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RESEARCH ARTICLE

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Comparing cataract surgery complication rates in veterans receiving VA and community care

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Abstract

Objectives: To compare 90-day postoperative complication rates between Veterans receiving cataract surgery in VA vs Community Care (CC) during the first year of implementation of the Veterans Choice Act.

Data Sources: Fiscal Year (FY) 2015 VA and CC outpatient data from VA's Corporate Data Warehouse (CDW) 10/01/14-9/30/15). FY14 data were used to obtain baseline clinical information prior to surgery.

Study Design: Retrospective one-year study using secondary data to compare 90-day complication rates following cataract surgery (measured using National Quality Forum (NQF) criteria) in VA vs CC. NQF defines major complications from a specified list of Current Procedural Terminology (CPT) codes. We ran a series of logistic regression models to predict 90-day complication rates, adjusting for Veterans' sociodemographic characteristics, comorbidities, preoperative ocular conditions, eye risk group, and type of cataract surgery (classified as routine vs complex).

Data Collection: We linked VA and CC users through patient identifiers obtained from the CDW files. Our sample included all enrolled Veterans who received outpatient cataract surgery either in the VA or through CC during FY15. Cataract surgeries were identified through CPT codes 66 984 (routine) and 66 982 (complex).

Principal Findings: Of the 83,879 cataract surgeries performed in FY15, 31 percent occurred through CC. Undergoing complex surgery and having a high-risk eye (based on preoperative ocular conditions) were the strongest clinical predictors of 90-day postoperative complications. Overall, we found low complication rates, ranging from 1.1 percent in low-risk eyes to 3.6 percent in high-risk eyes. After adjustment for important confounders (eg, race, rurality, and preoperative ocular conditions), there were no statistically significant differences in 90-day complication rates between Veterans receiving cataract surgery in VA vs CC.

Conclusions: As more Veterans seek care through CC, future studies should continue to monitor quality of care across the two care settings to help inform VA's "make vs buy decisions."

KEYWORDS
community health services, postoperative complications, quality of health care, safety, veterans

1 | INTRODUCTION

The Veterans Access, Choice and Accountability Act of 2014 ("Choice") was enacted in direct response to an "access crisis" involving long waitlists and delays in care.[1-3] Its primary intent was to ensure that Veterans have timely access to high-quality care through use of an expanded network of community providers paid for by the Veterans Health Administration (VA).[1,3] Choice allowed eligible Veterans who have to wait longer than 30 days for a specific health care service, live more than 40 miles from any VA clinic, or experience hardship in accessing VA care, the option to receive Community Care (CC). Its passage precipitated a major change in the way VA delivers care, transforming VA's primary role as a provider to that of both a provider and purchaser of care.

Since implementation of Choice in 2014, utilization of CC has increased rapidly over time. Currently, over 30 percent of Veteran care is delivered through the community.[4] The VA Maintaining Internal Systems and Strengthening Integrated Outside Networks (MISSION) Act of 2018 (S.2372) further expanded the circumstances under which Veterans can obtain CC (eg, providing access to CC if the VA identifies a medical service line that does not meet its standards for quality).[5-7] Thus, with broader eligibility criteria to receive CC, it is likely that Veterans will continue to increase their use of VA-purchased care.

Despite VA's strong commitment to provide Veterans with greater choice in accessing health care services,[8,9] less attention has focused on the quality of care that Veterans receive through VA-purchased care. To increase our understanding of the quality of care provided in VA vs CC, we selected cataract surgery as a prototype to examine for several reasons. First, it is one of the most common procedures performed in the United States (over 3 million cases annually)[10-12] and in VA (over 600 000 annually), particularly among those aged 65 and older.[13] Of the 9 million Veterans currently enrolled in VA, more than 5 million are ≥65 years of age, 17 percent of whom will likely develop cataracts by 2020.[14] Second, although VA has a comprehensive, nationwide ophthalmology program, with ophthalmology surgical training programs at 89 VA facilities and academic affiliations with over 80 percent of US ophthalmology residency training programs,[15] timely access to eye care services has become challenging due to increased demand as the population ages. Thus, it is likely that Veterans, particularly those residing further from VA ophthalmology services or in areas where increased demand exceeds the allocation of resources, will increase their use of CC in order to obtain cataract surgery in a timely manner.

