

Anesthesia Care for Cataract Surgery in Medicare Beneficiaries

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 Supplemental content

IMPORTANCE Cataract surgery in the US is routinely performed with anesthesia care, whereas anesthesia care for other elective, low-risk, outpatient procedures is applied more selectively.

OBJECTIVE To identify predictors of anesthesia care in Medicare beneficiaries undergoing cataract surgery and evaluate anesthesia care for cataract surgery compared with other elective, low-risk, outpatient procedures.

DESIGN, SETTING, AND PARTICIPANTS This population-based, retrospective observational cohort study included Medicare beneficiaries 66 years or older who underwent cataract surgery in 2017. The data were analyzed from August 2020 through May 2021.

INTERVENTIONS (FOR CLINICAL TRIALS) OR EXPOSURES (FOR OBSERVATIONAL STUDIES) Anesthesia care during elective, low-risk, outpatient procedures.

MAIN OUTCOMES AND MEASURES Prevalence of anesthesia care during cataract surgery compared with other low-risk procedures; association of anesthesia care with patient, clinician, and health system characteristics; and proportion of patients experiencing a systemic complication within 7 days of cataract surgery compared with patients undergoing other low-risk procedures.

RESULTS Among 36 652 cataract surgery patients, the mean (SD) age was 74.7 (6.1) years; 21 690 (59.2%) were female; 2200 (6.6%) were Black and 32 049 (87.4%) were White. Anesthesia care was more common among patients undergoing cataract surgery compared with patients undergoing other low-risk procedures (89.8% vs range of <1% to 70.2%). Neither the patient's age (adjusted odds ratio, 1.01; 95% CI, 1.00-1.02; $P = .01$) nor Charlson Comorbidity Index (CCI) score (CCI of ≥ 3 : adjusted odds ratio, 1.06; 95% CI, 0.95-1.18; $P = .28$; reference, CCI score of 0-1) was strongly associated with anesthesia care for cataract surgery, but a model comprising a single variable identifying the ophthalmologist predicted anesthesia care with a C statistic of 0.96. Approximately 6.0% of ophthalmologists never used anesthesia care, 76.6% always used anesthesia care, and 17.4% used it for only a subset of patients. Fewer cataract surgery patients experienced systemic complications within 7 days (2833 [7.7%]), even when limited to patients of ophthalmologists who never used anesthesia care (108 [7.4%]), than patients undergoing other low-risk procedures (range, 13.2%-52.2%).

CONCLUSIONS AND RELEVANCE The results of this cohort study suggest that systemic complications occurred less frequently after cataract surgery compared with other elective, low-risk, outpatient procedures during which anesthesia care was less commonly used. Anesthesia care was not associated with patient characteristics, such as older age or worse health status, but with the ophthalmologists' usual approach to cataract surgery sedation. The study findings suggest an opportunity to use anesthesia care more selectively in patients undergoing cataract surgery.

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Cataract surgery is a common elective surgical procedure among older adults, with more than 2 million cases performed annually in the US.¹ Ophthalmologic surgical advances during the past several decades have resulted in extremely low ophthalmologic complication rates, estimated at anywhere between 0.05% and 2.2%.²⁻⁷ Therefore, cataract surgery is generally accepted as a safe and effective intervention for senile cataract, with most patients experiencing a substantial improvement in vision and quality of life after surgery.⁸

Despite the known safety profile of cataract surgery, most cataract procedures in the US are performed with topical anesthesia with light intravenous sedation administered by an anesthesia-trained professional (either an anesthesiologist or nurse anesthetist). Care by an anesthesia-trained professional is considered the standard of care for cataract surgery sedation in the US. In contrast, cataract surgery in other countries is often performed without anesthetic monitoring or sedation.⁹⁻¹¹ Furthermore, many other low-risk elective outpatient procedures, including cardiac catheterization, gastrointestinal endoscopy, and bronchoscopy, are routinely performed in the US without the presence of an anesthesia-trained professional unless specifically requested for the procedure.

Physicians have stated that the rationale for routinely using anesthesia care for cataract surgery is the assumption that cataract surgery patients are at high risk for developing systemic perioperative complications because of their age and comorbid conditions.^{12,13} However, whether these patient factors, or other factors, explain the persistence of anesthesia care for patients undergoing cataract surgery has not been studied.¹⁴ Therefore, we conducted a retrospective observational cohort study comparing anesthesia care in Medicare cataract surgery patients with anesthesia care among Medicare patients undergoing other elective low-risk procedures, including upper endoscopy, screening colonoscopy, bronchoscopy, cardiac catheterization, percutaneous coronary intervention, and implantable cardiac device placement. We used hierarchical logistic regression to model the association of anesthesia care for cataract surgery with patient, clinician, and health system characteristics. We compared systemic perioperative complications in patients of ophthalmologists who never operated with anesthesia care, patients of ophthalmologists who always operated with anesthesia care, and patients undergoing other low-risk procedures.

Methods

Study Oversight and Data Source

This study was approved by the institutional review board at the University of California, San Francisco. The institutional review board waived the requirement to obtain informed consent from study participants. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for observational cohort studies¹⁵ (eTable 1 in the Supplement). We obtained US Centers for Medicare & Medicaid research

Key Points

Question What is the prevalence of anesthesia care during cataract surgery compared with other low-risk, outpatient procedures?

Findings In this cohort study of 36 652 cataract surgery patients, anesthesia care was more common among Medicare beneficiaries undergoing cataract surgery compared with other low-risk procedures (89.8% vs <1% to 70.2%), but cataract surgery patients experienced fewer systemic complications (7.7% vs 13.2% to 52.2%).

Meaning The study results suggest that systemic complications occurred less frequently among cataract surgery patients compared with patients undergoing procedures during which anesthesia care was less commonly used, suggesting an opportunity to use anesthesia resources more selectively in patients undergoing cataract surgery.

identifiable files for a 5% sample of Medicare beneficiaries undergoing cataract surgery in 2017. For each beneficiary, we accessed the Outpatient, Carrier, Medicare Provider Analysis and Review and Master Beneficiary Summary files representing all claims from January 1, 2016, through December 31, 2018.

