




Cost of cataract surgery at a provincial hospital in South Africa



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Background: Despite the high burden of cataracts, South Africa is not meeting its cataract surgery rate, mainly because of health system factors. Information on the costs involved can be beneficial in upscaling cataract surgery.

Aim: To estimate the cost of cataract surgery from the health service perspective.

Setting: Public-sector eye hospital in KwaZulu-Natal, South Africa.

Methods: A retrospective cost analysis using a mixed costing approach was used. The study population included adult patients who had cataract surgery performed at the hospital between 01 April 2018 and 31 March 2019. An activity-based approach was used.

Results: The cost for a cataract in a single eye in 2018/2019 was R4184.81 (\$299.00). The highest contributor to the cost was human resources (46%), followed by equipment (19%) and medication (17%). Doctors accounted for 59% of the human resource cost, followed by nurses (24%). Theatre equipment cost accounted for 97% of the equipment cost, with two major equipment (operating microscope and phacoemulsification machine) accounting for 80% (R587.80) per patient. The medication used for anaesthesia contributed 59% (R499.04) of the medication cost.

Conclusion: This is the first cost estimate of cataract surgery in the public sector in South Africa. It provides preliminary information that may be used to inform the buy-out of ophthalmology services when the National Health Insurance is implemented.

Contribution: This study provides useful information on costing cataract surgery in the African setting, and the information can be used to determine how to attain cataract surgery goals in a cost-effective manner.

Keywords: phacoemulsification; cost analysis; human resources; consumables; ophthalmologist; public sector.

Introduction

Cataracts are the leading cause of preventable blindness globally, and the second leading cause of moderate or severe vision impairment, with an estimated 52.6 million people having cataracts between 1990 and 2020.¹ Despite, being a leading cause of blindness and/or medium to severe visual impairment, the number of people becoming blind because of cataracts decreased between 1990 and 2010.² However, the burden of cataract-associated blindness and/or medium to severe visual impairment did not decline in Eastern sub-Saharan Africa.³

Estimates indicate that 6 million people in Africa, mostly the elderly and predominantly women, are blind because of cataracts.⁴ In South Africa, 50% of blindness is assumed to be because of cataracts.⁵ The prevalence of cataracts varies across the provinces; a population-based survey conducted in selected villages in Limpopo estimated a cataract prevalence of 44% with females making up 67% of the cases.⁴

People living with cataracts are generally older and concurrent co-morbidities are compounded by the impact of visual impairment including blindness. This has a detrimental effect on the overall quality of life of the individual and impacts on the social, psychological and financial wellbeing of the individual. Individuals with visual impairment are at an increased risk of falls, fractures, injuries and social isolation.⁶ The financial impact of cataract-associated visual blindness is experienced at an individual and societal level with estimates showing the global annual productivity loss because of moderate to severe visual impairment or blindness as \$411 billion USD or 0.3% of global gross domestic product (GDP).⁷

Cataracts are the second largest contributor to disability-adjusted life years (DALYs) among eye diseases.⁸ Low and low-middle income countries bear the highest burden of cataracts with the medians of age-standardised DALY rates in these countries reported as 99.37 and 93.46 per 100 000 population, respectively.⁹ In Southern sub-Saharan Africa, cataract-related blindness accounted for the highest age-standardised DALY rate of 339.26 per 100 000 population.⁹

Cataract surgery is the most successful modality of treatment; however, South Africa has lagged behind the Vision 2020 cataract surgery rate (CSR) target of at least 2000 per million population per year for the elimination of cataract blindness.¹⁰ The South African national CSR target was planned to increase from 1000 in 2005 to 2000 in 2010 but as CSRs have failed to reach targets each year, the target for 2010 was reduced to 1500.⁵ Not all provinces in South Africa have been able to reach this target, with KwaZulu-Natal having a CSR of 945 per population.¹¹ In 2015, it was estimated that the CSR in South Africa was 847 per million population.¹² A number of challenges affect the realisation of the proposed targets including unavailability of cataract services in rural areas, shortages of ophthalmologists and supportive ophthalmic health professionals, and inadequate cataract facilities and resources.⁴

Our literature review yielded no published research on the cost of cataract surgery in South Africa. In the private sector, the cost is largely dictated by medical insurance reimbursement tariffs. For patients paying out-of-pocket, the cost will vary based on the private facility, the surgeon and the type of intra-ocular lens. There are a number of public-private initiatives that link the private sector with the public sector and non-governmental organisations (NGOs) to offer free cataract surgery to patients, but the costs of these have not been disclosed. As these surgeries are based on donations from private providers or NGOs and the voluntary services of ophthalmologists, these costs will not reflect the actual cost of cataract surgery in the public sector. In the current era that foresees the implementation of National Health Insurance, it is important that cost estimates are determined to inform

models of care that involve task shifting and sharing, and contracting to reduce the cataract surgery backlogs and future surgeries.

