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Cognitive Impairment in Men Treated with Luteinizing Hormone-Releasing Hormone Agonists for Prostate Cancer: A Controlled Comparison

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Abstract

Goals of Work—Data suggest that treatment with luteinizing hormone-releasing hormone (LHRH) agonists may be associated with reduced cognitive functioning. The purpose of the current study was to compare rates of clinically-significant cognitive impairment in men treated with LHRH agonists to a matched sample of healthy men without cancer.

Patients and Methods—Participants were 48 men receiving LHRH agonist therapy for prostate cancer and 48 men with no history of cancer matched to patients on age and education. Participants were administered a battery of neuropsychological tests assessing the domains of verbal memory, verbal fluency, visuospatial memory, visuospatial abilities, and executive function. Clinically-significant impairment on individual tests was defined as −1.5 SD below the normative mean; overall impairment was defined as impaired performance on two or more tests.

Main Results—Patients did not differ from comparison subjects in age, ethnicity, race, education, or annual household income (*p*s > .05). No statistically significant differences in test means were found. Nevertheless, patients displayed greater overall impairment in cognitive functioning than comparison subjects (42% of patients versus 19% of comparison subjects, $p < .05$). Among patients, prior prostatectomy was associated with impaired immediate and delayed verbal memory (*p*s < .05).

Conclusions—Current findings suggest that LHRH agonists and surgery for prostate cancer are associated with clinically-significant impairment in cognitive functioning. Longitudinal studies are needed to examine changes in cognitive impairment before and after surgical and hormonal treatment for prostate cancer. Patients undergoing LHRH agonist therapy should be monitored for cognitive changes while on treatment.

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Keywords

Prostatic Neoplasms; Neuropsychological Tests; Cognition

In 2007 the American Society of Clinical Oncology (ASCO) issued updated, evidence-based guidelines for hormonal management of androgen-sensitive prostate cancer [1]. These guidelines recommend luteinizing hormone-releasing hormone (LHRH) agonists as the initial treatment for symptomatic metastatic disease and consider them to be of potential benefit in three other groups: 1) patients with rising prostate specific antigen (PSA) levels following surgery or radiotherapy, 2) patients with node positive disease who are asymptomatic for metastases, and 3) patients who are asymptomatic for metastases but have evidence of metastases on imaging studies. Indeed, studies suggest survival benefits of LHRH agonists plus radiotherapy for men with locally advanced disease [2, 3] and LHRH agonists for men with PSA-only recurrence [4]. Consequently, larger numbers of prostate cancer patients are being treated with LHRH agonists and for longer periods of time [5, 6]. Side effects of LHRH agonists include hot flashes, osteopenia, reduced sexual desire, fatigue, and risk of diabetes and cardiovascular disease [7–9].

There is conflicting evidence to suggest that impaired cognitive functioning may also be a side effect of LHRH agonists. Five studies have reported poorer cognitive functioning in patients on LHRH agonists compared to pre-treatment baseline or comparison participants [10–14]. For example, Cherrier and colleagues [15] evaluated cognitive functioning in patients prior to initiation of LHRH agonist therapy, after 3 and 9 months of treatment, and 3 months after the end of treatment. A sample of age- and education-matched men without cancer were also evaluated. Patients displayed significant declines in spatial reasoning, spatial abilities, and working memory following initiation of LHRH agonist therapy. Similarly, cognitive declines in spatial abilities and memory were reported in another study of patients assessed prior to LHRH agonist therapy and 3 and 9 months later compared to men without cancer [13]. In contrast, four studies have reported no differences or improved cognitive functioning in patients [16–19]. For example, in one of the largest studies to date, Joly and colleagues [19] found no differences in incidence or severity of cognitive impairment between 57 prostate cancer patients receiving LHRH agonist therapy and 51 age-matched controls without cancer. Another study found significant improvement over time in patients treated with LHRH agonist therapy assessed prior to initiation of treatment and 6 and 12 months later [10].

These conflicting results may be due in part to methodological limitations of existing research, such as absence of a comparison group in some studies and failure to match patients and comparison groups on variables related to cognitive functioning (e.g., age, education) in other studies. Moreover, data are sparse regarding rates of cognitive impairment in men treated with LHRH agonists. The present study was designed to address previous methodological limitations and provide rates of clinically-significant cognitive impairment in patients. Previous studies have reported average cognitive test score performance, which do not indicate what percentage of patients experience clinically-significant cognitive impairment. Information regarding rates of clinically-significant

cognitive impairment is important to help clinicians and patients evaluate potential risks of treatment. It was hypothesized that men receiving LHRH agonist therapy would exhibit higher rates of clinically-significant cognitive impairment than an age- and education matched comparison group of healthy men without cancer.