Cataract Surgery Cohort

We used the outpatient and carrier files to identify patients undergoing cataract surgery in 2017 using *Current Procedural Terminology (CPT)* codes for cataract surgery (66982, 66983, and 66984). We included patients 66 years or older with at least 12 months of eligibility before surgery who were enrolled in the Medicare fee-for-service program without a concurrent health management organization plan. We defined each beneficiary's index surgery date as the first date of an ophthalmology claim for routine cataract surgery. We excluded beneficiaries who had an *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* code indicating prior cataract surgery (Z98.4-Z98.49, Z96.1), had a cataract surgery claim in 2016, could not be linked to a hospital referral region, were institutionalized before the date of surgery, or whose cataract surgery was performed emergently (eFigure 1 in the Supplement).

Low-risk Procedure Cohort

We used the same age and eligibility criteria described previously to identify all Medicare patients within the 5% sample who underwent other selected elective, low-risk outpatient procedures in 2017 (eFigure 2 and eTable 2 in the Supplement). If a patient underwent 2 or more different types of low-risk procedures in 2017, all of these procedures were included in the study. For patients who had the same low-risk outpatient procedure multiple times in the year 2017, we only included the first-occurring procedure.

Patient and Clinician Characteristics

Patient characteristics included age, sex, race and ethnicity, and health status assessed using the Charlson Comorbidity Index (CCI) score. Race and ethnicity were obtained directly from the Master Beneficiary Summary files, which is populated from

Social Security Administration data on each beneficiary's self-reported race and/or ethnicity.¹⁶ We included race as a covariate in the study because others have reported racial disparities in cataract care.¹⁷ Because Medicare race data have been reported to be more accurate for Black and White beneficiaries compared with other racial and ethnic minority groups, we used 3 race categories in the study: Black, White, and Other. The "Other" category included beneficiaries classified by Medicare as Asian, Hispanic/Latinx, North American Native, Other, or Unknown. Procedure characteristics, including surgical volume and surgical setting, were obtained from the Medicare carrier files. We stratified physicians into quartiles of surgical volume according to the number of cataract procedures performed by each ophthalmologist in the 2017 Medicare 5% sample. For each ophthalmologist in the data set, we extracted physician demographic characteristics and number of years in practice from the 2017 American Medical Association Physician Masterfile and linked these variables to the Medicare files using each physician's National Provider Identification (NPI).¹⁸ Health system characteristics, including geographic region, physicians per capita, and health care expenditures per hospital referral region (HRR), were derived using the ophthalmologist's zip code in the Medicare carrier claims and the associated HRR.¹⁹

Definition of Anesthesia Care

Anesthesia CPT codes do not distinguish between monitored anesthesia care and general anesthesia. Therefore, we used the anesthesia CPT code for cataract surgery as well as for 17 each respective low-risk procedure to identify the presence of an anesthesia-trained professional during each procedure (eTable 3 in the Supplement).

Identification of Perioperative Complications

We used ICD-10 diagnosis codes to identify systemic perioperative complications within 7 days after each procedure based on the National Surgical Quality Improvement Project complication categories (eTable 4 in the Supplement).^{20,21} With the exception of a fall event, perioperative complications detected in the 30 days before the date of surgery were used to exclude preexisting conditions from being counted as new postoperative complications. We also assessed the frequency of hospital admissions and mortality within 7 days after each procedure.

Cataract Surgery Subcohort

Within the cataract surgery cohort, we identified the subset of patients who underwent at least 1 other low-risk procedure, either before or after cataract surgery, in the year 2017 (eFigure 3 in the Supplement). We excluded any low-risk procedures that occurred within 30 days before or after cataract surgery to avoid errors of attribution when linking perioperative complications to their corresponding procedure.

Statistical Analysis

We performed a descriptive analysis to determine the percentage of Medicare patients who received anesthesia care for cataract surgery. We used the Student *t* test and χ^2 test to com-

pare differences between patients who did and did not receive anesthesia care for cataract surgery. We identified independent predictors of anesthesia care for cataract surgery using hierarchical logistic regression, with the ophthalmologist as a random effect to account for clustering of patients by ophthalmologist. The association of the ophthalmologist with the use of anesthesia care during cataract surgery was summarized with the median odds ratio (OR).^{22,23} This summary statistic is a function of the estimated variance of the random effect and is directly comparable with ORs of fixed-effects variables.²⁴ To assess the differential contributions to the use of anesthesia care in association with the patient characteristics, the physician's preference for operating with anesthesia care, other procedural and health system variables, and physician demographic characteristics and years in practice, we created a series of models predicting anesthesia care for cataract surgery and calculated C statistics for each model.

We then identified the proportion of cataract surgery patients who experienced perioperative complications. To account for the possibility that anesthesia care may be associated with a decrease in the risk of perioperative complications after cataract surgery compared with patients undergoing surgery without anesthesia care, we calculated the proportion of each ophthalmologist's patients having cataract surgery with anesthesia care in 2017 (0%, >0% to <100%, and 100%) and stratified cataract surgery patients by the ophthalmologist's sedation approach. We used the χ^2 test and Fisher exact test to compare unadjusted outcomes. We used hierarchical logistic regression with the ophthalmologist as a random effect to model the association between the ophthalmologist's approach to anesthesia care and the risk of perioperative complications. We performed the same analyses after stratifying patients by receipt of anesthesia care during cataract surgery.

Finally, we compared the prevalence of anesthesia care for cataract surgery with anesthesia care for other low-risk procedures. As a sensitivity analysis, within the subset of cataract surgery patients who also underwent another low-risk procedure during the same calendar year, we assessed whether anesthesia care was used consistently in the same patient undergoing the 2 different procedures. We then identified the proportion of patients who experienced a complication after each of the other low-risk procedures compared with complications experienced by all cataract surgery patients, as well as the subset of cataract surgery patients whose ophthalmologists never used anesthesia care.

Statistical analyses were conducted with SAS, version 9.4 (SAS Institute). Statistical significance was set at $P = .05$.

Results

We identified 36 652 patients who underwent cataract surgery during 2017 with a mean (SD) age of 74.7 (6.1) years; 21 960 (59.2%) were female, 2200 (6.0%) were Black, 32 049 (87.4%) were White, and 32 913 (89.8%) underwent surgery with anesthesia care. The age and CCI score of patients who had cataract surgery with and without anesthesia care were similar (Table 1).

