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Comorbid Cognitive Impairment and Functional Trajectories in Low Vision Rehabilitation for Macular Disease

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Abstract

Background and Aims—Comorbid cognitive impairment is common among visually impaired older adults. This study investigated whether baseline cognitive status predicts functional trajectories among older adults in low vision rehabilitation (LVR) for macular disease.

Methods—The Telephone Interview for Cognitive Status – modified (TICS-m) was administered to macular disease patients aged ≥ 65 years receiving outpatient LVR. Mixed models assessed the rate of change in instrumental activities of daily living and visual function measures over a mean follow-up of 115 days.

Results—Of 91 participants, 17 (18.7%) had cognitive impairment (TICS-m score < 27) and 23 (25.3%) had marginal impairment (TICS-m scores 28 to 30). Controlling for age and gender, baseline cognitive status did not predict most functional outcomes. However, participants with marginal cognitive impairment experienced worse functional trajectories in ability to prepare meals ($p=0.03$) and activities that require distance vision ($p = 0.05$).

Conclusion—Patients with mild to moderate cognitive impairment should not be excluded from LVR, but programs should be prepared to detect and accommodate a range of cognitive ability.

Keywords

comorbidity; disability; dementia; macular degeneration; low vision rehabilitation

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Introduction

Cognitive impairment is detected more commonly in older adults with vision loss as compared to their peers with intact vision(1), and vision impairment has been associated with accelerated cognitive decline(2, 3). Age-related maculopathy and dementia have been postulated to share common etiologies and pathogenesis(4). Because the prevalence of both dementia and macular disease are increasing as the population ages(5, 6), the number of seniors living with co-existing visual and cognitive impairments is expected to rise.

Cognitive impairment is a strong predictor of functional decline in general populations of community-dwelling older persons(7), and individuals with co-existing visual and cognitive impairments are at even greater risk of functional limitations and development of disability (1). Qualitative research has revealed that older adults with concurrent visual and cognitive deficits experience significant distress and disorientation and these patients and their caregivers perceive many unmet needs and opportunities for better care coordination(8).

Efforts to improve care and maximize independence in older adults who have both vision loss and cognitive deficits will require a better understanding of the functional consequences of this increasingly common comorbidity. As with any pair of comorbidities, it will be important to understand how the presence of one condition may impact the treatment and management of the other. A mainstay of treatment for seniors with irreversible vision loss from macular disease is low vision rehabilitation (LVR)(5, 9). LVR is a multi-disciplinary service that incorporates the expertise of optometrists, occupational therapists, orientation and mobility specialists, and adaptive device technicians to improve functional outcomes for seniors with vision loss(10). Although LVR programs are somewhat variable and rehabilitation plans are individualized to patient goals, there are accepted standards for LVR whereby patients are taught about techniques or adaptive devices to help them perform visually-mediated tasks (9, 11, 12). Because cognitive ability could impact the ease and speed with which an older adult masters new techniques or devices, cognitive status may be an important component of success in LVR. Although one small previous study indicated that cognitively impaired LVR patients can experience improvement in visual acuity using low vision aides(13), the impact of cognitive status on task-related functional trajectories in LVR patients has not been described.

At present, cognitive assessment is not a standard component of LVR evaluation. Nonetheless, high rates of cognitive deficits among older adults referred to outpatient LVR have been reported (13, 14). The objective of the current study was to determine whether cognitive status is predictive of task-related functional trajectories among older adults receiving LVR. Because it may be possible to design enhanced LVR programs that better accommodate comorbid cognitive impairment, the findings of this study could suggest opportunities for improved care in the macular disease population.