Third, cataract surgery has well-defined outpatient postoperative complications that can be easily obtained using administrative data, thereby making comparisons across health care settings feasible. Fourth, although cataract surgery is considered relatively safe and effective,[11] with low complication rates compared to other procedures (reported rates range from 0.5%-3.0%),[10,16-19] studies have found differences in complication rates following cataract surgery across settings of care. For example, when comparing Veterans

What is Already Known on this Topic

- Cataract surgery is one of the most common procedures performed in both the United States and the VA, particularly among those aged 65 and older. Although it is considered relatively safe and effective, with low complication rates, some complications can lead to serious adverse consequences, such as permanent vision loss and reduced quality of life.
- Despite generally low complication rates, studies have found differences in complication rates after cataract surgery across settings of care, such as between the VA and private sector under Medicare.
- Timely access to eye care services in the VA has become challenging due to increased demand as the VA population ages.

What This Study Adds

- Ours is the first study to examine quality of care differences between cataract surgery delivered within the VA vs outside the VA through VA-purchased care in the community (Community Care) and will be an important baseline against which outcomes can be compared between these two settings. Development of eye risk categories for risk adjustment purposes in this study provides a more robust way of comparing cataract surgery outcomes across care settings.
- As expansion of Community Care continues to increase with passage of the MISSION Act, the information we provide to VA policy makers and other key stakeholders on quality of care differences between settings will be useful in informing "make vs buy" decisions (ie, do we increase VA capacity to provide more ophthalmologic care in-house or continue to expand Community Care in this area?).
- Our study also highlights the challenges in detecting statistically significant differences in procedures that have low complication rates, such as cataract surgery.

65 and older who received cataract surgery in VA compared to the private sector under Medicare, French et al found that complication rates in the VA were 50 percent higher than those in the private sector.[18] These complications can have serious adverse consequences, including permanent vision loss, visual impairment, reduced quality of life, and financial impact.[10-12]

Since recovery of functional vision after cataract surgery is partly attributable to the quality of surgery performed and vision loss may therefore be preventable, it is critically important to monitor and track the quality of care provided, particularly in light of the new MISSION eligibility criteria on quality and as VA's role as a purchaser of specialty care in the community expands.[7,11,12,18] As a first step in doing this, we compared postoperative complication rates between Veterans receiving cataract surgery in VA and through CC during the early period of Choice implementation. To enable fair comparisons across settings, we adjusted for patient- and eye-level factors that were shown to be important predictors of outcomes of cataract surgery in prior studies;[11,12,18,19] additional VA-specific sociodemographic variables; and a newly developed eye risk stratification. Our risk groups, once validated, will provide an important baseline when examining complication rates in VA and CC as use of CC increases.

2 | METHODS

2.1 | Study design, data, and cohort

This was a retrospective, one-year observational study conducted in the first year post-Choice implementation (Fiscal Year 2015 [FY15, 10/1/14-9/30/15]). We obtained VA and CC outpatient administrative data from the VA's Corporate Data Warehouse (CDW) to identify Veterans' outpatient VA and CC utilization of services related to cataract surgery as well as their comorbidities, ocular conditions, and specific medication use at the time of the index surgery. We also used VA and CC outpatient data from FY14 (10/1/13-9/30/14) to obtain baseline information on comorbidities and significant ocular conditions in the year prior to cataract surgery as well as specific medication use in the six months prior to surgery.

We identified Veterans who had cataract surgery performed in VA, including their sociodemographics, ocular conditions, comorbidities, and associated 30- and 90-day postoperative complications from the VA MedSAS outpatient datasets in the CDW. We also used the CC utilization tables in the CDW to identify Veterans who had cataract surgeries performed through VA-purchased care (including the traditional Fee and Choice programs), as well as their associated postoperative complications. Sociodemographics included age, gender, race, rurality, and "priority level." Priority level indicates a Veteran's enrollment priority in VA based on specific eligibility criteria, including severity of service-connected disabilities and income level. Veterans in the lowest priority groups have the highest enrollment priority and are exempt from copayments, whereas those in the highest groups have required copayments.[20] Medically relevant comorbidities such as diabetes, congestive heart failure, and cerebrovascular disease[18] were identified using International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM) diagnosis codes.

To control for comorbidities, we included VA's Nosos risk score, which was developed to characterize the disease burden of the Veteran population for the purpose of predicting expected total VA costs;[20-22] however, similar to other risk models, it is increasingly being adapted for broad-based use in risk adjustment.[23,24] We also identified significant preoperative ocular conditions that can affect the outcome of cataract surgery based on National Quality Forum (NQF) criteria,[17] such as glaucoma and uveitis (identified through specific ICD-9-CM diagnosis codes). Preoperative utilization of alpha-blocker medications (in particular, tamsulosin hydrochloride) was identified using both Healthcare Common Procedure Coding System codes and pharmacy data since these medications can increase risk of surgical complications.

We linked VA and CC users through patient identifiers obtained from CDW files. Our analytic cohort included all Veterans who received outpatient cataract surgery either in the VA or through CC during FY15. Although we describe the sociodemographic and clinical characteristics of our Veteran cohort at the patient level, all other analyses are conducted with "eye surgery" as the unit of analysis.

