Understanding reported cognitive dysfunction in older adults with cardiovascular disease

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Abstract: Older adults with cardiovascular disease (CVD) often report experiencing significant cognitive dysfunction in everyday life and exhibit deficits on neuropsychological testing. However, the relationship between subjective and objective cognitive dysfunction is inconsistent across studies and requires closer examination. Participants included 84 older adults with documented CVD and no history of neurological or severe psychiatric disorder. All participants underwent echocardiogram and neuropsychological assessment and completed self-report measures of perceived cognitive dysfunction, depression, and health-related quality of life. Results showed that concerns regarding distractibility and sustained attention were most common. Level of reported cognitive dysfunction was significantly related to depressive symptoms, quality of life, and performance on multiple cognitive tests. Exploratory regression analyses showed that depressive symptoms, physical health-related quality of life, and speeded sustained attention predicted reports of cognitive dysfunction, whereas demographic variables, cardiac output, and other cognitive tests did not. Should they be replicated, these findings suggest that reports of cognitive dysfunction in older adults with CVD largely reflect depressive symptoms and reduced quality of life.

Keywords: cardiovascular disease, cognition, quality of life, depression

Introduction

There is growing evidence that cardiovascular disease (CVD) is a risk factor for cognitive dysfunction long prior to onset of stroke or dementia (Mazzucchi et al 1986; Kalra et al 1993; Grubb et al 1996; Elwood et al 2002; O'Reilly et al 2003; Trojano et al 2003). These findings are consistent with the notion of vascular cognitive impairment (VCI), a proposed continuum of cognitive deficits that ranges from "brain at risk" to vascular dementia (Hachinski and Bowler 1993; Bowler et al 1999). Older adults with CVD are believed to fall in the middle of this continuum, exhibiting cognitive deficits and cerebrovascular disease without the functional impairment found in dementia (Mazzucchi et al 1986; Kalra et al 1993; Grubb et al 1996; Elwood et al 2002; O'Reilly et al 2003; Trojano et al 2003; Cook et al 2004; Kuo and Lipsitz 2004).

Given these findings, it is not surprising that older adults with CVD often report experiencing significant cognitive dysfunction in everyday life (Khatri et al 1999). However, less straightforward is the fact that these reports are more closely related to depressive symptoms than objective test performance (Newman et al 1989; Khatri et al 1999; Bergh et al 2002). Such findings suggest that older CVD patients lack insight into their level of cognitive function. Reduced awareness of cognitive function is not unique to CVD patients and is found in persons with a variety of psychiatric and neurological conditions. For example, persons with bipolar disorder and patients in the early stages of dementia also exhibit little awareness of their impairments (Burdick et al 20005; Spitznagel and Tremont 2005).

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However, methodological concerns of past studies encourage a re-examination of the relationship between subjective and objective cognitive impairment in CVD patients. Careful review shows that previous work often examined only cardiothoracic surgery patients, selected predictors from limited domains (ie, only cognitive and affective), and employed tests that tap cognitive abilities other than those patients report as being impaired (Newman et al 1989; Khatri et al 1999; Raja et al 2004). Each of these methodological choices may distort the observed relationship between reported cognitive dysfunction and test performance, raising the possibility that reports of cognitive dysfunction in CVD patients may not be as inaccurate as originally believed.

To clarify this possibility, the present study examined self-reported cognitive dysfunction in older adults with heterogeneous history of CVD. Variables were chosen to closely match those used in past studies and to extend the assessment of cognitive abilities that patients reported as being impaired. Using this method, we hypothesized that multiple factors, including cognitive performance, would be related to self-reported cognitive dysfunction of older adults with CVD.

Methods

The following methods were approved by the local Institutional Review Board prior to study onset.

Participants

Participants included 84 older adults enrolled in a prospective study of the neurocognitive consequences of CVD. They were required to have a documented history of CVD, a total score on the Mini Mental Status Examination (MMSE) above cutoff for dementia (Folstein et al 1975), and no history of neurological or severe psychiatric disorder. Participants were recruited from cardiology clinic patients and not selected based on concerns regarding possible cognitive dysfunction. Participants averaged 69.79 ± 7.87 years of age and 14.41 ± 2.72 years of education. Average MMSE score (28.52 ± 1.67) and cardiac ejection fraction (58.87 ± 11.65) were within normal ranges.

In terms of medical history, 46% of participants had a history of myocardial infarction, 37% coronary artery bypass, 11% valve repair or replacement, 13% heart failure, 74% hypertension, and 23% type 2 diabetes. Approximately 10% of participants had prior history of mild head injury, 9% transient ischemic attack, and 13% had history of depression.

Instrumentation

Subjective cognitive complaints

The Cognitive Difficulties Scale (CDS) is a pen-and-paper measure of subjective difficulties in attention, memory, perception, and psychomotor abilities (McNair and Kahn 1983). It has been used in both healthy and patient samples, including persons with CVD (McNair and Kahn 1983; Derouesne et al 1993; Derouesne et al 1999; Khatri et al 1999). The relationship among the CDS, depression, and cognitive function varies across studies. Although some studies show a strong relationship between the CDS and performance on neuropsychological tests, others find the CDS is more closely related to affective symptoms than cognitive dysfunction (Gass and Apple 1997; Derouesne et al 1999; Khatri et al 1999; Burdick et al 2005; Spitznagel and Tremont 2005).

Neuropsychological tests

All participants completed a neuropsychological test battery comprising tasks commonly used during clinical neuropsychological evaluation (Table 1). Domains included:

1) *Attention* (Trailmaking Test Part A [Reitan 1958], Digit Symbol-Coding [Wechsler 1997], Digit Span [Wechsler 1997], Stroop Color Word Test composite score for Word and Color trials [Golden 1978]);
2) *Executive function* (Trail Making Test B [Reitan 1958], Lexical Fluency [FAS; Eslinger et al 1984], Similarities [Wechsler 1997], Stroop Color Word Test Interference [Golden 1978]);
3) *Memory* (California Verbal Learning Test [Delis et al 1987], Brief Visuospatial Memory Test-Revised [Benedict 1997]);
4) *Language* (Boston Naming Test (Kaplan et al 1983], Category Fluency [Morris et al 1989]);
5) *Visuopatial skills* (Hooper Visual Organization Test [Hooper 1983], Block Design [Wechsler 1997]);
6) *Motor function* (Grooved Pegboard Test for dominant and nondominant hand [Klove 1963]).

Depression

The Beck Depression Inventory (BDI) assesses vegetative, affective, and cognitive symptoms of depression and has been used extensively in patient populations (Beck and Steer 1993; Richter et al 1998).

Quality of life

The Medical Outcomes Study SF-36 (Ware et al 1994) is a measure of subjective health used extensively in healthy

and medical populations, including persons with CVD (Rumsfeld et al 1999, 2001). Its eight domains were summarized into a Physical Composite Summary (PCS) and Mental Composite Summary scores (MCS), representing physical and mental quality of life, respectively.

Procedure After participants completed a written informed consent process, all instruments were administered in a one-to-one format by trained research team members. Participants completed self-report instruments after neuropsychological testing.

Data analysis Three sets of analyses were conducted to better understand the self reported cognitive dysfunction of older adults with CVD. First, bivariate Pearson correlation was used to determine the relationship between reported difficulties on the CDS and objective test performance. An item analysis was then conducted to identify the cognitive abilities of greatest concern in our sample. Finally, exploratory regression analyses were conducted to determine the relative contribution of various factors to CDS total score. More specifically, we conducted multiple regression with backward elimination using CDS total score as the dependent variable. Predictors included demographic characteristics, measures of cardiovascular disease, depressive symptoms, quality of life, and performance on tests that tap the most commonly reported areas of dysfunction.

Results

Test performance and reported cognitive dysfunction

Participants typically performed well on neuropsychological testing, with their combined performance falling within 1.5 standard deviations of the normative mean on all tests (Table 1). Bivariate correlation showed that CDS total score was significantly related to depressive symptoms on the BDI, quality of life indices from the SF-36, and performance on multiple neuropsychological tests (Table 1).

Table 1 Neuropsychological test performance, impairment and correlation to reported cognitive dysfunction

Test	Mean (SD)	>1.5 SD from mean	Correlation to CDS
Reported cognitive difficulties			
CDS total score	37.32 (21.56)	No	–
Attention			
Trials A	37.76 (12.44)	No	0.25[1]
Stroop Word and Color	43.52 (5.83)	No	−0.36[2]
WAIS-III Digit Span	17.51 (3.95)	No	−0.14
WAIS-III Symbol Coding	55.40 (13.89)	No	−0.19[1]
Executive function			
Stroop Interference	−13.65 (6.87)	No	0.15
Trials B	99.57 (51.47)	No	0.17
Lexical Fluency (FAS)	36.33 (11.84)	No	−0.17
WAIS-III Similarities	20.96 (5.24)	No	−0.14
Memory			
CVLT Trials 1–5 Total	46.58 (11.90)	No	−0.21[1]
CVLT Short Free Recall	9.23 (3.29)	No	−0.10
CVLT Long Free Recall	9.30 (3.52)	No	−0.14
CVLT Discrimination	91.33 (7.59)	No	−0.15
BVMT Trials 1–3 Total	16.83 (6.98)	No	−0.23[1]
BVMT Delayed Recall	6.94 (3.18)	No	−0.22[1]
BVMT Discrimination	5.05 (1.15)	No	−0.24[1]
Language			
Boston Naming Test	54.52 (5.65)	No	−0.19[1]
Category Fluency (Animals)	19.90 (5.53)	No	−0.05
Visuospatial			
HVOT	23.44 (3.74)	No	0.03
WAIS-III Block Design	31.85 (11.18)	No	−0.10
Motor			
Grooved Pegboard (D)	95.91 (26.37)	No	0.10
Grooved Pegboard (ND)	106.61 (33.41)	No	0.10
Mood			
Beck Depression Inventory	5.93 (4.49)	No	0.55[2]
Quality of life			
Physical Component Scale	42.73 (9.50)	No	−0.28[1]
Mental Component Scale	55.01 (7.73)	No	−0.45[2]

NOTE: All test scores are raw scores.

[1] two-tailed $p < 0.05$.

[2] two-tailed $p < 0.01$.

Abbreviations: BVMT, Brief Visuospatial Memory Test-Revised; CVLT, California Verbal Learning Test; CDS, Cognitive Difficulties Scale; D, dominant hand; ND, nondominant hand; HVOT, Hooper Visual Organization Test; WAIS, Wechsler Adult Intelligence Scale.

Item analysis

An item analysis was then conducted on the CDS. Corrected item-total correlations were used to identify the cognitive tasks of greatest concern to our sample of older adults with CVD. Results showed that difficulties with distractibility and sustained attention were most common, followed by language difficulties (Table 2).

Predicting reported cognitive dysfunction

Finally, exploratory regression analyses were conducted to examine the relative contribution of various factors to the subjective cognitive difficulties of older adults with CVD. Stepwise regression with backward elimination showed significant prediction of CDS total score ($F[3, 56] = 13.31$,

Table 2 Most common subjective cognitive problems in older adults with cardiovascular disease

Rank		Corrected item-total correlation
1	I cannot keep my mind on one thing.	0.76
2	I miss the point of what others are saying.	0.75
3	I have trouble getting out information that is at the tip of my tongue.	0.71
4	I find it hard to keep my mind on a task or job.	0.70
5	I find it hard to understand what I read.	0.68
6	I forget right away what people say to me.	0.68
7	I need to have instructions repeated several times.	0.68
8	I have trouble describing a program that I just watched on television.	0.66
9	When interrupted during reading, I have trouble finding my place again.	0.66
10	I have to do things very slowly to make sure I'm doing them right.	0.65

$p < 0.001$), with the final model accounting for 41.6% of the variance (Table 3). Three predictors remained significant, namely: BDI total score, PCS from the SF-36, and speeded sustained attention from the Stroop Color Word Test. Demographic variables, cardiac output, and other cognitive tests were not retained in the final model.

Discussion

The present study is the first to demonstrate that attention and language abilities are the most common cognitive concerns of older CVD patients. Reduced attentional abilities may be expected in persons with CVD, as they often show reduced performances on neuropsychological tasks tapping attention, psychomotor speed, and executive function (Mazzucchi et al 1986; Kalra et al 1993; Grubb et al 1996; Elwood et al 2002; O'Reilly et al 2003; Trojano et al 2003). Language impairment is not traditionally associated with CVD in the absence of stroke, though word-finding difficulties are part of both the normal aging process and a symptom of Alzheimer's disease (Mackay et al 2002; Testa et al 2004). Finding that language performance was within expected ranges implicates normal aging as a likely cause, but the very early effects of a neurodegenerative process cannot be fully ruled out. Prospective examination of our and other samples of CVD patients will help clarify whether reported word-finding difficulties predict later conversion to Alzheimer's disease.

Table 3 Predicting cardiovascular disease (CVD) total score in older adults with CVD

Included variables	B	b	p
Beck Depression Inventory	2.18	0.45	< 0.01
Physical Quality of Life	−0.48	−0.21	0.05
Stroop Sustained Attention	−1.10	−0.30	< 0.01
Intercept	92.80		
			$R^2 = 0.42$
			Adjusted $R^2 = 0.39$
			$R = 0.66$

Excluded variables	B	p	Partial correlation
Age	0.03	0.78	0.04
Education	−0.12	0.26	−0.15
Cardiac Output	0.12	0.27	0.15
Mental Quality of Life	−0.19	0.16	−0.19
Digit Symbol-Coding	−0.04	0.77	−0.04
CVLT Trial 1	−0.05	0.63	−0.07
FAS	0.04	0.73	0.05
Boston Naming Test	−0.13	0.22	−0.17

Abbreviations: CVLT, California Verbal Learning Test.

In the present study, reports of cognitive dysfunction were associated with reduced performance on multiple cognitive tests. However, the observed relationships were modest in size (range from −0.19 to −0.36) and explained little of the total variance. In contrast, depressive symptoms were closely related to reports of cognitive dysfunction ($r = 0.55$). Finding reported cognitive problems are more closely related to depressive symptoms than actual test performance is consistent with many past studies (Newman et al 1989; Khatri et al 1999; Raja et al 2004), though the exact reason for this relationship remains unclear. Several possible explanations for this finding exist, including shared method variance, the known effects of subclinical depression on cognitive performance, or an as yet unidentified factor (Wollert and Buchwald 1979).

Analyses also showed that quality of life contributes to the report of cognitive dysfunction in older adults with CVD. A relationship between quality of life and reported cognitive dysfunction has previously been found in healthy and other patient populations (Collins and Abeles 1996; Dijkstra et al 1998; Levy-Cushman and Abeles 1998). Physical illness is known to limit cognitive performance in several ways, including greater distraction, hypervigilance, and pre-occupation during tasks (Luoto et al 1999; Gasquione 2000). These changes would adversely impact the same attentional abilities reported by our sample as being impaired. However, once again, the effects of shared method variance on this relationship cannot be fully excluded and replication in other samples is needed.

The present findings highlight the complicated relationship among reported cognitive dysfunction,

depression, and actual test performance. Like many others, we found a weak relationship between reported cognitive dysfunction and actual test performance. This pattern emerged in our sample with intact test performance. Interestingly, reported cognitive dysfunction is also unrelated to actual test performance in Alzheimer's patients and psychiatric samples with significant cognitive impairment (Burdick et al 2005; Spitznagel and Tremont 2005). This pattern suggests two likely explanations. One possibility is that people generally have little insight into their level of cognitive function. This inability may well result from the difficulty in accurately evaluating cognitive function in everyday life or the effects of limited executive functioning (which has been associated with reduced awareness in patient populations (Michon et al 1994; Singh-Manoux et al 2003; Kuo et al 2004). A second possible explanation involves the use of cross sectional methodology. It is possible that between-subject differences (eg, level of depressive symptoms) obscure more subtle within-subject changes (eg, reporting a slight change from previous levels). Prospective examination of reported cognitive dysfunction and actual test performance are much needed, particularly studies that collect detailed information regarding subjective change in cognitive function.

The present study has important implications for clinicians working with older adults with CVD. Based on the present findings, CVD patients reporting cognitive dysfunction are most appropriately referred for neuropsychological evaluation to determine the relative contribution of depressive symptoms, reduced quality of life, and actual cognitive impairment to these complaints. Clinicians may also want to consider additional referral to exercise or rehabilitation program, as they are associated with improved mood, quality of life, and cognitive performance in both healthy and patient populations (Barnes et al 2003; Stewart et al 2003; Gunstad et al 2005).

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