision.[3] As preventable vision loss due to vitamin A deficiency and measles declines in the poorest regions of the world, cataracts are emerging as a leading, treatable cause of vision loss in children.[4-6] In Africa, the continent that shoulders a disproportionate burden of childhood blindness,[7] 9%-33% of visually impaired children in schools for the blind suffer from lens pathology.[1]

Cataract surgery with optical rehabilitation and amblyopia therapy may provide these children with functional vision, permitting them to access mainstream educational services and reducing the economic burden on families and communities. In Africa, however, low pediatric cataract awareness, poor access to quality surgical care, delay in presentation for surgery, and lack of resources for postoperative care remain major barriers.[8,9]

The World Health Organization and the International Agency for Prevention of Blindness have recommended that there be one child eye health tertiary facility (CEHTF) per 10 million people in developing countries.[5,10] CEHTFs were developed to maximize the utilization of scarce resources in developing countries and improve access to pediatric eye care. In theory, CEHTFs are placed in highly populated regions and are charged with the task of raising public awareness about pediatric eye problems, identifying children with ocular pathology, and delivering care.[5] In addition to serving as a center for patient care, each CEHTF also generates data for impact-oriented research. Current efforts to promote child eye health are centered around improving diagnosis and access to care for children with cataract, training local care providers to provide quality surgical and clinical care, and making these efforts more sustainable.

To quantify the burden placed on CEHTFs due to childhood cataracts, we performed a cost analysis at two existing CEHTFs in Malawi and Zambia. Zambia has a population of 13.47 million persons, with 59% of that population living at or below the national poverty line. Malawi has a population of 15.38 million persons, with 52% of that population living at or below the national poverty line.[11] Access to healthcare is limited in both countries by a paucity of providers and the availability of few, underfunded facilities. Many of the government eye units continue to provide services only with the added support of nongovernmental organizations (NGOs), which provide 25%-45% of the clinic's total running costs.[12] While many studies have illustrated the cost-effectiveness of cataract surgery in adults,[13-17] few have evaluated the cost of pediatric cataract surgery.[5,18,19] No existing study has objectively analyzed the cost of pediatric cataract surgery in Africa. The present cost of treatment study was performed to assist hospital administrators, local ophthalmologists, donors and nongovernmental organizations in determining fee structures for patients and formulating a budget as well as to facilitate NGOs in their allocation of resources for pediatric cataract surgery.

Methods

Institutional review board approval was obtained through Emory University and through IRB-equivalent boards at Kitwe Central Hospital (Kitwe, Zambia) and Queen Elizabeth Central Hospital (Blantyre, Malawi). In the summer of 2012, investigators traveled to two CEHTFs in Malawi and Zambia. Financial data was collected from the year 2011 pertaining to the pre-operative, intra-, and postoperative services required for a child with congenital or developmental cataract. This information included costs associated with three major components: labor (physicians, nurses, and other support staff), equipment (operating microscope, surgical tools, and other nondisposable equipment), and general treatment costs (disposable equipment and medications). The costs of these three components were added and the final sum was calculated per child for the year 2011.

In 2011 a total of 120 children were treated for congenital or developmental cataracts in Zambia and 112 in Malawi. Equipment and consumable costs were calculated based on purchase documentation and included acquisition costs when available. Importation and customs valuation documents were used where equipment was donated and not directly purchased. For each patient, the amount of consumables used was obtained by direct observation of identical procedures performed during the site visits. Values were confirmed by documentation in patient charts when available. Personnel costs were calculated using annual salary data for all persons involved in treatment. The average exchange rate for 2012 was used to convert foreign currencies into the US dollar amounts. Only persons directly involved in the diagnosis and treatment of childhood cataract were included in this study. Personnel for each site included one pediatric ophthalmologist, one or more anesthetists, one clinician (a midlevel provider), three nurses, patient attendants, and the childhood blindness and low vision coordinator. All costs were collected for the preoperative period, including preoperative office visits and other expenditures leading up to the actual surgical start time. The postoperative period included immediate recovery, the typical 7-day postoperative hospitalization, and bifocal glasses for optical correction.