Methods

Study Population

We recruited patients aged 65 years or older with macular disease who were evaluated in the Duke Low Vision Rehabilitation Clinic between September 2007 and March 2008. Exclusion criteria included hearing impairment or language barriers that precluded cognitive testing. Each week, we invited all eligible patients until the weekly recruitment goal of three to five patients was met. The weekly recruitment goal was intended to produce a sample size of 75 to 100 participants, which was estimated to yield 80% power to detect a clinically meaningful difference in IADL disability, assuming at least 23% of the cohort was cognitively impaired. Of 139 patients invited to participate, 103 (74.1%) signed consent

forms and 101 received cognitive testing at baseline. Those who declined to participate did not differ significantly from study participants on the basis of sex, race, or age. Ten patients were excluded because they lacked longitudinal functional data (i.e. functional measurements from at least two time points); the remaining 91 participants make up the cohort for this study. The study was approved by the Duke University Medical Center Institutional Review Board.

Data collection

Data were collected at baseline and during three follow-up telephone interviews, separated by at least 30 days. Three follow-up interviews were eventually completed by 86 of 91 (94.5%) study participants, although the amount of time between contacts varied due to participant availability. The mean length of follow-up was 115 ± 29 days, and maximum follow-up was 297 days. Functional data were determined by self-report, unless the participant was deemed to lack capacity during the consenting process. This occurred in the case of only one participant, whose functional data were collected from his proxy rather than by self-report. Data were collected by investigators who were not involved in the clinical care of the patients; the rehabilitation team was blinded to all data collected as part of the study.

Measures

Cognitive Status—Cognitive status was assessed with the Telephone Interview for Cognitive Status – modified (TICS-m), which was administered in person, in private exam rooms by trained administrators under supervision by a neuropsychologist. The TICS-m was chosen because it is a measure of global cognitive function that does not include visually mediated tasks such as drawing or reading (15, 16) and is not influenced by visual loss in older populations(17). The TICS-m was designed to assess orientation, comprehension, attention, naming, verbal abstraction, immediate and delayed verbal memory, working memory, and episodic memory(16, 18). Scores on this 50-point test were adjusted for years of education(19). Cognitive status was classified as normal (scores >30), marginal impairment (scores 28 to 30), or cognitive impairment (scores ≤ 27)(15, 20).

Function—The primary functional outcome measure was number of limitations in instrumental activities of daily living (IADLs). IADLs were chosen as the primary outcome because they are a commonly used and validated indicator of patient quality of life and need for care(21, 22). Further, LVR programs often specifically target IADL tasks, many of which involve both visual and cognitive ability. Participants reported their ability to perform seven IADLs: preparing meals, housework or handyman work, managing medications, getting to places outside walking distance, shopping, handling money, and using the telephone(23). Because the goal of LVR is to promote independence, responses were dichotomized to reflect independence in task performance (able to perform the task “without help” vs. requiring “some help” or “unable”).

As a secondary outcome, vision-dependent function was assessed with the Version 2000 National Eye Institute Vision Function Questionnaire – 25 (VFQ-25), a well-validated tool for measuring the influence of visual symptoms on generic health domains and daily living(24). We examined the VFQ-25 composite score and five subscales (possible scores 0 to 100, higher scores indicate better function): distance activities, near activities, mental health, role difficulties, and dependency(25). These subscales were selected because, of the eleven subscales that can be derived from the VFQ-25, the trajectories of these five seemed most likely to be affected by comorbid cognitive impairment.

Information on demographics, living status, and physician-diagnosed medical conditions was collected from participants in the baseline interview. The 15-item Geriatric Depression Scale (GDS) was administered to each participant at baseline(26). Information related to ophthalmologic medical history and visual acuity measures were abstracted from the Duke Eye Center chart by a certified ophthalmologic assistant using a standardized case report form.

Analysis

The Kruskal-Wallis test and Fisher's Exact test were used to compare univariate statistics across the three cognitive groups. To assess whether the rate of change in functional outcomes over time varied by cognitive group, we used linear mixed models (LMMs) or generalized linear mixed models (GLMMs). The GLMM does not require the data to be normally distributed and was used to model the primary outcome, total number of IADL limitations, as a Poisson distribution. Next, the probabilities of dependence in each IADL task were modeled as binomial distributions using separate GLMMs. Rates of change in VFQ-25 scores, which approximated normal distributions, were estimated with LMMS.

