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A Sustainable Model For Delivering High-Quality, Efficient Cataract Surgery In Southern India

ABSTRACT Cataracts are a leading cause of reversible blindness in India, where millions of people can be effectively treated for this condition with surgery. The Aravind Eye Care System in southern India developed an efficient system for delivering high-quality and low-cost cataract surgery. We provide a detailed accounting of costs of cataract surgery at the system and a cost-utility analysis. Total costs per operation were US$120, or $195 per quality-adjusted life-year gained. Using these data and population-based estimates of cataract prevalence, we calculate that eliminating cataract-related blindness and low vision in India would cost $2.6 billion and would yield a net societal benefit of $13.5 billion. Factors contributing to the highly cost-effective care at the Aravind Eye Care System include the domestic manufacturing of supplies, the use of a specialized workforce and standardized protocols, and the presence of few regulatory hurdles. Lessons learned from the system can help improve the delivery of cataract surgery and other ambulatory care surgeries in India and abroad.

A cataract is a progressive opacification of the eye's lens that reduces vision and, if left untreated, causes blindness. It is a leading cause of blindness worldwide and affects over nine million Indians.[1,2] Surgery, the only effective therapy, involves removing the cloudy native lens and replacing it with an artificial intraocular lens. Cataracts adversely affect quality of life, day-to-day functioning, and economic productivity in India,[3] where their economic burden is estimated to be $10 billion over ten years.[4] With a rapidly growing and aging population, India has seen little change in the prevalence of cataract-related blindness since the 1970s,[5] despite expanded access to surgical services.[2,5]

The Aravind Eye Care System is a group of eleven specialty eye hospitals in southern India.[6] Founded in 1976, it has a mission to eliminate needless blindness by providing appropriate, compassionate, and high-quality eye care for everyone. Annually, over 3.8 million patients receive care in the system, and more than 400,000 ocular procedures—two-thirds of which are cataract surgeries—are performed at its hospitals. Over half of the visits and surgeries are highly subsidized.[7] The system's ability to provide highly subsidized services for so many patients depends on its emphases on sustainability, efficiency, high quality, and low cost.

In the article we describe how the Aravind Eye Care System delivers highly efficient and high-quality cataract surgery to patients throughout southern India. We present a detailed accounting of the costs and a cost-utility analysis of cataract surgery at Aravind. Based on the data we collected, we generate a cost estimate for eliminating blindness and low vision related to cataracts throughout India should the system's model be expanded nationwide. We also examine innovative features of the model that others can learn from.

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This study was approved by the Institutional Review Boards of the University of Michigan and the Aravind Eye Care System.

Study Data And Methods

SAMPLE AND DATA Our subject population was a sample of the 10,954 patients who came to Aravind Eye Hospital in Madurai, India, for outpatient cataract surgery in July 2013. To be included in the study, patients had to be at least age forty, have a diagnosis of cataract in one or both eyes, and had to have been scheduled to undergo cataract surgery by phacoemulsification—a technique that involves the use of an ultrasonic hand piece to break the cataract up into pieces and aspirate it from the eye. The gold standard for cataract surgery, phacoemulsification is performed routinely in developed nations and increasingly in developing countries. Patients were excluded from our study if they were unable to provide consent or were not planning to return for postoperative care. We selected a random sample of 292 patients who met our criteria.

For each patient in the study, we collected data on preoperative and postoperative vision; the resources used during the surgery, including the type of intraocular lens implanted; and the total cost of performing the surgery. We also assessed the health-related quality of life for each patient before and one month after surgery. To do this, we used a version of the EuroQOL–5 Dimensions 3 Levels measure (EQ-5D-3L)—a survey that assesses respondents' health in five domains: mobility, self-care, usual activities, pain, and anxiety or depression—in Tamil, which was conducted face to face.[8]