Our study was deemed quality improvement and exempt from Institutional Review Board review. All analyses were conducted using SAS version 9.4.[25]

2.2 | Index cataract surgeries

We included procedures with Current Procedural Terminology (CPT) codes 66 984 (*routine* extracapsular cataract removal with insertion of intraocular lens [IOL] prosthesis) and 66 982 (*complex* extracapsular cataract extraction with insertion of IOL requiring devices or techniques not used in routine cataract surgery) that were performed in VA or CC in FY15. Because there could be more than one procedure per eye (eg, the first procedure for cataract removal, followed by secondary procedures for management of complications related to the index surgery), we counted only the first eligible procedure on each eye in defining a cataract surgery. Finally, we developed an algorithm (see Appendix S1) to link primary cataract surgeries and clinically relevant secondary procedures (complications) without eye laterality modifiers (right or left eye) that occurred within the 90-day window postsurgery. This was necessary because of the high level of eye laterality modifier missingness in secondary procedures in the VA data (about 40 percent in VA vs 5 percent in CC).

2.3 | 30-day and 90-day complications following cataract surgery

We used the NQF Measure #192, "Cataracts: Complications within 30 Days Following Cataract Surgery Requiring Additional Surgical

Procedures," to identify 30-day complications following cataract surgery. This measure has been nationally endorsed and is currently used as a clinical quality measure by the Centers for Medicare and Medicaid Services (CMS).[26] NQF defines major complications of cataract surgery from a specified list of CPTs that includes the presence of endophthalmitis, retained nuclear fragments, dislocated or wrong power intraocular lens (IOL), retinal detachment, or wound dehiscence (see Appendix S2 for list of CPT codes). We also identified 90-day complications of cataract surgery, since this is consistent with the 90-day global period for cataract surgery reimbursement established by CMS.[27] Although we focus on 90-day complication rates as our primary outcome measure (to increase the number of events and thus the stability of estimates), we also report 30-day complication rates as a basis for comparison with other studies that use the NQF measure. We counted complications that occurred from postsurgery day 1 to day 90, with the exception of 7 complications that were counted if they occurred within 90 days postsurgery, including the day of surgery (Appendix S2).

2.4 | Identifying low- and high-risk eye groups

Although the NQF measure is considered a good indicator of the quality of care, it was intended by the clinical experts who developed it to reflect the quality of services provided for patients who receive *uncomplicated* cataract surgery.[17] The measure identifies a clinically homogeneous low-risk cohort of cataract patients[28] and *excludes* patients with documentation of the presence of one or more preoperative ocular conditions (eg, glaucoma, corneal edema and traumatic cataract) or specific medication use (tamsulosin) (Appendix S2), whose history puts them at increased risk of postoperative complications after cataract surgery.[17,29,30]

Because of VA's expanding role as a purchaser of CC, and its interest in providing timely access to high-quality care both within and outside VA, we examined differences in the rate of postoperative complications among *all* cataract surgeries performed in VA and CC (ie, not just those at low risk). We used the NQF list of included and excluded ICD-9-CM codes, and data from both FY14 and FY15, as a starting point for defining low- and high-risk eye groups (see Appendix S3 for details). The NQF-defined low-risk homogenous group in our population had a 90-day complication rate of 1.3 percent. From those codes that were excluded from the NQF low-risk group, we identified a high-risk eye group in which the 90-day complication rate was at least 50 percent higher than that of the NQF low-risk group (>2.0 percent). The complication rate in this initial high-risk eye group (which comprised 2.4 percent of the population of eyes) was 4.5 percent. Next, to create a more inclusive low-risk eye group, we combined all remaining excluded NQF codes (the complication rate in this group was 1.1 percent) with cases in the NQF-defined low-risk group and cases that had ICD-9-CM code 366.9—"Unspecified Cataract" (these had a 90-day complication rate of 1.4 percent). We then moved the small number of patients ($n = 962$) who had one high-risk and one low-risk eye to the high-risk eye group to finalize the low- and high-risk eye groups. Based on clinical input and supported by empirical analysis, we assumed that if one eye was coded as high risk, the other eye was also likely to be high risk, and thus, the low-risk eyes were probably miscoded (the list of high- and low-risk eye codes is available from the authors).