Results

The direct costs for pediatric cataract surgery were separated into three categories: equipment, labor, and treatment costs. The equipment cost is reported here as a one-time capital expense because the equipment required already existed at the eye care facility. The main pieces of equipment consisted of an operating microscope, vitrectomy machine, anesthesia machine, and slit lamp. For equipment that was donated, valuations were based on customs forms used during importation. The equipment cost for Malawi and Zambia was $178,121 and $179,832 respectively. These pieces of equipment accounted for 64% and 62% of the total equipment cost for Malawi and Zambia respectively.

The annual direct costs for labor and treatment included preoperative, intraoperative, and postoperative expenses for one child with cataract and are summarized in Table 1. The total labor cost was the sum of the monthly salaries for all staff members directly involved in the treatment of pediatric cataract multiplied by 12. The monthly salaries were $5,446 in Malawi and $6,083 in Zambia. Medical staff included the clinician (midlevel provider),

pediatric ophthalmologist, anesthetist, and the refractionist. In Zambia, an anesthesiologist staffed the pediatric cataract cases while in Malawi, an anesthetist and an assistant were utilized for these cases. The nursing staff included a surgical nurse, circulating nurse, and a ward nurse. Other involved personnel included the childhood blindness and low vision coordinator, optical technicians, and optical dispensers. The total annual labor cost was $65,350 for Malawi and $73,000 for Zambia. Salaries are higher in Zambia than Malawi for each corresponding position, thus accounting for the differences seen between the two countries.

The cost of the consumables and medications were $85 per child in Malawi and $155 per child in Zambia. This value was multiplied by the total number of children treated for the year 2011. Thus the annual treatment costs were $9,550 for Malawi and $18,605 for Zambia. The cost per child for each site was calculated using the total cost for labor, consumables, and medications. In Malawi, the total cost was $74,900 per year and, in Zambia, it was $91,605 per year. Dividing these respective values by the total number of children treated,112 in Malawi and 120 in Zambia, yielded a total cost for pediatric cataract surgery of $689 per child in Malawi and $763 per child in Zambia.

Discussion

The World Health Organization's VISION 2020 initiative prioritized the prevention and treatment of childhood blindness.[20] Childhood cataracts continue to be a leading cause of childhood blindness throughout the developing world. At least 200,000 of the world's blind children are blind from cataract and 20,000-40,000 more are born each year with congenital cataracts.[21] In countries like Zambia and Malawi, as the incidence of blindness due to measles and vitamin A deficiency declines,[22] attention is turning to the identification and management of congenital and developmental cataract as a treatable cause of childhood blindness.

Few previous studies have examined the costs of pediatric cataract surgery. Agarwal and colleagues[5] surveyed 27 CEHTFs in Africa (response rate, 78%) in which the respondents reported that the average cost of providing surgery for congenital or developmental cataract was $340, whereas the average fee charged was $117. Gogate and colleagues[18] assessed the direct costs of pediatric cataract surgery from the provider's perspective, in Maharashtra, India, and found that the net average cost of pediatric cataract surgery ranged from $122 to $475 per eye. A cost analysis from a third-party payer perspective in the United States placed the cost of congenital cataract over 12 years at $18,839 per patient.[19] Of note, Stager and colleagues[19] included the costs of daily patching through 8 years of age, office follow-up and regular examinationss under anesthesia through 12 years of age, and any associated complications that might arise related to the initial surgery.[19]

To identify and quantify the resources necessary to address the burden of childhood cataracts at two CEHTFs in Africa, we calculated the cost in US dollars of treating a child with cataract to be $669 in Malawi and $763 in Zambia. Our cost estimate excluded the one-time cost of equipment, which was $178,121 in Malawi and $179,832 in Zambia. Because our goal was to approximate the cost of performing pediatric cataract surgery at an existing

facility, equipment cost was excluded because many pediatric eye clinics function as a part of a larger adult facility that already has most of the required equipment.

Initially, monthly salaries representing 100% of an employee's working time were utilized, although probably only a percentage of that person's time is devoted to the treatment of pediatric cataract. Because of the difficulty of obtaining highly specialized personnel part time in these locations, the entire monthly salary was considered a reasonable proxy for cost of human resources.

