Surgical Outcomes and Cost Basis for Resident-Performed Cataract Surgery in an Uninsured Patient Population

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**IMPORTANCE** In the past, resident physicians have provided care to indigent patients under the supervision of experienced physicians. General consensus exists regarding higher surgical costs of patient care at teaching hospitals. No study has examined the outcomes or the cost basis for resident physicians providing health care to an underserved population.

**OBJECTIVES** To evaluate the visual results in uninsured patients undergoing cataract surgery performed by resident surgeons at a single institution and to determine the cost-effectiveness of care.

**DESIGN AND SETTING** A retrospective case series of consecutive uninsured patients undergoing cataract procedures performed by attending-supervised resident physicians at the University of Washington from July 1, 2005, through June 30, 2011. Data obtained included demographic information, preoperative and postoperative best-corrected visual acuity (BCVA) in the eye undergoing the procedure, and surgical complications. We calculated the costs of services rendered and normalized them to 2011 dollars. These data were incorporated into time-trade-off discounted utility values. Data were expressed as mean (SD).

**PARTICIPANTS** One hundred forty-three consecutive patients.

**EXPOSURE** Cataract surgical procedures.

**MAIN OUTCOMES AND MEASURES** Costs of the surgical procedure and the utility value associated with the BCVA in the operated-on eye.

**RESULTS** The mean logMAR preoperative BCVA was 1.09 (0.74) (Snellen equivalent, 20/300). The best-recorded mean postoperative BCVA was 0.24 (0.42) (Snellen equivalent, 20/40), obtained at 3.77 (9.30) months. The final recorded mean BCVA was 0.27 (0.43) (Snellen equivalent, 20/40), obtained at a median (SD) follow-up of 16.32 (17.10) months. Four complications in 3 eyes required a second operation; 15 postoperative laser procedures were performed. The mean health care cost per patient was $3437.24 ($1334.68). Using these data, the mean utility value of cataract surgery in this population was 0.80 (0.12); the quality-adjusted life-years gained, 2.43 (1.87); and the discounted ratio of cost to utility, $1889.16 ($4800.62).

**CONCLUSIONS AND RELEVANCE** These data support the success and cost-effectiveness of supervised, resident-performed cataract surgery in an underserved patient population. This study lends support for continuing this traditional scheme of surgical training and education. Further work must ensure that we remain aware of the balance between education and patient care.
here exists an innate social dichotomy between the need to provide adequate education to future physicians and the desire of each patient to receive competent care. Traditionally, balance was achieved by allowing training physicians to care primarily for indigent patients; however, changes in health care throughout the past several decades have necessarily and appropriately strained this relationship. The complex and interconnected roles among resident physicians, patients receiving care at training hospitals, and the supervising faculty remain unresolved, with the ethos of transparency and autonomy at the center of the discussion.

The literature regarding resident physician influence on patient cost and surgical outcomes is inconclusive. Although patients admitted under the care of residents are generally accepted as having higher medical costs, leading to decreased hospital profitability, some studies have suggested otherwise. Although some analyses have found increased patient morbidity at teaching compared with nonteaching hospitals, most recent reports indicate that no significant difference or decreased risk exists at teaching hospitals, most recent reports indicate that no significant difference or decreased risk exists at teaching hospitals, although studies have suggested otherwise.

In addition to being the only level 1 trauma center in Washington State and a training site for the University of Washington Department of Ophthalmology residency program, Harborview Medical Center (HMC) serves as the Seattle metropolitan area “safety net” hospital and provides care to an expansive uninsured and immigrant population. The HMC serves patients who cannot otherwise pay for their health care via a well-established charity care program. The HMC provided charity care valued at $186,733,000 in 2010, the most recent year for which data are available. Cataar surgery services are provided under this program for patients with visual acuity poorer than 20/200 in the better-seeing eye or if a medical necessity for cataract surgery is deemed to exist. Medical necessity requests are evaluated on a case-by-case basis by supervising physicians and include indications such as phacomorphic glaucoma or cataract that impairs visualization and treatment of suspected proliferative diabetic retinopathy, among others.