We elected to use mixed models for several reasons. First, they appropriately handle observations that are not independent, as is the case with repeated measurements of function. Second, they model rate of change in an outcome, which can be determined from as few as two time-points, thus minimizing the impact of missing data, but allow the inclusion of data from all available measurement occasions. Third, they are an appropriate method for modeling a longitudinal outcome when participants' length of follow-up varies, as it did in this study. The disadvantage to mixed models is that, due to instability in crowded models, we were limited in the number of covariates.

Tests of significance were conducted in models that included gender, age, cognitive group, time, and a cognitive group by time interaction term. The primary test of interest was whether the cognitive group by time interaction term was significant because this test indicates whether the functional outcome profiles are the same for each cognitive group over time. A graphical representation of this relationship was obtained by graphing population lines calculated from parameter estimates using models containing only cognitive group, time and the cognitive group by time interaction term. Analyses were conducted with SAS software version 9.2 (Cary, NC); P value ≤ 0.05 indicated statistical significance.

Results

Participant Characteristics

Of 91 participants, 17 (18.7%) were cognitively impaired (TICS-m score ≤ 27), 23 (25.3%) were marginally impaired (TICS-m score 28 to 30), and the remaining 51 (56.0%) exhibited normal cognition (TICS-m score >30). Those with better cognitive performance were more likely to be younger and married (Table 1). Compared to the other two cognitive groups, the marginally impaired group contained more females and was less likely to have received intra-ocular treatment with laser, steroid, or vascular endothelial growth factor (VEGF). Otherwise, participants in the three cognitive groups were similar at baseline with respect to socioeconomic and health status and their ophthalmologic condition and visual acuity. Only four participants described their race as non-white, reflecting the fact that the most common diagnosis in this population was age-related macular degeneration, which has a predilection for Caucasians.

Functional Status at Baseline

Most participants admitted to limitations in one or more IADL task. The three cognitive groups did not differ significantly with respect to functional measures at baseline, although a higher proportion of cognitively intact participants reported no IADL limitations at the time of enrollment (Table 2). The tendency for cognitively impaired participants to report better vision-related mental health status, as reflected by the VFQ-25 mental health subscale, approached statistical significance ($p=0.07$). The mental health subscale assesses participants' subjective perception of worry, frustration, loss of control, and embarrassment related to their vision loss.

Functional Outcomes over Time

In models that adjusted for age, gender, and cognitive group, significant longitudinal changes were observed in few functional outcomes. Participants' total number of IADL limitations did not change significantly over time ($p=0.91$). Participants became less likely to report dependence in their ability to get to places outside walking distance ($p=0.02$) and (with borderline statistical significance) in their ability to use the telephone ($p=0.09$), whereas they became more likely to report dependence in the task of meal preparation ($p<0.001$). Participants' VFQ-25 composite scores declined over time with a predicted rate of decline of approximately 1.9 point every 100 days ($p=0.02$). However, in models adjusted for the same covariates (age, gender, cognitive group), the five examined VFQ-25 subscales remained stable during the study period.

Cognitive Status and Functional Trajectories

Cognitive status was not a significant predictor of functional trajectory for most of the outcomes we considered, including the study's primary outcome (total IADL limitations). Although the difference is not statistically significant, Figure 1 shows that while the average number of IADL limitations decreased slightly for cognitively intact and cognitively impaired participants over time (indicating functional improvement), marginally impaired participants reported increasing IADL limitations. When we modeled the probability of dependence in individual IADL tasks, the functional trajectories of the three cognitive groups differed significantly for only one task: "meal preparation." Also seen in Figure 1, the probability of being dependent in meal preparation increased over time in all cognitive groups but increased most steeply in the marginally impaired group ($p=0.03$).

