American Society of Anesthesiologists classification in cataract surgery: Results from the Ophthalmic Surgery Outcomes Data Project

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PURPOSE: To explore the association of American Society of Anesthesiologists (ASA) classification with cataract surgery outcomes.

SETTING: Five Veterans Affairs Medical Centers, United States.

DESIGN: Retrospective observational cohort study.

METHODS: The study analyzed the outcomes of cataract surgery cases. Corrected distance visual acuity (CDVA), unanticipated events, and vision-related quality of life (VRQL) were assessed using the National Eye Institute Visual Function Questionnaire (NEI-VFQ), comparing ASA classes I through IV. For some analyses, ASA classes I and II were designated as Group A and ASA classes III and IV were designated Group B.

RESULTS: Of the 4923 cases, 875 (17.8%) were in Group A, 4032 (81.9%) were in Group B, and 16 (0.3%) had missing data. The mean CDVA and mean composite NEI-VFQ score improved after cataract surgery in both groups ($P < .0001$); however, Group A had a better mean postoperative CDVA and postoperative VFQ composite scores than Group B ($P < .0001$, both outcomes). A higher ASA class was associated with an increased risk for 2 unanticipated events; that is, clinically significant macular edema (CSME) (Group A: 4 [0.47%] versus Group B: 50 [1.28%]; adjusted odds ratio [OR], 3.02; 95% confidence interval [CI], 1.02-13.05; $P = 0.04$) and readmission to the hospital within 30 days (2 [0.23%] versus 56 [1.41%]; OR, 8.26; 95% CI, 1.71-148.62; $P = .004$)

CONCLUSIONS: Among United States veterans, the ASA classification could be an important predictor of VRQL and visual outcomes. In this cohort, it was associated with an increased risk for 2 serious unanticipated events—CSME and readmission to the hospital—both costly, unwanted outcomes.

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The American Society of Anesthesiologists' (ASA) Physical Status classification was developed more than 60 years ago as a system to collect statistical data regarding anesthesia.[1] It evaluates the overall physical status of the patient before surgery and consists of 6 categories in its current form.[2,A]

The system has been validated[3] and is a significant predictor of postoperative outcomes in general and in vascular surgery.[4] A high ASA status is a risk factor for major medical complications in neurosurgery[5] and a predictor of postoperative mortality and morbidity after major noncardiac[6] and cardiac operations.[7] It has also been associated with increased surgical intensive care unit outcomes, such as length of stay, mechanical ventilation, vasopressor treatment duration, and the number of acquired organ dysfunctions.[8]

The ASA system evaluates a patient's physical status with regard to systemic diseases. Systemic conditions

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such as hypertension, diabetes mellitus, and respiratory disease have been associated with poor cataract outcomes in the very elderly.[9] The ASA class has been shown to be associated with unplanned admissions in outpatient ophthalmic surgery[10] and with mortality and morbidity among patients having ophthalmic surgery under local or general anesthesia.[11]

Although large studies have evaluated the cost burden and effectiveness of preoperative testing for cataract surgery,[12–14] they did not examine the visual outcomes of cataract surgery. We are unaware of previous studies of the association of ASA class with vision-related quality of life (VRQL) and found no reference to it in databases such as PubMed or Web of Science. Without examining ophthalmic outcomes of cataract surgery, it is not possible to fully analyze the value of the preoperative workup. In the current evidence-based literature, the association between ASA classification and visual outcomes, unanticipated events (complications), and VRQL after cataract surgery is not clear. If this association is defined, it might be possible to better anticipate cataract surgical risks and visual outcome expectations for patients presenting with systemic diseases. It might also provide an opportunity for improved informed consent processes and decision making and better optimization of patients with comorbidities before elective surgery, and it could potentially decrease the risk for poor surgical outcomes.

Since 1994, the Veterans Health Administration has used the Veterans Affairs Surgical Quality Improvement Program (previously the National Surgical Quality Improvement Program) to monitor outcomes of major surgeries, although the program did not initially include eye surgery. A similar program for ophthalmology, the Ophthalmic Surgery Outcomes Database Pilot Project, which included 4923 eyes of 3809 patients having cataract surgery, was performed from 2009 to 2012 at 5 Veterans Affairs medical centers across the United States.[15]

Through a retrospective analysis of the Ophthalmic Surgical Outcome Database (OSOD) data from the 5 Veterans Affairs medical centers, we studied the association of ASA class with visual outcomes of cataract surgery, unanticipated perioperative events, and VRQL measured using the National Eye Institute Visual Function Questionnaire (NEI-VFQ).

PATIENTS AND METHODS

The original OSOD pilot project was a quality-improvement program designed to assess and enhance the quality of cataract surgery in the Department of Veterans Affairs. The OSOD committee determined a set of data elements pertinent to cataract surgery that were culled from preoperative, intraoperative, and postoperative medical records of patients having surgery for cataract at 5 different sites of the Department of Veterans Affairs. After the quality-assurance program was completed, the Veterans Affairs Administration's National Surgery Office compiled the collected data in a deidentified database. With approval from the Veterans Affairs Boston Healthcare System Institutional Review Board and a data use agreement, this study retrospectively reviewed this deidentified database.[16,17]

Outcomes evaluated included postoperative corrected distance visual acuity (CDVA), VRQL measured using the NEI-VFQ, and unanticipated perioperative events and complications (Appendix A).