The aim of this study was to estimate the cost of cataract surgery at a public eye hospital situated in Durban, KwaZulu-Natal.

Methods

Study design

The study was a retrospective cost analysis using a mixed approach which included time-driven activity-based costing and top-down costing allocation. The cost analysis was carried out from a health service provider's perspective.

Study location and site

McCord Provincial Eye Hospital is a 100-bed referral eye hospital that receives patients on a referral basis only. The hospital is located in eThekweni Health District. In 2018/2019, there were six ophthalmologists, nine ophthalmology registrars and nine medical officers working at the hospital. There were three theatres available and cataract surgeries were performed daily from Mondays to Fridays.

Study population

The study population included adult patients (aged 18 years and older) who had cataract surgery performed at the hospital between 01 April 2018 and 31 March 2019.

Data collection

A process flow (Figure 1) was performed to ascertain the consultations and various examinations that a patient undergoes commencing with their first visit at McCord Provincial Eye Hospital, the cataract surgery and ending with the second post-operative visit 2 months after the surgery. An activity-based approach was used where the following was assessed at each service point: (1) the category of healthcare

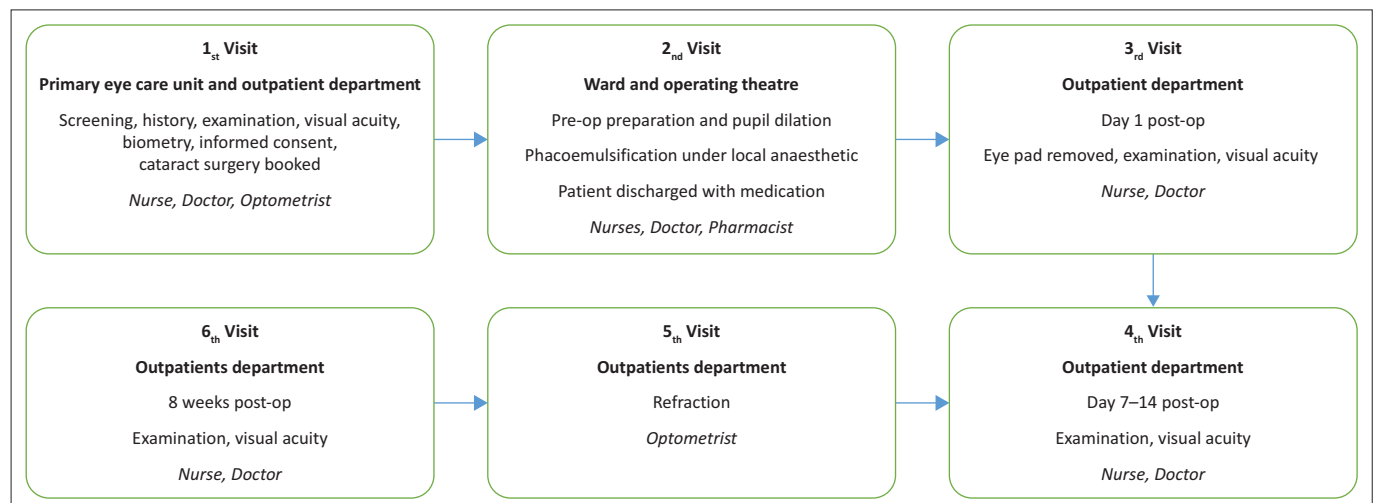


FIGURE 1: Process flow of patients undergoing cataract surgery at a specialised eye hospital.

TABLE 1: Components included for cataract surgery costing at a specialised eye hospital.

