Geographical Barriers to Surgical Treatment for Cataracts and Glaucoma among Medicare Beneficiaries in Rural California

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Background

- The National Eye Institute estimates that from 2010 to 2050, the number of people in the United States (US) with glaucoma is expected to increase from 2.7 million to 6.3 million. In the US, glaucoma is the leading cause of irreversible blindness.
- By 2050, the number of people in the US with cataracts is expected to double from 24.4 million to about 50 million. Cataracts are the leading cause of visual impairment (20/40 vision or worse in the better eye, even with eyeglasses) in the US.
- Healthy People 2030 identified increasing access to vision services in community health centers as a vision care objective to reduce eye health disparities.
- California, the most populous US state, has a 2019 estimated population of 837,284 people who live in rural areas.
- There is currently limited information on the association between type of geographic residence, distance to eye care providers and rate of surgical treatment for eye conditions.

Objectives

- To examine if geographic access to surgical treatment for cataracts and glaucoma varies among California Medicare beneficiaries that live in rural or urban regions of California.

Methods

- Inclusion criteria: Glaucoma and cataract beneficiaries who resided in CA in 2017, age 65 years or older, enrolled in Medicare part A and part B, and had at least one part B claim in 2017. In addition, both beneficiaries and eye care providers had valid CA ZIP codes.
- Glaucoma and cataract diagnosis was identified by the ICD-10 diagnosis codes, while glaucoma and cataract surgery was identified by the CPT codes.
- Exposure: urban or rural residence
- Outcome: rate of glaucoma or cataract surgery
- Urban or rural residence was determined by ZIP code using the HRSA List of Rural Counties and Designated Eligible Census Tracts in Metropolitan Counties and the 2017 SSA to Federal Information Processing Series (FIPS) Core-Based Statistical Area (CBSA) and Metropolitan and Micropolitan (MSA) County Crosswalk files.
- ArcGIS Pro was used to analyze the distance travelled from patient ZIP to provider ZIP.
- Logistic regression models were used to analyze the association between number of miles travelled to the provider and the occurrence of glaucoma or cataract surgery, controlling for age, sex, race/ethnicity, geographic class and overall burden of systemic disease with the Charlson Comorbidity Index Score (CCI) score.
- Multiple linear regression modeling was performed to compare mean distance travelled to surgery by geographic class, controlling for the same cofounders listed above.

Results

- The study sample included a total of 336,117 glaucoma patients of whom 82,583 (24.6%) resided in rural California and 445,164 cataract patients of whom 127,314 (28.6%) resided in rural California.
- A total of 24,324(7.2%) beneficiaries received glaucoma surgery. Beneficiaries that resided in rural California totaled to 5,414 (22.3%).
- A total of 93,460 (21.0%) received cataract surgery. Of those beneficiaries, 27,587 (29.5%) resided in rural California.
- On average, beneficiaries living in rural ZIP codes traveled 9.7 miles more for cataract surgery (β=9.7, 95% CI: 9.3 to 10.2) and 14.7 miles more for glaucoma surgery (β=14.7, 95% CI: 13.8 to 15.7) than those living in urban ZIP codes, controlling for age, sex, race/ethnicity, and CCI score.
- On average, beneficiaries living in rural ZIP codes spent 0.16 additional hours (about 10 minutes) traveling for cataract surgery (β=0.16, 95% CI: 0.15 to 0.17) and 0.24 additional hours (about 15 minutes) traveling for glaucoma surgery (β=0.24, 95% CI: 0.22 to 0.25) than those living in urban ZIP codes, controlling for age, sex, race/ethnicity, and CCI score.
- Greater travel distance and greater travel time was associated with reduced odds of cataract surgery, but increased odds of glaucoma surgery, controlling for age, sex, race/ethnicity, CCI score, and urban/rural residence (Table 3).

Table 1. Characteristics of 2017 California Medicare Beneficiaries by Eye Disease and Surgery

	All Beneficiaries with Glaucoma N = 336,117					All Beneficiaries with Cataracts N = 445,164				
	Beneficiaries with Glaucoma Surgery N = 24,324		Beneficiaries with Glaucoma, No Surgery N = 311,793		P-value	Beneficiaries with Cataract Surgery N = 93,460		All Beneficiaries with Cataracts, No Surgery N = 351,704		P-value
Age in years (n, %)										
65-69	4,705	19.34	57,968	18.59		19,610	20.98	85,172	24.22	
70-74	5,703	23.45	71,630	22.97		26,280	29.12	101,807	28.95	
75-79	5,418	22.27	65,730	21.08		23,354	24.99	77,211	21.95	
80-84	4,273	17.57	52,450	16.82		14,837	15.88	47,115	13.4	
85-89	2,659	10.93	37,093	11.9		7,046	7.54	25,587	7.28	
90+	1,566	6.44	26,922	8.63	p < 0.0001	2,333	2.5	14,812	4.21	p < 0.0001
Sex (n, %)										
Male	9,890	40.66	125,449	40.23		38,022	40.68	141,739	40.3	
Female	14,434	59.34	186,344	59.77	p = 0.19	55,438	59.32	209,965	59.7	p = 0.03
Race/Ethnicity (n, %)										
White	12,854	52.84	183,759	58.94		61,069	65.34	241,494	68.66	
Black	1,440	5.92	16,373	5.25		3,013	3.22	13,227	3.76	
Asian	4,495	18.48	56,671	18.18		11,966	12.8	42,011	11.94	
Hispanic/Latino	4,667	19.19	43,137	13.84		13,946	14.92	41,635	11.84	
Other	868	3.57	11,853	3.8	p < 0.0001	3,466	3.71	13,337	3.79	p < 0.0001
CCI Score (n, %)										
0	6,268	25.77	82,848	26.57		26,208	28.04	110,639	31.46	
1-2	8,923	36.68	112,760	36.17		34,945	37.39	125,863	35.79	
3-4	5,194	21.35	65,892	21.13		18,926	20.25	66,003	18.77	
5+	3,939	16.19	50,293	16.13	p = 0.05	13,381	14.32	49,199	13.99	p < 0.0001
Residence (n, %)										
Urban	18,910	77.74	234,624	75.25		65,873	70.48	251,977	71.64	
Rural	5,414	22.26	77,169	24.75	p < 0.0001	27,587	29.52	99,727	28.36	p < 0.0001
Travel (mean, SD)										
Travel time, hours	0.46	0.6	0.42	0.65	p < 0.0001	0.43	0.60	0.46	0.79	p < 0.0001
Travel distance, miles	17	33	16	36	p < 0.0001	17	33	19	45	p < 0.0001

