

Cost of pediatric cataract surgery in Maharashtra, India

Parikshit Gogate^{1,2}, Kuldeep Dole¹, Satish Ranade¹, Madan Deshpande¹

¹Lions Juhu Institute of Community Ophthalmology, H. V. Desai Eye Hospital, Pune, India

²Department of Pediatric Ophthalmology, H. V. Desai Eye Hospital, Pune, India

Correspondence to: Parikshit Gogate. Dr. Gogate's Eye Clinic, K102, Kumar Garima, Tadiwala Road, Pune 411001, India. parikshitgogate@hotmail.com

Received:2010-04-25 Accepted: 2010-05-22

Abstract

- **AIM:** To calculate the direct cost of pediatric cataract surgery, from the provider's perspective.
- **METHODS:** The direct cost was calculated using standard costing methods in a pediatric ophthalmology department of a comprehensive community eye care center in western India. Fixed costs included those of the building, interior decoration, out patient department's equipment, operation theater equipment, personnel, administration and hospital maintenance. The consumable costs included materials used during surgery. Only direct costs were considered.
- **RESULTS:** The average direct costs were Indian rupees (Rs.) 69 (\$1.77) for an outpatient department consultation, Rs.606 (\$15.53) for operation theater equipment use, and Rs. 2 427 (\$62.23) for personnel. The consumable costs ranged from Rs.1 452 (\$37.23) to 15 267 (\$391.46), depending on the protocol used. The net average cost of pediatric cataract surgery ranged from Rs. 4 722 (\$122) to Rs. 18 537 (\$475) per eye.
- **CONCLUSION:** Cataract surgery is cost intensive for children with cataract. Pediatric ophthalmologists should decide about most cost effective standards of care to rationalize consumable cost.
- **KEYWORDS:** pediatric cataract; cost of cataract; childhood blindness; eye care delivery

DOI:10.3980/j.issn.2222-3959.2010.02.22

Gogate P, Dole K, Ranade S, Deshpande M. Cost of pediatric cataract surgery in Maharashtra, India. *Int J Ophthalmol* 2010;3(2):182–186

INTRODUCTION

Cataract is an important component of avoidable blindness in children^[1]. Early identification and surgery

can cure a child of his or her visual handicap. Childhood blindness is a priority area in vision 2020, as blind children have a lifetime of blindness ahead of them^[2]. The surgical approach to cataract extraction in children differs from that in adults because anterior vitrectomy and primary posterior capsulotomy are essential for a clear visual axis and usually children are operated under general anesthesia^[3]. Furthermore, frequent post-operative care and management to prevent amblyopia is necessary. Ophthalmologists require special training and adequate experience to achieve a good outcome.

There have been many studies on the cost of cataract surgery in India in adults, with cost estimates ranging from \$15.34 to \$42.10^[4-6]. Cataract surgery in adult is one of the most cost effective health care intervention in terms of quality of life restored (DALYs-disability adjusted life years averted)^[7]. In contrast, there have been very few cost studies on pediatric cataract surgery^[8]. The ORBIS International has set up numerous pediatric ophthalmology centers in India, and the Government of India has invested in the *Sarva Shiksha Abhiyaan* (education for all scheme) to boost children's health and decrease disability to improve school attendance. This is also in line with the Vision 2020 objectives to reduce childhood blindness. The study was conducted in a tertiary eye care centre in Maharashtra state of India which had an ORBIS funded pediatric eye care centre that worked in close coordination with local government authorities. The centre catered to a population of ten million people, majority of them rural.

A study to calculate the cost of cataract surgery in children would help in making cost projections and to consider cost recovery options, program cost efficiency, and issues of equity and priority setting in eye care. This study aimed to estimate the cost for pediatric cataract surgery for the service provider (hospital or health care system, funded by the government, non-governmental organization or charity).

MATERIALS AND METHODS

The ethics committee of the hospital approved the study protocol. The study involved a retrospective review of direct costs incurred for cataract surgery in the financial year

2006-2007 (1st April 2006-31st March 2007, as per Indian convention) and adhered to the Helsinki protocol guidelines. As it did not impinge on patient care, and necessitated no collection of sensitive individual patient information, taking patients' consent was not considered necessary. Cost may be defined as the value of resources used to produce a good or health care service. There are two main alternatives with respect to measurement of these resources; financial and economic. Direct financial costs represent actual expenditure on services purchased. Costs are thus described in terms of how much money has been paid for the resources used in the project or service. Economic costs-use a broader definition of direct and indirect costs, including opportunity costs of time and the resources in alternative uses. In this paper we describe only direct financial costs incurred per case of pediatric cataract surgery.