2.5 | Analysis

We compared sociodemographic and clinical characteristics between Veterans who received cataract surgery in VA or CC. For the small number of Veterans who had surgery for one eye in VA and the other in CC (0.8 percent), we assigned them to either setting based on where the first cataract surgery was performed. We report both p-values (based on t-tests) and effect sizes (ESs, in this case, standardized differences in means or proportions) because with our large sample sizes, even trivial differences can be statistically significant. ESs below 0.10 are sometimes interpreted as indicating negligible differences between groups.[31]

For the rest of the analyses, eye was the unit of observation. We compared the percentage of surgeries performed that were complex (vs routine), the number of preoperative ocular conditions, and the percentage of eyes identified as high risk between VA and CC. We also compared postoperative 30-day and 90-day complication rates between cataract surgeries performed in VA vs CC, stratified by type of surgery (complex vs routine) and eye risk group (high vs low). We calculated relative risks (RRs) (the ratio of the CC complication rate to the VA complication rate) and attributable risks (ARs) (the CC complication rate minus the VA complication rate) and 95% confidence intervals (CIs).

We ran a series of models to predict 90-day postoperative complications. Because of small numbers of complications in some of the cells, we used Firth's penalized maximum likelihood logistic regression.[32] The first model included an indicator variable for CC (yes/no [Y/N]), complex surgery (Y/N), eye risk group (high-risk eye [Y/N],) and all 2- and 3-way interactions. The interaction terms in this model enabled us to examine whether the effect of CC differed depending on type of surgery and eye risk group. The next two models added increasingly large sets of sociodemographic and clinical variables. Specifically, the second model included CC, complex surgery, eye risk group, and all 2-way and 3-way interactions between these variables, plus the other sociodemographic and clinical variables from Table 1 that had ESs > 0.10. The third model included all the variables from Model 2, plus additional sociodemographic variables from Table 1 that had lower ESs. As a sensitivity analysis, we also ran this model using generalized estimating equations (GEE) with an exchangeable correlation matrix to account for possible correlation between complications in an individual's eyes. The fourth model eliminated the high-risk eye variable from Model 3, making it possible to compare results to analyses that did not use our eye risk groups.

We calculated adjusted odds ratios (ORs) and CIs, and p-values for model coefficients. We interpret the ORs from the models as RRs

TABLE 1 Characteristics of veterans undergoing routine or complex surgery by VHA providers or through community care during FY2015

	Overall	CC	VHA	*P*-value	Effect size
Patient-level characteristics					
Number of patients	61 749	17 203	44 546		
Age, mean (SD)	71.37 (8.91)	71.22 (8.80)	71.43 (8.96)	.007	0.024
Male, %	96.5	96.8	96.4	.013	0.023
Race, %					
White	78.7	81.9	77.4	<.001	0.11
Black	12.7	7.6	14.6	<.001	0.225
Other/not known	8.7	10.5	8	<.001	0.089
Marital status, %					
Single	7.5	6.4	7.9	<.001	0.058
Married	52.1	54.3	51.3	<.001	0.061
Divorced/separated	29.6	29.2	29.8	.173	0.012
Widowed	10.2	9.4	10.5	<.001	0.035
Other/unknown	0.6	0.6	0.6	.466	0.007
Rurality (Reference = urban)					
Rural	40.5	50.2	36.8	<.001	0.273
Urban	59.4	49.7	63.2	<.001	0.274
Not known	0.1	0.1	0.1	.025	0.02
VHA priority group, %[a]					
1-2	35.6	36.9	35.2	<.001	0.036
3	18.5	19.6	18.1	<.001	0.039
4	3.5	3.2	3.5	.037	0.019
5	42.1	40.1	42.9	<.001	0.057
6	0.1	0	0.1	.009	0.029
7-8	0.1	0	0.1	.006	0.029
Nosos risk score, mean (SD)	1.87 (2.40)	1.61 (2.15)	1.97 (2.47)	<.001	0.156
Comorbidities, %[b]					
Diabetes w/o complications	24.5	24.2	24.5	.374	0.008
Chronic obstructive pulmonary disease (COPD)	22.1	22.2	22	.583	0.005
Diabetes w/ complications	20.4	18.5	21.1	<.001	0.064
Heart arrhythmias	13.2	12.2	13.6	<.001	0.042
Vascular disease	12.1	10.8	12.6	<.001	0.057
Congestive heart failure (CHF)	11.6	10.5	12.1	<.001	0.049
Polyneuropathy	10.1	9.4	10.4	<.001	0.033
Depression w/o complications	9.4	8.9	9.6	.011	0.023
Cancer of breast or prostate	7.8	7.1	8.1	<.001	0.041
Drug abuse	5.5	4.9	5.7	<.001	0.037
Dementia	4.7	4.3	4.9	.003	0.028
Eye-level characteristics					
Number of surgeries	83 879	25 826	58 053		
Complex surgeries (CPT code 66 982), %	16.7	14.7	17.5	<.001	0.075
High-risk eye, %	2.4	4.4	1.6	<.001	0.166

(Continues)

TABLE 1 (Continued)

	Overall	CC	VHA	*P*-value	Effect size
No. of significant preoperative ocular conditions (column %)					
0	79.2	66.9	84.6	<.001	0.422
1	19.1	29.1	14.7	<.001	0.353
2	1.6	3.8	0.6	<.001	0.222
3	0.1	0.2	0.1	.001	0.023

Abbreviations: CC, Community Care; VHA, Veterans Health Administration.

