Evaluation of Medicare Costs of Endophthalmitis among Patients after Cataract Surgery

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Purpose: Endophthalmitis, an ophthalmic condition characterized by an inflammation of the intraocular cavity, can have substantial implications for vision. However, little is known about the cost of treatment. The objective of this study was to estimate the direct medical cost of treatment for endophthalmitis in the United States.

Design: Retrospective data analysis using the 1997 through 2001 Medicare Beneficiary Encrypted Files.

Participants: Beneficiaries who underwent cataract surgery were identified; baseline and clinical characteristics at the time of diagnosis were determined. Analyses stratified patients based on development of endophthalmitis in the year after surgery.

Methods: Claims and reimbursements for cases (patients undergoing cataract extraction in whom endophthalmitis developed) and controls (patients who did not experience endophthalmitis) were determined and rates of resource use and costs were calculated from the perspective of Medicare.

Main Outcome Measures: Annual Medicare payments and claims.

Results: A total of 417 beneficiaries with endophthalmitis occurring after cataract surgery were found; 139,558 had cataract surgery without subsequent endophthalmitis. Three fifths of beneficiaries were female and 89% were white. Ophthalmic claims and reimbursements were more than 1.45 times greater for cases than controls ($12,578 in higher claims and $3464 in higher reimbursements; \(P<0.0001\)).

Conclusions: These findings demonstrate a substantial cost associated with endophthalmitis. With recent studies suggesting that prophylaxis is effective in preventing endophthalmitis, there is potential that inexpensive prophylaxis could result in cost and resource savings to Medicare. Ophthalmology 2007;114:1094–1099 © 2007 by the American Academy of Ophthalmology.

Endophthalmitis is an infection of the eye that rapidly can result in substantial loss of vision and may require enucleation. There are 2 primary types of endophthalmitis. Exogenous endophthalmitis follows ophthalmic surgery or trauma and often is bacterial in nature, with the most cases resulting from Streptococcus or Staphylococcus.1 Postoperative endophthalmitis, which can occur years after surgery, is most common after cataract surgery and intraocular lens implantation (occurring among approximately 0.1% of patients5), but also can follow other types of ophthalmic surgeries. Prophylaxis for endophthalmitis is recommended by the American Academy of Ophthalmology for individuals undergoing ophthalmic surgery3; there is stronger evidence for certain prophylactic agents than others.4 Posttraumatic endophthalmitis is more likely to be polybacterial.5 The incidence of endophthalmitis after open globe injuries has been reported to be more than 6%.5 In contrast to exogenous endophthalmitis, endogenous endophthalmitis is caused by the introduction of the infectious organism from a remote site and is much less common, representing from 2% to 8% of all cases of endophthalmitis.2 Endogenous endophthalmitis is more likely to have a fungal cause than is exogenous endophthalmitis, with Candida or Aspergillus often being the causative organism, and is more common among immunocompromised individuals. In both exogenous and endogenous endophthalmitis, there can be rapid deterioration with irreparable visual loss occurring in as little as a few days. Evidence suggests that outcomes in postoperative endophthalmitis may be related to the type of surgery (e.g., cataract extraction, pars plana vitrectomy, or secondary intraocular lens implantation).6
Treatments for endophthalmitis include antibiotic injections, most frequently vancomycin with amikacin or ceftazidime. The Endophthalmitis Vitrectomy Study (EVS), a landmark research study that helped define timing and appropriateness of immediate vitrectomy in endophthalmitis, indicated that most bacterial isolates were susceptible to vancomycin. Fluoroquinolones also are used with intravitreal antibiotics in severe cases, although this class of antibiotics is not guideline recommended. Vitrectomy, which involves aspiration of the infectious contents of the vitreous and replacement with a saline solution, may be used as an adjunct to therapy by allowing better distribution of antibiotics, and often results in better outcomes.

The extent of visual loss associated with endophthalmitis is dependent on the causative agent, vision at the time of infection, and the type and timing of treatment. For example, the EVS study found that immediate vitrectomy limited visual loss among patients with light perception only at presentation. Although few studies present visual acuity outcomes, recent case studies demonstrate that visual loss after endophthalmitis can be substantial, with more than one third of patients at counting fingers visual acuity or worse.

Endophthalmitis treatment and subsequent visual loss can have a substantial economic impact on annual per-patient medical costs and should be considered in costs of complications associated with ophthalmic surgery. However, little has been published on the costs resulting from the condition. Preliminary evidence suggests that postoperative endophthalmitis significantly increases hospitalization stay and costs and that outpatient treatment is less costly than inpatient treatment. In contrast to these studies articulating the negative clinical and economic outcomes of endophthalmitis, promising clinical news exists about prophylaxis: a recent study conducted by the European Society of Cataract and Refractive Surgery (ESCRS) found that antibiotic prophylaxis can reduce the rate of endophthalmitis significantly. The objective of this study was to quantify annual direct medical costs associated with postoperative endophthalmitis among adults 65 years of age and older in the United States.

