A Cost Comparison of Cataract Surgeries in Three Countries — United States, India, and Nepal

Jiayin Xue, MD, MPH, John Hinkle, MD, Mary-Grace Reeves, MD/MBA, Luo Luo Zheng, MD, Vengadesan Natarajan, MBA, MPhil, Shyam Vyas, MD, Radhika Uperti Oli, MPH, Matt Oliva, MD, Robert Kaplan, PhD, Arnold Milstein, MD, MPH, Geoff Tabin, MD, Jeffrey L. Goldberg, MD, PhD, Kevin Schulman, MD, MBA

Vol. 2 No. 9 | September 2021
DOI: 10.1056/CAT.21.0151

U.S.-based cataract surgeries are costly compared with those performed in high-quality Indian and Nepalese eye centers. The authors used time-driven activity-based costing to evaluate phacoemulsification surgery across four sites: an academic hospital outpatient department (HOPD) and an ambulatory surgery center (ASC), both in the United States, Aravind Eye Hospital in Pondicherry, India (AEH-P), and Tilganga Institute of Ophthalmology (TIO) in Kathmandu, Nepal. Indexing HOPD to $100 and correcting for purchasing power parity, the costs of cataract care were $42.00 at ASC, $21.50 at AEH-P, and $16.10 at TIO. Lower cost at the two South Asian sites can be attributed in part to faster patient throughput, avoidance of intravenous anesthesia, increased use of mid-level staff, and more frequent reuse of supplies. Significant savings may be achieved in the United States through adoption of these practices, but it may require new incentives within the nation’s health system.

KEY TAKEAWAYS

» Even after controlling for international input prices, cataract surgery costs were still lower in high-volume surgical sites in India and Nepal than in the United States, suggesting that a different care delivery approach is needed.
The greatest contributor to cost at U.S.-based sites was personnel, while at the Indian and Nepalese sites, it was consumables. Notably, sites in the United States use more higher-cost nursing labor, while the South Asian sites typically use lower-cost technicians.

Adopting clinical processes from these high-quality, lower-cost providers; developing a top-of-the-license approach with optimization of physician time; instituting detailed process flows and task-specific staffing models; and strengthening the focus on supply costs could significantly reduce cataract surgery costs in the United States.

The Challenge

Cataract surgery is among the most frequently performed ambulatory surgeries in the United States.\textsuperscript{1,2} Total treatment costs for cataract surgeries are projected to reach more than $30 billion annually in the United States by 2050.\textsuperscript{3} Internationally, both Aravind Eye Hospital in Pondicherry, India (AEH-P), and the Tilganga Institute of Ophthalmology (TIO) in Kathmandu, Nepal, are known for performing high-volume, low-cost cataract surgeries with excellent outcomes.\textsuperscript{4–6} Their care processes evolved through a deliberate strategy of driving for efficiency to improve access in patient self-pay markets with enormous unmet clinical needs.\textsuperscript{7} While we know that the cost of cataract surgery in the United States is much higher than in India and Nepal, comprehensive comparisons of the process and cost of cataract care across countries are scarce.\textsuperscript{8} Thus, our challenge in examining exemplar organizations such as AEH-P and TIO is to spawn reverse innovation and to identify effective and efficient care delivery processes that can be adopted by care providers in the United States.

The Goal

We applied the time-driven activity-based costing (TDABC) method to conduct a detailed cost comparison between and among an academic hospital outpatient department (HOPD) and an ambulatory surgical center (ASC), both in the United States, and the AEH-P in India and the TIO in Nepal. We aimed to capture differences in care process and cost across the study sites and to identify opportunities for reverse innovation, in which discoveries from abroad are used to reduce the cost of care in the United States. Through this process, we hope to apply lessons learned that will enable U.S. providers to lower their cost of cataract care and further improve patient access.