[a]Priority Group 1: Veterans with VHA-rated service-connected disabilities 50% or more disabling; Veterans determined by VHA to be unemployable due to service-connected conditions; Priority Group 2: Veterans with VHA-rated service-connected disabilities 30% or 40% disabling; Priority Group 3: Veterans who are Former Prisoners of War (POWs); Veterans awarded a Purple Heart medal; Veterans whose discharge was for a disability that was incurred or aggravated in the line of duty; Veterans with VHA-rated service-connected disabilities 10% or 20% disabling; Veterans awarded "benefits for individuals disabled by treatment or vocational rehabilitation;" Veterans awarded the Medal Of Honor (MOH); Priority Group 4: Veterans who receive aid and attendance or housebound benefits from VHA; Veterans who are considered "catastrophically disabled" by VHA; Priority Group 5: Non-service-connected Veterans and noncompensable service-connected Veterans rated 0% disabled by VHA with annual income below VHA's; Veterans receiving VHA pension benefits; Veterans eligible for Medicaid programs; Priority Group 6: Compensable 0% service-connected Veterans; Veterans exposed to Ionizing Radiation during atmospheric testing or during the occupation of Hiroshima and Nagasaki; Project 112/SHAD participants; Veterans who served in Vietnam; Veterans of the Persian Gulf War; Veterans who served on active duty at Camp Lejeune for at least 30 d; Priority Group 7: Veterans with gross household income below the geographically adjusted income limits for their resident location and who agree to pay copays; Priority Group 8: Veterans with gross household income above the VA and the geographically adjusted income limits for their resident location and who agree to pay copays (US Department of Veterans Affairs 2017.)

[b]Patients could have more than 1 comorbidity.

and refer to them this way in the paper because: (a) our primary outcome, 90-day complication rates, was below 10 percent, and thus, the ORs closely approximate RRs;[33,34] and (b) RRs are easier to interpret and more understandable than ORs.[33,35]

Finally, because post hoc calculations of power as an aid in interpreting null findings can be problematic,[36] we examined the maximum ES supported by the data. Following Colgrave and Ruxton,[37] we used an equivalence test (ie, a test where the null hypothesis is defined as an ES large enough to be interesting), in which the null hypothesis is that the ES > the upper limit of the 95% CI. Because the upper CI limit is not greater than the specified null hypothesis, we can reject the null hypothesis at the 0.025 alpha level (since this is a one-tail test). Thus, the upper limit of the 95% CI is an estimate of the maximum ES (in this case, the RRs and the ARs) that is supported by the data.

3 | RESULTS

Our sample included a total of 61,749 Veterans; of these, 28 percent received cataract surgery in CC (Table 1). Despite statistically significant differences between most of the patient characteristics and setting of care (due to large sample sizes), most ESs were below 0.10, indicating small differences. Race, rurality, and Nosos risk score were the exceptions. Compared to Veterans treated in the VA, those treated in CC were more likely to be rural (50.2 vs 37 percent, ES = 0.27) and less likely to be black (8 vs 15 percent, ES = 0.23).

Table 1 also shows comparisons using eye as the unit of analysis. Of the 83,879 cataract surgeries performed on Veterans in FY15, 31 percent were done in CC. Although the percentage of eyes that underwent complex surgery in VA was relatively comparable to CC (17.5 vs 14.7 percent, ES = 0.08), Veterans who had cataract surgery in CC vs VA were more likely to have eyes in the high-risk eye group (4.4 vs 1.6 percent, ES = 0.17); they also had a higher percentage of eyes with documented preoperative ocular conditions (33.1 vs 15.4 percent, ES = 0.42).

Table 2 provides the numbers and rates that we used to calculate the RRs, ARs, and 95% CIs for complication rates that are shown in Table 3. Overall, the risk of 90-day complications was 5 percent lower for Veterans going to CC vs VA for complex surgery and 11 percent lower for routine surgery, although these differences were not statistically significant (the RR CIs included 1). The ARs were small, approximately 1 additional complication per 1000 surgeries, and not significant. For Veterans with low-risk eyes, the risk of 90-day postoperative complications for complex surgery was 15 percent lower in CC, although this was also not significant. However, for routine surgery, the risk was 17 percent lower in CC vs VA and statistically significant, a notable finding given that 82 percent of all surgeries were routine for low-risk eyes (Table 2).

