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Post-cataract Surgery Endophthalmitis in the United States: Analysis of the Complete 2003–2004 Medicare Database of Cataract Surgeries

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Abstract

OBJECTIVE—To estimate endophthalmitis incidence following cataract surgery nationally and at the state level in 2003–2004 and to explore risk factors.

DESIGN—Analysis of Medicare beneficiary claims data.

PARTICIPANTS—100% sample of Medicare recipients' claims for endophthalmitis and outpatient cataract surgery services.

METHODS—Cataract surgeries were identified by procedure codes and merged with demographic information. Cataract annual surgical volume was calculated for all surgeons. Presumed post-operative endophthalmitis cases were identified by International Classification of Diseases-9 Clinical Modification Codes (ICD-9-CM) on claims within 42 days after surgery. Endophthalmitis rates and 95% confidence intervals were calculated at state and national levels. Logistic regression was used to investigate the association between developing endophthalmitis and surgery location and surgeon factors.

MAIN OUTCOME MEASURES—Endophthalmitis incidence and risk factors.

RESULTS—4,006 cases of presumed endophthalmitis occurred following 3,280,966 cataract surgeries. The national rate in 2003 was 1.33 per 1000 surgeries (95% confidence interval [CI]: 1.27–1.38) and decreased to 1.11 per 1000 (95% CI: 1.06–1.16) in 2004. Males (relative risk [RR] 1.23, 95% CI: 1.15–1.31), older individuals (RR 1.53, 95% CI 1.38–1.69; 85+ compared to 65–74 years), Blacks (RR 1.17, 95% CI 1.03–1.33) and Native Americans (RR 1.72, 95% CI 1.07–2.77) had increased risk of disease. After adjustment, surgeries by surgeons with low annual volume (RR 3.80, 95% CI 3.13–4.61 for 1–50 compared to 1001+annual surgeries) and less experience

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(RR 1.41, 95% CI 1.25–1.59 1–10 compared to 30+ years) and surgeries per formed in 2003 (RR 1.20, 95% CI 1.13–1.28) had increased endophthalmitis risk.

CONCLUSIONS—Endophthalmitis rates are lower than previous-year US estimates, but remain higher than rates reported from a series of studies from Sweden; patient factors or methodological differences may contribute to differences across countries. Patient age, gender and race, and surgeon volume and years of experience are important risk factors.

Introduction

Cataract is highly prevalent among older Americans, and surgery is a rapid and cost-effective means for restoring vision. Approximately 5% of individuals aged 70 years and older in the United States (US) undergo cataract surgery each year.¹ While rare, postoperative endophthalmitis is a condition often associated with significant morbidity^{2,3} and treatment costs.^{4,5} Visual outcomes following endophthalmitis are often poor; approximately one third of individuals do not recover vision better than counting fingers,² and 50% do not achieve vision better than 20/40.³

Identifying the true rate of endophthalmitis at a national level is difficult given the rare nature of the disease. Single centers with large surgical volumes are able to estimate endophthalmitis rates across time within their center; however, their rates may not be representative of the patient population at large, since they do not capture the variation in techniques utilized across the country and typically include only a few highly-skilled surgeons. Large, administrative billing databases have the advantage of including surgeries from a wide range of settings across a broad patient population, thereby making them more representative of the general population.

Government health insurance databases are a useful resource for evaluating surgical complications. Within the United States, Medicare is a federal health insurance plan for older and disabled Americans. Residents become eligible for Medicare at age 65 if they and/or their spouse have worked in the US. Researchers may obtain access to specific parts of Medicare claims billing data by requesting either a complete dataset of all claims for 5% of all beneficiaries (“5% sample”) or requesting specific types of claims data for all beneficiaries with a particular disease or treatment code (“100% sample”). These data have been used to calculate endophthalmitis incidence at the national level. Based on data from the early 1980’s, Javitt et al utilized a 100% sample of Medicare data and estimated the rate of endophthalmitis at 1.2 cases per 1000 extracapsular surgeries performed on an inpatient basis.⁶ This estimate is in concordance with a meta analysis of 90 studies from a similar time period, which estimated an endophthalmitis rate of 1.3 per 1000 cataract surgeries,⁷ while center-specific rates for that time period range from 1 per 300 cataract procedures and as low as no events over a several-year period.^{8–11} The wide variation in center-specific rates shows how rates may be influenced by focusing on one specific institution or geographic location.

More recently, West et al utilized the Medicare 5% sample to estimate rates for 1994–2001¹² and reported that annual rates increased during this time, reaching a maximum of 2.36 per 1000 surgeries in 2000, and this rate is similar to the rate found by Taban et al in a meta-analysis of 215 articles.¹³ While the 5% sample of Medicare beneficiaries allows a broad overview of the rate at the national level, it does not allow additional analyses at a more local level. The current study utilized administrative data from 100% of the cataract surgeries billed to Medicare in 2003–4, which provided the opportunity to examine more recent rates of endophthalmitis and to analyze data at the state level.