Table 1. Baseline Characteristics of Cataract Surgery Cohort Stratified by Receipt of Anesthesia Care^a

| Characteristic | No. (%) | | | P value |
|---|---------------------------|-----------------------------------|--------------------|---------|
| | All patients (n = 36 652) | Anesthesia care With (n = 32 922) | Without (n = 3730) | |
| Patient characteristics | | | | |
| Age, mean (SD), y | 74.7 (6.1) | 74.7 (6.1) | 74.5 (6.1) | .07 |
| Sex | | | | |
| Female | 21 690 (59.2) | 19 574 (59.5) | 2116 (56.7) | .001 |
| Male | 14 962 (40.8) | 13 348 (40.5) | 1614 (43.3) | |
| Race and ethnicity | | | | |
| Black | 2200 (6.0) | 1884 (5.7) | 316 (8.5) | <.001 |
| White | 32 049 (87.4) | 28 886 (87.7) | 3163 (84.8) | |
| Other ^b | 2403 (6.6) | 2152 (6.5) | 251 (6.7) | |
| Charlson Comorbidity Index score | | | | |
| 0-1 | 18 319 (50.0) | 16 458 (50.0) | 1861 (49.9) | .72 |
| 2 | 5554 (15.2) | 5003 (15.2) | 551 (14.8) | |
| ≥3 | 12 779 (34.9) | 11 461 (34.8) | 1318 (35.3) | |
| Health system characteristics | | | | |
| Geographic region | | | | |
| Northeast | 6508 (17.8) | 5986 (18.2) | 522 (14.0) | <.001 |
| Midwest | 8124 (22.2) | 7122 (21.6) | 1002 (26.9) | |
| South | 14 914 (40.7) | 13 436 (40.8) | 1478 (40.0) | |
| West | 7106 (19.4) | 6378 (19.4) | 728 (19.5) | |
| Surgical setting | | | | |
| Ambulatory surgical center | 26 842 (73.2) | 24 464 (74.3) | 2378 (63.8) | <.001 |
| Office | 205 (0.6) | 173 (0.5) | 32 (0.9) | |
| Hospital outpatient department | 9001 (24.6) | 7792 (23.7) | 1209 (32.4) | |
| Other | 604 (1.7) | 493 (1.5) | 111 (3.0) | |
| Ophthalmologists per capita (range) | | | | |
| Q1 (1.57-3.97) | 9220 (25.2) | 8204 (24.9) | 1016 (27.2) | <.001 |
| Q2 (3.98-4.52) | 9142 (24.9) | 8059 (24.9) | 1083 (29.0) | |
| Q3 (4.54-5.61) | 9185 (25.1) | 8277 (25.1) | 908 (24.3) | |
| Q4 (5.62-9.78) | 9105 (24.8) | 8382 (25.5) | 723 (19.4) | |
| Anesthesiologists per capita (range) | | | | |
| Q1 (5.36-9.96) | 9328 (25.5) | 8470 (25.7) | 858 (23.0) | .003 |
| Q2 (10.02-11.93) | 9042 (24.7) | 8101 (24.6) | 941 (25.2) | |
| Q3 (11.95-14.33) | 9316 (25.4) | 8319 (25.3) | 997 (26.7) | |
| Q4 (14.36-19.58) | 8966 (24.5) | 8032 (24.4) | 934 (25.0) | |
| Health care expenditures per HRR (range) | | | | |
| Q1 (\$7973-\$9381) | 9275 (25.3) | 8251 (25.1) | 1024 (27.5) | <.001 |
| Q2 (\$9384-\$10 080) | 9119 (24.9) | 7983 (24.3) | 1136 (30.5) | |
| Q3 (\$10 087-\$11 587) | 9581 (26.1) | 8640 (26.2) | 941 (25.2) | |
| Q4 (\$11 593-\$14 619) | 8677 (23.7) | 8048 (24.5) | 629 (16.9) | |
| Physician characteristics | | | | |
| Physician age, mean (SD), y | 52.2 (10.1) | 52.2 (10.1) | 51.5 (10.2) | <.001 |
| Physician sex^c | | | | |
| Female | 4808 (13.2) | 4368 (13.3) | 440 (11.8) | .01 |
| Male | 31 667 (86.4) | 28 388 (86.2) | 3279 (87.9) | |
| No. of years of practice, mean (SD) | 25.5 (10.3) | 25.6 (10.3) | 24.9 (10.4) | <.001 |
| Annual surgical volume^d | | | | |
| Q1 (1-9) | 9311 (25.4) | 8317 (25.3) | 994 (26.7) | <.001 |
| Q2 (10-17) | 9795 (26.7) | 8905 (27.1) | 890 (23.9) | |
| Q3 (18-30) | 8783 (24.0) | 7847 (23.8) | 936 (25.1) | |
| Q4 (31-203) | 8763 (23.9) | 7853 (23.9) | 910 (24.4) | |

Abbreviations: HRR, hospital referral region; Q, quartile.

^a All results reported as the number and percentage of patients in each category except where otherwise indicated.

^b The Other category includes beneficiaries classified by Medicare as American Indian/Alaska Native, Asian/Pacific Islander, Hispanic, Other, or Unknown.

^c Missing for 177 physicians (with anesthesia care: 166; without anesthesia care: 11).

^d Annual surgical volume taken from the Medicare 5% sample must be multiplied by 20 to obtain a more accurate estimate of the total surgical volume ranges represented within each quartile.

Approximately 471 ophthalmologists (6.0%) never used anesthesia care, 5998 (76.6%) always used anesthesia care, and 1363 (17.4%) used it for only a subset of their patients. The patient's ophthalmologist was the strongest predictor of anesthesia care for cataract surgery, with a median OR of 11.71 (95% CI, 10.24-13.17) on univariate analysis. After adjusting for other variables, the median odds ratio was 9.33 (95% CI, 8.32-10.34; **Table 2**). Neither the patient's age (adjusted OR [AOR], 1.01; 95% CI, 1.00-1.02; $P = .01$) nor CCI score were strongly associated with the use of anesthesia care for cataract surgery (CCI of 2: AOR, 1.04; 95% CI, 0.90-1.20; $P = .58$; CCI of ≥ 3 : AOR, 1.06; 95% CI, 0.95-1.18; $P = .28$ vs CCI of 0-1). When we compared the differential contributions of the model predictors with the use of anesthesia care for cataract surgery, the model that comprised only patient characteristics had a C statistic of 0.53. A model with the ophthalmologist (as represented by the ophthalmologist's NPI) as the only variable had a C statistic of 0.96. The complete model, which included all predictor variables (ie, patient characteristics, the ophthalmologist's NPI, other procedural and health system variables, and the ophthalmologist's own demographic characteristics, number of years in practice, and annual surgical volume), also had a C statistic of 0.96.