The OSOD project used the NEI-VFQ to compare the patient's responses preoperatively and postoperatively (within 30 to 90 days of the procedure). The 26-item NEI-VFQ used in this database is a shorter and modified version of the 25-item NEI-VFQ (developed at RAND Health under the sponsorship of the NEI) and has been tested for validity and reliability.[18] The preoperative and postoperative VFQ subscales of general vision, ocular pain, near activities, distance activities, vision-specific subscales of social functioning, mental health, role difficulties and dependency, driving, color vision, peripheral vision, and composite score were evaluated.

The ASA classes I through IV are relevant to ophthalmic surgery; thus, only these were included in the database. Case records that included ASA status were used for all analyses. The quality-of-life analysis was limited to those who had also filled out preoperative NEI-VFQs and postoperative NEI-VFQs.

Statistical Analysis

Data were analyzed using Excel software (version 14.0, 2010, Microsoft Corp.) and JMP Pro software (version 11.0,

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SAS Institute). Outcomes analyzed included CDVA, unanticipated perioperative events, and VFQ scores. Descriptive statistics used mean, percentages, and standard deviations. The logMAR scale was used for visual acuity values before computation. To test statistically significant differences ($\alpha = 0.05$), the Fisher exact test (categorical variables), Wilcoxon signed-rank test and Kruskal-Wallis tests (rank-sums) (continuous variables), Exact Cochran Armitage test (trend), and logistic regression for adjusted odds ratios (OR) with likelihood test were used. Missing values were excluded from statistical analysis; P values less than 0.05 were considered statistically significant.

RESULTS

Demographics

Of 4923 records in the database, the ASA class status was missing in 16. Table 1 shows the number of cases, their demographic characteristics, and the systemic comorbidity distribution across ASA classes. There was a preponderance of men ($P = .0004$), and the mean age was greater as the ASA class increased ($P < .001$). The percentage of obese (body mass index [BMI] ≥ 30) patients was 4 (28.6%), 283 (33.4%), 1542 (42.6%), and 154 (48.3%) in ASA classes I, II, III, and IV, respectively. Of all patients in the obese category (1983), most (1542, 77.8%) were in ASA class III. As ASA class increased, so did the proportion of those with diabetes mellitus, hypertension, peripheral vascular disease, chronic obstructive pulmonary disease (COPD), and congestive heart failure. The only comorbidity not significantly different between the 4 groups was a history of hearing impairment.

Regardless of whether the demographic and systemic disease distributions were analyzed across 4 ASA classes separately or as 2 groups—Group A (ASA class I and class II) and Group B (ASA class III and class IV)—the significant difference held constant with the exception of the mean preoperative CDVA.

In both Groups A and B, topical anesthesia was the most frequently used type of anesthesia. Less commonly, sub-Tenon, peribulbar, and general anesthesia were also used, with a significant difference in frequency between groups. General anesthesia ($P < .001$) and peribulbar anesthesia ($P = .003$) were used significantly more often in Group B than in Group A (Table 1).

Visual Outcomes

There was significant improvement in CDVA after cataract surgery over preoperative levels in each of the 4 classes ($P < .001$) (Table 2). In both groups (A and B), there was significant improvement in CDVA from preoperative levels ($P < .001$). The mean

Table 1A. Demographic characteristics, comorbidities, and type of anesthesia used in cases in 4 ASA classes in 2 groups.

Parameter	Group A ASA Classes I, 11 (n = 875)	Group B ASA Classes III, IV (n = 4032)	P Value
Mean age (y) ± SD	66.33 ± 9.55	71.48 ± 9.47	<.001†
Male/female sex (n)	830/45	3921/108	.0004‡
Mean BMI (kg/m^2) ± SD	27.97 ± 5.41	29.4 ± 6.28	<.001†
Mean preoperative CDVA	0.54 ± 0.49	0.51 ± 0.42	.91†
Systemic comorbidities,* n/total (%)			
Diabetes	248/872 (28.4)	1803/4019 (44.9)	<.001‡
Hypertension	540/869 (62.1)	3346/4023 (83.2)	<.001‡
PVD	138/874 (15.8)	2062/4022 (51.3)	<.001‡
COPD	113/874 (12.9)	1120/4026 (27.8)	<.001‡
Congestive heart failure	16/874 (1.8)	451/4025 (11.2)	<.001‡
Dementia/cognitive impairment	11/871 (1.3)	143/4024 (3.6)	.0002‡
Anxiety	96/874 (11.0)	655/4026 (16.3)	<.001‡
Hard of hearing	155/874 (17.7)	826/4022 (20.5)	.06‡
Chemotherapy	6/872 (0.7)	71/4015 (1.8)	.02‡
Type of anesthesia, n/total (%)			
General	2/870 (0.2)	95/4015 (2.4)	<.001‡
Peribulbar	47/870 (5.4)	332/4015 (8.3)	.003‡
Retrobulbar	175/870 (20.1)	834/4015 (20.8)	.58‡
Sub-Tenon	296/870 (34.0)	729/4015 (18.2)	<.001‡
Topical only	350/870 (40.2)	2025/4015 (50.4)	<.001‡

ASA = American Society of Anesthesiologists; BMI = body mass index; CDVA = corrected distance visual acuity; COPD = chronic obstructive pulmonary disease; PVD = peripheral vascular disease
*See Table 1B for definitions of comorbidities.
†Wilcoxon/Kruskal-Wallis (rank-sums) test; missing data excluded
‡Fisher exact test

Table 1B. Definitions of comorbidities in Table 1A.