Materials and Methods

Participants

Medicare is the United States' federal health insurance plan which subsidizes healthcare costs for approximately 44 million elderly and disabled Americans. Estimates suggest that over 80% of cataract surgeries in the US are billed through Medicare.¹⁴ For rare but important complications of surgery, large administrative databases like Medicare are often the most comprehensive source of information, and are one of few sources that can provide precise estimates of incidence rates at the population level.

Medicare beneficiary claims data for the years 2003 and 2004 were obtained from the Centers for Medicare and Medicaid Services Research Data Distribution Center (CMS-RDDC) in the format of research-identifiable files (RIF). Data received included extracts from the standard analytic carrier files (formerly Physician/Supplier Part B file) containing all medical claims billed to Medicare for outpatient services (100% sample) under the fee-for-service plan (FFS). The data are person-specific and contain information on dates and place of service, diagnosis and procedure codes, the unique physician identification number (UPIN) for the provider submitting the claim, billing codes and associated charges and payments. In addition to individual provider claims, the carrier file also contains facility claims for procedures performed at ambulatory surgery centers (ASCs). In addition, we obtained the 2004 Medicare Physician Identification and Eligibility Registry (MPIER) file, which includes provider-specific information such as medical school graduation year, state of medical license, and specialty, and denominator files containing demographic information and type of Medicare coverage for all beneficiaries.

Identification of Study Cohort

CMS-RDDC provided a dataset that included all claims in the carrier file related to cataract surgery. These claims were identified by claims containing a line item procedure code for cataract extraction using the standard Current Procedural Terminology (CPT) codes¹⁵ for cataract surgery (Table 1). These data were merged with the MPIER file by physician UPIN and state where the cataract surgery was performed in order to identify the physician performing the procedure. Cataract surgery data were limited to allow a maximum of two cataract surgeries per beneficiary during the two-year study timeframe. Information within the line item claims was used to identify records that should be excluded. Records were excluded if data indicated the procedure was not performed, the procedure was a return to the operating room for a related procedure such as removal of retained lens material, the allowed billable amount was zero (non-covered service), or the line processing indicator code indicated an invalid or duplicate billing claim. Additionally, records were excluded when the only billing claim for a procedure was submitted by an optometrist, since optometrists are not licensed to perform cataract surgery in the United States.

Once the final set of cataract surgeries was determined, these records were merged with each annual denominator file to obtain information on demographic data and information on Medicare beneficiary and enrollment status, including Health Maintenance Organization (HMO) participation. Claims were limited to those for aged Medicare beneficiaries (65 or older) with continuous part B (outpatient and physician services) coverage and no HMO coverage at any time during the calendar year. Approximately 15% of Medicare beneficiaries participated in a Medicare HMO during 2003–4. HMO services are provided on a contract basis, and providers are reimbursed on a fixed-fee schedule, regardless of the number of procedures they perform or the number of office visits completed. As such, no claims data are available for cataract surgery or endophthalmitis-related visits and treatments for beneficiaries while participating in an HMO.

Initial evaluations at the state level suggested potential coding inaccuracies with some claims from Alaska. Specifically, less than one quarter of the surgeries coded as having been performed in Alaska matched with surgeons practicing in Alaska and 92% of the surgeries that did not match up with a provider were coded as being performed in Alaska. In addition, for simplicity, Hawaii and DC were also removed from the analysis, allowing for an analysis of the 48 contiguous states.

Identification of cases with post-operative endophthalmitis

CMS-RDDC provided a dataset that included all claims billed to Medicare in 2003–4 that included a line item diagnosis code for endophthalmitis using the International Classification of Diseases-9 Clinical Modification Codes (ICD-9-CM)¹⁶ (Table 1). In order to identify presumed endophthalmitis that was a direct result of cataract surgery, these data were then manipulated as follows. First, claims were limited to the first claim for each individual, given that once an individual has been diagnosed with endophthalmitis, the treating physician is likely to perform a more extended exam at all follow up visits, and, therefore, may continue to code for endophthalmitis in the years after the acute event. These data were then merged onto the final cataract surgery dataset, and the cataract surgery date was compared with the first endophthalmitis claim date. If the first endophthalmitis claim occurred within 42 days following cataract surgery, the event was assumed to be secondary to cataract surgery, and the individual was classified as an endophthalmitis case for this analysis. The data request for this study was limited to data for 2003–2004, as these were the most recent data available when this project began. Thus, to allow for appropriate calculation of endophthalmitis incidence in the latter part of 2004, surgeries that occurred within the last 42 days of 2004 (November 20, 2004 onward) were excluded.