Approximately 2833 cataract surgery patients (7.7%) experienced at least 1 systemic complication (eTable 5 in the **Supplement**); 103 patients (0.3%) were hospitalized, and 6 (0.02%) died within 7 days of surgery. There was no difference in the proportion of patients experiencing a systemic perioperative complication between ophthalmologists who always vs never used anesthesia care (**Figure 1**; eFigure 4 in the **Supplement**). After adjusting for other covariates, the hierarchical model showed no association between the ophthalmologist's sedation approach and systemic perioperative complications (eTable 6 in the **Supplement**). When we stratified by patient receipt of anesthesia care, although there was a slight increase in complications in patients who had surgery without anesthesia care, after adjusting for other covariates, the hierarchical model again showed no association between patient receipt of anesthesia care and systemic perioperative complications (eFigures 5 and 6 and eTable 7 in the **Supplement**).

Anesthesia care was much more commonly used during cataract surgery than all the other low-risk procedures we studied (**Figure 2**), ranging from 128 (1.4%) and 233 patients (0.7%) undergoing percutaneous coronary interventions and cardiac catheterizations to 37 351 (55.9%) and 58 768 patients (70.2%) undergoing upper endoscopy and screening colonoscopy, respectively. We observed similar variations in anesthesia care among the subset of cataract surgery patients who received anesthesia care and underwent another low-risk procedure during 2017 (eFigure 7 in the **Supplement**).

Despite the high rate of anesthesia care for cataract surgery compared with the other procedures, we found that systemic complications, including postprocedure hospitalizations and 7-day mortality, were more common among patients undergoing the other low-risk procedures, even when compared with cataract surgery patients whose ophthalmologists never used anesthesia care (**Figure 3**, A and B). Respiratory and cardiac complications were the most prevalent across

all procedures. Within the subset of cataract surgery patients who also underwent another low-risk procedure in 2017, we found similar differences in the rates of perioperative systemic complications, hospitalization, and mortality within 7 days (eFigures 8 and 9 in the **Supplement**).

Discussion

This cohort study found that most ophthalmologists use anesthesia care for at least a portion of patients undergoing cataract surgery, and nearly three-quarters of ophthalmologists used anesthesia care in 100% of cataract surgeries. We also found that the rate of systemic perioperative complications was similar between ophthalmologists who sometimes or always used anesthesia care compared with those who never did. The study results are consistent with other studies that show that complication rates for cataract surgery are not higher among patients who undergo cataract surgery without anesthesia care when using protocolized approaches and trained staff.^{9,10,25-29} In a large retrospective case series from Kaiser Permanente Colorado, where ophthalmologists routinely perform cataract surgery with nurse sedation in minor procedure rooms, there were minimal perioperative and ophthalmologic complications and comparable outcomes with cataract surgeries performed at ambulatory surgery centers.²⁵ In another study in which 6961 cataract surgeries were performed with topical anesthesia and monitoring by registered nurses, there were only 3 instances of adverse events that required emergency intervention (all of which ended up being vasovagal syncopal episodes that did not require admission).²⁷ These studies suggest that cataract surgery complication rates are low regardless of whether anesthesiologists are present to administer anesthesia care.

Because most ophthalmologists generally request anesthesia care during cataract surgery, we found significantly higher rates of anesthesia care among Medicare beneficiaries undergoing cataract surgery compared with beneficiaries undergoing other low-risk procedures in 2017, even when the same patient underwent cataract surgery and another procedure with higher risk in the same year. Patient risk factors, such as older age or having multiple comorbidities, have frequently been cited as justifications for anesthesia care during cataract surgery.^{12,13} However, the current study's hierarchical model suggested that patient-level risk factors were not strongly associated with the use of anesthesia care for cataract surgery. Instead, the strongest predictor of anesthesia care was the identity of the patient's ophthalmologist, which represents each individual physician's preference for anesthesia care during cataract surgery.

Belying the high prevalence of anesthesia use, cataract surgery patients had the lowest rate of perioperative complications, postprocedure hospitalization, and death of all the procedures we studied, even when limiting the cataract cohort to only the patients of ophthalmologists who never used anesthesia care. This is particularly notable as our definition of complications was broad and included events that may have been unrelated to the cataract surgery. These results suggest that

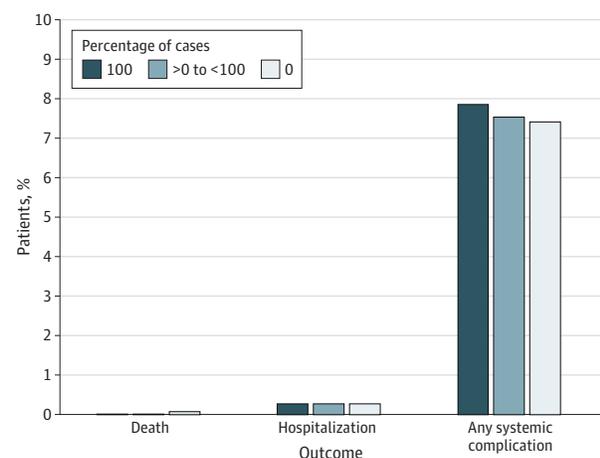
Table 2. Characteristics Associated With Anesthesia Care for Cataract Surgery

