

Title: Cost Efficiency and Cost Effectiveness of Cataract Surgery at Malaysian Ministry of Health Ophthalmic Services

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Abstract

Purpose: To determine the cost efficiency and to compare the cost effectiveness of conventional extracapsular cataract surgery (ECCE) and phacoemulsification at three hospitals of Malaysian Ministry of Health (MOH). **Methods:** Patient demography, pre-operative visual acuity, intra-operative complications, post-operative complications and post-operative visual acuity were recorded for two hundred and forty seven of the 400 patients who had cataract surgeries performed during a 2-week period. The cost of surgery, which included capital, staff and overhead, and patient care consumable costs was assessed prospectively in 8 randomly sampled patients over a 3-month period. Cost efficiency refers to cost per cataract surgery. Cost effectiveness refers to cost per successful cataract surgery. This is estimated by the ratio of cost efficiency to the proportion of successful cataract surgery. Successful surgery was defined as best corrected visual acuity (BCVA) of better than 6/12 at 3 months post-operatively. **Results:** Proportion of patients who had post-operative visual acuity of 6/12 or better was higher in phacoemulsification group (94%) as compared to ECCE group (81%). Conventional extracapsular cataract surgery with intraocular lens implant costs RM3442 (USD905.79) and phacoemulsification with intraocular lens implant costs RM4288 (USD 1128.42). **Discussion:** There was no significant difference in cost effectiveness between ECCE and phacoemulsification. The cost of cataract surgery in MOH hospital was found to be high due to the high overhead costs.

Introduction

Public healthcare programme evaluation includes determining the programme effectiveness (outcome assessment), efficiency (economic evaluation), accessibility (reach- ability of services) and equity (equal provision for equal needs) ^{1,2}. All agree that rigorous programme evaluation should be an integral component of programme operation; this however is rarely performed in practice.

Economic evaluation refers to the comparative analysis of alternative courses of action in terms of both their costs and outcomes³. It provides the necessary information for an objective assessment of the relative value for money, of competing health care interventions. Thus, it can assist informed and rational decision making on alternative uses of scarce health care resources. Health care consumes a significant proportion of a country resource; hence economists have increasingly subjected it to scrutiny.

Cataract is by far the most frequent cause of blindness in the developing nations. In the Malaysian National Eye Survey ⁴, the prevalence of cataract in the population over 40 years of age was 5.7%. Cataract was found to be the commonest cause of blindness (39%) and second commonest cause of visual impairment (36%) after uncorrected refractive error in Malaysia. Publicly funded cataract surgery plays a major role in blindness prevention in Malaysia as it aims to provide cheap and high quality cataract surgery to the public, and thus reduce the prevalence of blindness. About 30 Ministry of Health (MOH) hospitals and 3 university-affiliated hospitals provide this service across the country. Two types of cataract surgery are available in most hospitals in Malaysia, the conventional extracapsular cataract surgery (ECCE)

and phacoemulsification. The choice of surgical technique depends on the surgical expertise, the financial and technological resources available in the hospital, the density of the cataract and the presence of ocular co-morbidities.

Published data have shown that cataract surgery restores blind people to the work force such that they may earn many times the cost of surgery^{5,6,7}. Cataract surgery was included in the group of most cost-effective intervention (i.e. those that cost < \$25 per disability adjusted life year (DALY)) that can be offered in the developing world, using currently available technology^{8,9}. Thus, adequate technology and resources should be allocated to eradicate cataract blindness⁹.

To our knowledge, hard objective data on the cost effectiveness of any form of health care intervention is not available in Malaysia. Though such data has become increasingly available in other countries^{10,11}, but results of economic evaluation have very limited generalisability across borders. We therefore performed an economic evaluation of the Ministry of Health Malaysia cataract surgery services programme. Our objectives were to determine the cost efficiency and cost effectiveness of cataract surgeries in MOH hospitals, and to compare the cost effectiveness of phacoemulsification to ECCE. Cost efficiency referred to cost per cataract surgery. While cost effectiveness was measured as the ratio of cost efficiency to the proportion of successful cataract surgery performed.

Methods

This was a multi-centre observational study where three Ophthalmology Departments from the MOH hospitals participated. The perspective taken was that of MOH. This is justified by that the MOH is the ultimate decision-maker on the funding of its own programme. The objective of this cost-effectiveness analysis was to assist the decision-making process. Thus, only direct treatment costs borne by the MOH were included. Costs borne by patients including spectacles, direct non-treatment costs (e.g. transport to clinic), indirect costs (e.g. lost work time) and intangible costs (e.g. pain and anxiety); were excluded in this analysis. The time period was limited to 3 months post-operative period. Long-term costs and outcomes beyond the third month were not included. This was justified by the fact that costs and outcomes of cataract treatment were realised shortly after treatment (3 months). We also assumed that there would be little gain in life expectancy after cataract surgery. Hence future induced costs were ignored.