For Veterans with high-risk eyes who had complex surgery in CC, risk of 90-day complications was also 17 percent lower in CC than in VA but the results were not significant because of the much smaller number of eyes involved (Table 2). For routine surgery, the risk of a complication was 16 percent higher in CC, although the results were not significant.

The maximum 90-day RR supported by the data was 1.22 for Veterans in the "all eye" and "low-risk eye" groups; the maximum 90-day AR was 0.43 per 100 surgeries. For Veterans in the "high-risk eye" group who had complex surgery, the maximum RR supported by the

data was 1.63; for routine surgery, it was 2.15. The ARs were 3.38 and 1.99 for complex and routine surgery, respectively, per 100 surgeries.

Model 1 (Table 4) is the model analog of the eye risk category stratification in Table 3. In both the table and model, the RR of CC was 0.83, the CIs were similar, and both were statistically significant. The fact that none of the 2-way or 3-way interactions were statistically significant indicates that the overall effect of CC on complication rates does not depend on type of surgery or eye risk category.

We then added the important confounders from Table 1 (ie, those with effect sizes > 0.10) to the model (Table 5, Model 2). Once adjustment was made for the higher percent of blacks treated by VA (RR = 1.64, 95% CI 1.39-1.93, $P = .00$), the lower percent of eyes with only 1-2 preoperative ocular conditions (which had a protective effect, RR = 0.83, 95% CI 0.69-0.99, $P = .04$), and the higher percent of rural Veterans treated in CC, which also was protective (RR = 0.73, 95% CI 0.64-0.84, $P = .00$), the coefficient on CC (RR = 0.92, 95% CI 0.77-1.10) was no longer significant ($P = .35$).

Finally, including additional sociodemographic variables from Table 1 in the model (Appendix S4, Model 3) or incorporating individual indicator variables for priority groups 4-6 (Appendix S5, Model 4) had no effect on the CC coefficient or 95% CI. When Model 3 was run without the eye risk groups (Appendix S6, Model 5), the coefficient on CC increased slightly (RR = 0.95, 95% CI 0.80-1.13). Of particular note in this model, contrary to Model 1 results, having 1-2 preoperative ocular conditions was no longer protective (RR = 1.08), although this effect was not significant (95% CI 0.92-1.26). Results from the sensitivity analysis using the GEE model were similar to those in Model 3.

4 | DISCUSSION

This is the first study, to our knowledge, that examines differences in quality of care by comparing outcomes between Veterans receiving care in VA and CC after Choice implementation. Our study has several important policy-related findings. Even in the early Choice period (FY15), we found that almost 30 percent of all Veterans received cataract surgery in CC, consistent with other recent findings on the overall care provided to Veterans through CC.[4,38] These findings may reflect increased demand for ophthalmology services due to the aging Veteran population as noted earlier, the growing prevalence of diagnosed eye conditions relative to the resources currently available in VA, and/or a desire to have the procedure done close to the Veteran's home (particularly among rural Veterans).[39,40] If these trends continue, it will be important to better understand why Veterans use CC for cataract surgeries, identify patient populations best suited for surgery through CC vs VA to minimize risk of complications, and optimize referral practices accordingly to take advantage of VA care coordination and the breadth and strengths of VA's nationwide ophthalmology program.

Similar to other studies, routine cataract surgeries represented the majority of cases in our study (82.5 percent in VA and 85.3

TABLE 2 30-day and 90-day complication rates for community care (CC) and VA cataract surgeries by type of surgery and risk group

		Surgery type and provider			
		Complex surgeries		Routine surgeries	
	Overall	CC	VHA	CC	VHA
In all eyes					
Number of eyes	83 879	3808	10 164	22 018	47 889
30-day complication, % (*n*)	0.79 (666)	1.52 (58)	1.61 (164)	0.59 (131)	0.65 (313)
90-day complication, % (*n*)	1.17 (980)	2.13 (81)	2.24 (228)	0.89 (195)	0.99 (476)
In low-risk eyes					
Number of eyes	81 851	3539	9966	21 162	47 184
30-day complication, % (*n*)	0.75 (614)	1.30 (46)	1.53 (152)	0.54 (115)	0.64 (301)
90-day complication, % (*n*)	1.11 (907)	1.81 (64)	2.14 (213)	0.81 (171)	0.97 (459)
In high-risk eyes					
Number of eyes	2028	269	198	856	705
30-day complication, % (*n*)	2.56 (52)	4.46 (12)	6.06 (12)	1.87 (16)	1.70 (12)
90-day complication, % (*n*)	3.60 (73)	6.32 (17)	7.58 (15)	2.80 (24)	2.41 (17)

Abbreviations: CC, Community Care; VHA, Veterans Health Administration.