This survey can be used to determine the change in health-related quality of life associated with medical and surgical interventions. The scores of utility—that is, the levels of physical, mental, and social functioning—derived from this measure can be incorporated into economic analyses, so researchers can directly compare interventions of all sorts to determine which confers the greatest value. The survey is a valid measure of utility in patients with cataracts and is accepted by the National Institutes of Health for use in comparative economic analyses.[9]

RESOURCE USE, COST, AND COST-EFFECTIVENESS We used a micro-costing approach to calculate overall costs of cataract surgery on one eye, including pre- and postoperative care. Resource use was divided into five categories: overhead, labor, equipment, consumables, and indirect costs (which included patient travel and caregiver assistance). The costs of intraocular lenses and managing complications were also captured.

Costs were calculated based on information about resource use and surgical volume from the Aravind Eye Care System's administrative data. Overhead costs were allocated per surgery, and capital expenditures were allocated over the useful life of the equipment used. The mean cost of intraocular lenses and indirect costs were obtained from the 292 patients in our study. We converted all costs to 2016 US dollars. For additional details of our study methodology, see the online Appendix.[10]

We used EQ-5D-3L results to estimate health-related quality of life before and after surgery for all of the patients in our sample.[11] Next, we determined life expectancies for Indian males and females.[12] Lifetime quality-adjusted life-years (QALYs) gained from the surgery were calculated by summing QALYs in five-year intervals from each patient's current age to age 100. We assumed that after a gain in utility from the cataract surgery, each patient's utility would decline with age at the same rate that utilities decline in the United States.[13] In sensitivity analyses (described below), we varied this assumption. The probability of a patient's being alive at a given age was calculated using probability-of-death data for India.[12]

Incremental cost-effectiveness ratios (ICERs) were calculated by dividing the cost of cataract surgery in one eye by lifetime QALYs gained. ICERs were considered cost-effective if they were lower than the cost-effectiveness thresholds recommended by the World Health Organization (WHO),[14] based on the gross domestic product (GDP) per capita in India in 2016 (estimated to be approximately US$1,600).[15]

SENSITIVITY ANALYSES It can be challenging for patients to determine their own preferences for living in one state of health versus another. Therefore, in a sensitivity analysis we explored calculating gains in health-related quality of life by converting pre- and postoperative visual acuities into utility scores, instead of using data from the EQ-5D-3L survey.[16] In another sensitivity analysis, we varied the rate of decline in health utilities with age from no decline to double the rate of decline seen in US patients.

We also conducted a two-way sensitivity analysis to understand by how much utility gains and costs would have to change for cataract surgery to no longer be considered cost-effective. Finally, we used bootstrapping to resample 1,000 simulated cohorts of our 292 patients to understand how variation in costs and outcomes of individual patients affected uncertainty in our overall results.

INDIA'S UNMET NEED FOR CATARACT SURGERY To evaluate the impact of addressing the unmet

need for cataract surgery throughout India, we first estimated the current annual rate of cataract surgeries per million population and the number of cases of blindness and low vision due to cataracts in India in 2015.[5,17] *Blindness* in India is defined as vision of less than 6/60 (that is, worse than 20/200 vision) in the better-seeing eye.[18] *Low vision* is defined as vision less than 6/18 but at least 6/60 (that is, less than 20/60 but at least 20/200 vision) in the better-seeing eye.[17]

Using the cost data for cataract surgery at the Aravind Eye Care System as calculated above, we calculated the cost of providing cataract surgery in one eye on all Indians who are blind or have low vision due to cataracts. In another analysis, we estimated the costs of increasing the annual rate of cataract surgeries per million population in India from the current estimate of 5,721[5] to 10,000—a more realistic target than that in the previous analysis. To calculate the benefits of reducing blindness and low vision through cataract surgery, we multiplied the reduction in disability-adjusted life-years lost from these conditions by the per capita GDP, as others have done.[19]

LIMITATIONS Our study had several limitations. First, since the EQ-D5-3L is a general instrument used to measure health-related quality of life and is not designed specifically to study patients with cataracts, we suspect that we detected smaller improvements in utility than would have been the case if we had used a vision-specific measure of health-related quality of life. This limitation might have led us to underestimate the incremental cost-effectiveness ratio of cataract surgery.