Baseline cognitive status was not a significant predictor of the VFQ-25 composite score or four of five VFQ-25 subscale trajectories. However, compared to the other cognitive groups, the 23 participants with marginal cognitive impairment reported significantly steeper declines in the distance activities subscale ($p=0.05$, Figure 2). The distance activities subscale assesses the perceived impact of vision loss on participants' ability to see movies, plays, or sporting events or to accomplish specific activities that require distance vision such as recognizing store names or reading street signs and managing stairs and curbs.

Discussion

To our knowledge, this is the first study to describe the longitudinal functional impact of cognitive impairment in older LVR patients with macular disease. Baseline cognitive status did not predict the rate of change in twelve of fourteen functional outcomes. However, when functional trajectories did differ significantly by cognitive group, the worst trajectories were observed among participants with marginal impairment, rather than those with more severe cognitive impairment. This finding merits further investigation but suggests that standardized LVR protocols may be needed to better detect and accommodate subtle cognitive deficits.

Our hypothesis was that more significant cognitive impairment would be associated with steeper functional decline. Thus, it initially seemed counter-intuitive that patients who were marginally cognitively impaired would exhibit worse functional trajectories than patients with more severe impairment. This finding may reflect the ability of low vision providers to successfully modify care when cognitive deficits are obvious. Although all study participants received a “standard” LVR intervention, this type of longitudinal rehabilitation program has greater potential for variability and individualization than a simple intervention, such as a medication. For example, when a patient exhibits obvious memory loss, astute LVR providers may repeat their instructions, simplify their rehabilitation plans, or enlist a caregiver to reinforce training at home. Because formal cognitive assessment is not regularly performed in low vision rehabilitation, subtle cognitive impairment may go undetected, making these patients less likely to receive appropriately tailored care. Moreover, individuals with marginal cognitive ability may represent a particularly tenuous group of patients, being at high risk for functional deterioration yet unlikely to benefit from an education-based intervention, such as LVR, that does not routinely account for cognitive deficits.

Of course, other potential explanations for the findings exist, including the possibility that the results were impacted by bias. For example, the self-reported functional outcomes were subject to reporting bias, and the more cognitively impaired individuals may have over-estimated their functional independence and well-being. Previous authors have observed that self-reported outcomes are reliable in older adults with mild cognitive impairment, but become unreliable when cognitive impairment is severe(27). It is notable that “severe” cognitive impairment was rare in our study cohort, probably because referring physicians recognize that LVR may be minimally effective for patients with advanced dementia. Among the cognitively impaired participants in the current study, only one had a TICS-m score below twenty. Nonetheless, future studies should include measures of function which are performance-based or caregiver-reported.

It is also possible that observed differences between the cognitive groups occurred due to confounding. Although all cognitive groups had similar visual acuity at baseline, a lower proportion of marginally impaired participants had received treatment with laser, steroids, or VEG-F. This difference could have confounded the results if the group with marginal cognitive impairment experienced a more precipitous deterioration in visual acuity over the course of the study, which exacerbated their functional decline. Similarly, although the cognitively impaired and marginally impaired groups had similar baseline scores on the geriatric depression scale, the cognitively impaired group had more favorable scores on the VFQ-25 mental health subscale. Depressive symptomatology has been associated with worse vision-specific function in macular disease populations(28), and better affective health in the cognitively impaired group may have confounded our results.

We also acknowledge that multiple tests were performed, increasing the likelihood that significant differences were the result of alpha error (observing a difference between groups due to sampling error, or chance, rather than true population difference). It is notable, however, that we consistently observed that the group with marginal cognitive impairment under-performed the other two groups on several longitudinal measures of function. This result merits confirmation in future study.