TABLE 3 Relative and attributable risks of complications and their 95% confidence intervals

	Surgery type and provider	
	Complex surgeries	**Routine surgeries**
In all eyes		
30-day complications		
Relative risk[a]	0.94 (0.70, 1.27)	0.91 (0.74, 1.16)
Attributable risk[b]	−0.09 (−0.56, 0.38)	−0.06 (−0.19, 0.07)
90-day complication, % (n)		
Relative risk	0.95 (0.74, 1.22)	0.89 (0.75, 1.05)
Attributable risk	−0.12 (−0.66, 0.43)	−0.11 (−0.26, 0.05)
In low-risk eyes		
30-day complications		
Relative Risk	0.85 (0.61, 1.18)	0.85 (0.69, 1.06)
Attributable risk	−0.23 (−0.69, 0.24)	−0.10 (−0.22, 0.03)
90-day complication, % (n)		
Relative risk	0.85 (0.64, 1.12)	0.83 (0.70, 0.99)
Attributable risk	−0.33 (−0.87, 0.22)	−0.17 (−0.32, −0.00)
In high-risk eyes		
30-day complications		
Relative risk	0.74 (0.34, 1.60)	1.10 (0.52, 2.31)
Attributable risk	−1.60 (−5.65, 2.45)	0.17 (−1.16, 1.49)
90-day complication, % (n)		
Relative risk	0.83 (0.43, 1.63)	1.16 (0.63, 2.15)
Attributable risk	−1.26 (−5.89, 3.38)	0.39 (−1.20, 1.99)

Abbreviations: CC, Community Care; VHA, Veterans Health Administration.

[a]Relative Risk = CC rate/VA rate.

[b]Attributable Risk = (CC rate − VA rate) × 100.

percent in CC).[11,18,41] Although overall complication rates were low (1.17 percent), the complication rates in high-risk eyes were over three times higher. Other significant risk factors, similar to those noted previously in the literature,[10-12,16,18] included complex cataract surgery, black race, and rurality.[40] Although the presence of preoperative ocular conditions was positively associated with higher complication rates (though this association was not statistically significant), once risk category was added to the model, there was a lower risk of complications among patients with 1-2 preoperative ocular conditions compared to those with none. This reflects the strong association between ocular conditions and risk category, which can make interpretation of the coefficient for ocular conditions problematic.

Contrary to an earlier study which found that Veterans receiving cataract surgery in VA had a 50 percent higher complication rate than Veterans undergoing the same procedure under Medicare,[18] we found no statistically significant differences in complication rates between VA and CC once we adjusted for important confounders. These differences may be related to the different time periods of our studies, the characteristics of Veterans using Medicare coverage vs CC, and methodological differences. Nonetheless, this finding should help mitigate concerns about the quality of VA care and those related to VA-purchased care (particularly since studies conducted in the early Choice implementation period elaborated on delays in treatment and other administrative hurdles when referring Veterans to CC).[42-45] However, because our study is limited to cataract surgery and to the subset of VA patients eligible for CC in FY15, future studies need to determine whether our findings persist under the MISSION Act (which broadens CC eligibility) when other procedures and conditions are compared across the two settings.

One of the important contributions to the literature and a strength of our study is distinguishing between high- and low-risk eye groups, highlighting the value of using both clinical insights and empirical data to develop risk categories. This helped us to identify routine cataract surgeries in low-risk eyes in CC that were at lower risk of complications than those in VA (albeit no longer statistically significant in adjusted analyses). Because our risk categories were developed based upon two years of data, validation in more recent larger samples is needed before they can be used more widely.

A challenge in evaluating a procedure like cataract surgery is the low complication rate, which can make it difficult to detect statistically significant differences in complications between VA and CC. Despite this, for analyses involving "all eyes" and "low-risk eyes," we were able to rule out the possibility that the complication rate in CC was greater than 1.22 times that in the VA and that the additional number of complications was greater than 0.43 per 100 surgeries. However, conclusions about high-risk eyes are more tentative. For complex surgery, the complication rate in CC could have been up to 1.63 times higher in CC (up to 3.38 additional cases per 100 surgeries), and for routine surgery, up to 2.15 times higher (up to 1.99 additional cases per 100 surgeries) than in VA.