Materials and Methods

Data were analyzed from the 1997 through 2001 Medicare Beneficiary Encrypted Files (BEF). The BEF represents a systematic 5% sample of all Medicare enrollees and is representative of U.S. citizens 65 years of age and older. The random sample used for this claims data set is selected by the Centers for Medicare & Medicaid Services (CMS) based on the same algorithm each year; the 5% sample is created based on selecting records with 05, 20, 45, 70, or 95 in position 8 and 9 of the beneficiary-specific Health Insurance Claim number. Thus, the same patients are included in the BEF data each year (unless they die) as well as new patients entering each year; therefore, longitudinal treatment patterns can be evaluated. The BEF data consist of 7 claims components: inpatient, outpatient (covering ambulatory and outpatient care provided in a hospital facility), durable medical equipment, hospice, home health agency, skilled nursing facility, and physician/supplier (part B, covering outpatient care not provided in hospitals as well as physical and occupational therapy) claims. The BEF data were treated with appropriate integrity, security, and confidentiality, as detailed in the Data Use Agreement required by the Centers for Medicare & Medicaid Services.

For this study, data from the outpatient and part B (physician/supplier) files from all patients with 1 or more claims for cataract surgery (current procedural technology codes 66820–66984) initially were reviewed. Patients were included if they had at least 6 months of data before the surgery and 12 months of data after the surgery. The date of cataract surgery was identified as the index date for the patient; those who had a second cataract surgery during the 12-month follow-up were excluded from the analysis. Patients younger than 65 years who were included in the Medicare data (for reasons such as renal failure) were excluded from the analysis. Patients who had cataract surgery and experienced endophthalmitis (defined as one or more claims coded as International Classification of Diseases 9 codes 360.00, 360.01, or 360.02) during the follow-up period (cases) were compared with those who had cataract surgery but did not experience subsequent endophthalmitis (controls).

Both claims (amounts billed to Medicare by medical professionals or institutions) and reimbursements (amounts paid by Medicare) coded for ophthalmic care (International Classification of Diseases codes 360–379) were included in the analysis. Costs of ophthalmic diagnostic procedures (current procedural technology codes 92015–92287) were evaluated in a separate analysis. Costs are presented as mean annual claims and reimbursements and were inflated to U.S. dollars for the first half of 2005 using the Bureau of Labor Statistics’ Consumer Price Index for medical care commodities. Resource utilization and costs were calculated and compared between cases and controls. Because not every patient incurs expenditures for a given type of endophthalmitis care, this group of patients forms a distinct subgroup within the study cohort, and their congregated response at 0 is inconsistent with the usual linear model assumptions. We adopted the Tobit, or corner solution, model for this comparison, which explicitly recognizes this subpopulation in the likelihood function and provides unbiased estimates of the differences between cases and controls. Tables present the difference in annual claims and payments between cases and controls and the ratio (cost for cases divided by cost for controls). To account for cost outliers, the data were winsorized, with the top and bottom 0.5% of observations reset to the values of the 99.5 and 0.5 percentiles, respectively. All data analysis was performed using SAS software version 9.1 (SAS Institute, Cary, NC).

Results

Table 1 presents demographic characteristics of cases (n = 417) versus controls (n = 139,558). Cases and controls were similar in...
Table 2. Concomitant Ophthalmic Conditions before Cataract Surgery

<table>
<thead>
<tr>
<th>Condition (ICD-9/V code)</th>
<th>Cases (Endophthalmitis Diagnosis)</th>
<th>Controls (No Endophthalmitis Diagnosis)</th>
<th>Difference (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retinal detachments and defects (361)</td>
<td>0.2%</td>
<td>0.6%</td>
<td>−0.4% (−0.8% to 0.1%)</td>
</tr>
<tr>
<td>Diabetic retinopathy (362.0)</td>
<td>3.1%</td>
<td>1.8%</td>
<td>1.3% (−0.4% to 3.0%)</td>
</tr>
<tr>
<td>Retinal vascular occlusion (362.3)</td>
<td>1.4%</td>
<td>0.7%</td>
<td>0.7% (−0.5% to 1.8%)</td>
</tr>
<tr>
<td>Macular degeneration (362.50, 362.51, 362.52, 362.57)</td>
<td>5.3%</td>
<td>5.5%</td>
<td>−0.2% (−2.3% to 2.0%)</td>
</tr>
<tr>
<td>Glaucoma (365)*</td>
<td>12.7%</td>
<td>9.4%</td>
<td>3.3% (0.5% to 6.5%)</td>
</tr>
<tr>
<td>Uveitis (364.1–364.3)</td>
<td>0.5%</td>
<td>0.3%</td>
<td>0.2% (−0.5% to 0.9%)</td>
</tr>
<tr>
<td>Disorders of vitreous body (379.2)</td>
<td>2.9%</td>
<td>2.5%</td>
<td>0.4% (−1.2% to 2.0%)</td>
</tr>
<tr>
<td>Vision loss (369)</td>
<td>0.2%</td>
<td>0.5%</td>
<td>−0.3% (−0.7% to 0.2%)</td>
</tr>
<tr>
<td>Other disorders of globe (360.03, 360.04, 360.1–360.4, 360.8, 360.9)*</td>
<td>1.4%</td>
<td>0.1%</td>
<td>1.3% (0.2% to 2.5%)</td>
</tr>
<tr>
<td>Other ophthalmic disorders (363, 364, 368, 370–379 except 364.0–364.3 and 379.2)*</td>
<td>14.9%</td>
<td>11.0%</td>
<td>3.9% (0.5% to 7.3%)</td>
</tr>
</tbody>
</table>