Comorbidity	Definition
Hypertension	History of a persistent elevation of systolic blood pressure >140 mm Hg and diastolic blood pressure >90 mm Hg requiring an antihypertensive treatment (eg, diuretics, β-blockers, angiotensin-converting-enzyme inhibitors, or calcium channel blockers).
PVD	This variable is positive if the patient had a history of cerebral, coronary, or PVD or a diagnosis of atrial fibrillation, stent placement, etc.
COPD	This variable is positive if the patient had (1) COPD, (2) asthma, (3) dyspnea at rest, or (4) sleep apnea.
Congestive heart failure	This variable is positive if evidence of history of congestive heart failure was present in the medical record.
Dementia	This variable is positive with any diagnosis of dementia or cognitive impairment.
Anxiety	This variable is positive if there is a notation of anxiety disorder, claustrophobia, or posttraumatic stress disorder in the preop history and physical exam or if there was an inability to lie flat and still under a drape during surgery in the alternate eye because of anxiety.
Hard of hearing	A history of significant hearing impairment is defined as difficulty understanding normal conversation without an increase in volume or an assisted-hearing device. This variable is positive if difficulty hearing is noted during the exam or hearing impairment is noted in the audiology note.
Chemotherapy	This variable is positive if the patient was currently taking, or had taken within past 30 days, an immunosuppression agent.

COPD = chronic obstructive pulmonary disease; PVD = peripheral vascular disease

postoperative CDVA (logMAR ± SD) was better in Group A than in Group B (0.06 ± 0.22 versus 0.09 ± 0.24; $P < .001$). Most patients achieved a postoperative CDVA of 20/40 or better. Seven hundred forty-nine Group A cases (94.6%) and 3334 Group B cases (93.4%) achieved a final postoperative CDVA of 20/40 or better ($P = .23$). As ASA class increased, the proportion of those achieving a CDVA of 20/40 or better decreased, and this linear trend was statistically significant ($P = .0017$).

Unanticipated Perioperative Events

The following unanticipated events occurred more frequently in Group B than in Group A (Table 3): intraoperative floppy-iris syndrome ($P = .003$), iris prolapse ($P = .02$), corneal stromal edema ($P = .02$), clinically significant macular edema (CSME) ($P = .048$), and postoperative hospital admission within 30 days ($P = .002$).

Table 2. Visual outcomes in 4 ASA classes.

	Mean CDVA (LogMAR) ± SD			Number (%)
ASA Class	Preop	Postop	*P* Value*	Postop CDVA 20/40 or Better
I	0.56 ± 0.48	0.02 ± 0.12	.001	12 (100.0)
II	0.54 ± 0.49	0.06 ± 0.22	<.001	737 (94.5)
III	0.51 ± 0.42	0.08 ± 0.23	<.001	3083 (93.8)
IV	0.57 ± 0.45	0.14 ± 0.32	<.001	251 (87.8)

ASA = American Society of Anesthesiologists; CDVA = corrected distance visual acuity
*Preoperative versus postoperative; Wilcoxon signed-rank test

To evaluate this association further, logistic regression was performed to adjust for all demographic characteristics in Table 1A. A higher ASA class (Group B, ASA class III and class IV) increased the risk for CSME and readmission to the hospital within 30 days of surgery (Table 4).

There were 8 deaths within 30 days of phacoemulsification. All deaths occurred in patients of higher ASA classes (Group B). There were no significant differences in age, sex, BMI, history of diabetes, hypertension, congestive heart failure, type of anesthesia, drug use, alcohol use, smoking, or ASA classification between the patients who died and the rest of the cohort. However, patients with a history of COPD were at significantly higher risk of all-cause death after cataract surgery ($P = .0419$). Of all patients who died, 5 (62.5%) had COPD and 3 (37.5%) did not have COPD.

Of those who used anticoagulants, the highest proportion of cases stopping anticoagulant use preoperatively was those having retrobulbar anesthesia (Table 5).

The OSOD reports whether a patient was taking anticoagulant drugs. It does not specify which anticoagulant (eg, aspirin, clopidogrel, warfarin) was being used. Because postoperative cardiovascular events, retrobulbar hemorrhage, and hyphema were not reported as specific data points, their occurrence could not be compared among the different anesthesia types.

Vision-Related Quality of Life

Of the 4923 cases, 3141 completed both the presurgical NEI-VF and postsurgical NEI-VF questionnaires. Of those, 622 cases (19.8%) were in ASA classes I and II

Table 3. Unanticipated perioperative events classified into 2 ASA groups.