There were also some limitations that may have contributed to observed differences in complication rates between VA and CC. We examined the early post-Choice period, and findings could have changed in more recent years, particularly with increased CC utilization. However, at the time of our study, data after FY15 were incomplete and not ready for analysis. We also lacked information on two factors likely associated with the quality of surgical care: the individual surgeon (ie, whether the individual surgeon who performed the cataract surgery was a resident in training [more applicable to VA due to its large residency programs] or an attending surgeon), and the facility where the cataract surgery was performed. Findings

TABLE 4 Logistic regression model 1:90-day complications of cataract surgery (with setting of care, eye risk category, and type of surgery)

	Coefficient	OR[a]	CI low	CI high	*P*-value
(Intercept)	-4.622	0.010	0.009	0.011	.000
Complex surgery (Reference = routine)	0.800	2.226	1.886	2.618	.000
CC (Community care)	-0.185	0.831	0.695	0.989	.037
High-risk eye	0.950	2.585	1.536	4.060	.001
Complex surgery*CC	0.021	1.021	0.730	1.418	.901
Complex surgery*High-risk eye	0.401	1.493	0.718	3.077	.279
CC*High-risk eye	0.331	1.393	0.734	2.695	.312
Complex surgery*CC*High-risk eye	-0.366	0.694	0.254	1.890	.474

Abbreviations: CC, Community Care; VHA, Veterans Health Administration.
[a]We refer to these as RRs in the text.

from the literature on surgical experience are mixed; some VA studies show positive outcomes from resident-operated cases (such as significant improvements in visual acuity and function),[46] while others suggest that resident surgery may be partially responsible for the higher complication rates found in the VA compared to Medicare.[47] Further, assessing VA facility-level variation in complication rates is an important next step, particularly since there is limited knowledge about this.[48] If access or quality issues were identified at the facility level, this would help inform VA as to which facilities might need additional resources to provide more timely, high-quality care, and which ones have serious enough problems that Veterans would be better served by obtaining their ophthalmologic care in CC. Additional research is needed in both these areas in order to better understand the relationship of resident surgery and facility-level factors to surgical outcomes in VA.

Our findings may also reflect the potential influence of differential coding practices between the VA and the private sector which may have important implications for other studies comparing VA and CC. Because the VA uses global budgeting, less attention is paid to coding due to the lack of financial incentives

TABLE 5 Logistic regression model 2:90-day complications of cataract surgery (with Table 4 variables and important confounders)

	Coefficient	OR[a]	CI low	CI high	*P*-value
(Intercept)	−4.591	0.010	0.009	0.011	.000
Complex Surgery (Reference = routine)	0.782	2.187	1.851	2.575	.000
CC (Community care)	−0.085	0.918	0.765	1.097	.349
High-risk eye	1.020	2.774	1.610	4.497	.001
Rurality (Reference = urban)					
Rural	−0.311	0.733	0.637	0.841	.000
Not known	1.221	3.390	0.925	8.770	.063
Race (Reference = white)					
Black	0.494	1.639	1.387	1.929	.000
Other	0.245	1.277	1.026	1.573	.029
Nosos risk score	−0.003	0.997	0.970	1.023	.827
Number of preoperative ocular conditions (Reference = 0)					
1-2 Conditions	−0.185	0.831	0.693	0.991	.039
3 + Conditions	0.567	1.764	0.482	4.554	.346
Complex surgery*CC	0.034	1.035	0.739	1.437	.839
Complex surgery*High-risk eye	0.418	1.518	0.729	3.135	.261
CC*High-risk Eye	0.315	1.371	0.721	2.657	.337
Complex surgery*CC*High-risk eye	−0.418	0.658	0.241	1.797	.414

Abbreviations: CC, Community Care; VHA, Veterans Health Administration.
[a]We refer to these as RRs in the text.

compared to those in CC. "Upcoding," the practice of increased diagnostic intensity that occurs in the private sector so that health plans can receive higher payment rates, is largely absent in VA.[49-52] Our finding that both preoperative ocular conditions and high-risk eyes were twice as common in CC than in VA (despite the fact that complex surgery was more common in VA) is likely an artifact of VA "undercoding" and CC "upcoding" practices. However, these coding practices could change under the MISSION Act if quality comparisons become an important eligibility criterion for outsourcing care.

Despite the algorithm we developed to capture secondary procedures that were missing eye modifier codes in VA data, we still may have omitted or misassigned some secondary procedures to index cataract surgeries. Lastly, our study was limited to examination of cataract surgery in the Veteran population, a population with greater comorbidity than the non-Veteran population.

Providing high-quality care is an important priority for VA, as highlighted in the new MISSION eligibility criteria;[7] thus, when increasing Veterans' choice in health care, differences in quality of care between VA and CC should be totally transparent. Future work is needed to explore how CC use is affected by geographic access, how cataract surgery costs compare between VA and CC, and how patient selection can be optimized for VA and CC settings in order to balance convenience and ease of access with high-quality and cost-effective care. As VA's role as a purchaser of care grows, it must continue to monitor quality of care to inform "make vs buy" decisions. Our research provides an example of the types of studies necessary to support these important decisions.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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