Cataract surgery outcome

To determine outcome, 400 patients were enrolled retrospectively from May 16, 2000 to May 30, 2000, and data on patient demography, pre-operative visual acuity, intra-operative complication, post-operative complication and post-operative visual acuity were abstracted from medical records. Two hundred and forty seven of these patients fitted into the inclusion criteria of this study, and were therefore eligible for analysis. The inclusion criteria consisted of age 40 years or older, pre-op visual acuity worse than or equal to 6/12 and absence of pre-existing ocular co-morbidity. Including patients with pre-existing ocular co-morbidity would confound the post-operative visual outcome.

Outcome was measured as refracted or best-corrected visual acuity (BCVA) 3 months post-operatively. Successful surgery was defined as BCVA of better than 6/12 at 3 months post-operatively.

Costs

The cost categories identified and measured were:

1. Capital costs which included building and capital equipment. All capital costs were annualised to year 2000. Building cost was amortised over 30 years at 3% discount rates. Equipment cost was adjusted for inflation using gross domestic product (GDP) deflator to year 2000 from its year of purchase, and then amortised over its estimated useful life at 3% discount rate. Land was not depreciated. The use of 3% discount rate was consistent with the shadow price of capital approach to evaluating public investments.^{12,13}
2. Staff and overhead costs, which included administration and supportive services like laundry, cleaning, building and equipment maintenance, utilities and telephone. These were measured at the hospital or Eye Department level. Hence, part of these costs was allocated to cataract treatment service provided by the Ophthalmology departments.
3. Patient care consumable costs, which included laboratory tests and X-ray, pharmaceuticals, hospitalisation, surgical consumables (gauze, scalpel, etc). To determine these costs, 8 patients (4 each of phacoemulsification and ECCE) were randomly sampled from each hospital and prospectively followed up to measure actual cost of all the consumables utilised over the course of their care till 3 months post-op, through micro-costing.

All costs were valued in 2000 constant Ringgit Malaysia. Market or purchase price was used for all identified resources. Both resource utilisation (cost) and outcome data collected were subjected to central quality control as well as verification and query at site.

Cost efficiency refers to cost per cataract surgery performed. This was estimated by the ratio of cost of providing cataract service in 1999 to the number of cataract surgeries performed in 1999.

Cost effectiveness refers to cost per successful cataract surgery. This is estimated by the ratio of cost efficiency as estimated above to the proportion of successful surgery. The incremental cost effectiveness ratio of phacoemulsification (R_T) was estimated by

$$R_T = \frac{C_T - C_C}{E_T - E_C}$$

Where C_T and E_T were the sample estimates of the cost and treatment effect of phacoemulsification respectively, and C_C and E_C were the sample estimates of the cost and treatment effect of the control treatment, ECCE, respectively.

Non-parametric bootstrap method ¹⁴ was used to estimate its standard error and setting up confidence interval. Sensitivity analysis was performed by varying the discount rate for cost (5%) and using the minimum and maximum overhead cost estimates in the sample.

Results

A total of 247 patients were enrolled for analysis. Out of this 157 underwent ECCE and 90 underwent phacoemulsification. The mean age in both groups was similar, which was 66 years for ECCE and 63 years for phacoemulsification. There were more females than males in both groups. Age-related cataract constituted the majority of primary disease in both groups i.e. 94% for ECCE group and 91% for phacoemulsification group. The common systemic co-morbidities for both the ECCE and phacoemulsification groups were hypertension, diabetes mellitus and ischaemic heart disease. Table 1 shows the baseline characteristics of patients in the ECCE and phacoemulsification groups.

The only characteristic that differed significantly between the two groups was pre-operative visual acuity . Fifty seven percent of ECCE patients had visual acuity of counting fingers or worse as compared to 19% of phacoemulsification patients.

Table 2 shows the comparison of treatment outcomes of ECCE and phacoemulsification. There was no difference in the mean length of stay in the hospital in the two groups; 2.4 days in ECCE group and 2.5 days in the phacoemulsification group. Similarly, the complication rates in both groups were comparable with 28% in the ECCE group and 24% in the phacoemulsification group. However, there was a significant difference in the post-operative BCVA at 3 months between the two groups, with 94% (95%CI 88%, 98%) of the phacoemulsification group had BCVA better than 6/12 as compared to 81% (95%CI 75%,87%) of the ECCE group.

The comparison of costs per cataract surgery is shown in Table 3. The cost of phacoemulsification, which was RM4288 was slightly more than that for ECCE, which was RM3442. The higher cost of phacoemulsification was attributed to higher equipment, overhead and consumable costs.

The capital costs were consistent and only made up less than one tenth of the total cost for both ECCE and phacoemulsification, at RM278 (8.1%) and RM321 (7.5%) respectively. However, as expected the consumable cost for phacoemulsification (RM 1265) was markedly more than that for ECCE (RM694). The increased consumable cost contributes to 67.5% of the total extra expenditure incurred by phacoemulsification.

Overheads accounted for the largest proportion of the cost for both groups, which was RM1975 for ECCE and RM2207 for phacoemulsification. This made up 57.4% and 51.5 % of the total cost for ECCE and phacoemulsification respectively.

With 94% success rate (95% CI 88%, 98%) in phacoemulsification and 81% in ECCE (95% CI 75%, 87%), the cost effectiveness ratio (CER), calculated as cost per cataract surgery divided by percentage of successful surgery, was 4249 for ECCE and 4561 for phacoemulsification (Table 4). However, the comparison was statistically inconclusive. The 95% confidence interval of the incremental cost effectiveness of switching from ECCE to phacoemulsification ranged from 0 to 22771. Hence we cannot conclude if phacoemulsification or ECCE was more cost effective.

In the sensitivity analysis, the CER for both groups were calculated with the minimum and maximum overhead costs. However, we found that variation of allocated overhead costs had no impact on CER results. As shown in Table 5, discounting costs and outcome at 5% did not change the relative cost-effectiveness of ECCE versus phacoemulsification.

Discussion

The results of this evaluation should be interpreted cautiously. The main weakness was the small sample size for the costing estimate. Though the cost per operation was calculated based on only 8 patients, it was done through micro-costing where cost for every item or consumable used for the patient was quantified and was not based on budget assumption. Though spectacles were more commonly needed for ECCE patients who might have substantial astigmatism due to larger incision, the cost of spectacle was not included in this study as it was borne by patient and it was of negligible price, i.e. RM 200 per pair. Thus, adding the cost of spectacle would not increase the cost of ECCE significantly.

The cost of public hospital services was found to be high due to the high overhead costs. On speculating, the reasons for this may be two folds. Firstly, the overhead cost estimates were uncertain as it was based on reports from the hospital administration rather than actual costing of overheads in the Ophthalmology departments. However, sensitivity analysis showed that the cost effectiveness ratio were insensitive to the change in overhead cost (Table 5). Secondly, perhaps the high overhead costs could be due to the low volume of cataract surgery performed at the MOH hospitals. Increasing the number of cataract surgeries performed may reduce the overhead cost, though restraints of paramedical staff and shortage of operating time may pose a

problem. Besides, more MOH hospitals should perform day care cataract surgery so as to increase the volume of cataract surgery.

There was no significant difference between the cost effectiveness of ECCE and phacoemulsification. However, there were limitations in the assessment of cost effectiveness between the two types of cataract surgeries. Firstly the samples size in the two groups was imbalanced in its baseline distribution, having more subjects in the ECCE group. Secondly, there was no randomisation of surgical technique in the study subjects.

The proportion of patients who had post-operative visual outcome of 6/12 or better was significantly higher in patients who had phacoemulsification than patients who had ECCE. BCVA was chosen as visual outcome measurement, as it is one of the most commonly reported cataract outcome measures in the literature worldwide. Uncorrected or unaided visual acuity was not used as it would not be a fair comparison for ECCE as astigmatism induced by larger incision in ECCE is correctable by spectacles and would become less obvious overtime. The current challenge and indeed better measures of successful outcome will be the rapidity with which stable levels of uncorrected visual acuity are obtained in patients. Beside BCVA, quality of life or visual function after cataract surgery is obviously relevant and important outcome measurement as cataract has considerable impact on patients' daily activities and lifestyle.

Returning to our research question, how cost effective is the MOH cataract surgery programme? An absolute CER value, like RM4249 per successful correction, is hard to interpret on its own in the absence of any benchmark that defines cost effectiveness. One could compare the results with those from other countries, preferably other developing countries. International inter-study

comparisons are of course fraught with difficulties given methodological differences between studies and more seriously, differences in purchasing power. Nevertheless, as shown in Table 4, CER of the MOH cataract surgery programme is RM4249 (US\$1118) for ECCE and RM4561 (US\$1200) for phacoemulsification. As compared to a cost-effectiveness study of public-funded cataract surgery in India¹⁰, the CER for Medical College hospitals was US\$176 for ECCE. However, their study measured cost effectiveness as cost per cataract surgery multiplied by 100 divided by percentage of satisfied patient. “Satisfied patients” is a subjective measurement of success, which is largely dependent on the preoperative visual debilitation and patients’ expectations.

There is a large variation in the cost of cataract surgery in different parts of the world as seen in table 5. India shows the lowest cost per cataract in comparison to the USA¹⁶ where the cost per cataract surgery is nearly 20 times that of cataract surgery in the government sector in India¹⁰. This huge difference in cost comes as no surprise and in fact reflects the economic stability and status of the country concerned. This study has shown that we are almost comparable to that of Australia¹¹, whose currency value is almost twice that of Malaysian Ringgit.

In conclusion, cataract surgery services provided by the Malaysian MOH hospitals were almost comparable with Australia, though not as cost-effective as that in India. The study has shown that phacoemulsification was as cost effective as ECCE. The study has also indicated that there is much room for improvement in the cataract surgery services provided by the MOH, with the aim to provide large volume, low cost and yet high quality cataract surgery. Such economic evaluation is a useful tool in the planning and operation of health care programme, particularly in the public sector.

As this is the first comparative economic analysis of phacoemulsification versus ECCE in Malaysia, the report raises more questions than it answers. Thus, we propose that a second phase of this study, where larger sample size to be captured to provide a better insight into cost efficiency and cost effectiveness, as well as the quality of cataract service and factors influencing the service, to be done. The results of this study are valuable reference for future related studies.

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Table 1: Baseline characteristics of subjects in the ECCE and phacoemulsification groups

Characteristics	ECCE N=157	Phacoemulsification N=90
Age in years, Mean (SD)	66 (10)	63 (9)
Gender (%)		
Male	41	46
Female	59	54
Pre-op Visual Acuity (%)		
6/12 - 6/36	17	49
6/60 – 1/60	27	32
Counting finger or worst	57	19
Primary disease (%)		
Age-related	94	91
Others	6	9
Co-morbidities (%)		
Hypertension	38	33
Diabetes mellitus	29	28
Renal failure	4	2
Ischaemic heart disease	11	11
Asthma or Chronic obstructive airway disease	5	4

Table 2: Comparison of treatment outcomes of ECCE and phacoemulsification

Outcomes	ECCE N=157	Phacoemulsification N=90
Mean Length of stay (95% CI)	2.1 (1.5, 2.7)	2.4 (1.8, 3.1)
Complications		
Intra-op complications	17 % (11, 23)	14 % (8, 23)
Post-op complications	15% (10, 22)	19% (11, 29)
All	28% (21, 36)	24% (16, 35)
Visual acuity at 3 months post-op	(%)	(%)
Better than 6/12	81	94
6/12 - 6/36	13	4
6/60 – 1/60	4	1
Counting finger or worse	1	0
Proportion (95% CI) with successful correction of VA	81% (75,87)	94% (88, 98)

Table 3: Comparison of cost per cataract surgery

Category	ECCE		Phacoemulsification	
	Cost *(RM)	%	Cost *(RM)	%
Capital cost				
Land	7	0.2	7	.2
Building	46	1.3	46	1.1
Equipment	225	6.5	268	6.2
Subtotal, Capital	278	8.1	321	7.5
Recurrent cost				
Staff	495	14.4	495	11.5
Overhead	1975	57.4	2207	51.5
Consumable	694	20.2	1265	29.5
Subtotal, Recurrent	3164	91.9	3967	92.5
Total	3442	100	4288	100

* RM1.00 (Malaysian Ringgit) = 0.263 US\$

Table 4 : Cost-effectiveness ratio of ECCE versus phacoemulsification

	ECCE		Phacoemulsification		Increment (Phacoemulsification- ECCE)	
Cost (RM) (95% CI)	3442	(2773, 4110)	4288	(3396, 5179)	846	-
% Success (95% CI)	81%	(75,87)	94%	(88,98)	13%	-
Cost- Effectiveness ratio (95% CI)	4249	(3744, 5403)	4561	(3469, 4962)	6507	(0,22,771)

Table 5: Sensitivity analysis

	Cost-Effectiveness ratio ECCE	Cost-Effectiveness ratio Phacoemulsification	Incremental Cost-Effectiveness ratio
Overhead cost:			
Minimum	3893	4008	884
Maximum	8914	8334	-4461
Cost Discount rate			
5%	4290	4602	2400

Table 6: Comparison of local cost per ECCE with that of other countries (Cost inflated by 4% to year 2000)

Country	Australia	USA	India	Malaysia
Cost (RM*)	2283	12403	547	3442

* *RM1.00 (Malaysian Ringgit) = 0.263 US\$*

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