The Execution

TDABC is a systematic approach to measuring the costs of producing products and services that has been widely applied in health care settings.\textsuperscript{9–12} An accompanying Appendix includes further information and data associated with the authors’ research. Within the Appendix, Section A addresses the TDABC process.
Development of the Process Maps

At each of the four sites, local clinicians and staff were observed and interviewed to construct detailed process maps for preoperative visits, day-of-surgery activities, and on-site postoperative visits for cataract phacoemulsification surgeries. Each process map included the personnel, time, and space involved for individual activity required to complete the procedure. The process maps were then validated with multiple in-person observations, with the exception of ASC because of the Covid-19 pandemic; in that case, internal personnel provided validation through virtual meetings. When available, clinical process times were extracted from electronic records. Interviews and process map development began in November 2019 and were completed by June 2020.

Development of the Unit Cost Data

For each step in the process map, individual activity costs were calculated from administrative data. Costs were developed for personnel, equipment, space, and consumables. The consumables cost included all disposable supplies and medications, including the most commonly used monofocal lens at each site but excluding premium options such as toric and multifocal lenses because they are infrequently used in the South Asian settings. The most recent purchasing data available from 2020 were considered.

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All costs were calculated in local currency values and then converted to international dollars on the basis of purchasing power parities. All dollar amounts were converted to indexed costs, arbitrarily setting HOPD’s total cost to $100 to maintain confidentiality of each institution’s financial data. (In 2021, Medicare.gov listed the national average cost for cataract surgery as $1,587 at ASCs and $2,627 at HOPDs. Without Medicare or private insurance, out-of-pocket costs can be as much as $3,000 to $6,000 per eye.)

Analysis of Site Costs

We used the process maps and unit costs of resources at each site to calculate the total cost of a single phacoemulsification surgery. We compared cost differences across sites by category: consumables, personnel, equipment, and space. To examine personnel costs, we performed an analysis of three labor attributes at each site: labor price, skill mix, and efficiency. Labor price is the average cost of labor per minute, including salary and benefits, for each personnel type. Skill mix is defined as the percent allocation of the types of personnel involved in the care process. Efficiency was defined as the total amount of personnel time required to provide care for a patient, from the first preoperative visit to the last postoperative visit.
In further analysis, in Section B of the Appendix, we separately applied the values for the three labor attributes of the lower cost site to those of the higher cost site to understand the opportunity for cost saving from adopting alternative labor models. In Section C of the Appendix, we present the process maps for preoperative, day of surgery, and postoperative activities for each of the four organizations.

**Hurdles**

Navigating complex organizational structures to access financial data was difficult at times. Various components of cost data often resided within different departments, and successful acquisition of the data required navigating departmental policies and influencing stakeholders. Because of structural and data limitations, we could not accurately compare administrative and other overhead costs on a per-patient basis. We included only direct clinical labor as personnel cost.

**The Team**

The core team consisted of seven faculty and medical trainees from the Stanford School of Medicine. We collaborated closely with surgeons and researchers at TIO and AEH-P, as well as with surgeons and administrative staff from the two U.S. sites. For similar efforts in the future, we would recommend that teams have at least one senior executive or physician at each site to get organizational buy-in, one project manager, one working team physician, and one researcher familiar with TDABC methods. The project will also likely involve at least half a dozen administrative staff at each site, depending on how the data are stored.

**Metrics**

Complete process maps for cataract surgery were constructed from interviews and clinical observations. Figure 1 represents just one example; others appear in Section C of the Appendix.

Several key differences in clinical flow, staffing, timing, and materials were identified. The South Asian sites did not routinely use IV anesthesia, had higher surgical volume (per surgeon and per facility), had faster operating room (OR) throughput, utilized more assistants and technicians, and reused and recycled more materials; details are provided in Sections D and E of the Appendix.

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The median OR time ranged from 18 minutes (TIO) to 48 minutes (HOPD); operative time from first incision to finish ranged from 10 minutes (ASC) to 19 minutes (HOPD); turnover time between patients in the room ranged from 2 minutes (AEH-P and TIO) to 17 minutes (HOPD).
Even after converting to international dollars, the U.S.-based sites had much higher costs than the two South Asia sites (Figure 2).

Personnel were the highest cost category for the U.S.-based sites, while consumables were the highest cost category for South Asian sites. In addition, both personnel and consumables accounted for significant cost differences between the two sites in the United States (Figure 3).