Recalculating the personnel (labor) cost according to the proportion of each employee's time spent specifically devoted to pediatric cataract management, about 20% based on observations during the site visit and personal communication with the head of the Eye Department at the Malawi CEHTF (GM), would reduce the labor costs for Malawi to $13,070 and for and Zambia to $14,600. These figures represent 20% of the original respective estimates for total annual labor cost utilizing 100% of employee's time ($65,349.60 and $73,000.08). Adding the recalculated labor costs to the annual treatment costs (see Table 1) of $9,550 in Malawi and $18,604 in Zambia yields $22,620 and $33,205, respectively. Dividing these numbers by the number of children treated in each country yields $202 per child treated in Malawi and $277 in Zambia. These figures are similar to those of Agarwal and colleagues[5] and Gogate and colleagues[18] and reflect the reality that the majority of employee time in the CEHTF is currently directed toward pediatric ocular conditions other than cataract.

There were several limitations to our study. First, there were some instances where financial data pertaining to certain consumables and nonconsumables was missing. Data obtained from the original suppliers was substituted and every effort was made to obtain the original costs. Second, a large proportion of the equipment used at both sites was donated by charitable organizations. The only financial data obtainable for this equipment was customs valuations, and these often represented a reduced amount based on the used equipment value. Because most CEHTFs receive equipment in a similar fashion, this data was included in the study. Third, postoperative follow-up at both of the CHETF sites is highly variable and often limited. Ideally, under the current CEHTF model, patients would return for regular follow-up care. Currently, many patients are kept at the surgical site for up to 1 week after surgery. Therefore, compared with the US cost analysis study, which included medications, supplies for optical rehabilitation and amblyopia therapy, and any associated surgeries over a 12-year postoperative period, [19] we were only able to include the costs associated with 1 week of postoperative care. Reoperation costs could not be analyzed due to incomplete follow-up.

Pediatric cataracts must be identified and treated in a timely manner, given the certainty of irreversible amblyopia without appropriate intervention.[20] Future studies should focus on elucidating the cost-effectiveness of early cataract extraction and demonstrating an improved quality of life for affected children and their families after pediatric cataract surgery.

The number of pediatric cataract surgeries performed in pediatric ophthalmology centers in Africa continues to increase[23] as public awareness of childhood cataracts increases and access is improved. Our cost-analysis study will facilitate resource allocation to the screening, treatment, and management of childhood cataract by facilitating informed decisions regarding future and existing CEHTFs. Quantifying the financial need associated with pediatric cataract surgery, in conjunction with continued efforts to define the educational and logistical barriers related to delayed presentation and poor follow-up, should promote a comprehensive plan to address the treatable problem of childhood cataracts.

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References

1. Kong L, Fry M, Al-Samarraie M, Gilbert C, Steinkuller PG. An update on progress and the changing epidemiology of causes of childhood blindness worldwide. J AAPOS. 2012; 16:501–7. [PubMed: 23237744]
2. World Health Organization. [Accessed November 8, 2013] Visual impairment and blindness. 2012. http://www.who.int/mediacentre/factsheets/fs282/en/
3. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol. 2011; 1:1.
4. Frick KD, Foster A. The magnitude and cost of global blindness: an increasing problem that can be alleviated. Am J Ophthalmol. 2003; 135:471–6. [PubMed: 12654362]
5. Agarwal PK, Bowman R, Courtright P. Child Eye Health Tertiary Facilities in Africa. J AAPOS. 2010; 14:263–6. [PubMed: 20603061]
6. Gogate P, Kalua K, Courtright P. Blindness in childhood in developing countries: time for a reassessment? PLoS Med. 2009; 6(12):e1000177. [PubMed: 19997501]
7. Resnikoff S, Pascolini D, Etya'ale D, et al. Global data on visual impairment in the year 2002. Bull World Health Organ. 2004; 82:844–51. [PubMed: 15640920]
8. Mwende J, Bronsard A, Mosha M, et al. Delay in presentation to hospital for surgery for congenital and developmental cataract in Tanzania. Br J Ophthalmol. 2005; 89:1478–82. [PubMed: 16234457]
9. Bronsard A, Geneau R, Shirima S, Courtright P, Mwende J. Why are children brought late for cataract surgery? Qualitative findings from Tanzania. Ophthalmic Epidemiol. 2008; 15:383–8. [PubMed: 19065431]
10. World Health Organization. Preventing blindness in children. Report of a WHO/IAPB scientific meeting. 1999 WHO/PBL/00.77.
11. World Health Organization. [Accessed 5/22/13] Available at: http://www.who.int/countries/en/
12. Eliah E, Shayo A, Gendo C, Courtright P, Theraney M, Lewallen S. Can VISION 2020 be implemented in rural government settings? Findings from two programmes in Tanzania. Trop Med Int Health. 2008; 13:1284–7. [PubMed: 18937744]
13. Agarwal A, Kumar DA. Cost-effectiveness of cataract surgery. Curr Opin Ophthalmol. 2011; 22:15–8. [PubMed: 21088579]
14. Langsingh VC, Carter MJ, Martens M. Global cost-effectiveness of cataract surgery. Ophthalmology. 2007; 114:1670–78. [PubMed: 17383730]
15. Busbee BG, Brown MM, Brown GC, Sharma S. Incremental cost-effectiveness of initial cataract surgery. Ophthalmology. 2002; 109:606–13. [PubMed: 11874769]