| Characteristic | Patient characteristics only | | Ophthalmologist only, MOR (95% CI) | Ophthalmologist plus all other variables | |
|---|------------------------------|---------|------------------------------------|--|---------|
| | AOR (95% CI) | P value | | AOR (95% CI) | P value |
| Patient characteristics | | | | | |
| Age, y | 1.01 (1.00-1.01) | .07 | NA | 1.01 (1.00-1.02) | .01 |
| Sex | | | | | |
| Female | 1.13 (1.06-1.21) | <.001 | NA | 1.15 (1.04-1.27) | .01 |
| Male | 1 [Reference] | NA | NA | 1 [Reference] | NA |
| Race and ethnicity | | | | | |
| Black | 0.65 (0.57-0.73) | <.001 | NA | 0.50 (0.41-0.60) | <.001 |
| White | 1 [Reference] | NA | NA | 1 [Reference] | NA |
| Other ^a | 0.95 (0.83-1.09) | .46 | NA | 0.93 (0.75-1.14) | .46 |
| Charlson Comorbidity Index score | | | | | |
| 0-1 | 1 [Reference] | NA | NA | 1 [Reference] | NA |
| 2 | 1.03 (0.93-1.14) | .55 | NA | 1.04 (0.90-1.20) | .58 |
| ≥3 | 1.02 (0.94-1.10) | .68 | NA | 1.06 (0.95-1.18) | .28 |
| Health system characteristics | | | | | |
| Geographic region | | | | | |
| Northeast | | | | 1 [Reference] | NA |
| Midwest | NA | NA | NA | 0.89 (0.66-1.18) | .42 |
| South | | | | 0.93 (0.71-1.21) | .57 |
| West | | | | 0.76 (0.57-1.01) | .05 |
| Surgical setting | | | | | |
| Ambulatory surgical center | | | | 1 [Reference] | |
| Office | | | | 0.47 (0.25-0.86) | .01 |
| Hospital outpatient department | NA | NA | NA | 0.53 (0.46-0.62) | <.001 |
| Other | | | | 0.45 (0.27-0.74) | .002 |
| Ophthalmologists per capita (range) | | | | | |
| Q1 (1.57-3.97) | | | | 1 [Reference] | NA |
| Q2 (3.98-4.52) | | | | 0.93 (0.73-1.19) | .57 |
| Q3 (4.54-5.61) | NA | NA | NA | 1.27 (0.99-1.63) | .06 |
| Q4 (5.62-9.78) | | | | 1.41 (1.05-1.91) | .02 |
| Anesthesiologists per capita (range) | | | | | |
| Q1 (5.36-9.96) | | | | 1 [Reference] | NA |
| Q2 (10.02-11.93) | | | | 0.76 (0.60-0.97) | .03 |
| Q3 (11.95-14.33) | NA | NA | NA | 0.64 (0.50-0.83) | <.001 |
| Q4 (14.36-19.58) | | | | 0.60 (0.45-0.79) | <.001 |
| Health care expenditures per HRR | | | | | |
| Q1 (\$7973-\$9381) | | | | 1 [Reference] | NA |
| Q2 (\$9384-\$10 080) | | | | 0.92 (0.72-1.17) | .48 |
| Q3 (\$10 087-\$11 587) | NA | NA | NA | 1.48 (1.17-1.88) | .001 |
| Q4 (\$11 593-\$14 619) | | | | 1.66 (1.26-2.20) | <.001 |
| Physician characteristics | | | | | |
| Physician age | NA | NA | NA | 1.05 (1.01-1.09) | .01 |
| Physician sex | | | | | |
| Male | | | | 1 [Reference] | NA |
| Female | NA | NA | NA | 1.34 (1.06-1.70) | .01 |
| No. of years of practice | NA | NA | NA | 0.96 (0.93-1.00) | .04 |
| Annual surgical volume | | | | | |
| Q1 (1-9) | | | | 1 [Reference] | NA |
| Q2 (10-17) | | | | 1.40 (1.14-1.72) | .001 |
| Q3 (18-30) | NA | NA | NA | 0.97 (0.76-1.23) | .80 |
| Q4 (31-203) | | | | 1.05 (0.78-1.41) | .73 |
| Ophthalmologist NPI, MOR (95% CI) | NA | NA | 11.71 (10.24-13.17) | 9.33 (8.32-10.34) | NA |
| C statistic | 0.53 | | 0.96 | 0.96 | NA |

Abbreviations: AOR, adjusted odds ratio; HRR, hospital referral region; MOR, median odds ratio; NA, not applicable; NPI, National Provider Identification; Q, quartile.

^a The Other category includes beneficiaries classified by Medicare as American Indian/Alaska Native, Asian/Pacific Islander, Hispanic, Other, or Unknown.

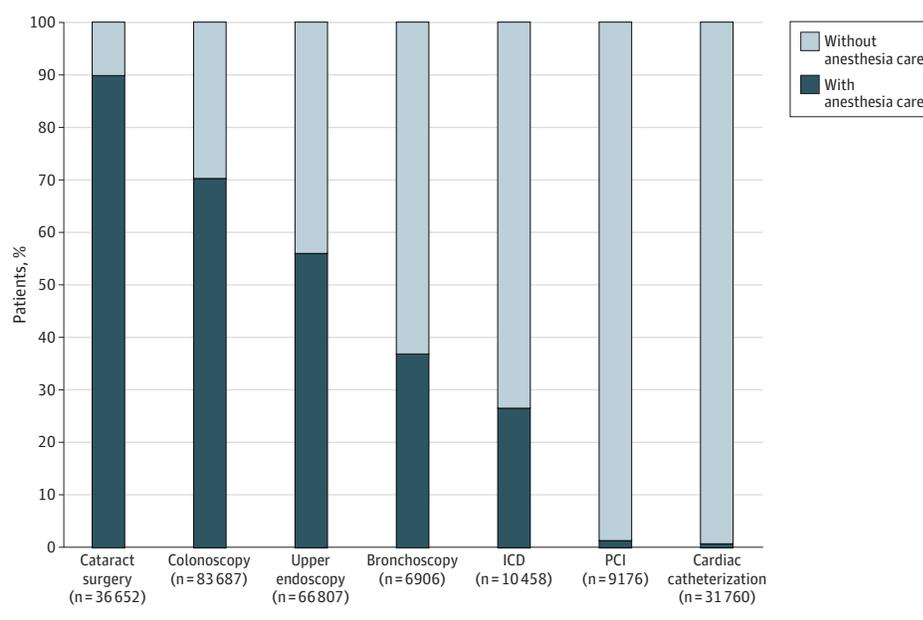
Figure 1. Death, Hospitalization, and Systemic Complications Within 7 Days After Cataract Surgery Stratified by the Proportion of Each Ophthalmologist's Cataract Surgery Cases Performed With Anesthesia Care