Analysis of incidence and measures of risk

Annual endophthalmitis rates were calculated for each state individually and for the 48 states overall. The carrier and denominator files provide information on a limited number of potential risk factors including age, race, gender and location of surgery (hospital outpatient center vs. ASC). Each surgeon's annual Medicare surgical volume was calculated by summing the number of cataract surgeries for each individual UPIN number over the two-year period and dividing by two. Surgeons' years of experience were calculated by subtracting the medical school graduation year from 2004. Logistic regression was used to investigate the association between developing endophthalmitis and each of these factors, adjusting for gender, age, and race. All analyses were performed using SAS software version 9.2 (SAS Institute, Cary, NC).

The Johns Hopkins Medicine Institutional Review Board and the Privacy Board at the Centers for Medicare and Medicaid Services approved the research protocol.

Results

The final analytic dataset contained 3,280,966 cataract surgeries within the two-year period, after excluding 165,452 surgeries which were performed in the last 42 days in 2004. Forty-four percent of individuals (n=1,005,826) undergoing cataract surgery had surgery on both eyes within the study period. In total, 4,006 patients developed endophthalmitis within 42 days of cataract surgery. The national endophthalmitis rate in 2003 was 1.32 per 1000 surgeries (95% confidence interval (CI): 1.27–1.38) and decreased to 1.11 per 1000 surgeries (95% CI: 1.06–1.16) in 2004 (Table 2). After adjusting for age, sex, race, surgical setting, surgeon years of experience and annual cataract surgery volume, surgeries performed in 2004 remained 13% less likely to develop endophthalmitis than surgeries performed in 2003.

Two-year average unadjusted state-based rates ranged from 0.4 – 2.1 per 1000 surgeries across states, with 50% of states having rates between 1.05 and 1.38 cases per 1000 surgeries (Tables 2 and 3). The annual number of surgeries performed varied substantially across states (4,500–280,000). Taking into account the wider confidence intervals associated with smaller numbers of surgeries and accompanying endophthalmitis cases, endophthalmitis rates were still statistically significantly different across states.

An inverse dose-response relationship was seen between endophthalmitis rates and surgical volume, with a four-fold difference in endophthalmitis rates among surgeries performed by surgeons completing 50 or fewer surgeries per year compared with surgeries performed by surgeons whose annual volume was more than 1000 surgeries (Table 4). While 30% of surgeries were performed by surgeons who complete 200 or fewer surgeries per year, these surgeries accounted for 46% of endophthalmitis cases. The association between low surgical volume and higher endophthalmitis rates persisted in multivariate models (Table 5).

After adjustment for age, race, sex, year, surgical setting, surgeon experience and surgeon volume, differences between states were still apparent, with state-based adjusted rates ranging from 0.81 cases per 1000 surgeries to 2.62 (inter-quartile range 1.43–1.71) (Figure 1 and Table 3; Table 3 available at <http://aaojournal.org>). No distinct geographic pattern in endophthalmitis rates was observed. In general, the lowest rates were seen in very northern states such as Idaho, South Dakota and New Hampshire and the highest rates were seen in southern states such as Mississippi and Oklahoma. However, rates at the upper end of the range also were seen in very northern states such as Montana and Wyoming, and several southerly states had adjusted rates below 1.5 per 1000 surgeries, suggesting that climate and latitude do not influence endophthalmitis rates.

Fewer years of surgical experience correlated with increased endophthalmitis rates. In comparison to surgeries performed by surgeons with 30 years or more experience, surgeries performed by surgeons with fewer than 10 years of experience carried a 41% increased risk (relative risk (RR) 1.41; 95% CI: 1.25–1.59), even after adjusting for surgical volume, surgical setting and patient factors (Table 5).

Roughly fifty percent of all surgeries were performed in ASCs. In univariate analyses, surgeries performed in hospital outpatient centers had a 23% higher risk of endophthalmitis than surgeries performed in ASCs. However, after adjusting for age, gender, race, year of surgery and surgeon volume and experience, the risk associated with surgical setting was no longer apparent (adjusted RR 1.05; 95% CI 0.98–1.12). This finding is not surprising because while the age of patients receiving surgery was not different by setting, higher volume surgeons were more likely to work in ASCs. In ASCs, 13.1% of surgeries were performed by high volume surgeons (annual surgery volume >1000) compared to 3.7% of surgeries performed in hospitals.

Endophthalmitis risk increased with increasing age. Cataract surgery patients aged 85 years and older had a 53% increased risk of endophthalmitis compared with individuals aged 65–74 years (Table 4). Surgeries on males carried a 23% increased risk. Endophthalmitis risk varied by racial group, and surgeries on Black and Native Americans had increased risk compared to whites after adjustment (17% and 72% increased risk, respectively).