Components	Sub-components
Human resources	Doctors
	Nurses
	Optometrist
	Pharmacist
	Administrative staff
Consumables	General orderly
	Disposables
	Dressings (including eye patches)
	Surgical packs including phaco pack and tip
Equipment	Intra-ocular lens
	Outpatient equipment
	Theatre equipment
	Optometry equipment

professional performing the service, (2) the duration of the service, (3) equipment used, (4) the dosage of medication prescribed or dispensed to the patient and (5) consumables used. We estimated the total duration that a patient spends in contact with healthcare professionals across all six visits to be 183 min. This excluded all waiting times. A cost based on hospital expenditure was calculated for all direct patient activities. Utilities and indirect costs were not included.

Cost data were retrieved from the hospital information systems including the Personal and Salary System and Basic Accounting System by the finance manager. Pharmaceutical and consumable costs were obtained from the Pharmacy Department.

Data analysis

All data were recorded on a Microsoft Excel® (Microsoft Corp, Redmond, WA, United States) spreadsheet and analysed. The costs are presented in the currency of the South African Rand. Average exchange rates for 2018/2019 were used as follows: R14.00 = \$1.00, R16.00 = €1.00. We calculated the total cost of cataract surgeries at a public sector provincial eye hospital in KwaZulu-Natal for the financial year and cost per cataract surgery for a single eye.

Human resources cost per cataract

Total cost to the company calculated for a medical specialist (grade 3), medical officer (grade 3), professional nurse (grade 2), specialist professional nurse (grade 3), optometrist, pharmacist, general orderly and an administrator (Table 1). The grade refers to the number of years of experience with an increase in salary as the grade increases. In 2018/2019, there were 229 working days for the year (365 – less weekends, public holidays and annual leave of 21 days). Total minutes of employment based on an 8-h day were equal to 109920 min. The cost per minute for each staff was calculated and multiplied by the estimated minutes of patient consultation.

Consumables cost

The unit cost of each item was multiplied by the estimated quantity of consumption. The consumables included all items

that were used during consultations and during the cataract surgery (Table 1). The items included the phaco pack which included the consumables used for the phacoemulsification equipment and the phacoemulsification needle tip, the intra-ocular lens, alcohol swabs, sterile gloves, caps, mask, syringes, blades, drapes, surgical gown, povidone-iodine, intravenous cannula, needles, eye pad and micropore strapping and identification bands. During the costing period (2018/2019), one phaco pack and needle tip was used per slate. Based on the number of surgeries performed using phacoemulsification, we calculated the cost at an average of six patients per pack and needle tip.

Equipment cost

Straight-line depreciation was used to calculate the annual cost of equipment. No discounting was applied, as we did not have the dates of purchase of equipment. The equipment was depreciated over a 3-year to 6-year period depending on the type of equipment. The amortised cost was divided by the total number of patients using the equipment for the year (74 120 patients for outpatient equipment; 4480 patients for surgical equipment and 2280 patients for cataract-specific equipment). The unit cost was then multiplied by the number of patients who had cataract surgery. The cost per cataract was based on the unit value multiplied by duration. We included all equipment that was used during the patients' pre-operative and post-operative visits as an outpatient, and in theatre during the procedure (Table 1).

Pharmaceutical cost

The medication costs were based on the medication dispensed multiplied by the unit value. For multiple vial doses, the cost was based on the quantity consumed as a proportion of the total vial cost.

Sensitivity analysis

We varied the level of the medical specialist (based on salary scales) to cater for the different scenarios that are likely to occur in this setting as it is a teaching hospital. We also considered the cost if one phaco pack and needle tip was used per patient as per the manufacturer guidelines.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of KwaZulu-Natal, Biomedical Research Ethics Committee on 25 November 2020. The ethics approval number is BREC/00002067/2020.