Ophthalmologists were categorized according to the percentage of patients who underwent cataract surgery with anesthesia care during 2017. Outcomes were assessed by calculating the percentage of cataract surgery patients within each anesthesia care category who experienced the respective outcomes of death, hospitalization, or systemic complications within 7 days after their procedure. The number of ophthalmologists in each anesthesia care category included 0% of cases ($n = 471$); >0 to <100% of cases ($n = 1363$); and 100% of cases ($n = 5998$). The number of patients in each anesthesia care category included 0% of cases ($n = 1459$); >0 to <100% of cases ($n = 10\,645$); and 100% of cases ($n = 24\,548$). Deaths stratified by anesthesia care category: 0% (0.07% [$n = 1$]); more than 0% to less than 100% (0.01% [$n = 1$]); 100% (0.02% [$n = 4$]; $P = .27$). Hospitalizations stratified by anesthesia care category: 0% (0.27% [$n = 4$]); more than 0% to less than 100% (0.28% [$n = 30$]); 100% (0.28% [$n = 69$]; $P > .99$). Systemic complications stratified by anesthesia care category: 0% (7.40% [$n = 108$]); more than 0% to less than 100% (7.52% [$n = 801$]); 100% (7.84% [$n = 1924$]; $P = .54$).

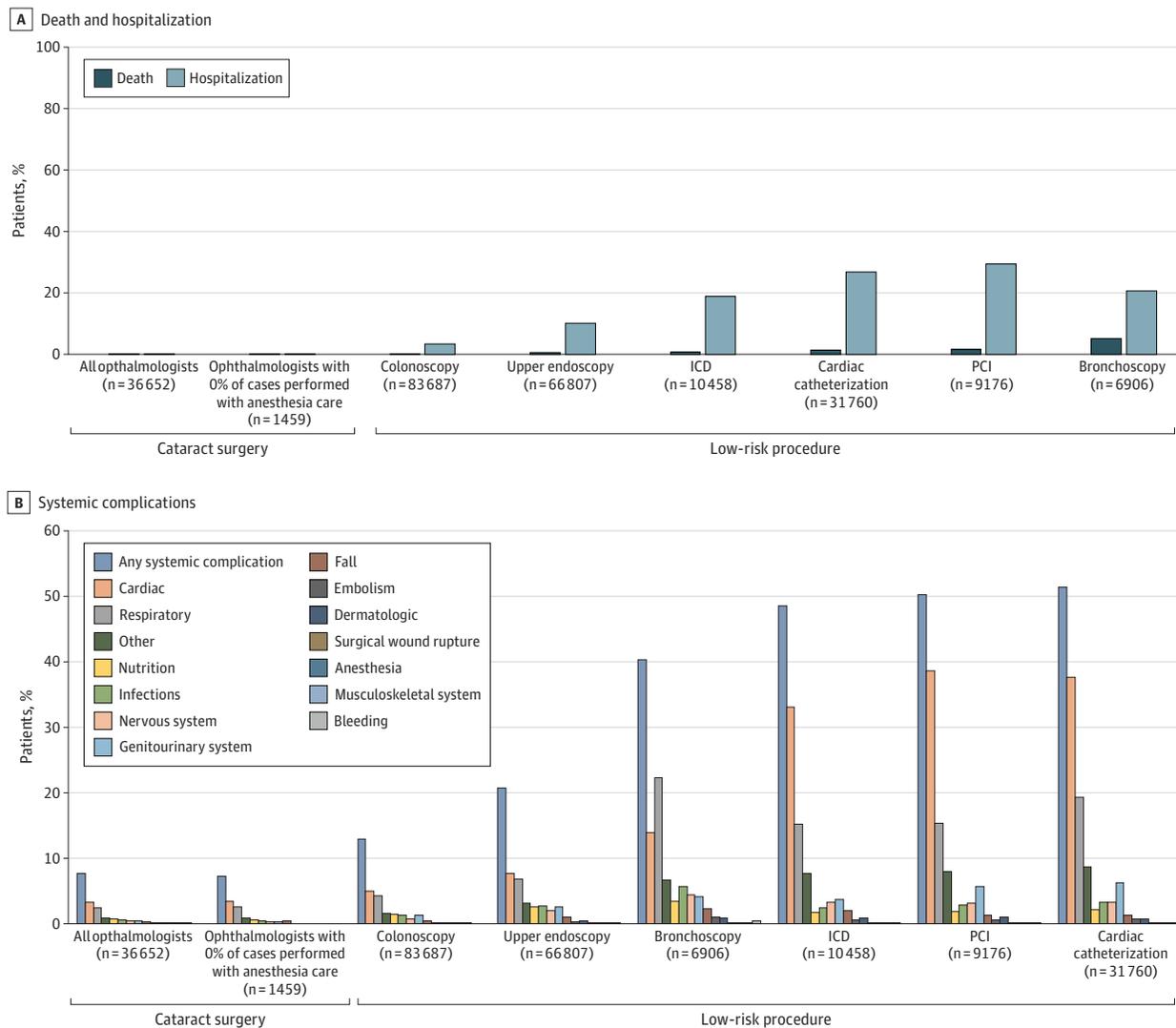
cataract surgery is just as safe as the other procedures that do not routinely use anesthesia care. Despite this, the threshold for engagement of anesthesiologist expertise appears far lower for cataract surgery than for other elective low-risk procedures. Ophthalmologists who operate with anesthesia care may prefer to have an anesthesiologist readily available to manage unexpected perioperative events, regardless of the patients' underlying medical complexity. Likewise, the internal medicine subspecialists performing these comparable low-risk procedures are more likely to be well versed in the management of acute cardiovascular events compared with ophthalmologists, which may affect their decision to forgo anesthesiology services. Moreover, the unique nature of intraocular surgery must be considered, because surgeon diversion to address the distraction of an acute intraoperative event, including unexpected patient movement, has the potential for substantial ocular morbidity. While modern cataract surgery using phacoemulsification can be performed with topical anesthetics administered in the form of eye drops, some ophthalmologists may still request anesthesia care if they routinely perform retrobulbar or peribulbar blocks for intraoperative analgesia, which comes with its own inherent risks and can be uncomfortable for the patient while the block is being administered. We also recognize that many ophthalmologists practice in settings in which the provision of anesthesia care is the default model of sedation for cataract surgery; therefore, ophthalmologists may not have agency regarding the decision to proceed without anesthesia care the same way they might choose to forgo preoperative testing for their patients. There may also be institutional barriers to operating without anesthesia care, even among ophthalmologists who would be amenable to that approach. Nevertheless, approximately 10% to 12% of Medicare Medicare cataract surgery patients are already undergoing cataract surgery without anesthesia care with no