Discussion

These analyses report rates of endophthalmitis secondary to cataract surgery in the US for 2003–2004 using data from all surgeries performed on individuals with Medicare coverage in the fee-for-service setting. Over 3 million cataract surgeries were evaluated in this analysis, allowing calculation of precise annual estimates of endophthalmitis (1.22 per 1000

surgeries, on average). This dataset is larger by an order of magnitude than other population-based studies previously reported in Canada,¹⁷ Taiwan,¹⁸ Australia,¹⁹ the United Kingdom,²⁰ Sweden,^{21–24} Norway,²⁵ Finland,²⁶ Denmark,²⁷ and the Netherlands.²⁸

Population-based studies can be generalized to the community more easily than center-specific studies, as they represent the broad range of conditions under which surgeries are conducted on diverse populations in a wide range of settings by many surgeons with varying levels of experience. In this analysis, we had the opportunity to access the complete Medicare billing dataset of cataract surgeries, while previous studies have been limited to 5% of the sample.^{12;29} Use of the full Medicare database allows not only precise estimates of endophthalmitis incidence, but also more detailed exploration of possible risk factors for disease. It also affords the opportunity to look at state-based rates, which is not feasible with smaller databases. Indeed we report differences in the rate of endophthalmitis between states, with adjusted rates ranging from 0.8–2.6. These differences are only partly accounted for by surgical factors and characteristics of patients accessing surgery in each state, suggesting that other factors may also play a role in this variation. Some potential factors that cannot be addressed in this paper include differences in socioeconomic status and general health of the population in each state.

As we and others have previously reported, we found that patient factors such as older age^{17;30;31} and male gender^{8;17} are associated with a higher risk of endophthalmitis after cataract surgery. Comorbidities, such as diabetes, hypertension and stroke are prevalent in cataract surgery populations and increase with age.³² While health-status data were not available, these variables likely would contribute to the age effect observed in this study. The increased risk of endophthalmitis in Blacks and Native Americans may be linked to social disadvantage and poorer general health status in these groups.

We found that fewer years of surgical experience increased the risk of post-operative endophthalmitis. With the exception of comparisons involving surgeons still in training,³³ we believe this finding has not been previously reported. All of the surgeries included in this analysis were performed by physicians who were already in practice settings with their own UPINs. However, some of these surgeries surely were performed with an ophthalmology resident assisting, and we have not adjusted for this possibility. It is unlikely that surgeries including a resident would have a substantive influence on the outcome, given the small proportion of resident-assisted surgeries in the total volume of cataract surgery. Further, we have demonstrated that while experience is relevant, higher annual volume of surgery independently reduces risk of endophthalmitis. This finding is consistent with conclusions from Taiwan for endophthalmitis¹⁸ and in Canada for general post-surgical adverse events following cataract surgery.³⁴ None of these studies, however, sheds light on what characteristics associated with higher volume (e.g., quicker surgery, more secure wounds, potential differences in anti-infection measures, etc.) are actually responsible for the reduced risk of endophthalmitis.

The Medicare billing database has been shown to be a valuable tool for evaluation of the apparent temporal trends in endophthalmitis across years in the US.¹² We also find a temporal trend, where surgeries performed in 2003 had a higher risk of endophthalmitis compared to surgeries performed in 2004. It is unlikely that such a difference is a result of changes in procedure and diagnosis coding, as none of the codes utilized in this study changed during this time period, and the short duration makes it unlikely that a meaningful number of providers changed their billing practices during this time. This finding is in agreement with data from Canada¹⁷ and a single academic center in Florida,³⁵ where more recent surgeries had lower risk. This risk reduction persisted after adjustment for available patient and surgical factors. However, information on surgical technique and prophylaxis

were not available in this analysis, and it is possible that these factors have changed with time in the US. The authors are currently conducting further research in a nationally representative case-control study of endophthalmitis to address these questions.

The current study reports endophthalmitis rates that are lower than rates reported for prior years by our study team.¹² In the prior study, the rate of endophthalmitis increased over a several-year period, peaking in 2000 and then showing a slight decline in 2001. Our study team did not have access to 2002 data for either analysis. Before making direct comparisons between the two studies, several factors should be noted. First, the earlier study did not have access to date-specific data for several years, but instead relied on the use of calendar quarter as the time unit. As a result, for comparison across years, that study utilized a 90-day rate for years in which date-specific data were available while the current study used six weeks as the cutoff. Although the vast majority of endophthalmitis occur within the first few weeks after surgery, one would expect a slightly lower rate when using a 6-week cutoff.

In addition, somewhat different methodology was used in the current study. In this study, more billing data were available, which allowed a more precise determination of which records were true cataract surgery data as compared to one-day post-operative data. In addition, CPT code 66840 was not used since it can reflect post-cataract surgery removal of retained lens material rather than an incident cataract surgery. Determining which direction such increased precision of cataract surgeries would alter the rates is difficult to predict. The current study also utilized the 100% sample data while the earlier study utilized 5% sample data. With such large databases, one would expect that the 5% sample would also give a reliable estimate, but with less precision than the 100% sample. One may argue that the switch from inpatient to nearly exclusively outpatient management of endophthalmitis cases may have affected case ascertainment. However, our methods are based on CPT coding, and it is unlikely that a substantial portion of tap and inject procedures are not billed. Therefore, we believe that our methods captured the vast majority of cases. Finally, endophthalmitis rates may indeed have declined during this time period. In the early 2000's, significant attention began being placed on examining whether wound construction has an effect on endophthalmitis rates, with particular emphasis on the use of clear corneal incisions.^{13;36-39} As a result, surgeons may have changed their practice to improve the quality and closure of their incisions, and these changes may have had an effect on endophthalmitis rates. Wound construction continues to be a popular area of research with numerous studies in recent years investigating this question.^{11;20;30;40-44}