The sites in the United States have longer clinical care time and rely much more heavily on nurses compared with the Indian and Nepalese sites, which relied on mid-level providers who provide most of the preoperative and postoperative care, such as obtaining vital signs, providing counseling, and administering eye drops (Figure 4).
Although labor price accounts for the largest individual contributor of personnel cost difference between the U.S. and the South Asian sites, this analysis showed that HOPD could save 56% of personnel cost by adopting TIO’s skill mix and efficiency (Table 1).

The main source of cost difference between AEH-P and TIO was intraocular lens selection. Most patients at AEH-P for cataract care receive in-house–manufactured lenses; however, those
Comparison of Cost Differences Among Sites

Indexing a U.S.-based academic hospital outpatient department (HOPD) at $100, we examined how the four cost components (personnel, consumables, equipment, and space) contributed to total cost differences among the sites, from the highest-costing (HOPD) to the lowest-costing site, Tilganga Institute of Ophthalmology (TIO). AEH-P = Aravind Eye Hospital in Pondicherry, India, ASC = ambulatory surgery center.

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who choose phacoemulsification surgeries tend to be insured or are financially able to pay out of pocket for imported monofocal lenses. (The difference in products is analogous to brand-name and generic drugs.) At TIO, almost all patients receive in-house–manufactured lenses. If patients at AEH-P chose in-house–manufactured lenses, total cost would decrease by 70%, and total surgical costs at AEH-P would be lower than at TIO. Of note, providers in the United States do not have in-house lens manufacturing capacity; all U.S. patients receive commercially branded lenses.
FIGURE 4

Distribution of Clinical Care Time by Personnel Mix

This represents the total clinical care time for cataract surgery spent by all providers (i.e., if a 5-minute activity involved three providers simultaneously, the total clinical care time would be 15 minutes). Attending Doctors of Medicine (MDs) included ophthalmologists, anesthesiologists, and internists (where it applied). Nurses included clinic, pre- and postoperative, and operating room nurses, as well as nurse anesthetists. Other staff included medical assistants, technicians, a variety of mid-level providers (called MLOPs at Aravind Eye Hospital in Pondicherry, India [AEH-P]), and administrative staff directly involved in patient care. See Appendix process maps for detailed responsibilities of each type of mid-level provider. ASC = ambulatory surgery center, HOPD = hospital outpatient department, TIO = Tilganga Institute of Ophthalmology.

Clinical Care Time by Personnel Mix

Source: The authors

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Where to Start

There are several issues that health care leaders should consider if they want to decrease operating costs for their cataract surgery services.

Market and Cultural Differences

Some of the cost variance identified between South Asian and U.S. sites may be rooted in differences in local labor practices and regulations. For example, a no-appointment system with extended work hours at AEH-P contributes to lower personnel cost per minute, a practice that would not be feasible in the United States. The sites in India and Nepal also have a much higher volume of patients who are willing to wait for extended periods while receiving clinical services, which allows for optimization of efficiency from the provider’s perspective. Surgeons at AEH-P and TIO perform surgeries back-to-back with little delay, and they spend little time in preoperative or postoperative care.

OR Turnover

In addition to having a high volume of patients, at AEH-P, two patients occupy the same OR suite concurrently, allowing equipment setup for the subsequent patient while the index patient is still occupying the OR. ASC leverages a similar parallel model by setting up sterile trays in a new OR while the surgeon is finishing their index case.

At AEH-P in India and TIO in Nepal, surgeons can move from one patient to the next without having to change mask, cap, and gown, or even gloves — gloves are sanitized with rubbing alcohol between patients — saving both time and consumables. Although the U.S. regulatory environment precludes these practices, there is no evidence that either AEH-P or TIO incur higher rates of postoperative infectious endophthalmitis compared with the United States. Shortening time in the OR not only produces cost savings per patient, but also enables surgeons to perform more surgeries in the OR each day (Appendix, Section D).