Second, our sample was limited to paying patients who underwent outpatient surgery by phacoemulsification at Aravind Eye Hospital–Madurai. Our findings might not be generalizable to patients who received surgery at no charge or a reduced rate or to those who had surgery using a different technique. Many patients in the Aravind Eye Care System receive cataract surgery for less than the full fee. Two-thirds of cataract surgeries are done by techniques other than phacoemulsification and allow for the implantation of intraocular lenses that cost no more than $2.[20] Thus, the costs of these surgeries would be expected to be even lower than our calculations.

Third, the costs that we calculated of addressing blindness and low vision resulting from cataracts across India did not include the capital costs of constructing new facilities or the costs of outreach and transporting patients to surgical centers. Appendix Exhibit 1[10] provides some information on capital costs.

Study Results

PATIENT CHARACTERISTICS In July 2013, 10,954 patients underwent cataract surgery at Aravind Eye Hospital in Madurai. After restricting our sample to patients who paid for their surgery (using their own financial resources or private medical insurance) and underwent cataract surgery by phacoemulsification, as explained above, we selected a random sample of 292 patients who met our other inclusion criteria. The mean age of study participants was 61.4 years (standard deviation: 8.6), and 149 (51 percent) were female (Appendix Exhibit 2).[10]

SURGICAL OUTCOMES The mean best-corrected visual acuity improved from 6/24 (20/80 vision) before surgery to 6/7.5 (20/25 vision) one month after surgery, and 288 patients (98.6 percent) had improved vision at that point (Appendix Exhibit 3).[10] Excluding three patients with missing data, only three other patients of the remaining 389 (1.0 percent) developed a complication—and all three who had a complication achieved visual acuity of greater than 6/9 (20/30 vision).

COST AND COST-EFFECTIVENESS OF CATARACT SURGERY Not including the cost of the intraocular lens, the mean medical cost (fixed plus variable direct costs) for each cataract surgery was $49 (Exhibit 1). (All costs reported here are in US dollars.) Before surgery, each patient was counseled on the advantages, disadvantages, and costs of all types of intraocular lenses available. The cost of the lenses ranged from $13 for one produced in India to $252 for one produced elsewhere. The most commonly used lens—chosen by 48 percent of the patients in our sample—cost $13, and 60 percent of all lenses implanted were manufactured in India.

Besides the intraocular lens, the largest variable costs were $11 for consumables and $16 for labor. Labor costs per case were $2 for the surgeon and $13 collectively for other staff. Given the types of intraocular lenses selected by the patients in this study (Appendix Exhibit 4),[10] the mean overall total direct cost was $95 (95% confidence interval: 90, 100). Patients also incurred indirect costs of travel, food, and missed work during the perioperative period, which averaged $25 (95% CI: 17, 29) per surgery. Mean total societal costs (direct plus indirect costs) per surgery were $120.

The mean utility score was 0.84 before and 0.88 after the surgery, for a gain of 0.04 (95% CI: 0.03, 0.06). Accounting for utility gain over the patients' mean life expectancy and considering declines from aging, the estimated utility gain was 0.62 QALY (95% CI: 0.37, 0.86). Using the mean intraocular lens cost and assuming that utility declines over a patient's lifetime, the ICER

EXHIBIT 1

Per surgery costs of cataract surgery at Aravind Eye Hospital–Madurai, July 2013

	Cost of surgery (2016 $US)	
	Using cost of the most common IOL	Using mean IOL cost
FIXED COSTS		
Overhead (indirect)	0.99	0.99
Phaco machine and parts	4.89	4.89
Other durables	2.55	2.55
All fixed costs	8.42	8.42
VARIABLE COSTS		
Overhead	13.72	13.72
Consumables	11.17	11.17
Labor		
Surgeons	2.34	2.34
Other staff	13.42	13.42
All labor costs	15.76	15.76
Complications	0.37	0.37
All variable costs	41.01	41.01
All fixed and variable costs (without IOL)	49.43	49.43
IOL	13.29	45.93
TOTAL COSTS		
Medical (direct)	62.72	95.37
Patient (indirect)	24.87	24.87
Societal	87.59	120.24