Internationally reported estimates of the incidence of endophthalmitis following cataract surgery range widely, with rates reported as high as 1 per 300 cataract procedures and as low as no events over a several-year period.⁸⁻¹¹ The overall annual rate of endophthalmitis secondary to cataract surgery reported from this US-based study is substantially higher than the rate reported in Sweden (0.48 per 1000 surgeries) for the same time period,³⁰ but very similar to the rate reported for the same time period in Ontario, Canada (1.4 per 1000 surgeries).⁴⁵ The reason for differences between countries is uncertain, and may include differences in surgical procedures, prophylaxis practices, differences in racial or socioeconomic status, or methodological differences in measurement. Several researchers have debated the reasons for the differences in rates between Sweden and Ontario, with some proposing that the difference results from the use of intracameral antibiotics, while others suggest it is a difference in patient populations.⁴⁶⁻⁴⁸ A similar debate could be held with these data; however, as with the Ontario-based study, these data are based on billing claims and as such do not include information regarding the antibiotic prophylaxis used by each surgeon. Detailed medical record review would be required to determine which hypothesis holds true.

Recent surveys of surgeons in the US showed that a large and increasing proportion of procedures are performed at ASCs. In agreement with Leaming,⁴⁹ we found that 50% of procedures were conducted at an ASC, and the majority of these surgeries were performed by higher-volume cataract surgeons. The lower rate of endophthalmitis in ASCs is likely explained by differences in surgeon characteristics in these settings, and not by the relative safety of the setting itself. Possible hypotheses to explain lower risk in high-volume surgeons might include differences in procedure including antibiotic prophylaxis, better wound construction, faster surgery and fewer intra-operative complications; however, these theories could not be explored in this dataset.

This analysis was based on carrier file claims data, and as such, only includes claims for fee-for-service (FFS) Medicare surgeries. In 2003–2004, 15% of Medicare participants in the 48 contiguous states had HMO coverage, and their surgeries are not included in the carrier file data. Therefore, our estimate of cataract surgeries does not provide a complete count of the cataract surgeries performed on Medicare beneficiaries during this time period. Furthermore, individuals enrolled in Medicare HMOs may differ from FFS individuals. Given the relatively small proportion of individuals enrolled in HMOs, it is unlikely that the inclusion of these individuals would substantially alter the interpretation of results.

Another limitation of the methodology is that identification of endophthalmitis cases relied on the accuracy of billing codes, which may be subject to misclassification. Li et al previously reported high rates of misclassification in coding both cataract surgery and endophthalmitis claims in Western Australia for 1980–1999.⁵⁰ This rate of misclassification likely is not applicable to the US rate, given the differences in coding practices in the US, and the long-standing use of ICD-9-CM codes in the US. Tielsch et al previously reported a misclassification rate of approximately 34% for identifying retinal detachment post-cataract surgery using Medicare claims data from the early 1990's.⁵¹ However, nearly half of this misclassification came from identifying retinal detachment procedures performed on the contra-lateral eye. In the current study, contra-lateral eye issues are less likely to be a problem, given the rare nature of endophthalmitis, and with cataract surgery being one of the primary risk factors in developing endophthalmitis. Additionally in this study, if an individual had surgery on both eyes within a short time period and developed endophthalmitis after one surgery, the eye to which the endophthalmitis would have been assigned is irrelevant. In either case, the individual would be considered to have endophthalmitis and would contribute one endophthalmitis case and two cataract surgeries to the analysis. Furthermore, several recent studies using Medicare data have reported improved accuracy in coding, with positive predictive values typically above 90% for diseases ranging from Alzheimer's to kidney-cancer surgery.^{52–54}

In summary, the 2003–2004 complete Medicare claims dataset of cataract surgeries has been used to make precise, population-based estimates of the risk of endophthalmitis secondary to cataract surgery in the US. Although the analysis demonstrated a decrease between 2003 and 2004, rates remain above published rates from Sweden, and it is likely that rates could be further reduced with changes in practice patterns. Although variation in endophthalmitis rates was seen across states, 50% of states had an adjusted rate between 1.43 and 1.71 cases per 1000 surgeries, and most states with higher or lower rates were those with smaller populations, which resulted in wider confidence intervals. Despite this, the size of variation suggests an area for future research to elucidate whether potential interventions might reduce disparities. Differences in socioeconomic status and health status across states may well explain part of the variation in rates. The analysis approach utilized here is valuable for ongoing monitoring of endophthalmitis rates, a disease which, though rare, is important given the large number of individuals who have cataract surgery each year in the US.