Personnel Use

Another major contributor to higher cost in the United States is the use of expensive providers. At AEH-P and TIO, ophthalmic assistants and mid-level ophthalmic providers are non-registered...
nurse and non–Doctor of Medicine caregivers who deliver most of the pre- and postoperative care. At HOPD, physicians and nurses take on the majority of these tasks. In the United States, state laws vary on which functions medical assistants (MAs) and licensed vocational nurses (LVNs) can perform. In California, trained MAs are allowed to take preliminary patient histories, check vital signs, perform bedside blood glucose testing, and administer ophthalmic drops. In addition, LVNs can start IV fluids and provide education and training for patients and families. These and many other functions in the perioperative period could be efficiently and safely performed by these lower-cost staff.

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At TIO, almost all patients receive in-house-manufactured lenses. If patients at AEH-P chose in-house-manufactured lenses, total cost would decrease by 70%, and total surgical costs at AEH-P would be lower than at TIO. Of note, providers in the United States do not have in-house lens manufacturing capacity; all U.S. patients receive commercially branded lenses.

In the fee-for-service practice environment of the United States, IV sedation with monitoring by certified registered nurse anesthetists and anesthesiologists is common practice during cataract surgeries, but this approach is almost never undertaken at AEH-P and TIO. A study of more than 13,500 patients who underwent office-based cataract surgeries at Kaiser Permanente Colorado, which does not use fee-for-service payments, suggests that cataract surgeries can be performed safely in the U.S. without IV anesthesia. In 2018, one U.S. insurer, Anthem, attempted to eliminate reimbursement for anesthesia monitoring for cataract surgery. However, it encountered strong resistance from medical associations. A further limitation is that in the United States, ophthalmologists are trained to perform cataract surgeries under anesthesia.

Consumables

Even though consumables are the biggest cost driver at AEH-P and TIO, HOPD and ASC still incur a much higher consumables cost compared with these sites. We found that, excluding pricing differences, the use of disposable items also plays a role in elevated costs in the United States. For example, the phacoemulsification tip and tubing are treated as disposable at HOPD and ASC, whereas they are routinely sterilized and reused abroad. The American Academy of Ophthalmology supports off-label reuse of these tips, but institutional cultural practices discourage reuse of items labeled by their manufacturers as single use.

Changes in purchasing and reimbursement models can also lower costs. For example, HOPD purchased its highest-cost consumable, a branded injection medication used to stabilize and protect the eye during surgery, as a separate product. In contrast, ASC negotiated a significant discount by having its supplier include this medication as part of a preassembled consumables package.

Previously, ASC separately billed the insurer or patient its $415 cost for using a branded drug to maintain pupil dilation during surgery. After the Centers for Medicare & Medicaid Services’ (CMS)
pass-through payment provision for this medication expired, ASC switched to a generic epinephrine solution, which is comparable in efficacy and costs less than $1 per patient. Our analysis reflects the costs at ASC after the termination of the pass-through payment.

**Limitations**

This study could not address the relationship between patient characteristics and costs; therefore, in the U.S.-based sites, we could not exclude patient selection as a factor in assessing efficiency of the HOPD and AMC. Further, we assessed costs at only one type of each facility in the United States, at one point in time, so there may be variation in costs within each facility type across markets.

**Health System Implications**

AEH-P and TIO have evolved systematic approaches to reducing cost as a means of increasing access to care for the populations they serve. Similar to a Ford manufacturing plant, at AEH-P and TIO, every step of the cataract process has been carefully designed, iterated, and standardized to promote speed while maintaining quality. The patient is funneled through a moving process, and each provider delivers care at the top of their license. At AEH-P and TIO, efficiency is not provided at the expense of clinical quality (although comparisons of clinical outcomes across sites are problematic because the data are not regularly or uniformly reported in the United States or globally).

Whether such innovations can be implemented in the United States remains an open question. Several innovations, such as training lower-cost personnel to perform tasks currently performed by surgeons or nurses, can be readily adopted in the U.S. market. Other, more radical ideas, such as treating two patients concurrently in the same OR, seem unlikely for adoption in the United States. Office-based cataract surgery without IV anesthesia has been shown to be safe and implementable in the United States.