Event	Number (%)		*P* Value*
	Group A (ASA Classes I and II)	Group B (ASA Classes III and IV)	
Corneal wound burn	2 (0.2)	4 (0.1)	.29
Corneal trauma	7 (0.8)	19 (0.5)	.21
Intraoperative floppy-iris syndrome	28 (3.2)	224 (5.6)	.003
Iris prolapse	10 (1.1)	99 (2.5)	.02
Iris trauma	6 (0.7)	46 (1.1)	.28
Zonular dehiscence with vitrectomy	3 (0.3)	23 (0.6)	.61
Zonular dehiscence without vitrectomy	6 (0.7)	39 (1.0)	.56
Anterior capsule tear	29 (3.3)	129 (3.2)	.83
Posterior capsule tear with vitrectomy	18 (2.1)	128 (3.2)	.09
Posterior capsule tear without vitrectomy	8 (0.9)	45 (1.1)	.72
Choroidal effusion	0	1 (0.02)	.99
Choroidal hemorrhage	0	1 (0.02)	.99
Conversion to large-incision surgery	5 (0.6)	19 (0.5)	.60
Corneal stromal edema	33 (3.9)	232 (6.0)	.02
Inflammation at 1 month	124 (14.7)	576 (14.9)	.91
30-day refraction < or > 0.75 D of target refraction	116 (14.3)	559 (15.4)	.48
CME	21 (2.5)	90 (2.3)	.80
CSME	4 (0.5)	50 (1.3)	.048
Retained lens material with repeat surgery within 30 days	2 (0.2)	29 (0.7)	.10
Retained lens material without repeat surgery within 30 days	12 (1.4)	69 (1.8)	.56
IOP <5 mm Hg for more than 1 week	2 (0.2)	6 (0.1)	.64
IOP >25 mm Hg for more than 1 week	18 (2.1)	55 (1.4)	.13
Retinal detachment	3 (0.3)	8 (0.2)	.43
Infectious endophthalmitis	2 (0.2)	4 (0.1)	.29
Sterile endophthalmitis	0	1 (0.03)	.99
Further surgery in operative eye within 30 days	10 (1.2)	84 (2.1)	.07
Wrong-side surgery	—	—	—
Wrong IOL	—	—	—
Hospital admission postoperatively	2 (0.2)	56 (1.4)	.002
Death within 30 days	0	8 (0.2)	.36

CME = cystoid macular edema; CSME = clinically significant macular edema (any thickening of the macular area present postoperatively); IOL = intraocular lens; IOP = intraocular pressure (missing data excluded)
*Group A versus Group B; Fisher exact test

(Group A) and 2519 cases (80.2%) were in ASA classes III and IV (Group B). Analysis of the overall VFQ composite score showed that cataract surgery led to a significant increase in visual function in both groups ($P < .001$). The mean postoperative composite score in Group B patients was significantly lower than that in Group A patients ($P < .001$). The VFQ scores were significantly higher in Group A in all subscales except ocular pain, driving during daytime in familiar places and at night, and peripheral vision (Table 6). The use of parametric tests rather than nonparametric tests yielded results similar to those reported above. The only change was in the *P* value for Driving Plus VFQ score. Using nonparametric tests, the *P* value was 0.047. Using parametric tests, the *P* value was 0.13.

When analyzing eyes with a preoperative CDVA 20/40 or better, those in Group A had significantly better composite scores on the postoperative NEI-VFQ than eyes in Group B (88.41 ± 12.71 versus 85.81 ± 14.64; $P < .001$). In cases in which the preoperative CDVA was worse than 20/40, patients in Group A still had significantly better postoperative NEI-VFQ composite scores than those in Group B (84.63 ± 18.11 versus 82.78 ± 17.52; $P < .001$).

DISCUSSION

We set out to determine whether the ASA physical status system is associated with unanticipated perioperative events, visual outcomes, and VRQL in veterans having cataract surgery. We found that ASA class was associated with the unanticipated events of CSME and hospital admission within 30 days of the procedure. As ASA class increased, the proportion of

Table 4. Association of ASA class with perioperative events adjusted odds ratio with 95% CI (adjusted for age, sex, BMI, mean preoperative visual acuity, diabetes, hypertension, PVD, COPD, congestive heart failure, dementia/cognitive impairment, anxiety, hard of hearing, chemotherapy, type of anesthesia).

Event	Adjusted OR	95% CI	*P* Value* (OR)
Intraoperative floppy-iris syndrome	1.28	0.83, 2.02	.27
Iris prolapse	1.25	0.64, 2.67	.52
Corneal stromal edema	1.32	0.89, 2.03	.17
CSME	3.02	1.02, 13.05	.04
Hospital admission postoperatively	8.26	1.71, 148.62	.004

CI = confidence interval; CSME = clinically significant macular edema; OR = odds ratio
*Tests and CIs on odds ratios are likelihood ratio based.

Table 5. Cataract surgery patients taking anticoagulants and whether they discontinued them.