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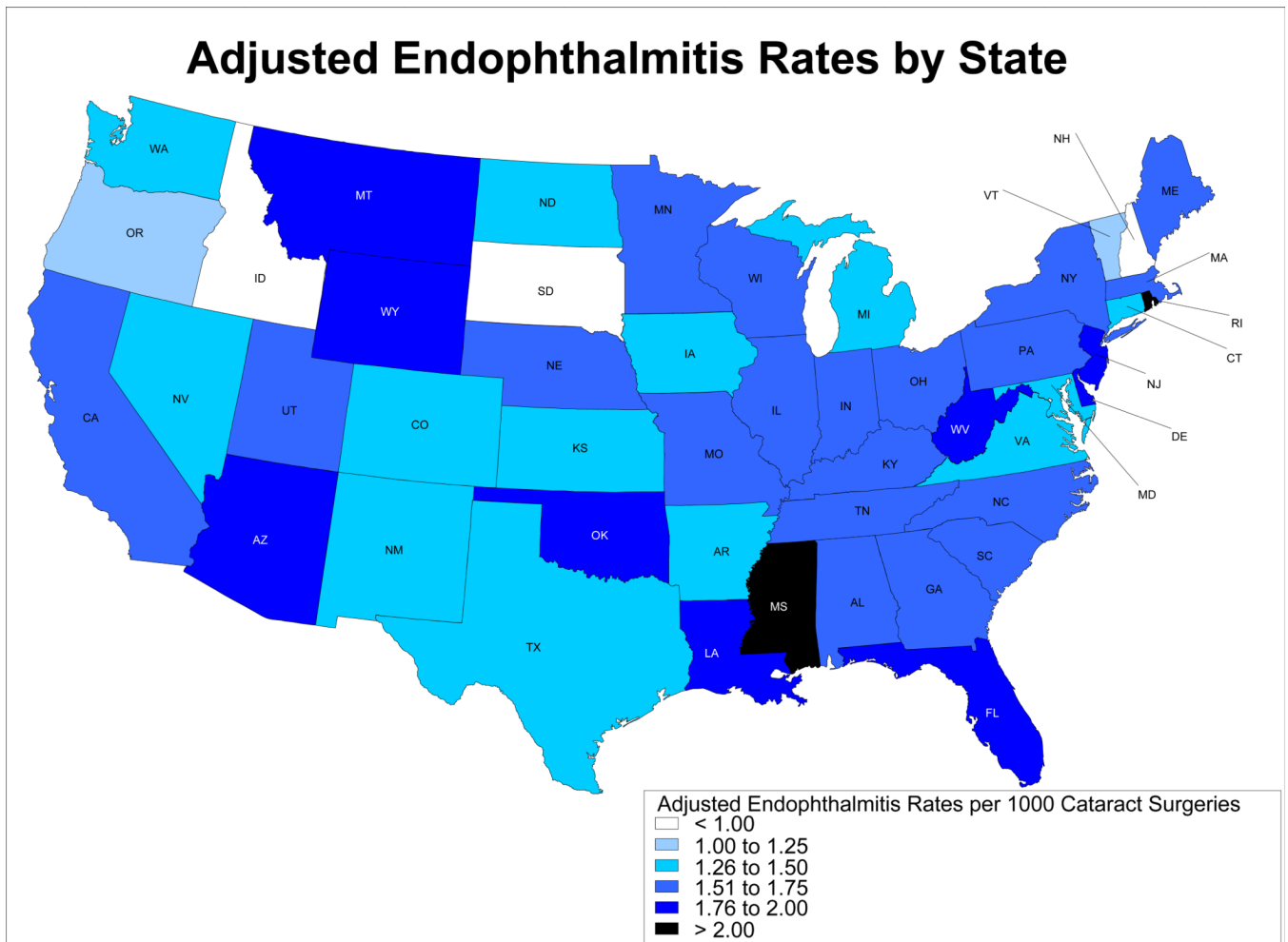


Figure.
Rates of Endophthalmitis by State, Adjusted for age, sex, year of surgery, surgical setting, surgeon experience and surgeon volume

Table 1

Procedure and diagnostic codes used in analysis

	Description
CPT code	
66850	Removal of lens material, phacofragmentation technique (mechanical or ultrasonic) (e.g., phacoemulsification) with aspiration
66920	Removal of lens material; intracapsular
66930	Removal of lens material; intracapsular, for dislocated lens
66940	Removal of lens material; extracapsular (other than 66840, 66850, 66852)
66982	Extracapsular cataract removal with insertion of IOL prosthesis (1-stage procedure), manual or mechanical technique (e.g., irrigation and aspiration or phacoemulsification) complex, requiring devices or techniques not generally used in routine cataract surgery
66983	Intracapsular extraction with insertion of IOL prosthesis (1-stage procedure)
66984	Extracapsular cataract removal with insertion of IOL prosthesis (1-stage procedure), manual or mechanical technique (e.g., irrigation and aspiration or phacoemulsification)
ICD-9-CM code	
360.00	Purulent endophthalmitis, unspecified
360.01	Acute endophthalmitis
360.02	Panophthalmitis
360.03	Chronic endophthalmitis
360.04	Vitreous abscess