From a management perspective, leaders at institutions such as HOPD and ASC would have a higher incentive to adopt these findings if all services for cataract surgery were reimbursed through a bundled payment model, rather than with fee-for-service payments for individual components, such as separate payments for surgery and anesthesia. At HOPD, several different hospital departments are involved in providing cataract surgery. The political dynamics of optimization of a single service line in a matrix reporting structure remain challenging.

In recent years, lowered CMS cataract reimbursements and rollout of the value-based Merit-based Incentive Program System measure for cataract surgeries have prompted providers to reexamine their costs. Incentives for higher productivity and lower cost could also be catalyzed if institutions competed for cataract business on the basis of their outcomes and quoted prices, such as through a competitive bidding process, or through the shoppable services initiative recently created by the U.S. Department of Health and Human Services. Price transparency through shoppable services would enable patients to compare among facilities, further exerting pressure on cataract providers to lower both their costs and pricing. AEH-P and TIO suggest the concept of a focused factory or Centers of Excellence program can achieve remarkable performance for patients receiving cataract care.

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Jiayin Xue, MD, MPH  
Senior Scholar, Stanford University School of Medicine, Clinical Excellence Research Center, Stanford, California, USA

John Hinkle, MD  
Ophthalmology Resident, Stanford Medicine, Spencer Center for Vision Research, Byers Eye Institute, Ophthalmology, Stanford, California, USA

International Fellow, Himalayan Cataract Project, Waterbury, Vermont, USA

Mary-Grace Reeves, MD/MBA  
Medical/Graduate Student, Stanford University School of Medicine, Clinical Excellence Research Center, Stanford Medicine, Spencer Center for Vision Research, Byers Eye Institute, Ophthalmology, and Stanford University Graduate School of Business, Stanford, California, USA

Luo Luo Zheng, MD  
Chief Ophthalmology Resident, Stanford Medicine, Spencer Center for Vision Research, Byers Eye Institute, Ophthalmology, Stanford, California, USA

Vengadesan Natarajan, MBA, MPhil  
Quality Manager, Aravind Eye Hospital – Pondicherry, Pondicherry, India

Shyam Vyas, MD  
Professor of Ophthalmology, Tilganga Institute of Ophthalmology, Kathmandu, Nepal

Radhika Upreti Oli, MPH  
Senior Research Officer, Nepal Eye Program, Tilganga Institute of Ophthalmology, Kathmandu, Nepal

Matt Oliva, MD  
Board Member, Himalayan Cataract Project, Waterbury, Vermont, USA

Robert Kaplan, PhD  
Professor, Harvard University, Harvard Business School, Boston, Massachusetts, USA

Arnold Milstein, MD, MPH  
Director, Stanford University, Clinical Excellence Research Center, Stanford, California, USA

Geoff Tabin, MD  
Professor of Ophthalmology and Global Medicine, Stanford Medicine, Spencer Center for Vision Research, Byers Eye Institute, Ophthalmology, Stanford, California, USA

Co-Founder and Chairman, Himalayan Cataract Project, Waterbury, Vermont, USA
Appendix

Supplementary Appendix

Acknowledgments

We thank our collaborators at each of the research sites for their help in validating the process maps and with financial data gathering. We gratefully acknowledge support from the Fairweather Foundation, the National Eye Institute (P30 EY-026877), and Research to Prevent Blindness, Inc.

Disclosures: Jiayin Xue*, John Hinkle*, Mary-Grace Reeves*, Luo Luo Zheng*, Vengadesan Natarajan, Shyam Vyas, Radhika Upreti Oli, Matt Oliva, Robert Kaplan, Arnold Milstein, Geoff Tabin, Jeffrey L. Goldberg, and Kevin Schulman have nothing to disclose. Internal Review Board and administrative approvals: this study was reviewed by the Stanford Institutional Review Board and determined to be a nonhuman subject study. The study was also approved by administrative leadership at each institution and respective institutional review boards where applicable. The two U.S. institutions have elected to remain anonymous. *Each of the designated authors has moved on to other positions since the manuscript was originally crafted and submitted.

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