Anesthesia/Anticoagulant Use (n = 3360)	Number (%)
General	
Taking anticoagulants	51 (1.5)
Discontinued all	10 (19.6)
Continued all	37 (72.5)
Missing	4 (7.8)
Peribulbar	
Taking anticoagulants	246 (7.3)
Discontinued all	8 (3.3)
Continued all	205 (83.3)
Missing	33 (13.4)
Retrobulbar	
Taking anticoagulants	635 (18.9)
Discontinued all	297 (46.8)
Continued all	285 (44.9)
Missing	53 (8.3)
Sub-Tenon	
Taking anticoagulants	740 (22.0)
Discontinued all	4 (0.5)
Continued all	711 (96.1)
Missing	25 (3.4)
Topical only	
Taking anticoagulants	1677 (49.9)
Discontinued all	236 (14.1)
Continued all	1313 (78.3)
Missing	128 (7.6)
Missing	
Taking anticoagulants	11 (0.3)
Discontinued all	1 (9.1)
Continued all	9 (81.8)
Missing	1 (9.1)

those achieving a CDVA of 20/40 or better decreased, and this trend was statistically significant ($P = .0017$). Patients in high ASA classes (those with severe systemic disease that might be a constant threat to life) had significantly lower visual function scores than those who had a mild systemic disease or were healthy preoperatively.

Although Schein et al.[12] reported that routine medical testing before cataract surgery did not appreciably increase the safety of surgery, their study did not evaluate visual outcomes of cataract surgery and the follow-up time was only 7 days, not the 30-day postoperative period during which events are considered related to the surgery by most mortality and morbidity standards. It is important to note that all patients in that study had a preoperative medical examination by their healthcare provider and completed a standardized medical history questionnaire. As for special testing (laboratory and/or electrocardiogram [EKG]), patients were assigned to a routine-testing group or a no-testing group. If a patient originally assigned to the no-testing group was found to require testing during the preoperative history and physical examination or on review of the medical history questionnaire, that patient was reassigned to the testing group. Therefore, any patient found to require testing (laboratory and/or EKG) through the history and physical examination or health survey received that testing. A recent Cochrane review[13] noted that "despite the rare occurrence, adverse medical events precipitated by cataract surgery remain a concern because of the large number of elderly patients with multiple medical comorbidities who have cataract surgery in various settings."

The breakdown of patients by ASA class in our study showed a less healthy population than that described by Schein et al.[12] (Table 7). In addition to the longer follow-up (30 days versus 7 days), our study assessed vision-related outcomes and eye-related complications and thus offers an opportunity to assess the relationship of preoperative evaluation and ASA class with the outcomes of cataract surgery in the U.S. veteran population.

Cavallini et al.[19] compared the incidence of ophthalmologic and systemic complications in 1276 cataract surgery patients randomized equally into 2 groups: those who did not have preoperative testing and those who had preoperative testing. They found no statistically significant differences in either outcome between the 2 groups. Although the Cavallini et al. study used randomization, the similarity between the 2 groups was assumed without a comparison of preoperative baseline characteristics being reported. They also excluded less healthy patients who had ongoing treatment with anticoagulants (3360 [68.4%] cases in the OSOD database were taking anticoagulant medication[s]) and subcutaneous insulin therapy (2056 [41.9%] cases in the OSOD database were on oral hypoglycemic therapy or insulin), thus potentially removing

Table 6. National Eye Institute Visual Function Questionnaire scores by ASA class.

NEI-VFQ 25 Subscale	Group A (ASA I, II) Preoperative Mean ± SD	Group A (ASA I, II) Postoperative Mean ± SD	Group A (ASA I, II) *P* Value*	Group B (ASA III, IV) Preoperative Mean ± SD	Group B (ASA III, IV) Postoperative Mean ± SD	Group B (ASA III, IV) *P* Value*	*P* Value† A Vs B Preop	*P* Value† A Vs B Postop
General vision	50.57 ± 19.10	81.42 ± 17.32	<.001	51.27 ± 19.10	77.87 ± 17.87	<.001	.35	<.001
Ocular pain	76.02 ± 23.00	85.27 ± 18.74	<.001	74.86 ± 23.30	84.18 ± 18.94	<.001	.20	.10
Near activities	53.59 ± 23.76	81.26 ± 21.65	<.001	53.83 ± 24.50	78.61 ± 23.35	<.001	.72	.009
Distance activities	59.00 ± 25.12	86.75 ± 20.16	<.001	58.38 ± 25.88	83.93 ± 21.19	<.001	.61	.001
Vision specific								
Social functioning	75.06 ± 25.04	93.20 ± 16.41	<.001	74.96 ± 25.51	91.77 ± 17.13	<.001	.80	.005
Mental health	52.82 ± 27.98	81.13 ± 23.10	<.001	53.35 ± 27.90	77.83 ± 24.95	<.001	.72	.001
Role difficulties	56.17 ± 29.28	82.91 ± 25.77	<.001	54.42 ± 29.37	79.06 ± 27.52	<.001	.14	.0002
Dependency	70.76 ± 30.15	89.34 ± 22.22	<.001	68.72 ± 30.43	86.57 ± 23.76	<.001	.08	.001
Driving‡	63.45 ± 24.64	87.05 ± 19.01	<.001	63.70 ± 24.99	85.74 ± 19.06	<.001	.69	.06
Driving plus§	61.27 ± 24.36	86.07 ± 19.65	<.001	62.16 ± 24.58	84.71 ± 19.65	<.001	.39	.047
Color vision	81.13 ± 25.02	94.03 ± 15.90	<.001	79.30 ± 26.32	92.82 ± 16.86	<.001	.11	.02
Peripheral vision	66.17 ± 27.69	88.62 ± 19.86	<.001	66.53 ± 27.17	86.95 ± 21.20	<.001	.79	.06
Composite score	63.58 ± 19.86	85.99 ± 16.43	<.001	63.22 ± 19.80	83.70 ± 16.85	<.001	.56	<.001