The detailed cost calculations were done using standard methods [9,10]. In our calculations there were two main categories: fixed costs associated with the facility, and variable costs associated with consumable materials. The fixed facility cost included capital costs, which were defined as those resources that last longer than one year, and recurrent cost, which were defined as those resources that were used up in the course of a financial year and had to be paid for regularly.

The items in capital costs included: the cost of constructing the building, buying vehicles, buying new equipment with a unit price of \$100 or more. Their annual cost was considered by dividing their initial cost with approximate life (the depreciation incurred) [11,12]. The items in recurrent costs included: personnel, specifically administrators, doctors, supervisors, laboratory technician, health worker; supplies, specifically the drugs, syringes, and small equipment; building operation and maintenance including electricity, water, and telephone use and cleaning; vehicle operation and maintenance including the purchase of spare parts, tires and insurance. The remuneration given to the staff was considered as the price paid for their training and use of professional expertise. This was derived from the hospital's annual accounts statement. Where consumables were used for multiple surgeries, the cost per operation was calculated by dividing the cost of the consumable by number of operations it was used for.

The hospital's child friendly out-patient's departments equipment included the cost of two slit lamps, an autorefractometer, Perkins tonometer, synoptophore, A-B scan, a hand held slit lamp, Cambridge, Cardiff and Lea charts, TNO Titmus test, prism bar, set of loose prisms,

Table 1 Cost of out-patient department equipment and screening camp equipment (in Indian rupees)

Equipment	Number	Price Rs
Slit lamps	2	55000
Autorefractometer	1	190750
Perkins tonometer	1	73625
Synoptophore	1	45000
A-B scan	1	800000
Cambridge charts	1	22483
Hand held slit lamp	1	22250
Cardiff chart	1	46120
Lea charts	1	19500
TNO Titmus test	1	20177
Prism bar	1	9250
Loose prisms	1	15300
Lensometer	1	8500
Chair-units	2	103636
Keratometer	1	16000
Vehicle	1	400000
Total		1847591
Per year cost (Considering life for 7 years)		263942

lensometer, two chair units and a keratometer. The operation theatre equipment cost consisted of the cost of one phacomachine, two operating microscopes, vitrectomy probes, two Boyles apparatus, suction machine, motorized operation table, cataract sets, pulse-oxygen oxygen cylinders and anesthesia resuscitation equipment.

The hospital had a fixed protocol for pediatric cataract surgery, primary posterior capsulotomy and anterior vitrectomy was done for all children aged up to six years. Intra-ocular lenses were used in all pediatric cataracts after the age of 18 months and in unilateral cataracts after the age of nine months. All children undergoing the surgery were kept admitted for at least one post-operative day. The initial medicines needed after surgery were provided by the hospital itself. Spectacles were used for post-operative visual rehabilitation and they had to be purchased by the child's parents.

RESULTS

The total fixed costs of the hospital's child friendly out-patient department's equipment.[Indian rupees(Rs) 1 847 591] was divided by its seven-year life to get an annual cost of Rs. 263 942 (Table 1). The total cost of construction of the pediatric OPD (Rs. 1 600 000), pediatric ward (Rs. 630 000) and its child friendly interior decoration (Rs. 1 400 000), was Rs. 3 630 000. Assuming a life of 20 years, the cost per year was Rs. 181 500. The total cost of the OPD equipment and building per year was 445 442 which was divided by 6 441, the number of patients seen in those 12 months to get a cost of Rs. 69 (\$1.77) for each child examined in the outpatient

Costing of pediatric cataract surgery

Table 2 Cost of operation theatre equipment (in Indian rupees)

Equipment	Number	Price Rs
Operating microscope	2	900000
Phaco machine	1	950000
Vitrectomy probes	1	160000
Boyle's apparatus	2	76000
Suction machine	1	7000
Motorized operation table	1	45000
Cataract Set	5	55000
Pulse-oxymeter	2	120000
Oxygen cylinder (5 Ltr)	10	43220
Oxygen cylinder (10 Ltr)	10	48920
Anesthesia resuscitation equipment	1	5000
Total		2410140
Per year (Considering for 5 years)		482028
Used for 796 operations		605.56
So cost Per surgery		606 (\$15.53)

department. The cost of the operation theater(OT) equipment was Rs. 2 410 140 (Table 2). The total cost was divided by five, assuming equipment life of five years, to get annual cost of Rs. 482 028. This was divided by 796, the number of operations done in those 12 months, to get a figure of Rs. 606 (\$15.53) per operation (Table 2-the cost of OT equipment).