To our knowledge, no studies have been performed examining the outcomes or the cost basis for resident physician involvement in the care of an underserved population. The purpose of this study was to evaluate the visual outcomes of these uninsured patients undergoing cataract operations by attending-supervised resident surgeons at a single institution and to determine the cost-effectiveness of their care.

Methods

A retrospective review was conducted of consecutive cataract procedures performed on uninsured patients by attending-supervised resident physicians at HMC from July 1, 2005, through June 30, 2011. This project was approved by the Human Subjects Division of the University of Washington institutional review board.

Patient medical records were selected using the 2 common Current Procedural Terminology codes for cataract surgery: 66982 (cataract surgery, complex) and 66984 (cataract surgery with intraocular lens, 1 stage). The only exclusion criterion was applied to patients who underwent cataract extraction combined with another planned incisional surgery (n = 4). Data collected included patient age, sex, race, primary language, preoperative best-corrected Snellen visual acuity (BCVA) in the eye undergoing the procedure, postoperative BCVA in that same eye, postoperative BCVA at the time of the most recent patient visit, the time (in months) that the most improved and most recent BCVA was obtained after surgery, ocular comorbidities, and surgical complications.

Medical Costs

The cost of the initial office visit, diagnostic testing including an A-scan of axial length, intraocular lens calculations, the allowable professional fee for facility-based surgery, the facility price of cataract surgery, and complications were all obtained using the Centers for Medicare & Medicaid Services 2011 physician fee schedule for Seattle, Washington. The institutional costs of anesthesia and operating room services were provided by HMC Financial Services as an estimate based on the costs for the billed Current Procedural Terminology code for the prior fiscal year. The medications included in the cost analysis were topical cycloplegics used for surgery and topical antibiotics and topical corticosteroids used for a 1-month postoperative period and were provided in 2011 dollars by the HMC pharmacy.

Utilities

We used a patient preference-based, time-trade-off method to quantify the utility value associated with the BCVA in the eye undergoing the procedure. By convention, a value of 1.00 is equivalent to permanent perfect vision and 0.26 is equivalent to no perception of light in either eye. Using this well-established method, the patient determines the quantity of time they would trade to have the quality of life associated with 20/20 vision. The quality-adjusted life-years (QALYs) gained for an intervention were calculated based on utility gain using the following formula:

\[
\text{QALY Gain} = [(\text{Outcome Utility} - \text{Baseline Utility}) \times \text{Years of Benefit}].
\]

The ratio of cost to utility (cost-utility ratio) was derived by dividing the cost of an intervention by the QALY gain. Discounted cost utility in US dollars was determined by assuming a 3% discounting rate per year. Life expectancy was modeled from mortality data using US Social Security period life tables (http://www.ssa.gov/OACT/STATS/table4c6.html). All costs were in 2011 US dollars and were converted when necessary using the Consumer Price Index data for urban consumers. We performed a 1-way sensitivity analysis on the values of cost, utility, discount rate, and life expectancy. Unless otherwise indicated, data are expressed as mean (SD).
Results

A total of 143 uninsured patients underwent cataract surgery performed by an ophthalmology resident at HMC during the study period. Baseline demographics and characteristics of the study population are displayed in Table 1. After conversion to logMAR units, the mean preoperative BCVA was 1.09 (0.74) (Snellen equivalent, 20/300; median, 20/200). The mean logMAR of the best-recorded postoperative BCVA was 0.24 (0.42) (Snellen equivalent, 20/40; median, 20/25), obtained at 3.77 (9.30) months. The final recorded mean logMAR BCVA of 0.27 (0.43) (Snellen equivalent, 20/40; median, 20/25) was obtained at 16.32 (17.10) months. Graphical analysis of the individual patient results and population-based visual acuity outcomes are shown in Figure 1 and Figure 2. Four complications occurred in 3 eyes, requiring a second operation, including 2 eyes with retained lens fragments requiring a subsequent pars plana vitrectomy/lensectomy and 1 patient undergoing an intraocular lens exchange for an unexpected postoperative hyperopia. One of the patients who underwent pars plana lensectomy developed a rhegmatogenous retinal detachment on postoperative day 3 and required an additional subsequent pars plana vitrectomy. Fifteen postoperative laser procedures were performed, including 13 Nd:YAG laser-assisted capsulotomies for posterior capsular opacification and 2 Nd:YAG laser-assisted vitreolyses.