ASA = American Society of Anesthesiologists; NEI-VFQ = National Eye Institute Visual Function Questionnaire
*Wilcoxon signed-rank test
†Wilcoxon rank-sums test for postoperative mean scores
‡Driving includes VFQ Driving subscale average of scores on 2 questions. Question 15: How much difficulty do you have driving during the daytime in familiar places? Question 16: How much difficulty do you have driving at night?
§Driving plus includes VFQ Driving subscale average with added item; ie, average of question 15, question 16, and question 17: How much difficulty do you have driving in difficult conditions, such as in bad weather, during rush hour, on the freeway, or in city traffic?

from analysis those who might be at risk for readmission or for other adverse events related to cardiovascular, circulatory dysfunction, and diabetes-related ocular and systemic complications. Cavallini et al.[19] did not report ASA classes; however, considering that they eliminated patients described above, it is fair to say that their population was healthier at baseline than that in the OSOD. The same can be said for the Schein et al.[12] study in which the majority of patients (64.3%) were ASA class I and class II versus the OSOD in which the majority of patients (81.9%) were in ASA class III and class IV. Despite their analysis of a presumably healthier group of patients, Cavallini et al.[19] note that "in absolute terms the risk of intra- or postoperative ocular adverse events was higher in the group without preoperative tests" compared with those who had preoperative tests. From their results, it seems that patients who did not have preoperative testing had a 30% increase in risk for an intraoperative ophthalmic complication and a 20% increase in risk for postoperative ophthalmic complications than those who did have preoperative testing. Thus, the findings in the study would seem to support selective testing after a routine preoperative examination, even in a relatively healthy population of patients.

In a recent study using Medicare data of 440 857 patients, Chen et al.[14] analyzed the prevalence and costs of preoperative medical testing, comparing data in the month before cataract surgery with the preceding 11 months. They found that preoperative testing before cataract surgery occurred frequently, driven primarily by the ophthalmologist performing the surgery and the occurrence of a preoperative office visit. However, their cost-analysis study did not consider perioperative or postoperative outcomes, systemic or ophthalmic. Therefore, its utility must be viewed with caution.

Two unwanted outcomes (readmission postoperatively and CSME) had a significant association with

Table 7. Distribution of cases across ASA class comparing the current study with the study by Schein et al.[12]

Study	Number (%) ASA Class I	ASA Class II	ASA Class III	ASA Class IV	Missing/Unknown
Schein et al. (n = 19 250)	1795 (9.3)	10 598 (55.0)	6692 (34.8)	133 (0.7)	32 (0.2)
Current (n = 4923)	14 (0.3)	861 (17.5)	3708 (75.3)	324 (6.6)	16 (0.3)

ASA = American Society of Anesthesiologists

ASA class in our study. There is 1 report available for comparison of readmission after cataract surgery.[10] In their 25-patient case-control study, Freeman et al.[10] found that age, present or previous medical conditions, blood pressure, and ASA class (among other factors) were not associated with unplanned admission after planned outpatient surgery, whereas the duration of surgery, fentanyl dose, and use of enflurane were associated. The small number in that study limits its power. Our results, with a much larger database, found that ASA class, as well as history of congestive heart failure and chronic alcohol use, were associated with postoperative hospital admission. We did not find an association of age, hypertension, type of anesthesia, or duration of surgery with hospital admission within 30 days. These differences could be because of the large difference in sample sizes in the 2 studies and that ASA class IV patients were excluded in the Freeman et al. study.

Clinically significant macular edema can be a complication of diabetes. In our study, the proportion of patients with a history of diabetes in the 4 ASA classes was as follows: 0 (0.0%) in class I, 248 (28.9%) in class II, 1637 (44.3%) in class III, and 166 (51.2%) in class IV. This increasing proportion of diabetes was statistically significant ($P < .0001$, Cochran-Armitage test for trend). When comparing Group A (ASA class I and class II) AND Group B (ASA class III and class IV), diabetes was more common in higher ASA classes (248 [28.4%] versus 1803 [44.9%]; $P < .0001$). This helps explain the greater prevalence of CSME in higher ASA classes (4 [0.5%] versus 50 [1.3%]; $P = .048$). A recent study[20] identified total serum cholesterol and hemoglobin A1c (HbA1c) as the 2 most important risk factors associated with CSME in patients with nonproliferative diabetic retinopathy. In the OSOD project, cholesterol was not measured. The HbA1c was tested, and the levels were significantly higher in Group B patients than in Group A patients (7.37 ± 1.57 versus 7.21 ± 1.65; $P = .04$).