Figure 2. Prevalence of Anesthesia Care for Selected Low-risk Procedures in the 2017 Medicare 5% Sample



ICD indicates *International Classification of Diseases*; PCI, percutaneous coronary intervention.

Figure 3. Death, Hospitalization, and Systemic Complications Within 7 Days After Each Low-risk Procedure Compared With Cataract Surgery



ICD indicates *International Classification of Diseases*; n, the number of patients having each procedure; PCI, percutaneous coronary intervention.

appreciable difference in perioperative complication rates, suggesting that a subset of cataract surgery cases can safely be completed without anesthesiologist involvement.

Some payers and policy makers have questioned the need for anesthesia care for cataract surgery.^{25,30} For example, in 2018, a major health insurance company released clinical guidelines proposing to stop reimbursing anesthesiologists for anesthesia care for routine cataract surgery (which would have required that any sedation for the procedure would instead be administered and monitored by the ophthalmologist performing surgery).³⁰ At the time, the American Academy of Ophthalmology, American Society of Anesthesiologists, and California Society of Anesthesiology issued statements opposing the change because of patient safety concerns and the lack of evidence to justify the change in practice; thus, the guidelines were never implemented.³¹⁻³³ While the current study adds to the growing evidence base, it does not offer sufficient

justification for the complete removal of anesthesia-trained clinicians from the cataract surgery suite. We believe that there may be patients who would benefit from intraoperative monitoring by an anesthesiologist, including those patients with cataracts who may require general anesthesia to undergo surgery. More studies will be needed to determine how best to risk stratify patients, and whether anesthesia care is associated with a reduction in complications in the highest-risk patients.

Limitations

This study had some limitations. First, we conducted a retrospective observational study using administrative claims, so we cannot draw causal inferences regarding anesthesia care and perioperative complications. Second, because anesthesia CPT codes do not distinguish between monitored anesthesia care and general anesthesia, we could not determine the specific anesthetic approach used during any of the proce-

dures we studied. Third, we used *ICD-10* codes to identify perioperative systemic complications; therefore, we could not assess whether anesthesia care for cataract surgery was associated with ophthalmologic outcomes, such as best-corrected visual acuity. Fourth, although we accounted for systemic complications within 7 days of the procedures we studied, we cannot definitively attribute these complications to the procedures themselves. For example, some of the *ICD-10* diagnosis codes we used to define systemic complications may reflect diagnoses that were coded during the usual course of health care during the 7 days following the procedure of interest. While we removed preexisting complications from the outcome definition, we may still be overestimating the complication rate after each of these low-risk procedures compared with what has previously been reported in the literature. We also did not account for transient complications that may have not been severe enough to warrant a diagnosis or claim for reimbursement. Despite these limitations, this study

highlights the disconnect between the risk of cataract surgery and the reliance on anesthesia care compared with the other elective, low-risk procedures we studied.

Conclusions

This cohort study found that anesthesia care was not associated with lower perioperative systemic complication rates among cataract surgery patients and that the rate of complications was lower for cataract surgery compared with other low-risk procedures for which anesthesia care is less commonly used. Because most ophthalmologists always use anesthesia care for cataract surgery, these findings suggest an opportunity to use anesthesia care more selectively in patients undergoing cataract surgery. Additional studies will be needed to determine how best to allocate anesthesia resources for cataract surgery sedation in the US.

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REFERENCES

- French DD, Margo CE, Behrens JJ, Greenberg PB. Rates of routine cataract surgery among Medicare beneficiaries. *JAMA Ophthalmol*. 2017;135(2):163-165. doi:10.1001/jamaophthalmol.2016.5174
- Schein OD, Katz J, Bass EB, et al; Study of Medical Testing for Cataract Surgery. The value of routine preoperative medical testing before cataract surgery. *N Engl J Med*. 2000;342(3):168-175. doi:10.1056/NEJM200001203420304
- Katz J, Feldman MA, Bass EB, et al; Study of Medical Testing for Cataract Surgery Study Team. Adverse intraoperative medical events and their association with anesthesia management strategies in cataract surgery. *Ophthalmology*. 2001;108(10):1721-1726. doi:10.1016/S0161-6420(01)00704-7
- Sharwood PL, Thomas D, Roberts TV. Adverse medical events associated with cataract surgery performed under topical anaesthesia. *Clin Exp Ophthalmol*. 2008;36(9):842-846. doi:10.1111/j.1442-9071.2009.01924.x
- Stein JD, Grossman DS, Mundy KM, Sugar A, Sloan FA. Severe adverse events after cataract surgery among Medicare beneficiaries.