The mean cost per patient was $3437.24 ($1334.68). Using visual acuity data of individual cases as described above, the mean calculated utility value of cataract surgery in this population was 0.80 (0.12), and the mean QALYs gained were 2.43 (1.87), yielding a discounted cost-utility ratio of $1889.16 ($4800.62). Because these findings are specific to the costs at our institution, we performed a separate analysis using a standard estimated cost of initial cataract surgery and associated complications from the PORT (US National Cataract Patient Outcomes Research Team) data.17,19 Using the PORT costs, a similar discounting method and our patient visual acuity data yielded a slightly higher discounted mean cost-utility ratio of $2118.84 ($1621.78).

Table 1. Baseline Demographic Characteristics of 143 Uninsured Patients Undergoing Resident-Performed Cataract Surgery

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Dataa</th>
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<tbody>
<tr>
<td>Age at surgery, mean (SD) [range], y</td>
<td>61.1 (13.3) [21-67]</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>75 (52.4)</td>
</tr>
<tr>
<td>Female</td>
<td>68 (47.6)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>43 (30.1)</td>
</tr>
<tr>
<td>Black</td>
<td>32 (22.4)</td>
</tr>
<tr>
<td>Asian</td>
<td>44 (30.8)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>23 (16.1)</td>
</tr>
<tr>
<td>Not reported</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Primary language</td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>67 (46.9)</td>
</tr>
<tr>
<td>Spanish</td>
<td>19 (13.3)</td>
</tr>
<tr>
<td>Africanb</td>
<td>19 (13.3)</td>
</tr>
<tr>
<td>Filipino/Marshallese</td>
<td>13 (9.1)</td>
</tr>
<tr>
<td>Vietnamese</td>
<td>12 (8.4)</td>
</tr>
<tr>
<td>Indian</td>
<td>6 (4.2)</td>
</tr>
<tr>
<td>Chinese</td>
<td>5 (3.5)</td>
</tr>
<tr>
<td>Cambodian</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>CPT code</td>
<td></td>
</tr>
<tr>
<td>66982</td>
<td>40 (28.0)</td>
</tr>
<tr>
<td>66984</td>
<td>103 (72.0)</td>
</tr>
</tbody>
</table>


a Unless otherwise indicated, data are expressed as number (percentage) of patients. Percentages have been rounded and might not total 100.

b Indicates any language spoken on the African continent.

Figure 1. Individual Outcomes in Best-Corrected Visual Acuity (BCVA) of Patients in an Underserved Population Undergoing Cataract Extraction

Figure 2. Change in the Distribution of Best-Corrected Visual Acuity (BCVA) in an Underserved Population Undergoing Cataract Extraction
Figure 3. Discounted Cost Utility as a Factor of Preoperative Best-Corrected Visual Acuity (BCVA) in an Underserved Population of Patients Undergoing Cataract Extraction

We performed 1-way sensitivity analyses to evaluate the variability inherent to estimates of cost and utility value, resulting in moderate changes. When the total costs were increased by 25%, similar to variables used in other studies, the discounted cost-utility ratio was $2361.45 ($6000.77), whereas decreasing costs by 25% yielded a discounted cost-utility ratio of $1416.87 ($3600.46). Raising all utility values by 25% yielded a discounted cost-utility ratio of $1511.33 ($3840.50), whereas lowering them by 25% yielded a discounted cost-utility ratio of $2518.88 ($6400.82). To address the assumption that vision gained by a specific intervention will decrease in value over time, changes in the yearly discount rate were also analyzed. Varying the yearly discount rate resulted in a discounted cost-utility ratio of $1082.19 ($2477.16) for a 0% rate, $2892.70 ($7767.74) for a 5% rate, and $11 263.74 ($30 758.64) for a 10% rate. Provided that the mortality rate of our uninsured population may indeed vary from reported life tables, decreasing the life expectancy of each patient in the study resulted in a discounted cost-utility ratio of $2099.07 ($5334.02) for a 10% decrease in $2518.88 ($6400.82) for a 25% decrease. Although general consensus exists regarding the standard for an intervention to be considered cost-effective, some authors have suggested an upper limit of $100 000/QALY27 or $50 000/QALY.28 Regardless of the stringency of criteria one chooses, the discounted cost-utility ratio of $1889.16 determined in this study appears highly cost-effective. Table 2 compares the effectiveness of our study with a sample of other reported interventions. However, an important distinction between our data and those in the sample interventions needs to be made: the costs in our study are an estimate of resource intensity required by the intervention, not a true estimate of cost reimbursement. The patients in our study are uninsured and health care is provided as a charity; therefore, the cost-effectiveness is a measure of the value, financing, and resource intensity of the intervention.