*P<0.05.

terms of gender, race, and mean age. Ophthalmic comorbid conditions of cases and controls, as assessed in the 3 months before the index date, are presented in Table 2 and generally are similar. Cases were significantly more likely to have glaucoma (12.7% vs. 9.4%; P<0.05), disorders of the globe (1.4% vs. 0.1%; P<0.05), or other ophthalmic disorders (14.9% vs. 11.0%; P<0.05). We do not know of data to suggest that conditions included in the latter 2 categories, such as hypotony, degenerative conditions of the globe, chorioretinal inflammations, or night blindness, necessarily would affect costs and thus did not control for differences in these comorbid conditions.

Table 3 presents ophthalmic claims and payments for cases and controls. Total claims and payments were approximately 2.5 times more for cases than for controls (P<0.001). Hospice care and durable medical equipment were used rarely in both case and control groups, and there were no differences between case and control claims or payments. Part B services were incurred by virtually all cases and controls, but claims and payments were almost twice as high for cases than for controls (claims, $11 742 for cases vs. $5391 for controls; payments, $3217 for cases vs. $1671 for controls; both comparisons, P<0.001). There were notable differences in the frequency of use of other services. A greater proportion of endophthalmitis patients than controls (20% vs. 2%, respectively) received inpatient care coded for an ophthalmic condition during the study period, and both claims and payments were significantly higher for cases than for controls (both P<0.001). Similarly, the differences in use of home health agency and skilled nursing facility services were much greater for cases and controls, as were the associated claims and payments (P<0.001, all comparisons). Both these types of services were used fairly infrequently and did not contribute substantially to the total cost. Finally, outpatient service use was higher for cases than controls (83.5% vs. 52.4%), with the associated claims and payments also statistically significantly higher (both, P<0.001).

Table 4 shows claims and payments for specific ophthalmic services: diagnostic and ophthalmologist visits. In both cases, claims and payments were at least twice as high for cases than for controls and all comparisons were significant (P<0.001). Ophthalmologist visits comprised a substantial portion (approximately three fourths) of all part B ophthalmic claims. Interestingly, although diagnostic tests were used more among cases than controls, only slightly more than half of cases reported having had any diagnostic tests.

Discussion

This study evaluated rates of resource utilization and costs for individuals with endophthalmitis. Our analysis indicated...
substantial increases in costs (both claims or reimbursements) associated with a diagnosis of endophthalmitis. Few prior studies have evaluated the costs associated with endophthalmitis. A German survey of patients who had undergone cataract surgery or who had self-reported endophthalmitis found cost advantages to prophylactic antibiotic treatment. Not surprisingly, Fongse et al found that length of stay was greater and inpatient charges were higher for patients undergoing cataract surgery who contracted endophthalmitis compared with those who did not. Using data from a subset of patients in the EVS, Wisniewski et al found that the most charge-effective treatment (that is, using a measure similar to a cost-effectiveness ratio but considering change in charges as the numerator) was dependent on the initial visual functioning of the patient. For example, among patients with only light perception visual acuity, better results were associated with pars plana vitrectomy rather than with vitreous tap or biopsy, whereas among those with visual acuity of hand movements or better, there was no difference in outcomes. That study also found other factors associated with higher costs, including being female, having diabetes, or having symptoms of red eye. Sulkes et al compared costs for treating endophthalmitis through inpatient versus outpatient care. This study found that use of treatments based on the EVS guidelines on an outpatient basis would result in substantial cost savings compared with inpatient treatment.

Little is known about typical characteristics of patients affected with endophthalmitis. Cataracts are more common in women than men, and given that cataract surgery is a common precursor of endophthalmitis, the high proportion of women in this study population is not unexpected.