The staff remuneration per month includes one pediatric ophthalmologist (Rs. 40 000), one anesthetist (Rs. 40 000), two optometrists (Rs. 25 000), two nurses (Rs. 9 000), two counselors (Rs. 9 000), a pediatrician (Rs. 24 000), a project manger (Rs. 8 000), and two helpers (Rs. 6 000). Only those staff working full time for the pediatric ophthalmology clinic were considered. If certain staff worked part-time, then their remuneration was considered according to the time spent. As two pediatric ophthalmologists worked half their time for pediatric care and the rest half for adult eye care, only the salary of a single ophthalmologist was considered. Some staff also worked for non-surgical activities, but as their contribution was necessary for pediatric cataract care, their remuneration was included in entirety. The total annual salary cost of Rs. 1 932 000-was divided by 796, the total number of pediatric surgeries (cataract and other) done in that period to get Rs. 2 427 (\$62.23) per surgery. This was considered as the price paid for their training and professional expertise. Thus, the net fixed facility cost was Rs. 3 270 (\$83.85) for each surgery (Rs. 69 cost for out patients equipment and building, Rs. 606 for OT fixed facility, Rs 2 472 personnel cost, Rs. 23 office expense and Rs. 145 hospital maintenance).

The cost of consumables used, which varied from Rs. 1 452 (\$37.23) to Rs. 15 267 (\$391.46) depending upon the type of

Table 3 Consumable cost (in Indian rupees)

Item	Minimum	Maximum
IOL	150	4950
Viscoelastic	48	1750
Drapes	0	68
Vitrectomy	500	3000
Keratome blades	210	1500
Anesthesia gases	218	1900
Dark glasses	12	160
Drugs	94	512
Eye patch	25	50
Laboratory investigations	60	950
Irrigating solution	18	102
Intracath	14	14
All others	75	75
Medicine	28	250
Total	1452 (\$37.23)	15267 (\$391.46)

consumables used. The cost of the consumables varied depending on different standards of care and different protocols. The USA-made Alcon acrysoft intraocular lens (hydrophobic acrylic) cost Rs. 4 950, while the Indian-made poly-methyl-methacrylate (PMMA) single piece lens cost Rs. 150. The viscoelastic cost varied between use of Indian made hydroxy-propyl-methyl cellulose (Rs. 48) to United States made sodium hyaluronate (Healon GV Rs. 1 750). The costs of disposable drapes and pathology investigations also varied. Alcon disposable keratomes cost Rs. 1 500 compared to Rs. 210 for locally made disposable blades. The cost of vitrectomy probes also varied if they were to be re-used (Table 3).

The total cost of one pediatric cataract surgery thus varied between Rs. 4 722 (\$122) and Rs. 18 537 (\$475). Researchers estimate that there are 190 000 children blind from cataract globally, nearly one fourth of them from India ^[8]. The cost of treating 50 000 pediatric cataracts at the rate of \$400 each is not huge, just \$ 20 000 000 (or one hundred crore Indian rupees).

DISCUSSION

The average direct costs were Rs. 69(\$1.77) for an outpatient department consultation, Rs. 606(15.53) for operation theater equipment use, and Rs. 2,42 (\$62.23) for personnel. The consumable costs ranged from Rs. 1 452 (\$37.23) to 15 267 (\$391.46), depending on the protocol used. The net average cost of pediatric cataract surgery ranged from Rs. 4 722 (\$122) to Rs.18 537(\$475) per eye. Pediatric cataract surgery is an important component of children's eye care service delivery programs. There is a great need to conduct operational research to facilitate realistic costing of services, which would benefit the funding agencies, the hospital