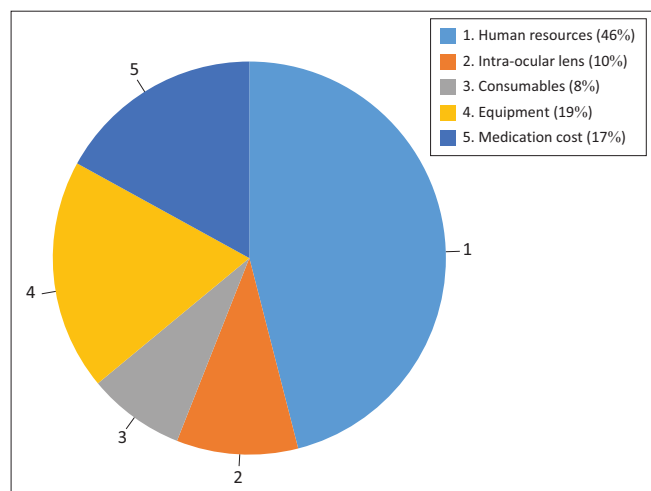
Results

A total of 5382 ophthalmic procedures were performed at McCord Provincial Eye Hospital during the financial period 01 April 2018 to 31 March 2019. Cataract surgery accounted for 58% (3117) of these procedures, of which 85% (2645) were performed using phacoemulsification.

TABLE 2: Cost per patient for a single eye cataract surgery in 2018/2019 at McCord Eye Hospital.

Cost components	Cost per patient
Human resources	R1923.06
3 Piece 27.0 D intra-ocular lens	R405.58
Consumables	R349.60
Equipment	R778.79
Medication cost	R727.78
Total costs excluding indirect expenses	R4184.81
Cost in euros	€262.00
Cost in US dollars	\$299.00

US, United States; D, dioptre.

**FIGURE 2:** Proportion of costs for cataract surgery.

Cost per cataract

The total direct cost for the 2645 patients who underwent cataract surgery via phacoemulsification amounted to R11068810.11 or 7% of the total budget for 2018/2019 for McCord Eye Hospital (R149201000.00).

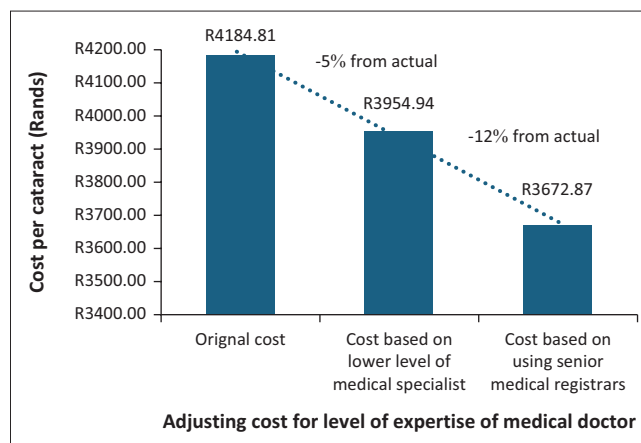
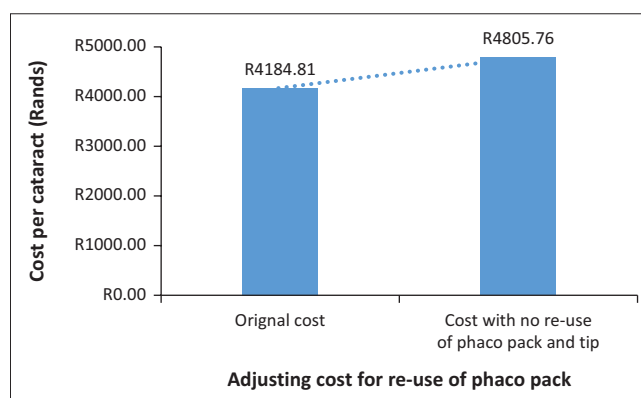
The cost for a cataract in a single eye in 2018/2019 at McCord Provincial Eye Hospital was calculated at R4184.81 (Table 2). The highest contributor to the cost was human resources (46%), followed by equipment (19%), consumables (18%) and medication (17%) (Figure 2). The intra-ocular lenses contributed 54% of the consumable costs and 10% of the total cost (Table 2). Doctors accounted for 59% of the human resource cost, followed by nurses (24%). Theatre equipment cost accounted for 97% of the equipment cost, with two major equipment (operating microscope and phacoemulsification machine) accounting for 80% (R587.80) per patient. The medication used for anaesthesia contributed 59% (R499.04) of the medication cost.

Sensitivity analysis

The following scenarios were used to modify the human resources cost:

Scenario 1: Grade 1 medical specialist instead of a grade 3 medical specialist

Scenario 2: Senior Medical Registrar instead of a medical specialist

**FIGURE 3:** Changing cataract prices with varying human resources category.**FIGURE 4:** Change in cataract cost using one phaco pack and tip per patient.