The overall mortality in our total study population of 4854 cataract surgery patients (69 records of the total 4923 had mortality status missing, 8 deaths) was 1.65 per 1000 patients. All 8 deaths were in higher ASA classes (III or IV). This is in the range reported in previous studies of mortality rates in ophthalmic and/or cataract surgery (0.92 per 1000 to 7.1 per 1000).[11,21–23]

In our study, we found a significant association between a history of COPD and 30-day postoperative mortality in cataract surgery patients. Although in studies by Badrinath et al.[11] and Petruscak et al.,[22] most patients who died after cataract surgery had cardiovascular conditions; chronic pulmonary disease was identified as a significant predictor of 90-day mortality (OR, 1.69; 95% CI, 1.34-2.14) in the study by Greenberg et al.[21] Patients, anesthetists, and ophthalmic surgeons should consider this additional factor when weighing the risks and benefits of elective cataract surgery in patients with COPD. Perhaps consultation with medical and pulmonary physicians, more rigorous optimization before surgery, and closer follow-up could help minimize this significant risk.

The CDVA improved significantly after cataract surgery in all ASA classes in our study. The proportion of those with a postoperative CDVA of 20/40 or better decreased with increasing ASA class in a statistically significant trend. Our findings suggest that with respect to improvement in visual outcomes, cataract surgery should be considered beneficial in all these groups, although the CDVA outcome was worse in patients in higher ASA classes. This information should be a part of the informed consent process.

We found that ASA class was associated with postoperative VRQL outcomes. As might be expected in an elderly population with systemic diseases, the postoperative quality-of-life scores in those in higher ASA classes were lower than those of patients in lower ASA classes. However, an improvement in VFQ composite scores from preoperative to postoperative was seen in all ASA classes. In the subscales of ocular pain, driving during daytime in familiar places and at night, driving in difficult conditions (bad weather, during rush hour, on the freeway, or in city traffic), and peripheral vision, the postoperative VFQ scores were not statistically different between the 2 groups, suggesting that patients in higher ASA classes can achieve outcomes similar to those in lower ASA classes in these domains. This is encouraging because these activities cover a wide range of activities and experiences of elderly patients. However, patients in Group B had lower scores than those in Group A for color vision, near activities, distance activities, vision-specific outcomes, and VFQ outcomes (social functioning, mental health, role difficulties, dependency). This could be because of poorer visual acuity outcomes in Group B patients. This is important to recognize and discuss with patients preoperatively to ensure expectations are clear. The ASA class appears to be an important factor in setting these expectations.

Our study has shortcomings, including the inherent limitations of retrospective reviews of deidentified data sets. The demographics of our study population in the Veterans Affairs system might not be reflected in the general population and appears to be quite different from patient demographics outside Veterans Affairs available in the current body of literature. Veterans Affairs has a higher percentage of ASA class III and class IV patients having cataract surgery[12] (Table 7). The cohort of veterans in our study comprised primarily men and included cases from

Veterans Affairs centers in Massachusetts, Pennsylvania, Missouri, Tennessee, and Texas. Although the geographic distribution was wide, the generalizability of our results might be limited. The postoperative events were assessed 30 days after the principal procedure. It is possible that the complication rates could be different with a longer postoperative follow-up.

In conclusion, we found ASA classification to be useful in estimating the likelihood of better visual outcomes, perioperative events, and VRQL in veterans having cataract surgery. Patients in all ASA classes had better visual outcomes after cataract surgery. Despite similar preoperative visual acuity levels across all ASA classes, patients in ASA class I and class II had better postoperative visual acuity and quality-of-life scores than those in class III and class IV. The complications of CSME and readmission within 30 days of cataract surgery were associated with ASA class. A history of COPD appeared to be associated with an increased risk for death after cataract surgery, a finding that warrants cautious and timely management before and after cataract surgery.

Considering the relationship of ASA class with visual acuity, quality of life, and specific unanticipated events, preoperative assessment of patients in the Veterans Affairs system is important in determining the level of risk, fully informing patients of those risks, setting reasonable expectations, and preparing appropriately for intraoperative and postoperative management.

WHAT WAS KNOWN

- Routine preoperative testing in cataract surgery occurs frequently, driven primarily by the ophthalmologist performing the surgery and the occurrence of a preoperative office visit.

WHAT THIS PAPER ADDS

- Veterans in ASA classes I, II, III, and IV benefited from cataract surgery. Those in higher ASA classes experienced poorer visual acuity and VRQL outcomes and higher rates of 2 costly and undesired unanticipated events: CSME and readmission within 30 days of surgery.
- Routine preoperative evaluation in the form of ASA classification for veterans scheduled for cataract surgery was valuable in determining the level of risk; adequately informing patients of those risks; setting postoperative outcome expectations; and preparing for preoperative, perioperative, and postoperative management.
- Patients with a history of COPD were at significantly higher risk for all-cause death within 30 days after cataract surgery.