administration and ophthalmologists to finalize the fees structure for the patients, and also to assist with budgeting. Financial sustainability is always desired in any program, as the funding agency cannot fund a program indefinitely. Costing exercises give health planners a realistic idea of how much revenue collection is needed for financial sustainability once donor funding ends. This costing exercise was done in a relatively high volume setting, so extrapolating the results of our study to the organizations with low volume pediatric cataract should be done with caution. This study also considered the cost of setting up a pediatric ophthalmology department from a scratch. But often pediatric ophthalmology services are often piggy backed on adult services in tertiary eye care centers and the cost may be less. A longer training is needed to sub-specialize in pediatric ophthalmology, optometry and pediatric anesthesia. The cost of this training was considered as the salary given to the pediatric ophthalmology team. The team has to spend a longer time with each (child) patient as compared to adult cataracts. Pediatric cataracts also require a longer and more intense follow-up for refraction and amblyopia treatment as compared to adult cataracts. So the personnel cost for the pediatric cataract team would be more than for adult cataract. The personnel cost in the adult cataract costing study from Pune was less than \$10 per surgery, much less than that for pediatric cataract^[4,5]. The personnel cost may be overestimated as these personnel are often used for adult cataract work too, but this was less likely in the present study in a busy pediatric ophthalmology department and the actual time spent was used to calculate the respective cost. As the numbers increase, with the total fixed costs remaining the same, the per unit fixed cost decreases. In the present study, if we can increase the out-patient load and operate more number of children, the cost per surgery would come down, up to the point of maximal capacity^[10].

Consumable costs may vary widely depending on the protocol for the use of consumables; with a three to five fold difference depending on the use of various consumables (USA vs Indian manufactured consumables), as there was no uniformity in the use of consumables for the surgery. The price of viscoelastic may vary from Rs. 48 to Rs. 1 850 and of the intra ocular lens from Rs. 150 to Rs. 4 750 depending on manufacturer. Higher cost consumables (Western studies: best corrected vision, BCVA>6/18 in 70% of the eyes)^[3,12] may be giving better results compared to lower cost consumables (Nepal, Indian studies: BCVA>6/18 in 40% of the eyes)^[13,14], but deprivational amblyopia and timing of surgery may be the cause of difference. Better results in

developed countries setting may be due to less delay between diagnosis of cataract and its surgery, as well as better amblyopia management^[15]. Higher cost lens like Alcon AcrySof may cause lesser posterior capsular opacification as compared to PMMA lenses, but anterior vitrectomy and primary posterior capsulotomy was done in all eyes aged less than six years. Use of high viscosity visco-elastic substances like sodium hyaluronate may perhaps increase the incidence of post-operative glaucoma.

Pediatric ophthalmologists need to agree on the accepted standards of care in order to standardize pediatric eye care delivery and help predict costs. Also general anesthesia with its cost and risk is also needed. The surgical skills are also more demanding and the result not always as favorable due to deprivational amblyopia, delayed presentation for surgery and the vulnerability of the pediatric eye to postoperative inflammation and change of refractive status. Western^[16] and Indian^[17] series put the result of adult cataract as more than 90% eyes gaining BCVA better than 6/12, while the result for pediatric cataract are 40-70 % >6/18^[13-15]. This relatively subnormal vision can still make an enormous difference in quality of life of children operated upon.

The results show that pediatric cataract surgery is much costlier than adult cataract surgery in India. The cost of adult cataract has been estimated to range from \$15.34 to \$42.10^[4-6], whilst the costs estimates in this study on pediatric cataract in a community eye care setting ranged from Rs. 4 722(\$121) to Rs 18 537(\$475). However, these costs would be efficient if reduction in the number of blind-person years is considered^[18]. An adult cataract blind when operated upon gains on an average five blindness free years, in contrast, pediatric cataract operated in a blind child gives that child almost fifty blindness free years. The concept of blind-person years was introduced to calculate the burden of blindness by a particular disease entity on a community^[19]. Pediatric cataract surgery is thus more cost effective for every rupee or dollar spent as it leads to greater blind-person free years as compared to adult cataract surgery^[20]. So even if it is almost three times as costlier than adult cataract surgery, if the premise of blind-person years saved is considered, it is three times as cost effective as adult cataract surgery and it is worth funding^[8]. The limiting factor may be our ability to find such children and get them to the appropriate pediatric eye care facility.