The American Board of Ophthalmology has added a surgical competency to the 6 core competencies that the Accreditation Council for Graduate Medical Education requires all residents to master before graduation.

Implementing adequate surgical training in an ophthalmology department is a sizeable task, and perhaps the single largest aspect is teaching phacoemulsification cataract surgery. Microsurgical technique permits only 1 operating surgeon at a time, patients are usually awake during the procedure, and surgical complications can have profound visual consequences. Furthermore, many academic programs have been increasing patient volume in response to declining reimbursement, adding a significant time constraint to the operating room.

The influence of resident physicians on patient outcomes and costs of care remains undetermined, with universal consensus only regarding higher surgical costs for patients at teaching hospitals due to increased operative time for resident cases.5,6,8,11-13 A recent report found that at the Lebanon Veterans Affairs Medical Center, Lebanon, Pennsylvania, resident surgeons took a mean of 12 minutes longer per cataract surgery at an added cost of $105 per case early in their training compared with attending physicians; the increased time and cost normalized as residents progressed to later stages of training.
training.\textsuperscript{45} Despite any incremental costs associated with resident cataract surgery, it remained highly cost-effective in our patient population. To ensure that costs of care were not significantly different from other studies, the estimated cost of treatment, including complications, from the PORT data\textsuperscript{17,19} was incorporated into a separate analysis and suggested only a modest decrease in the discounted cost-utility ratio from our findings ($1889.16 vs $2118.84). The median postoperative BCVA of 20/25 achieved in our patients is consistent with prior large-scale cataract surgery in the United States,\textsuperscript{19,46} whereas the median preoperative BCVA of 20/200 in our series is significantly worse than the median acuity of 20/60 in other series.\textsuperscript{19,46} The considerable gain in visual acuity achieved by the patients in our study contributes to the cost-effectiveness of surgery in this population.

Multiple reports address surgical complications in resident cases, generally with supportive results. Although posterior capsular tear or vitreous loss occurs in 3.0% to 6.7% of cases,\textsuperscript{47-51} the rates of retinal detachment (0.69%)\textsuperscript{50} and endophthalmitis (0.11%)\textsuperscript{52} among resident-performed operations are comparable to those of larger series with experienced surgeons. The uncommon rate of complications requiring additional surgery in our series compares favorably with the literature.\textsuperscript{19,46} The 9% occurrence of posterior capsular opacification requiring Nd:YAG capsulotomy is much lower than the 28% reported in the literature at 5 years,\textsuperscript{53} but the rate likely reflects the limited follow-up in our patient population (median [SD], 16.32 [17.10] months) rather than a lower incidence.

This study has several important limitations. As a retrospective study from a single institution, the sample size is relatively small. The ability to extrapolate the cost-effectiveness to patients undergoing cataract surgery with better preoperative visual acuity is somewhat limited owing to the small number of patients who were enrolled in our program at those levels of visual acuity. Patients had more severe disease at their initial examination than a typical US population, and follow-up was too short to capture the true rate of late postoperative complications, such as posterior capsular opacification, with accuracy. The life expectancy of our patient population may differ significantly from the mortality tables used in the analysis. If the life expectancy is significantly reduced in this uninsured population, as suggested by multiple studies,\textsuperscript{18} the discounted cost-utility ratio will also be proportionately increased. However, as suggested by the univariate analysis, decreasing the life expectancy by as much as 25% did not significantly alter the cost-effectiveness. The utility values applied in this study were not specifically based on patient training, rather than the underlying cause, has been shown to correlate most closely with utility values.\textsuperscript{16} Furthermore, altering the utility values to 25% with 1-way sensitivity analysis did not significantly alter the cost-effectiveness of the intervention. The increased case time associated with other studies of resident-performed surgery was not included in our calculations. Under this program, surgery is performed by senior residents with supervision by an attending physician, and other studies have noted that the extended case time associated with resident surgery normalizes with more advanced training, which should minimize this artifact.\textsuperscript{45}

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Discounted Cost-Utility Ratio, $</th>
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<tbody>
<tr>
<td>Carpal tunnel syndrome surgery at age 65 y \textsuperscript{54}</td>
<td>335</td>
</tr>
<tr>
<td>Laser photocoagulation for threshold retinopathy of prematurity \textsuperscript{50}</td>
<td>1089</td>
</tr>
<tr>
<td>Vitrectomy for vitreous hemorrhage in type 1 diabetes mellitus \textsuperscript{51}</td>
<td>1309</td>
</tr>
<tr>
<td>Helicobacter pylori eradication for dyspepsia \textsuperscript{52}</td>
<td>1697</td>
</tr>
<tr>
<td>HMC resident cataract surgery</td>
<td>1889</td>
</tr>
<tr>
<td>Treatment of amblyopia \textsuperscript{53}</td>
<td>2929</td>
</tr>
<tr>
<td>Early vs deferred vitrectomy for proliferative diabetic retinopathy \textsuperscript{54}</td>
<td>2965</td>
</tr>
<tr>
<td>Cataract surgery in first eye \textsuperscript{37}</td>
<td>3027</td>
</tr>
<tr>
<td>Cataract surgery in second eye \textsuperscript{35}</td>
<td>3910</td>
</tr>
<tr>
<td>Laser photocoagulation for diabetic macular edema \textsuperscript{56}</td>
<td>5279</td>
</tr>
<tr>
<td>Vitrectomy with membrane peel for macular pucker \textsuperscript{57}</td>
<td>5655</td>
</tr>
<tr>
<td>Single-vessel artery bypass surgery for disease of the left anterior descending artery \textsuperscript{58}</td>
<td>9133</td>
</tr>
<tr>
<td>Laser photocoagulation for macular edema from branch retinal vein occlusion \textsuperscript{79}</td>
<td>9168</td>
</tr>
<tr>
<td>Atrophic macular degeneration treated with AREDS oral supplementation \textsuperscript{72}</td>
<td>1064</td>
</tr>
<tr>
<td>Chemoprophylaxis after occupational HIV exposure \textsuperscript{73}</td>
<td>52 382</td>
</tr>
<tr>
<td>Intravitreal ranibizumab for neovascular macular degeneration \textsuperscript{60}</td>
<td>53 099</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus and HbA\textsubscript{1c} level of 11% with no previous retinopathy, screening annually vs biannually \textsuperscript{41}</td>
<td>62 921</td>
</tr>
<tr>
<td>HMG-CoA reductase inhibitors for hyperlipidemia \textsuperscript{74}</td>
<td>77 225</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus and HbA\textsubscript{1c} level of 7% with no previous retinopathy, screening annually vs biannually \textsuperscript{41}</td>
<td>328 453</td>
</tr>
</tbody>
</table>

Abbreviations: AREDS, Age-Related Eye Disease Study; HbA\textsubscript{1c}, hemoglobin A\textsubscript{1c}; HIV, human immunodeficiency virus; HMC, Harborview Medical Center; HMG-CoA, hydroxymethyl glutaryl coenzyme A.

* Calculated by dividing the cost of an intervention by the quality-adjusted life-years gained.
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REFERENCES


OPHTHALMIC IMAGES

Spontaneous Vitreous Hemorrhage in a Case of Retinal Cavernous Hemangioma
A Rare Presentation

Aashraya Karpe, MS; G. Suganeswari, DO, DNB

A 10-year-old boy presented with sudden-onset blurring of vision in the left eye. He had a right-sided temporo-occipital vascular tumor. Spontaneous vitreous hemorrhage was seen with retinal cavernous hemangioma, which was managed conservatively, leading to complete resolution of blood.