16. Hiratsuka Y, Yamada M, Murakami A, Okada AA, Yamashita H, Ohashi Y, Yamagishi N, Tamura H, Fukuhara S, Takura T. Eye Care Comparative Effectiveness Research Team (ECCERT). Cost-effectiveness of cataract surgery in Japan. Jpn J Ophthalmol. 2011; 55:333–42. [PubMed: 21695383]
17. Griffiths U, Bozzani F, Muleya L, Mumba M. Costs of eye care services: prospective study from a faith-based hospital in Zambia. Ophthalmic Epidemiol. Epub ahead of print October 4, 2013.
18. Gogate P, Dole K, Ranade S, Deshpande M. Cost of pediatric cataract surgery in Maharashtra, India. Int J Ophthalmol. 2010; 3:182–6. [PubMed: 22553549]
19. Stager DR Jr, Felius J, Beauchamp GR. Congenital cataract cost. Ophthalmology. 2009; 116:2484.e1–2. [PubMed: 19948291]
20. Gilbert C, Foster A. Childhood blindness in the context of VISION 2020—the right to sight. Bull World Health Organ. 2001; 79:227–32. [PubMed: 11285667]
21. Foster A, Gilbert C, Rahi J. Epidemiology of cataract in childhood: a global perspective. J Cataract Refract Surg. 1997; 23(Suppl 1):601–4. [PubMed: 9278811]
22. Courtright P, Hutchinson A, Lewallen S. Visual impairment in children in middle and lower-income countries. Arch Dis Child. 2011; 96:1129–34. [PubMed: 21868404]
23. Baden C, Shija F, Lewallen S, Courtright P, Hall A. Glaucoma after pediatric cataract surgery in a population with limited access to care. J AAPOS. 2013; 17:158–62. [PubMed: 23528376]

Table 1
Cost of pediatric cataract surgery in Blantyre, Malawi, and Kitwe, Zambia, in 2011

	Units	Malawi	Zambia
		USD	USD
Labor cost			
Medical staff (ophthalmologist, refractionist, anesthetist, clinician)	Month	3,757	3,719
Nursing staff (surgical nurse, circulating nurse, ward nurse)	Month	720	1,243
Other staff (CHBLVC, optical technician and dispenser)	Month	969	1,121
Total	Month	5,446	6,083
Total annual labor cost	Year	65,350	73,000
Treatment			
Consumable	Per child	78	133
Medication	Per child	7	22
Total	Per child	85	155
Volume	Year	112	120
Total annual treatment cost	Year	9,550	18,605
Total cost	Per child	669	763
Adjusted total cost[a]	Per child	202	277

CHBLVC, childhood blindness and low vision coordinator.

[a]Derived from estimating the labor cost allocation proportional to the employees' time (20%) devoted to pediatric cataract management.