SOURCE Authors' analysis. **NOTES** There were 292 patients in the study sample. Resources used were evaluated based on practices in July 2013, but values shown were converted and inflated to 2016 US dollars. Appendix Exhibit 9 provides costs in Indian rupees (see Note 10 in text). The most common intraocular lens (IOL) was the aurofoldable lens manufactured by Aurolab, in Madurai, India, which cost US$13. Appendix Exhibit 4 provides information on determining the mean cost of an IOL (see Note 10 in text). The Appendix also includes details about the cost calculations. Patient indirect costs were patient and family time, food, and travel. "Phaco" is phacoemulsification (explained in the text). Numbers may not sum to totals because of rounding.

EXHIBIT 2

Cost-effectiveness of cataract surgery at Aravind Eye Hospital–Madurai, July 2013

	QALYs gained		
Total cost of surgery	**Number**	**95% CI**	**ICER**
Using cost of the most common IOL $88	0.79	(0.38, 1.20)	111
Using mean IOL cost $120	0.62	(0.37, 0.86)	195
Using cost of an IOL commonly used in US $174	0.81	(0.35, 1.28)	214

SOURCE Authors' analysis. **NOTES** Resources used were evaluated based on practices in July 2013, but values shown were converted and inflated to 2016 US dollars. Appendix Exhibit 10 provides costs in Indian rupees (see Note 10 in text). The incremental cost-effectiveness ratio (ICER) is cost of surgery in one eye divided by quality-adjusted life-year (QALY) gained. The most common intraocular lens (IOL) was the aurofoldable lens manufactured by Aurolab in Madurai, India, which cost US$13 (139 of the 292 patients in our sample used this IOL). When added to the other fixed and variable medical costs and other societal costs, the total cost is $88 (as shown in Exhibit 1). Appendix Exhibit 4 provides information on determining the mean cost of an IOL (see Note 10 in text). When added to the other fixed and variable medical costs and other societal costs, the total cost is $120 (as shown in Exhibit 1). An IOL commonly used in the United States is the Acrysof aspheric lens, which cost $100 (33 patients in our sample used this lens). With $49 in other medical expenses of cataract surgery and $25 in indirect patient costs, the total cost is $174. The Appendix includes an additional description of the utility gain calculations (see Note 10 in text). CI is confidence interval.

of phacoemulsification in the Aravind Eye Care System was $195—well below the WHO threshold[14] based on India's per capita GDP of about $1,600[15] (Exhibit 2).

SENSITIVITY ANALYSES Varying the method of calculating health utility gains by using utility scores associated with visual acuity levels instead of EQ-5D-3L results made cataract surgery appear even more cost-effective: The initial utility gained from the surgery became 0.19 (95% CI: 0.18, 0.20), which made the ICER $42 per QALY.

Next, we varied the rate of utility decline with age from no decline at all to a decline twice as fast as that in the United States. In each case, the change in the ICER was minimal ($3 or less, depending on the intraocular lens chosen) (Appendix Exhibit 5).[10]

A two-way sensitivity analysis showed that health gains would have to be substantially lower (about one-tenth of what we estimated) or costs much higher (about ten times higher) for high-volume cataract surgery in the Aravind Eye Care System to be considered not cost-effective (Appendix Exhibit 6).[10] The probabilistic sensitivity analysis showed that any randomness because of the patients selected for this study was unlikely to have altered the likelihood that cataract surgery would be considered cost-effective (Appendix Exhibit 7).[10]

ELIMINATING CATARACT-RELATED BLINDNESS AND LOW VISION IN INDIA Providing surgery to one eye for all thirty million Indians who are blind or have low vision because of cataracts would cost US$2.6 billion in direct plus indirect costs (Exhibit 3). However, the benefits would be valued at $16 billion, for a net gain of over $13 billion. Increasing the rate of cataract surgeries in India from the current estimate of 5,721 to 10,000 surgeries per million annually would cost $497 million. But the benefits would be valued at $5.4 billion, for a net gain of $4.9 billion (Exhibit 3).