Table 2. Summary of Travel Time and Distance among 2017 California Medicare Beneficiaries who Received Eye Surgery by Urban/Rural Residence

	All Beneficiaries with Glaucoma Surgery N = 24,324					All Beneficiaries with Cataract Surgery N = 93,460				
	Urban Residence N = 18,910		Rural Residence N = 5,414		P-value	Urban Residence N = 65,873		Rural Residence N = 27,587		P-value
Travel (mean, SD)										
Travel time, hr	0.40	0.53	0.65	0.79	p < 0.0001	0.39	0.53	0.55	0.73	p < 0.0001
Travel distance, mi	14	28	29	44	p < 0.0001	14	29	24	40	p < 0.0001

Table 3. Multivariable logistic regressions assessing associations between travel measurements and odds of surgery*

Variable	Interval	Glaucoma Surgery OR	Glaucoma Surgery 95% CI	Cataract Surgery OR	Cataract Surgery 95% CI
Travel Time	**1 additional hour**	1.10	1.08 to 1.12	0.94	0.93 to 0.95
Travel Distance	**100 additional miles**	1.13	1.09 to 1.16	0.86	0.84 to 0.87

*covariates adjusted for in multivariable model include: age, sex, race/ethnicity, CCI score and urban/rural residence

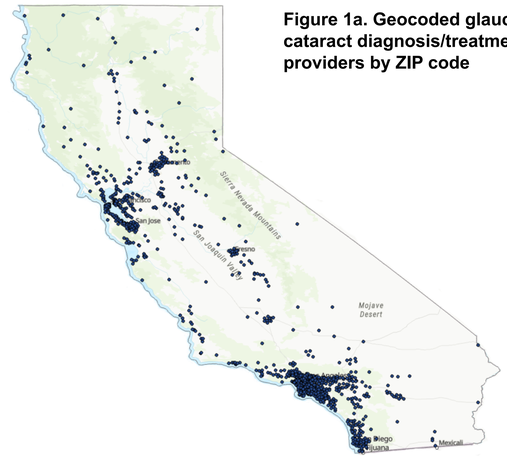

Figure 1a. Geocoded glaucoma and/or cataract diagnosis/treatment/surgery providers by ZIP code

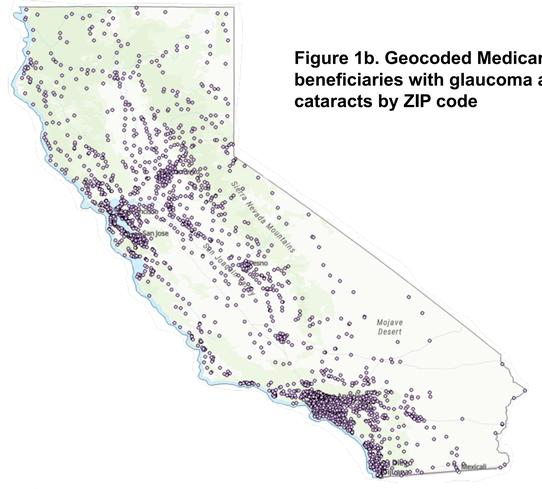

Figure 1b. Geocoded Medicare beneficiaries with glaucoma and/or cataracts by ZIP code

Conclusions

- Medicare beneficiaries who resided in rural California had to travel longer and further to undergo their glaucoma and cataract providers than beneficiaries that live in non-rural areas.
- Among all cataract Medicare patients, a longer travel distance and time was associated with lower odds of cataract surgery, but higher odds of glaucoma surgery.
- Rural patients travel longer and further to cataract providers. In fact, rural patients had increased access to cataract surgery although longer distance/travel time was associated with lower odds of cataract surgery.
- Rural patients also traveled longer and further to glaucoma providers, but rural patients had lower odds for glaucoma surgery and longer distance/travel time was associated with higher odds of glaucoma surgery.
- The main limitations of this study are related to the modifiable areal unit problem. Using ZIP code for travel time causes the loss of specificity. However, ZIP code is the smallest areal unit available in the California Medicare MBSF and Part B Carrier Claim files.

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