Ophthalmology. 2011;118(9):1716-1723. doi:10.1016/j.ophtha.2011.02.024

6. Pershing S, Morrison DE, Hernandez-Boussard T. Cataract surgery complications and revisit rates among three states. *Am J Ophthalmol*. 2016;171:130-138. doi:10.1016/j.ajo.2016.08.036

7. Pershing S, Henderson VW, Goldstein MK, et al. Cataract surgery complexity and surgical complication rates among Medicare beneficiaries with and without dementia. *Am J Ophthalmol*. 2021;221:27-38. doi:10.1016/j.ajo.2020.08.025

8. Liu YC, Wilkins M, Kim T, Malyugin B, Mehta JS. Cataracts. *Lancet*. 2017;390(10094):600-612. doi:10.1016/S0140-6736(17)30544-5

9. Zakrzewski PA, Friel T, Fox G, Braga-Mele R. Monitored anesthesia care provided by registered respiratory care practitioners during cataract surgery: a report of 1957 cases. *Ophthalmology*. 2005;112(2):272-277. doi:10.1016/j.ophtha.2004.08.016

10. Zakrzewski PA, Banashkevich AV, Friel T, Braga-Mele R. Monitored anesthesia care by registered respiratory therapists during cataract surgery: an update. *Ophthalmology*. 2010;117(5):897-902. doi:10.1016/j.ophtha.2009.10.005

11. Norregaard JC. Results from the International Cataract Surgery Outcomes Study. *Acta Ophthalmologica Scandinavica*. 2007;85:5-32. doi:10.1111/j.1600-0420.2007.00937.x

12. Kent C. Cataract surgery: is an anesthesiologist necessary? Accessed August 8, 2021. <https://www.reviewofophthalmology.com/article/ataract-surgery-is-an-anesthesiologist-necessary>

13. Fang ZT. Anesthesia management of ophthalmic surgery in geriatric patients. Accessed July 28, 2021. <https://www.aao.org/Assets/0985ab39-20ce-4779-9322-e718972edd86/635711977904770000/anesthesia-management-of-ophthalmic-surgery-in-geriatric-patients.pdf>

14. Redberg RF. Mandatory anesthesia. *JAMA Intern Med*. 2013;173(18):1671.

15. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement:

guidelines for reporting observational studies. *Ann Intern Med*. 2007;147(8):573-577. doi:10.7326/0003-4819-147-8-200710160-00010

16. Filice CE, Joynt KE. Examining race and ethnicity information in Medicare administrative data. *Med Care*. 2017;55(12):e170-e176. doi:10.1097/MLR.0000000000000608

17. Mahr MA, Hodge DO, Erie JC. Racial/ethnic differences in rates of complex cataract surgery among United States Medicare beneficiaries. *J Cataract Refract Surg*. 2018;44(2):140-143. doi:10.1016/j.jcrs.2017.10.049

18. US Centers for Medicaid & Medicare Services. National Provider Identifier standard (NPI). Accessed June 17, 2021. <https://www.cms.gov/Regulations-and-Guidance/Administrative-Simplification/NationalProviderStand>

19. Dartmouth Atlas Project. Medicare reimbursements. Accessed September 23, 2020. <http://www.dartmouthatlas.org>

20. American College of Surgeons. User guide for the 2017 ACS NSQIP Participant Use Data File (PUF). Accessed November 11, 2020. https://www.facs.org/-/media/files/quality%20programs/nsqip/nsqip_puf_userguide_2017.ashx

21. Storesund A, Haugen AS, Hjortås M, et al. Accuracy of surgical complication rate estimation using ICD-10 codes. *Br J Surg*. 2019;106(3):236-244. doi:10.1002/bjs.10985

22. Larsen K, Merlo J. Appropriate assessment of neighborhood effects on individual health: integrating random and fixed effects in multilevel logistic regression. *Am J Epidemiol*. 2005;161(1):81-88. doi:10.1093/aje/kwi017

23. Merlo J, Chaix B, Ohlsson H, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Health*. 2006;60(4):290-297. doi:10.1136/jech.2004.029454

24. Chen CL, Lin GA, Bardach NS, et al. Preoperative medical testing in Medicare patients undergoing cataract surgery. *N Engl J Med*. 2015;372(16):1530-1538. doi:10.1056/NEJMsa1410846

25. Ianchulev T, Litoff D, Ellinger D, Stiverson K, Packer M. Office-based cataract surgery: population health outcomes study of more than 21 000 cases in the United States. *Ophthalmology*. 2016;123(4):723-728. doi:10.1016/j.ophtha.2015.12.020

26. Rocha G, Turner C. Safety of cataract surgery under topical anesthesia with oral sedation without anesthetic monitoring. *Canadian J Ophthalmol*. 2007;42(2):288-294.

27. Koolwijk J, Fick M, Selles C, et al. Outpatient cataract surgery: incident and procedural risk analysis do not support current clinical ophthalmology guidelines. *Ophthalmology*. 2015;122(2):281-287. doi:10.1016/j.ophtha.2014.08.030

28. Kent-Smith BT, Wallace GM. Routine cataract surgery without the presence of an anaesthetist. *Clin Exp Ophthalmol*. 2007;35(6):589. doi:10.1111/j.1442-9071.2007.01553.x

29. Murray P, Adams K, Haddad P, Murray N, O'Rourke M. The routine requirement for anaesthetists in local anaesthetic cataract surgery. *Clin Exp Ophthalmol*. 2007;35(2):195-196. doi:10.1111/j.1442-9071.2006.01441.x

30. Anthem. CG-MED-60 monitored anesthesia care and general anesthesia for cataract surgery. Accessed March 16, 2019. <https://www.asahq.org/-/media/sites/asahq/files/public/advocacy/alerts/washington%20alerts/2018-02-28-cg-med-60-monitored-anesthesia-care-and-general-anesthesia-for-ataract-surgery.pdf?la=en>

31. American Academy of Ophthalmology. Pressure on Anthem grows—Academy keeps pushing for cataract-surgery anesthesia coverage. Accessed February 22, 2019. <https://www.aao.org/eye-on-advocacy-article/pressure-anthem-cover-ataract-surgery-anesthesia>

32. California Medical Association. CMA calls for investigation into Anthem restricting use of sedation during cataract surgery. Accessed February 20, 2019. <https://www.cmadocs.org/newsroom/news/view/ArticleID/21466/t/CMA-calls-for-investigation-into-Anthem-policy-restricting-use-of-sedation-during-ataract-surgery>

33. American Society of Anesthesiologists. ASA calls on Anthem to rescind its new policy on anesthesia for cataract surgery. Accessed February 19, 2019. <https://www.asahq.org/advocacy-and-asapac/fda-and-washington-alerts/washington-alerts/2018/02/asa-calls-on-anthem-to-rescind-its-new-policy-on-anesthesia-for-ataract-surgery?&ct=fd2b35b6cdb74e0b126f4539b73b56360091233e85002bc197d8049fa56b7a4253b022b37557ad25186cfc15475fa96cd09811e97c66fe62b04a1ec1298f82ef>