Materials and Methods

Participant Selection and Recruitment

Following IRB approval, participants were recruited between September 2005 and July 2007.

Patient participants—Patients were eligible to participate if they: 1) were able to speak and read English; 2) had at least an eighth grade education; 3) were receiving treatment with either an LHRH agonist alone or combined anti-androgen/LHRH agonist therapy for non-metastatic prostate cancer; 4) had been treated continuously with either an LHRH agonist alone or combined anti-androgen/LHRH agonist therapy for at least six months prior to assessment; 5) were not suspected to be demented as assessed by clinical history and the Short Portable Mental Status Questionnaire;[20] and 6) were able to provide informed consent. Patients were screened for eligibility and were asked to provide written informed consent during a scheduled outpatient appointment with their oncologist at the Moffitt Cancer Center (MCC) or the James A. Haley VAMC (JAHVAMC).

Comparison participants—Men were eligible to participate if they: 1) were able to speak and read English; 2) had at least an eighth grade education; 3) reported no history of cancer diagnosis other than basal cell skin carcinoma; 4) were within five years of age of the patient participant to whom they were being matched; 5) had the same educational level as the patient participant to whom they were being matched (i.e., ≤12 years versus >12 years); 6) were not suspected to be demented as assessed by the Short Portable Mental Status Questionnaire [20]; 7) had a working telephone number and mailing address; 8) were able to provide informed consent. Comparison participants were recruited using contact information contained in a commercially-available marketing database (Marketing Systems Group, Fort Washington, PA).

Measures

Age, race, ethnicity, marital status, annual household income, and education were assessed in all participants through self-report. Time since diagnosis, disease stage, type and length of continuous treatment with LHRH agonist therapy, and previous treatment for prostate cancer were assessed in patients through medical chart review. Neuropsychological tests were selected based on a review of published literature at the time of study design [10–12, 17, 18]. Preference was given to tests with demonstrated reliability, validity, and availability of published norms. The battery was designed to assess five major domains of cognitive functioning: verbal memory, verbal fluency, visuospatial memory, visuospatial abilities, and executive function.

Verbal memory—Verbal memory was assessed using the Hopkins Verbal Learning Test-Revised (HVLT-R) [21, 22]. Respondents were given three trials to learn a list of twelve concrete nouns organized into three taxonomic categories. After an intervening period in which other tests were administered, respondents were given a delayed free recall task. Two measures of memory performance were derived from this task: immediate recall and delayed free recall.

Verbal fluency—The Controlled Oral Word Association test (COWA) [23] was used to assess verbal fluency. It consists of three one-minute trials during which respondents were asked to generate as many words as they could think of beginning with a given letter of the alphabet, excluding proper nouns, numbers, and the same word with a different suffix. A total score was determined by calculating the number of different words produced across the three trials (C, F, and L).

Visuospatial memory—Visuospatial memory was assessed using the Brief Visuospatial Memory Test-Revised (BVMT-R) .[24]. Participants were presented with six geometric figures printed in a 2 x 3 array. In three learning trials, participants viewed the array for 10 seconds and were then asked to draw as many of the figures as possible in their correct location. After a 25-minute delay, participants were asked to draw the figures from memory. Then, participants were asked to identify the six figures from among twelve figures. These procedures were used to obtain two summary scores. The immediate recall score represents the number of design features correctly reproduced across the three learning trials. The delayed recall score represents the number of design features correctly reproduced 25 minutes following presentation.

Visuospatial abilities—The Card Rotations Test [25] was used to assess visuospatial abilities. Participants were provided with 20 separate items and were asked to match a target stimulus figure with drawings showing the same stimulus figure in possible different rotations. A point was awarded for each item when the stimulus figure selected was the target stimulus figure rotated on a 360-degree axis (i.e., not “flipped over”). A total score was computed based on the number of stimulus figures correctly identified in three minutes minus the number incorrectly identified.

Executive function—Executive function was assessed with the Symbol Digit Modalities Test (SDMT) [26]. It requires participants to write the number that corresponds with each symbol for a series of 110 items in which the symbol but not the number appears. Participants identified the correct number using a key provided in which a different abstract symbol was matched with a different number. A total score was determined by calculating the number of items correctly completed in 90 seconds.