CPT=Current Procedural Terminology; IOL=intraocular lens; ICD-9-CM=International Classification of Diseases, 9th Revision, Clinical Modification

Table 2

Overall Post-cataract Surgery Endophthalmitis Rate by Year

Year	Cataract Surgeries (N)	Endophthalmitis Cases (N)	Endophthalmitis Rate/1000 Surgeries within 42 days	95% Confidence Interval
2003	1,704,197	2,253	1.32	1.27–1.38
2004	1,576,769	1,753	1.11	1.06–1.16
Overall	3,280,966	4,006	1.22	1.18–1.26

Table 3

Post-Cataract Surgery Endophthalmitis Rates in 2003–2004 by State*

State*	# Cataract Surgeries	# Endophthalmitis Cases	Unadjusted		Adjusted	
			Rate (per 1000 surgeries)	95% CI [§]	Rate (per 1000 surgeries) [§]	95% CI [§]
Alabama (AL)	66602	71	1.07	0.8 -- 1.33	1.68	1.36 -- 1.99
Arizona (AZ)	54163	79	1.46	1.16 -- 1.75	1.87	1.53 -- 2.21
Arkansas (AR)	46193	35	0.76	0.44 -- 1.08	1.35	0.99 -- 1.71
California	225021	312	1.39	1.24 -- 1.53	1.58	1.37 -- 1.79
Colorado (CO)	31212	43	1.38	0.99 -- 1.77	1.46	1.04 -- 1.89
Connecticut (CT)	44581	62	1.39	1.07 -- 1.71	1.43	1.06 -- 1.8
Delaware (DE)	12329	17	1.38	0.76 -- 2	2.00	1.37 -- 2.64
Florida (FL)	284312	366	1.29	1.16 -- 1.42	1.79	1.58 -- 2.01
Georgia (GA)	91903	98	1.07	0.84 -- 1.29	1.53	1.25 -- 1.81
Idaho (ID)	17683	7	0.40	0.00 -- 0.91	0.81	0.25 -- 1.36
Illinois (IL)	136574	181	1.33	1.14 -- 1.51	1.65	1.4 -- 1.9
Indiana (IN)	101451	102	1.01	0.79 -- 1.22	1.60	1.33 -- 1.88
Iowa (IA)	50620	41	0.81	0.51 -- 1.11	1.32	0.97 -- 1.67
Kansas (KS)	44144	41	0.93	0.6 -- 1.25	1.45	1.08 -- 1.82
Kentucky (KY)	54921	68	1.24	0.95 -- 1.53	1.65	1.31 -- 1.99
Louisiana (LA)	55070	79	1.43	1.14 -- 1.73	1.88	1.54 -- 2.22
Maine (ME)	21420	24	1.12	0.65 -- 1.59	1.61	1.11 -- 2.11
Maryland (MD)	55171	72	1.31	1.01 -- 1.6	1.41	1.06 -- 1.75
Massachusetts (MA)	66132	87	1.32	1.05 -- 1.58	1.57	1.25 -- 1.89
Michigan (MI)	142570	149	1.05	0.86 -- 1.23	1.43	1.18 -- 1.68
Minnesota (MN)	53806	72	1.34	1.04 -- 1.63	1.54	1.19 -- 1.88
Mississippi (MS)	42866	90	2.10	1.77 -- 2.43	2.62	2.25 -- 3
Missouri (MO)	76214	96	1.26	1.01 -- 1.51	1.72	1.41 -- 2.02
Montana (MT)	14402	21	1.46	0.89 -- 2.03	1.81	1.22 -- 2.41