Because endophthalmitis is likely to result in visual impairment, it is possible, as other studies indicate, that there are increased health care resource utilization and costs associated with visual impairment. For example, Morse et al found that visual impairment was associated with an increase of 2.4 days to the average inpatient length of stay, controlling for sociodemographic and clinical factors. People with visual impairments also are more likely to fall and incur injuries, both of which can be expensive, yet the sequelae of these falls may not be coded as ophthalmic. Thus, the increased costs in nonophthalmic care also may be associated with visual impairment and, indirectly, with endophthalmitis.

These findings assume greater importance given the evidence from a recent review that the rate of endophthalmitis subsequent to cataract surgery has increased over the past decades. Incision type may affect incidence; however, multiple other factors also may affect the rate of endophthalmitis. Many of these factors, such as increased use of outpatient surgery, use of topical rather than injected anesthesia, and changes in materials, may continue to change over time. Continued vigilance will be necessary to curtail the substantial increases in cost resulting from endophthalmitis, because incidence is likely to increase.

This study examined endophthalmitis after cataract surgery only. However, there are other precursors to endophthalmitis. In fact, other types of surgeries, such as glaucoma filtering surgery, may be associated with higher rates of late-onset infection. Eyes with bleb leaks after filtering surgery are significantly more likely than those without leaks to experience blebitis or endophthalmitis. Clinical factors also can affect the rate of infection in filtration surgery, such as location of the filtering bleb or performing a full-thickness or partial-thickness procedure. These characteristics cannot be extracted from Medicare claims. Additional analyses that explore costs and outcomes with endophthalmitis subsequent to various surgery types would be useful, but chart reviews would be necessary to explore clinical factors in more detail.

There are certain limitations in this study. First, Medicare claims constitute an administrative and billing database and are fundamentally not a clinical data file. As such, important clinical indicators (e.g., use of self-administered medications, binocular vs. monocular disease, visual acuity) and laboratory results are not available for examination and inclusion in analyses. Also, intraoperative medication use would be included in the overall reimbursement, and thus it cannot be determined how many, if any, patients received antibiotic prophylaxis while under surgical care. Further, it is not possible to determine for certain whether the episode of endophthalmitis was in the same eye that previously underwent cataract surgery or even that the endophthalmitis was bacterial or associated with surgery. Although this is likely, it cannot be verified from the claims, as laterality often is missing from submitted charges. By requiring a 6-month period free of other cataract surgeries and including only patients with a single surgery during the follow-up period, the study tried to increase the likelihood that the endophthalmitis was associated with the

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### Table 4. Medicare Claims (Charges) and Reimbursements (Payments) for Ophthalmic Care for Cataract Patients, Diagnostic Services and Ophthalmologist Visits

<table>
<thead>
<tr>
<th>Type</th>
<th>Cases (n = 417)</th>
<th>Controls (n = 139 558)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% with Claim</td>
<td>Average Claim</td>
<td>Average Payment</td>
</tr>
<tr>
<td>Diagnostic services*†</td>
<td>51.3%</td>
<td>$545</td>
<td>$219</td>
</tr>
<tr>
<td>Ophthalmologist visits*†</td>
<td>98.9%</td>
<td>$8959</td>
<td>$2518</td>
</tr>
</tbody>
</table>

*P<0.001, cases vs. controls, for differences in both claims and payments.
†Diagnostic services were found in part B and outpatient only. Ophthalmologist visits are found under part B only.
‡Ratio = cases/controls.
cost savings to Medicare associated with prophylaxis for serious consideration should be given to the potential for Medicare payments almost $3500 greater for these patients, as outcome measures for endophthalmitis. However, patients are likely to experience some amount of the use of these as outcome measures for endophthalmitis. Although visual impairment costs are not well understood, they are likely to be substantial. Diagnostic codes associated with low vision are used infrequently in Medicare data, preventing increases in the rates of Medicare charges and reimbursements for individuals with endophthalmitis compared with those who underwent cataract surgery but were not treated for endophthalmitis.

Although much of the literature points to an increase in the burden of endophthalmitis, recent results demonstrating success of antibiotic prophylaxis could alter this trajectory. Intracameral cefoxime significantly reduced the rate of postoperative endophthalmitis in a multicountry study. Future studies may explore other methods of prophylaxis. Considering the substantial burden of this infection and the relatively low cost of prophylaxis, prophylaxis should be considered before cataract extraction or other relevant ophthalmic surgeries. Given the early discontinuation of the European Society of Cataract and Refractive Surgery endophthalmitis study because of positive findings about prophylaxis, it may not be possible to conduct a prospective cost-effectiveness study comparing prophylaxis with no prophylaxis. However, with as many as 0.1% of patients contracting endophthalmitis after cataract surgery and Medicare payments almost $3500 greater for these patients, serious consideration should be given to the potential for cost savings to Medicare associated with prophylaxis for endophthalmitis.

References