By varying the level of the medical specialist (Figure 3), there is a decline of 5% from the initial model to

Scenario 1 (R3954.54), and a 12% – 13% reduction to Scenario 2 (R3672.87).

When adjusting the cost for no re-use of the phaco pack and tip, there was a 15% increase in the cost (R4805.76) (Figure 4).

Discussion

This is the first published report on the cost of cataract surgery at a public hospital in South Africa. Our cost of R4061.00 (€262.00) per cataract per eye is lower than the costs reported from Europe which ranged from €318.00 in Hungary to €1087.00 in Italy in 2006.¹³ The difference in costs across these European countries was attributed to the healthcare setting and the quality and quantity of resources utilised.¹³ Similarly, the price of cataract surgery in the private sector in South Africa which ranges from R22000.00 to R25000.00 based on the medical insurance scheme, exceeds the amount reported in this study. One of the main contributors to this higher cost is likely because of the intra-ocular lens that is used in the private sector where there is often a choice of multifocal, toric, presbyopic and extended depth of focus intra-ocular lenses. Additionally, the phaco pack and needle tip is not re-used in the private sector, and the cost will also

take into consideration an anaesthetist and running operational costs which were not included in our study.

In 2016, the Western Cape Department of Health in South Africa reported that with the assistance of a non-profit organisation, the cost of cataract surgery at a public hospital was R1800. It is not explicit what this cost covers, and may only include nursing staff and consumables.¹⁴

In Paraguay, in 2011, the cost of cataract surgery (direct fee) to the patient was estimated at \$334.00.¹⁵ This amount excluded patient transport, medication and accommodation required. Our cost of \$299.00 in 2018/2019 is lower but does not take into consideration patient transport. However, it must be noted that the Department of Health provides transport for patients who are referred to McCord Provincial Eye Hospital from another district.

Findings from South India indicate an average cost of \$38.00 for cataract surgery using phacoemulsification.¹⁶ Another costing study at the Aravind Eye Hospital in India estimated that total direct and indirect costs of phacoemulsification could range between \$41.00 and \$125.00 depending on the cost of the lens.¹⁷ These costs are significantly lower than our findings. The locally made lens in India cost \$13.00 compared to \$96 for an internationally made lens.¹⁷ The cost of the lens used in this study was \$29.00. In India, human resources, medication and equipment also cost far lower in comparison to South Africa and many other countries.

The high contribution (46%) of human resources to the overall cost is not surprising as this costing activity was conducted at a specialised eye hospital that is used for the teaching of registrars who are training to become ophthalmologists. In contrast, human resources contributed 25% to the total cost at the Aravind Eye Hospital and less than 8% in South India.^{16,17} Surgeon costs in the United States were estimated to be \$761.00 per cataract surgery in 2013, which is far higher than our total human resource costs. We did not include the costs for an anaesthetist, as the local anaesthetic is administered by the surgeon.

The 15% increase in cost without re-using the phaco pack or tip must be noted. The re-use of a phaco pack and needle tip for multiple patients is not in accordance with the manufacturer's guidelines. However, research in the South African setting suggests that the re-use of the tubing does not yield increased microbial growth,¹⁸ and there is currently inconclusive evidence on the risks associated with the re-use of these single-use items.¹⁹

The limitations of this study include that it was carried out at a single site which is a specialised eye hospital in the province, and may therefore not represent what the cost of cataract surgery may be at a different type of hospital. Secondly, we costed monocular lenses only as that is what is used for cataract surgery in the public sector, and surgery using phacoemulsification, both of which limit comparisons with

settings where there are more diverse options with other methods of cataract surgery such as femtosecond laser-assisted surgery. Finally, this costing did not consider any indirect costs such as hospital utilities, security and maintenance costs.

Conclusion

This study identified the main cost drivers for cataract surgery in the public sector in KwaZulu-Natal, South Africa. This information is important to decide on appropriate service models when planning for the implementation of the National Health Insurance. These cost estimates can also be used to determine how best to attain the cataract surgery goals in a cost-effective manner. Further research is required that would take into consideration all indirect costs that were not included in this study.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

T.N. conceptualised the research, assisted with data collection, and reviewed the manuscript. O.H.M. and S.M. supervised the data collection, analysed the data, and wrote and reviewed the manuscript.

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Data availability

Research data are not shared as per agreement with the hospital providing the data.

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