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APPENDIX A
Unanticipated Intraoperative and Postoperative Events and Their Definitions

Intraoperative Unanticipated Events

- *Corneal wound burn.* This variable is positive if electrocautery was used for hemostasis or during closure of the conjunctiva at the conclusion of the case.
- *Corneal trauma.* This variable is positive if any untoward event results in corneal damage during the case.
- *Intraoperative floppy-iris syndrome.* This variable is positive if substantial changes in pupil size or substantial movement of the iris occurred during the removal of the cataractous lens.
- *Iris prolapse.* This variable is positive when a portion of the iris prolapsed through the corneal wound.
- *Iris trauma.* This variable is positive if there was any injury to the iris mentioned in the complications section of the operative note.
- *Zonular dehiscence with vitrectomy.* This variable is positive if there is mention of broken zonular fibers or displacement of the capsular bag in the complications section of the operative report and there was removal of vitreous from the anterior chamber of the eye using an automated mechanical vitrector.
- *Zonular dehiscence without vitrectomy.* This variable is positive if there is any mention of broken zonular fibers or displacement of the capsular bag in the complications section of the operative report and there was no removal of vitreous from the anterior chamber of the eye using an automated mechanical vitrector.
- *Anterior capsule tear.* This variable is positive if there is mention of any tear that extends beyond the normal area of the capsulorhexis that might impinge on the stability or viability of the capsular bag to receive the intraocular lens.
- *Posterior capsule tear with vitrectomy.* This variable is positive if there is any mention of a hole or tear in the posterior capsule in the complications section of the operative note and there was removal of vitreous from the anterior chamber of the eye using an automated mechanical vitrector.
- *Posterior capsule tear without vitrectomy.* This variable is positive if there is mention of a hole or tear in the posterior capsule in the complications section of the operative note and there was no removal of vitreous from the anterior chamber of the eye using an automated mechanical vitrector.
- *Choroidal effusion.* This variable is positive if the complications section of the operative report mentions that the choroid vessels became swollen and displaced the contents of the eye.
- *Choroidal hemorrhage.* This variable is positive if the complications section of the operative report

mentions that the choroid vessels became swollen and displaced the contents of the eye and there were broken blood vessels that could potentially lead to an expulsive hemorrhage.
- *Conversion to large-incision surgery.* This variable is positive if during the course of the cataract procedure, phacoemulsification becomes impossible. Often, original incisions have to be extended to provide access to the lens for safe removal by another technique.

Postoperative Unanticipated Events

- *Corneal stromal edema.* Indicates the presence of swelling of the corneal stroma.
- *Inflammation at 1 month.* This variable is positive if there is postoperative intraocular inflammation hallmarked by the presence of cell (white blood cells) and/or flare (smoky-appearing protein in the aqueous humor) in the anterior chamber.
- *30-day refraction <0.75 D or >0.75 D of target refraction.* This variable is positive if the 30-day spherical equivalent (autocalculated) is more than 0.75 D different in the target refraction in the operative eye.
- *Cystoid macular edema.* This variable is positive if swelling or thickening of the macula, the area of the retina responsible for central vision, in any form is present postoperatively.
- *Clinically significant macular edema.* This variable is positive if thickening of the macular area, the area of the retina responsible for central vision, is present postoperatively.
- *Retained lens material with repeat surgery within 30 days.* Indicates whether any fragments of lens material were retained in the operative eye postoperatively followed by eye surgery within 30 days.
- *Retained lens material without repeat surgery within 30 days.* Indicates whether any fragments of lens material were retained in the operative eye postoperatively not followed by eye surgery within 30 days.
- *Intraocular pressure <5 mm Hg for >1 week.* This variable is positive if the intraocular pressure in the operative eye is less than 5 mm Hg at any point beyond 1 week postoperatively.
- *Intraocular pressure >25 mm Hg for >1 week.* This variable is positive if the intraocular pressure in the operative eye is greater than 25 mm Hg at any point beyond 1 week postoperatively.
- *Retinal detachment.* This variable is positive if a separation of the retina from its attachments to the underlying tissue within the eye (all cause) is present in the operative eye within 30 days of the principal procedure.
- *Infectious endophthalmitis.* Indicates whether inflammation of the intraocular cavities (ie, the aqueous and/or vitreous humor) with presence of infection occurred in the operative eye postoperatively.
- *Sterile endophthalmitis.* Indicates whether inflammation of the intraocular cavities (ie, the aqueous and/or vitreous humor) with no infection detected occurred in the operative eye postoperatively.
- *Further surgery in operative eye within 30 days.* This variable is positive if further surgery (all cause) is necessary in the operative eye within 30 days of the principal procedure.
- *Wrong-side surgery.* This variable is positive if the eye listed in the surgery paperwork does not match the eye in which the surgery was performed.
- *Wrong intraocular lens.* This variable is positive if the wrong intraocular lens was used during the surgery. Generally, the intraocular lens has the incorrect dioptric power or has passed its expiration date.
- *Hospital admission postoperatively.* This variable is positive if the patient is admitted to a hospital (all cause, excluding lodging or 24-hour observation) within 30 days of the principal procedure.
- *Death within 30 days.* This variable is positive if the patient dies (all cause) within 30 days of the principal procedure.