Acknowledgements: Dr. Tasanee Smith (USA) and Dr. Praveen Nirmalan (India) for help in cost calculation and write-up of the manuscript. ORBIS International, India country office supported the pediatric ophthalmology

Costing of pediatric cataract surgery

department from June 2004. Dr. Rajiv Khandekar (Oman) for his valuable inputs.

REFERENCES

- 1 Foster A, Gilbert CE. Epidemiology of childhood blindness. *Eye* 1992;6:173–176
- 2 Johnson GJ. Vision 2020: the right to sight: report on the sixth general assembly of the international agency for the prevention of blindness (IAPB). *Community Eye Health* 1999;12(32):59–60
- 3 Wilson ME, Trivedi RH, Suresh Pande. Multicenter randomized controlled clinical trial in pediatric cataract surgery: efficacy and effectiveness. *Am J Ophthalmol* 2007;144(4):616–617
- 4 Gogate P. M, Wormald RP, Deshpande M. Is manual small incision cataract surgery affordable in the developing countries? A cost comparison with extracapsular cataract extraction. *Br J Ophthalmol* 2003;87:841–844
- 5 Gogate P, Deshpande M, Nirmalan PK. Why do phacoemulsification? Manual small-incision cataract surgery is almost as effective, but less expensive. *Ophthalmology* 2007;114:965–968
- 6 Muralikrishnan R, Venkatesh R, Prajna NV, Frick KD. Economic cost of cataract surgery procedures in an established eye care centre in Southern India. *Ophthalmic Epidemiol* 2004;11(5):369–380
- 7 Porter R. Global initiative: the economic case. *Community Eye Health* 1998;27:44–45
- 8 Shammanna BR. Childhood cataract: magnitude, management, economics and impact. *Community Eye Health* 2004;17(50):17–18
- 9 Drummond MF, Jefferson TO. Guidelines for authors and peer reviewers of economic submission to the BMJ. *BMJ* 1996;313:275–283
- 10 Foster A, Thulsiraj RD. Planning, management and evaluation of eye care services. In: Jhonson G, Minassian DC, Weale R, eds. *Epidemiology of Eye Disease*. London: Chapman & Hall Medical 1998:351–370
- 11 <http://lawincometaxindia.gov.in/DitTaxmann/IncomeTaxActs/2005ITAct/section32>
- 12 Ledoux DM, Trivedi RH, Wilson ME, Payne JF. Pediatric cataract extraction with IOL: visual acuity outcome when measured at age 4 years and older. *JAAPOS* 2007;11:218–224
- 13 Khandekar R, Sudhan A, Jain BK, Shrivastav K, Sachan R. Pediatric cataract and surgery outcomes in Central India: a hospital based study. *Ind J Med Sci* 2007;61(1):15–22
- 14 Thakur J, Reddy H, Wilson ME Jr, Paudyal G, Gurung R, Thapa S, Tabin G, Ruit S. Pediatric cataract surgery in Nepal. *J Cataract Refract Surg* 2004;30(8):1629–1635
- 15 Gogate P, Khandekar R, Srisrimal M, Dole K, Taras S, Kulkarni S, Ranade S, Deshpande M. Cataracts with delayed presentation in children. Are they worth operating upon? *Ophthalmic Epidemiol* 2010;17(1):25–33
- 16 Desai P, Minassian DC, Reidy A. National Cataract Surgery Survey 97–98: a report. *Br J Ophthalmol* 1999;83:1336–1340
- 17 Venkatesh R, Muralikrishnan R, Balent LC, Prakash SK, Prajna NV. Outcomes of high volume cataract surgeries in a developing country. *Br J Ophthalmol* 2005;89:1079–1083
- 18 Rahi JS, Gilbert CE, Foster A, Minassian D. Measuring the burden of childhood blindness. *Br J Ophthalmol* 1999;83:387–388
- 19 Gilbert C, Rahi JS, Quinn GE. Visual impairment and blindness in children. In: Jhonson GJ, Minassian D, Weale RA, West SK, eds. *Epidemiology of Eye Disease*. 2nd edition. London: Arnold publishers 2003:260–286
- 20 Foster A, Gilbert C. Childhood blindness in the context of Vision 2020—the right to sight. *Bull World Health Org* 2001;79:227–232