State*	# Cataract Surgeries	# Endophthalmitis Cases	Unadjusted		Adjusted	
			Rate (per 1000 surgeries)	95% CI [†]	Rate (per 1000 surgeries) [§]	95% CI [§]
Nebraska (NE)	27172	30	1.10	0.69 -- 1.52	1.53	1.08 -- 1.98
Nevada (NV)	18884	19	1.01	0.51 -- 1.5	1.49	0.96 -- 2.02
New Hampshire (NH)	13378	11	0.82	0.23 -- 1.41	0.90	0.27 -- 1.53
New Jersey (NJ)	95981	149	1.55	1.33 -- 1.77	1.88	1.6 -- 2.16
New Mexico (NM)	16734	15	0.90	0.37 -- 1.43	1.38	0.83 -- 1.93
New York (NY)	168047	232	1.38	1.21 -- 1.55	1.51	1.28 -- 1.75
North Carolina (NC)	113504	123	1.08	0.88 -- 1.29	1.54	1.27 -- 1.8
North Dakota (ND)	14681	13	0.89	0.32 -- 1.45	1.30	0.71 -- 1.89
Ohio (OH)	140920	161	1.14	0.96 -- 1.32	1.53	1.28 -- 1.78
Oklahoma (OK)	52214	76	1.46	1.16 -- 1.76	1.97	1.64 -- 2.31
Oregon (OR)	30523	32	1.05	0.66 -- 1.44	1.19	0.76 -- 1.62
Pennsylvania (PA)	147454	186	1.26	1.08 -- 1.44	1.59	1.34 -- 1.84
Rhode Island (RI)	8807	16	1.82	1.09 -- 2.55	2.08	1.32 -- 2.84
South Carolina (SC)	56045	63	1.12	0.83 -- 1.41	1.52	1.18 -- 1.85
South Dakota (SD)	14255	8	0.56	0.00 -- 1.13	0.89	0.29 -- 1.49
Tennessee (TN)	86345	110	1.27	1.04 -- 1.51	1.71	1.43 -- 2
Texas (TX)	217056	227	1.05	0.9 -- 1.19	1.48	1.27 -- 1.7
Utah (UT)	24213	31	1.28	0.84 -- 1.72	1.60	1.12 -- 2.07
Vermont (VT)	6396	6	0.94	0.08 -- 1.79	1.19	0.31 -- 2.07
Virginia (VA)	80746	88	1.09	0.85 -- 1.33	1.47	1.17 -- 1.76
Washington (WA)	56952	60	1.05	0.77 -- 1.34	1.37	1.04 -- 1.7
West Virginia (WV)	24973	37	1.48	1.05 -- 1.91	1.94	1.47 -- 2.42
Wisconsin (WI)	71811	93	1.30	1.04 -- 1.55	1.57	1.26 -- 1.88
Wyoming (WY)	4515	7	1.55	0.53 -- 2.57	1.88	0.85 -- 2.92

* State within the United States

[†] CI: Confidence Interval

§ Adjusted for age, sex, race, surgery setting, surgeon years of experience and surgeon volume

Table 4

Endophthalmitis Rate by Annual Medicare Surgical Volume^a

Annual Medicare Surgery Volume	Total Physicians N(%)	Total Surgeries N(%)	Total Endophthalmitis Cases	Overall Endophthalmitis Rate/1000 surgeries ^b	95% Confidence Interval
1-50	4543 (38.3%)	137,200 (4.2%)	352	2.57	(2.30 – 2.83)
51-200	4529 (38.2%)	975,370 (30.1%)	1,455	1.49	(1.42 – 1.57)
201-500	2253 (19.0%)	1,295,972 (39.9%)	1,512	1.17	(1.11 – 1.23)
501-1000	451 (3.8%)	565,158 (17.4%)	454	0.80	(0.73 – 0.88)
1001+	97 (0.8%)	272,198 (8.4%)	168	0.62	(0.52 – 0.71)

^aExcludes 35,068 (1.1%) surgeries with unique physician identification numbers (UPIN) that cannot be attributed to a specific surgeon and surgeries for which surgeon characteristics data were missing.

^bRate is overall for all surgeries within a specific annual volume category and does not reflect the average rate of endophthalmitis within each category.

Table 5

Univariate and Multivariate Analyses of Risk Factors for Endophthalmitis after Cataract Surgery

	Unadjusted Relative Risk	95% CI	Adjusted Relative Risk	95% CI
Age				
65 – 74 years	1.00	Reference	1.00	Reference
75 – 84 years	1.12	1.04–1.19	1.11	1.04–1.19
85+ years	1.58	1.43–1.74	1.53	1.38–1.69
Sex				
Female	1.00	Reference	1.00	Reference
Male	1.19	1.11–1.26	1.23	1.15–1.31
Race				
Black	1.22	1.08–1.38	1.17	1.03–1.33
Hispanic	1.13	0.89–1.42	1.09	0.86–1.38
Asian	1.16	0.91–1.50	0.99	0.76–1.29
Native American	1.52	0.96–2.42	1.72	1.07–2.77
Others	1.40	1.12–1.91	1.27	0.92–1.75
White	1.00	Reference	1.00	Reference
Year				
2003	1.19	1.12–1.27	1.20	1.13–1.28
2004	1.00	Reference	1.00	Reference
Ambulatory Surgery Center				
No	1.23	1.15–1.31	1.05	0.98–1.12
Yes	1.00	Reference	1.00	Reference
Surgery volume				
1–50	4.17	3.47–5.01	3.80	3.13–4.61
51–200	2.42	2.06–2.84	2.32	1.97–2.74
201–500	1.89	1.61–2.22	1.84	1.56–2.17
501–1000	1.30	1.09–1.55	1.30	1.09–1.56
1001+	1.00	Reference	1.00	Reference
Surgeon experience				
1–10 years	1.55	1.38–1.74	1.41	1.25–1.59
11–20 years	1.18	1.08–1.28	1.22	1.12–1.33
21–30 years	1.06	0.97–1.15	1.10	1.01–1.20
30+ years	1.00	Reference	1.00	Reference

CI: Confidence Interval