Nevertheless, the current study is an important contribution to the limited existing data on functional trajectories of older macular disease patients in LVR. One controlled study involving macular disease patients in the Veterans Affairs (VA) system found that the group which received an intensive, outpatient LVR intervention exhibited mean improvements in scores on the VA Low-Vision Visual Functioning Questionnaire over four months, whereas

the control group exhibited declines(10). Of note, that study excluded participants with TICS-m scores of 30 or less(10). A separate group reported that three months after visiting a low-vision clinic at a private academic institution, patients' VFQ scores were stable or modestly improved (by two to eight points on some subscales), but that study population was younger than our patient population, and the cognitive status of participants was not reported(29). In our study, most VFQ measures did not change significantly over time, and the average VFQ-25 composite score trended down slowly at a rate of about 1.9 points per 100 days. Previous work suggests that differences of four to six points on this tool correlate to clinically significant change in macular disease populations(30). The VFQ-25 is responsive to disease progression and worsening visual acuity (10, 31); thus, relative stabilization of VFQ scores in older adults with macular disease likely represents intervention success.

To our knowledge, this is the first study to describe trajectory patterns for specific IADL tasks in an LVR population. Regardless of cognitive status, participants were at risk of becoming dependent in meal preparation over time, whereas favorable functional trajectories were observed for "getting places outside walking distance" and "using the telephone." This study does not provide insights about why disability status was more dynamic for certain tasks or why participants seemed most susceptible to new disability in "meal preparation." The specific goals of LVR are typically set by the patient at the initial evaluation, and functional improvement may be most likely for tasks that the patient identifies as points of emphasis. Our finding that task-specific ability changed over the course of this relatively short study highlights the importance of continually reassessing dependence on crucial self-care tasks (such as meal preparation) and targeting rehabilitation efforts when declines are noted.

Several limitations of this study may affect interpretation of results. First, information is lacking on changes in visual acuity and health status, which may have influenced functional outcomes during the follow-up period. Second, the outcomes are validated indicators of function, but because each patient's rehabilitation plan is goal-directed and individualized, the extent to which each rehabilitation intervention targeted the particular items and tasks assessed in the functional questionnaires is unknown. Although changes in these functional measures may not fully reflect success or failure of rehabilitation, understanding how cognitive status may predict these important functional outcomes in this population is valuable. Third, the study was conducted at a single site, diminishing generalizability of findings.

Conclusions

This study contributes important information about the functional trajectories of older macular disease patients receiving low vision services and expands on previous studies by considering the functional consequences of comorbid cognitive impairment. A high proportion of macular disease patients who were referred for LVR had detectable cognitive deficits, but global cognitive status at baseline was not a robust predictor of functional outcomes. The patients who experienced significantly steeper functional decline on some measures were those with marginal cognitive impairment. The findings suggest that patients with mild or moderate cognitive impairment should not be excluded from LVR. However, LVR programs should be prepared to detect and accommodate a range of cognitive abilities.

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Figure 1. Predicted Trajectories of IADL Disability by Cognitive Group

Panel A depicts the predicted number of limitations in seven instrumental activities of daily living (IADL) over time. Panel B depicts the predicted probability of being dependent in the IADL task of meal preparation. P values refer to a test of whether functional trajectories differ by cognitive group.

Figure 2. Predicted Trajectories of VFQ-25 Composite and Activities Scores by Cognitive Group
 Panel A depicts the predicted score on the VFQ-25 composite scale over time. Panel B depicts the predicted VFQ-25 distance activities subscale score and Panel C depicts the predicted VFQ-25 near activities subscale score. P values refer to a test of whether functional trajectories differ by cognitive group.