Statistical Analysis

Raw test scores on neuropsychological tests were converted to standardized scores based on published normative data to facilitate comparisons between tests. Scores on the HVLT-R, BVMT-R, were standardized according to age-adjusted norms [27, 28]. SDMT scores were standardized according to age- and education-adjusted norms [26]. Scores on the COWA

were standardized according to education-adjusted norms [29]. Scores on the CRT were standardized using norms that were neither age- nor education-adjusted [25]. When using age-adjusted norms for patients older than the eldest normed group (i.e., BVMT-R, SDMT), norms from the eldest normed group were used. In accordance with previous research, [30] clinically-significant impairment on individual tests was defined as −1.5 SD below the normative mean; overall impairment was defined as impaired performance on two or more tests. Chi square analyses and t tests were used to determine significant differences in study variables between the patient and comparison groups. Effect sizes were calculated for differences in impairment in accordance with Chinn [31]. Post hoc analyses were conducted to explore relationships between cognitive impairment and clinical characteristics; these consisted of Pearson correlations, point biserial correlations, and phi coefficients. Analyses were conducted using SAS (Cary, NC) statistical software.

Results

Sociodemographic and clinical characteristics of the sample are displayed in Table 1. In 8 of 48 control subjects, there were discrepancies between level of education reported during eligibility screening and reported during the assessment. However, there were no significant differences overall between patient and comparison groups in education or other sociodemographic characteristics. Data from these 8 participants were included in analyses. As shown in Table 2, patients displayed lower scores and higher rates of impairment on five of seven individual tests and a greater number impaired tests, although chi squares and t tests indicated that these differences were not statistically significant. However, the patient group displayed significantly greater overall impairment (defined as the percentage of individuals with impaired performance on two or more tests) than the comparison group. Effect sizes for comparisons in which the patient group showed greater impairment than the comparison group were in the small to medium range as defined by Cohen (*d*s=.26–.62) [32]. Results of exploratory post-hoc analyses examining relationships between clinical characteristics and cognitive impairment are shown in Table 3. Findings indicated that previous prostatectomy was associated with significantly higher rates of impairment in immediate and delayed verbal memory.

Discussion

The aim of the current study was to examine rates of clinically-significant cognitive impairment in prostate cancer patients treated with LHRH agonists compared to a matched comparison group of healthy men without cancer. Patients were significantly more likely to display overall cognitive impairment, defined as impaired performance on two or more tests, than comparison participants. Patients also exhibited lower mean functioning and higher rates of impairment than comparison participants on five of seven tests of cognitive functioning, although these differences were not statistically significant. Effect sizes for group differences in impairment were in the small to medium range. This pattern of findings suggests that there are likely additional clinically-significant cognitive differences between patients and comparison participants but that our study did not have enough power to detect them. While this study is one of the largest to date, additional larger studies are needed to confirm our findings.

To our knowledge, only one other study has reported rates of clinically-significant impairment in patients treated with LHRH agonists. In a sample similar to ours in terms of age, education, and time on treatment, Joly and colleagues [19] reported no significant differences in incidence of cognitive impairment between patients (23%) and an age-matched comparison group of men without cancer (35%). The sizable difference in percentages indicates that the study may have been underpowered to detect group differences. Regarding mean cognitive performance levels, the lack of significant findings in the current study stands in contrast with previous research comparing men treated with LHRH agonists to men without cancer. For example, Green and colleagues [12] reported that patients on LHRH agonists performed significantly poorer on verbal memory and attention than a non-cancer comparison group at pre-treatment baseline and 6 and 12 months later. The sample was similar to ours in terms of age and estimated IQ but were less educated (i.e. a mean of 9 years). Bussiere and colleagues [14] also found that patients displayed significantly worse retention of verbal information than a healthy comparison group; their sample was similar to ours in terms of age and education but had been on androgen deprivation therapy longer (i.e., a mean of 5 years). Taken together, available data suggest that there may be subgroups of patients treated with LHRH agonists who experience clinically-significant cognitive impairment. The presence of these subgroups may not be reflected in mean performance levels. Future studies should report both mean performance levels and rates of cognitive impairment.

An unexpected finding in the current study was the relationship between prior prostatectomy and impairment in immediate and delayed verbal memory in patients treated with LHRH agonists. This finding suggests that there may be deleterious effects of anesthesia on this older population of cancer patients. To the best of our knowledge, no other study has examined the relationship between surgery and cognitive functioning in men with prostate cancer. Further study is needed to examine potential effects of surgery on cognitive functioning in this population, such as through the use of multivariate analyses controlling for other relevant clinical and demographic characteristics.