Discussion

These findings provide a detailed accounting of the cost of cataract surgery at the Aravind Eye Care System and highlight how, at only US$195 per QALY, cataract surgery can be very cost-effective. We also used cost data from patients undergoing surgery at Aravind Eye Hospital-Madurai to estimate the cost of addressing the public health burden of blindness and low vision due to cataracts throughout India. If the system's model were applied nationwide, cataract surgery on one eye could be performed on the thirty million Indians with cataract-related blindness or low vision at a cost of under $3 billion, with an estimated net economic benefit that would ex-

EXHIBIT 3

Cost of decreasing blindness and low vision related to cataracts in India

	Increasing annual cataract surgery rate to 10,000 per million population	Eliminating cataract-related blindness and low vision		
		Blindness	Low vision	Both
Population (millions)	5.68	7.8	22.4	30.2
Costs (millions)				
Direct	US$356	US$491	US$1,404	US$1,895
Indirect (patient and family time, food, and travel)	141	195	557	751
Total	497	686	1,961	2,647
Benefits (millions)	5,387	7,428	8,674	16,103
Net gain (millions)	4,890	6,743	6,713	13,456

SOURCE Authors' analysis. **NOTES** Costs are in 2016 US dollars. Appendix Exhibit 11 provides costs in Indian rupees (see Note 10 in text). The current estimated rate of cataract surgery in India is 5,721 surgeries per million population per year (see Note 5 in text). Increasing the rate to 10,000 would require an additional 4,279 surgeries per million population per year. Multiplying this number by the population of India yields 5.68 million cases. The estimated numbers of people who are blind or have low vision (both defined in the text) due to cataracts does not include cases that will develop in the future. The Appendix also includes details about the cost calculations (see Note 10 in text). Numbers may not sum to totals because of rounding.

ceed $13 billion. More realistically, doubling the present rate of cataract surgeries to 10,000 surgeries per million population annually would have a net economic benefit of nearly $5 billion.

COST AND EFFICIENCY AT THE ARAVIND EYE CARE SYSTEM Several factors have contributed to the sustainability and growth of the Aravind Eye Care System over the past four decades and to the institution's ability to extend surgical services to patients who cannot afford to pay for them (Appendix Exhibit 8).[10] Sustainability requires an ongoing demand for eye care services and judicious use of resources. Demand for surgical services depends on the delivery of safe and effective care and a delivery design based on a deep understanding of cultural barriers that may impede the uptake of care.[21] It also requires reaching out to underserved communities and occasionally assisting patients with transportation to the health care facility for surgery. Likewise, using resources efficiently entails developing processes to improve patient throughput, limiting waste, and maximizing human capital.

MANUFACTURING AFFORDABLE SURGICAL EQUIPMENT One method that the Aravind Eye Care System uses to keep costs low is the purchasing of surgical equipment and medications from domestic manufacturers such as Aurolab (an affiliate company of the Aravind Eye Care System), which sell these items at low prices to institutions domestically and abroad. For example, the Aurolab intraocular lens selected by nearly half of the patients in our study costs only US$13, while consumables used for the surgery added an average of just US$11 per operation. Patients play an active role in choosing their intraocular lens and the type of cataract surgery that they will undergo (Appendix Exhibit 4),[10] navigating the available options with the help of trained cataract counselors. The transparent pricing system allows patients to make more informed decisions.

LABOR FORCE To maintain efficiency and keep costs low, the Aravind Eye Care System depends on paraprofessionals such as cataract counselors and mid-level ophthalmic personnel, who perform the majority of perioperative clinical services. In contrast, in developed countries, the surgeon customarily discusses the details of surgery with the patient and performs all preoperative and postoperative care. By design, the Aravind Eye Care System approach increases patient throughput, improves communication, reduces bottlenecks that would occur if all patients were evaluated by the relatively small number of surgeons, and maximizes the time that surgeons can devote to performing surgery.

Since mid-level ophthalmic personnel perform most of the perioperative care,[22] Aravind Eye Care System surgeons operating in the high-volume operating rooms can perform six to eight surgeries hourly. The average cost per surgery to cover a surgeon's salary is less than US$3, which is many orders of magnitude lower than in developed countries. Each employee of the Aravind Eye Care System is trained to perform specific tasks, and processes are highly standardized so that the system makes the most efficient use of its employees' skills.

EFFICIENT USE OF OPERATING ROOMS Each operating room allocates at least two operating tables per surgeon, which allows for fast transitions between surgeries and enables surgeons to perform 2,000 or more cataract surgeries annu-

ally.[23] While one patient is undergoing surgery, mid-level ophthalmic personnel are preparing another on the adjacent operating table. When surgery on the first patient is completed, the surgeon rotates her or his chair to the adjacent patient, applies antiseptic to her or his gloves, and starts the next procedure.

Surgeons do not routinely change gloves and gowns or leave the operating room between surgeries. These measures optimize surgeons' productivity. Despite its divergence from US standards, the Aravind Eye Care System has complication rates as low as or lower than those in developed countries.[20] The system's leaders continually monitor surgical quality, complication rates, and surgeons' productivity.

SOCIETAL BENEFITS The benefits of cataract surgery at the Aravind Eye Care System extend beyond individual patients. Cataract-related blindness in India disproportionately affects the poor,[24] and the treatment of this condition has important secondary societal benefits.[4] For example, in a study of patients from Tamil Nadu who underwent cataract surgery, at one year after the surgery—compared to before the surgery—33 percent more of the patients were engaged in income-generating activities, the proportion of households with a monthly income of less than 1,000 rupees (about US$15) had decreased from 51 percent to 21 percent, and widowed patients were more likely to have remarried.[3] Thus, beyond the moral value of providing care to the poor, doing so may benefit the local economy by increasing productivity and individual wealth.

The employment of hundreds of mid-level ophthalmic personnel, known as "sisters," also benefits the local economy. Sisters are recruited from high schools in rural areas and spend two years in training to become nurses, cataract counselors, operating room assistants, educators, or research assistants. They frequently send some of their earnings back home to family members, further helping local economies.

IMPROVING SURGICAL CARE

▶ **IN INDIA:** The management principles that the Aravind Eye Care System uses to optimize patient flow and efficiency could be applied to other medical fields. This is particularly true in India, where fewer regulatory and cultural barriers exist than is the case in many developed nations. For example, endoscopy and hernia repair are high-volume ambulatory care procedures that might benefit from aspects of the Aravind Eye Care System model. In fact, employing techniques similar to those used at the Aravind system, the Narayana Institute of Cardiac Sciences, in Bangalore, India, has developed an efficient system for delivering cardiac care to many patients.[25] Policy makers in India could consider implementing initiatives to give these kinds of high-value practice models a trial with other surgeries. If this is successful, the public sector could incentivize the establishment of surgical centers that focus on high-volume procedures throughout India.

The benefits of cataract surgery at the Aravind Eye Care System extend beyond individual patients.

▶ **IN DEVELOPED NATIONS:** Outpatient surgery now accounts for 60 percent of all operations in the United States.[26] US policy makers and hospital administrators might consider applying some features of the Aravind Eye Care System model to ophthalmic and nonophthalmic ambulatory care surgery to improve efficiency and lower costs. However, adopting certain features might not be practical or feasible.

For example, US regulations require surgeons to exit the operating room and change their gowns and gloves between cases. This practice decreases efficiency and adds cost, especially for high-volume procedures such as cataract surgery. Although one might assume that these practices reduce infection risk, the very low surgical infection rates at the Aravind Eye Care System, which are comparable to those at US cataract centers of excellence, suggest otherwise.[27] Unfortunately, no mechanism exists to pilot-test interventions that deviate from regulatory standards, such as those of the Joint Commission,[28] to determine whether strict adherence to such regulations does or does not improve surgical outcomes and the regulations' effect on efficiency and care costs.

At the Aravind Eye Care System, all patients are evaluated by an ophthalmologist before surgery, but the surgeon who will be performing their operation is seen by only a small subset of patients (those whose cases are complex and those who specifically request such a meeting). The cataract counselors and mid-level ophthalmic personnel are well trained to discuss the risks and benefits of the surgery and answer patients' questions. By comparison, patients in the United States often expect to develop a relationship with their surgeon before surgery and might be less

The Aravind Eye Care System approach challenges conventional beliefs about health care delivery.

accepting of this protocol than patients in developing nations. And, like patient-physician communication, patient privacy is highly valued in the United States. Thus, US patients might not accept the common practice in developing countries of having two or more patients occupy one operating room simultaneously. Thus, regulatory hurdles and cultural differences may represent roadblocks to the adoption of certain features of the Aravind Eye Care System approach in most developed nations.

Furthermore, some health care fields could benefit more than others from different facets of the system's care delivery model. In fact, in some fields, efficiency gains could be offset by potential harm to patients. For example, changing gloves between patients would be essential in infectious disease clinics, and using surgical counselors for certain complex surgeries might be impractical. Nonetheless, the Aravind Eye Care System approach challenges conventional beliefs about health care delivery, and this may prove valuable to future efforts anywhere in the world to contain health care costs while maintaining high quality.

MEETING INDIA'S NEED FOR CATARACT SURGERY Despite impressive progress in addressing the need for cataract surgery in India, little progress was made in reducing cataract-related blindness in India until the 1990s, when the Cataract Blindness Control Program was initiated.[29] Cataract-related blindness in the population decreased from 7.6 percent in 1989 to a projected rate of 3.4 percent in 2015.[5] This large decrease has mirrored an increase in the rate of cataract surgeries, from 1,342 per million population in 1990 to 4,500 per million population in 2005.[5] Nonetheless, the absolute number of people affected by cataract blindness has been relatively stable because of the considerable growth and aging of the Indian population.[5]

The WHO's Vision 2020 initiative has prioritized the elimination of avoidable blindness by 2020.[5] Achieving this goal in India would require a large increase in access to cataract surgery.[5] Approximately thirty million people in India are blind or have low vision due to cataracts.[17] We estimate that the cost of providing cataract surgery in one eye for this population would be around US$2.6 billion but would have a net economic benefit of US$13.5 billion.

However, even if this ambitious goal were met, this approach would not address incident disease, which is rapidly increasing as a result of the aging of the Indian population.[5] A more attainable goal would be to roughly double the annual rate of cataract surgeries per million population. Using the Aravind Eye Care System model, the cost of expanding cataract surgical services in India would be approximately US$500 million but would have an overall economic net benefit of nearly US$5 billion. This approach could have a large impact on Indians affected by cataracts in the short and longer terms.

Conclusion

We have discussed a successful approach developed by the Aravind Eye Care System that offers efficient, high-quality cataract surgery to millions of people in India. Through innovative strategies aimed at curtailing costs without jeopardizing the quality of care, the Aravind Eye Care System has developed a model that is sustainable and may serve as a template for health care professionals and health policy makers seeking to improve the delivery of high-volume ambulatory surgical care in India and elsewhere. ■

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10 To access the Appendix, click on the Appendix link in the box to the right of the article online.

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