Table 1

Characteristics of the Cohort

Characteristic	Full Cohort N=91	Cognitive Impairment N=17	Marginal Cognitive Impairment N=23	No Cognitive Impairment N=51	P value
Age in years, Mean $\pm$ SD	80.1 $\pm$ 8.0	86.1 $\pm$ 7.1	81.7 $\pm$ 8.2	77.4 $\pm$ 7.0	<0.001
% Female	64.4%	64.7%	91.3%	52.0%	0.003
% White	95.6%	100%	87.0%	98.0%	0.08
Education					0.15
% high school	34.1%	47.1%	43.5%	25.5%	
% any college	46.1%	47.0%	30.4%	52.9%	
% beyond college	19.8%	5.9%	26.1%	21.6%	
% Married	46.2%	17.6%	26.1%	64.7%	<0.001
% Depression (GDS 5)	26.4%	29.4%	30.4%	23.5%	0.76
No. of 14 comorbid diagnoses endorsed, Mean $\pm$ SD	2.7 $\pm$ 1.6	2.9 $\pm$ 1.9	2.6 $\pm$ 1.3	2.7 $\pm$ 1.6	0.90
TICS-m scores, Mean $\pm$ SD	31.1 $\pm$ 5.1	24 $\pm$ 4.9	29.0 $\pm$ 0.8	34.5 $\pm$ 2.9	N/A
Range of scores	7 to 44	7 to 27	28 to 30	31 to 44	
Best corrected ETDRS visual acuity in better eye, median (IQR)	20/50 (20/40 to 20/100)	20/50 (20/50 to 20/100)	20/50 (20/32 to 20/80)	20/50 (20/40 to 20/160)	0.78
Type of primary Mac. disease					0.13
% Wet AMD	55.8%	56.2%	38.1%	63.3%	
% Dry AMD	20.9%	31.2%	28.6%	14.3%	
% DME	1.2%	6.3%	0%	0%	
% ERM	2.3%	0%	4.8%	2.1%	
% Other	19.8%	6.3%	28.6%	20.4%	
% with history of laser, steroid, or anti VEG-F treatment	57.8%	53.3%	33.3%	70.2%	0.02
% with a change in visual acuity of 3 or more ETDRS chart lines in previous year	21.5%	28.6%	19.1%	20.5%	0.81
% who report functional limitations from vision loss for at least one year duration	97.6%	100%	95.2%	97.9%	0.68

P values reflect significance of differences across cognitive groups SD = standard deviation; GDS = geriatric depression scale; TICS-m score = Telephone Interview for Cognitive Status-modified; ETDRS = early treatment diabetic retinopathy study; IQR = inter-quartile range; AMD = age-related macular disease; DME = diabetic macular edema; ERM = epiretinal membrane; LVR = low vision rehabilitation; VEG-F = vascular endothelial growth factor

Table 2

Functional Measures at Baseline, by Cognitive Group

Function Measure	Full Cohort N=91	Cognitive Impairment N= 17	Marginal Cognitive Impairment N=23	No Cognitive Impairment N=51	p value
Total IADL Limitations (Possible range 0 to 7), Median (IQR)	2.0 (1.0 to 4.0)	2.0 (1.0 to 4.0)	2.0 (1.0 to 4.0)	1.0 (0 to 4.0)	0.21
VFQ-25 100-point Composite Score, Mean $\pm$ SD	64.6 $\pm$ 16.3	70.1 $\pm$ 14.7	61.4 $\pm$ 16.8	64.3 $\pm$ 16.3	0.29
VFQ-25 Subscales, Mean $\pm$ SD (100-point scales)					
Mental Health	61.9 $\pm$ 23.9	74.3 $\pm$ 22.9	57.1 $\pm$ 26.4	60.1 $\pm$ 22.2	0.07
Role Difficulties	56.7 $\pm$ 28.0	58.5 $\pm$ 23.1	47.7 $\pm$ 31.8	60.1 $\pm$ 27.3	0.27
Dependency	62.8 $\pm$ 29.3	65.8 $\pm$ 32.6	58.0 $\pm$ 31.9	63.9 $\pm$ 27.4	0.69
Distance Activities	49.6 $\pm$ 29.1	49.5 $\pm$ 34.5	47.4 $\pm$ 32.7	50.5 $\pm$ 26.0	0.84
Near Activities	45.3 $\pm$ 24.4	49.0 $\pm$ 26.5	45.9 $\pm$ 21.4	43.9 $\pm$ 25.3	0.78

p values reflect significance of differences across cognitive groups IADL = instrumental activities of daily living; VFQ = Visual function questionnaire IQR = inter-quartile range; SD = standard deviation