The current study is characterized by a number of strengths, such as recruitment of a matched comparison group. Comparison participants were matched to patients on age and education, two variables that can affect cognitive functioning. This matching procedure was successful, as comparison participants did not differ from patients on these or other sociodemographic variables. Additionally, comparison participants were recruited from a mailing list, rather than nominated by patients, to ensure independence between patient and comparison participant responses. Another strength of the study was examination of rates of clinically-significant impairment. Information regarding clinically-significant impairment serves to enhance the interpretation of study results by researchers, clinicians, and patients. The study is also characterized by some limitations. The sample was predominantly white and non-Hispanic, limiting our ability to draw conclusions about the effects of LHRH agonist therapy for other racial and ethnic groups including African-Americans, a group disproportionately affected by prostate cancer. Because the study was not longitudinal, we are unable to draw conclusions about change in cognitive impairment over time in patients versus comparison participants. For example, it is unclear whether patients may have exhibited cognitive impairment prior to undergoing LHRH agonist therapy. Longitudinal

studies are needed to determine whether rates of cognitive impairment increase following initiation of LHRH agonist therapy. Finally, the current study did not assess levels of testosterone in patients and controls. Thus, we cannot be certain that men in the comparison group were characterized by normal levels of testosterone. This issue is important because the risk of hypogonadism increases with age [33].

Although it is unclear how LHRH agonist therapy may exert an influence on cognitive functioning, one possibility is through reduction in testosterone and/or estradiol. Testosterone supplementation has been associated with improved cognitive functioning in healthy older men [34, 35]. In addition, some studies suggest that reductions in testosterone and estradiol in patients on LHRH agonist therapy are correlated with reductions in cognitive functioning [16, 18], although other studies have found no differences [13, 17]. Additional reasons for reduced cognitive functioning in patients on LHRH agonist therapy may include poor sleep due to hot flashes or cancer-related distress. Future studies are needed to determine the mechanisms through which LHRH agonist therapy is associated with cognitive impairment.

In summary, results of the current study suggest that men treated with LHRH agonist therapy evidence higher rates of clinically-significant overall cognitive impairment compared to men with no history of cancer. In terms of research implications, these findings highlight the need for larger, longitudinal studies to assess magnitude, nature, and course of cognitive changes associated with LHRH agonist therapy. In terms of clinical implications, current findings suggest that patients should be monitored for cognitive changes while on LHRH agonist therapy as part of a comprehensive assessment of treatment-related toxicity.

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References

1. Loblaw DA, Virgo KS, Nam R, Somerfield MR, Ben-Josef E, Mendelson DS, Middleton R, Sharp SA, Smith TJ, Talcott J, Taplin M, Vogelzang NJ, Wade JL 3rd, Bennett CL, Scher HI. Initial hormonal management of androgen-sensitive metastatic, recurrent, or progressive prostate cancer: 2006 update of an American Society of Clinical Oncology practice guideline. J Clin Oncol. 2007; 25:1596–1605. [PubMed: 17404365]
2. Bolla M, Collette L, Blank L, Warde P, Dubois JB, Mirimanoff RO, Storme G, Bernier J, Kuten A, Sternberg C, Mattelaer J, Lopez Torecilla J, Pfeffer JR, Lino Cutajar C, Zurlo A, Pierart M. Long-term results with immediate androgen suppression and external irradiation in patients with locally advanced prostate cancer (an EORTC study): a phase III randomised trial. Lancet. 2002; 360:103–106. [PubMed: 12126818]
3. Bolla M, de Reijke TM, Zurlo A, Collette L. Adjuvant hormone therapy in locally advanced and localized prostate cancer: three EORTC trials. Front Radiat Ther Oncol. 2002; 36:81–86. [PubMed: 11842758]
4. The Medical Research Council Prostate Cancer Working Party Investigators Group. Immediate versus deferred treatment for advanced prostatic cancer: initial results of the Medical Research Council Trial. The Medical Research Council Prostate Cancer Working Party Investigators Group. Br J Urol. 1997; 79:235–246. [PubMed: 9052476]

5. Barrass BJ, Thurairaja R, Persad RA. More should be done to prevent the harmful effects of long-term androgen ablation therapy in prostate cancer. BJU Int. 2004; 93:1175–1176. [PubMed: 15180599]
6. Nelson CJ, Lee JS, Gamboa MC, Roth AJ. Cognitive effects of hormone therapy in men with prostate cancer: a review. Cancer. 2008; 113:1097–1106. [PubMed: 18666210]
7. Sanda MG, Dunn RL, Michalski J, Sandler HM, Northouse L, Hembroff L, Lin X, Greenfield TK, Litwin MS, Saigal CS, Mahadevan A, Klein E, