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ORIGINAL ARTICLE

Cardiopulmonary Exercise Testing Is Well Tolerated in People With Alzheimer-Related Cognitive Impairment

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Abstract

Objective: To retrospectively assess whether cardiopulmonary exercise testing would be well tolerated in individuals with Alzheimer disease (AD) compared with a nondemented peer group.

Design: We retrospectively reviewed 575 cardiopulmonary exercise tests (CPETs) in individuals with and without cognitive impairment caused by AD.

Setting: University medical center.

Participants: Exercise tests (N=575) were reviewed for nondemented individuals (n=340) and those with AD-related cognitive impairment (n=235).

Interventions: Not applicable.

Main Outcome Measures: The main outcome measure for this study was reporting the reason for CPET termination. The hypothesis reported was formulated after data collection.

Results: We found that in cognitively impaired individuals, CPETs were terminated because of fall risk more often, but that overall test termination was infrequent—5.5% versus 2.1% (P=.04) in peers without cognitive impairment. We recorded 6 cardiovascular and 7 fall risk events in those with AD, compared with 7 cardiovascular and 0 fall risk events in those without cognitive impairment.

Conclusions: Our findings support using CPETs to assess peak oxygen consumption in older adults with cognitive impairment caused by AD. Archives of Physical Medicine and Rehabilitation 2014;95:1714-8

Increasing attention is being paid to the benefits of physical activity, specifically aerobic exercise, to support and maintain cognitive performance as we age,[1] and as a potential therapeutic intervention for those with cognitive impairment caused by Alzheimer disease (AD).[2] Most of the guidelines for exercise testing and prescription for this clinical population are based on available literature for older adults.[3] As we move toward recommending and incorporating aerobic exercise for people with early AD, using the information generated from the cardiopulmonary exercise test (CPET) will provide useful information regarding cardiopulmonary fitness and guiding exercise prescription. The published data to date of those characterized with mild cognitive impairment likely related to AD and cardiopulmonary exercise testing[4-6] have not reported information regarding exercise testing termination criteria and whether cardiopulmonary exercise testing is well tolerated in people with early AD. Recent reviews have noted the lack of CPET-based aerobic exercise prescription in clinical trials.[7]

When considering cardiopulmonary exercise testing for persons with cognitive impairment, several concerns have been expressed such as the reliability of the test for research or exercise prescription,[3] and impaired communication and understanding during the CPET.[8] Additional concerns may include poor safety awareness and the potential for behavioral disturbance. In addition, we suspect that there is a continued hesitance in the research[7]

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and clinical communities to perform CPETs in this population, although there are few data to support these concerns.

To our knowledge, no data have been published regarding CPET tolerability, and cardiovascular and fall risk adverse events in individuals with AD. The University of Kansas Alzheimer's Disease Center has performed 235 CPETs on individuals with cognitive impairment related to possible and probable AD. Our goal was to retrospectively assess whether individuals with AD had early CPET termination compared with a nondemented peer group.

Methods

Participants

We reviewed source documentation for 575 tests on 326 unique individuals. This dataset included all CPETs performed for 3 research studies between July 2005 and March 2013: the Brain Aging Project on which we have previously reported,[9] the Alzheimer's Disease Exercise Program Trial (NCT01128361),[9] and the Trial of Exercise for Aging and Memory (NCT01129115). The procedures used in this study were approved by the Institutional Review Board at Kansas University Medical Center. Written informed consent was obtained from all individuals or their legal representative before study participation. In cases where a legal representative consented for the participant, the participant provided informed assent. All participants, regardless of suspected cognitive impairment, underwent a semistructured interview with a knowledgeable informant. Medications, medical history, education, demographic information, and family history were collected. We determined dementia status and probable etiology based on clinical evaluation. All participants included in the cognitive impairment cohort for this retrospective analysis were judged to have possible or probable AD. This evaluation method has a diagnostic accuracy for AD of 93%,[10] and is sensitive to detecting the earliest stages of AD.[11] Severity of dementia was characterized using the Clinical Dementia Rating (CDR) scale.[4] The CDR assesses impairment in multiple domains. An algorithm is used to generate a global dementia severity score (very mild, 0.5; mild, 1; moderate, 2; severe, 3), or the domains can be summed to create a more sensitive measure of dementia severity (CDR sum of boxes, range 0−18).

Cardiopulmonary exercise test

Our CPET methodology has been previously published.[12] Briefly, we conducted a medical screen to determine cardiac risk and whether any absolute or relative contraindications to exercise testing were present.[13,14] We used a modified Cornell Bruce protocol on a treadmill. Speed and incline changes were preset and controlled by the metabolic analysis software.[a] Expired gases were captured using a nose clip, mouthpiece, and 2-way nonrebreathing valve.[b] Participants were oriented to the Borg Rating of Perceived Exertion (RPE) 6 to 20 scale before beginning the CPET. The exercise physiologist would point to the number on the RPE scale, and to determine the perceived exertion level, participants communicated by head nodding (yes) or shaking left to right (no). Thirty seconds before the beginning of the next stage, the exercise physiologist reminded participants of their previous level and asked them about subsequently greater levels until the participant indicated "yes." Participants could elect to end the test by raising their hand. Our staff exercise physiologist led the test, while a nurse took blood pressures on the opposite side of the exercise physiologist. For safety, a spotter stood behind and to the side of the participant, and a medical monitor (physician or nurse practitioner) observed real-time electrocardiography. We used American College of Sports Medicine (ACSM) recommendations for absolute and relative indications for terminating tests.[13]

We recorded any instance of early termination of the CPET by the medical monitor because of cardiovascular or fall risk concerns (ie, unsteady gait) or by the study participant. We followed guidelines for indications for termination of exercise testing.[13,14] Absolute indications for test termination were as follows: (1) decrease in systolic blood pressure of ≥10mmHg from baseline blood pressure despite an increase in workload, when accompanied by other evidence of ischemia; (2) moderate to severe angina; (3) increasing nervous system symptoms (eg, ataxia, dizziness, or near syncope); (4) signs of poor perfusion (cyanosis or pallor); (5) sustained ventricular tachycardia or other arrhythmia including second- or third-degree atrioventricular block that interferes with cardiac output during exercise; and (6) ST-segment elevation (≥1.0mm in leads without diagnostic Q waves, other than V1 or aVR). Relative indications for early test termination were as follows: (1) ST or QRS changes such as excessive ST depression (>2mm horizontal or downsloping ST-segment depression) or marked axis shift; (2) arrhythmias other than sustained ventricular tachycardia, including multifocal premature ventricular contractions, triplets of premature ventricular contractions, supraventricular tachycardia, heart block, or bradyarrhythmias; (3) unusual shortness of breath, wheezing, leg cramps, or claudication; (4) development of bundle branch block or intraventricular conduction delay that could not be distinguished from ventricular tachycardia; (5) increasing chest pain; and (6) hypertensive response (systolic blood pressure >250mmHg and/or diastolic blood pressure >115mmHg).

The remaining CPETs were terminated either volitionally by the participant (peak exercise test) or by the exercise physiologist if balance was compromised or when 3 of 4 of the following maximal effort criteria were met[15]: (1) plateau in oxygen consumption with additional load (<100-mL increase over last 1min mean of prior stage); (2) heart rate >90% of age-predicted maximum; (3) respiratory exchange ratio >1.1; and (4) RPE ≥17.

Statistical analysis

Group differences between those with and without cognitive impairment were tested using parametric or nonparametric tests, as appropriate. Differences in early test termination between those with and without cognitive impairment were evaluated using the Fisher exact test. For exercise test values, only those tests that were not terminated early by the testing staff were included in analyses. Analyses were conducted using R (version 2.15.3[c]).

Results

Participant characteristics

Table 1 provides summary demographic and testing information. The group with cognitive impairment had fewer women but was

List of abbreviations:

ACSM	American College of Sports Medicine
AD	Alzheimer disease
CDR	Clinical Dementia Rating
CPET	cardiopulmonary exercise test
RPE	rating of perceived exertion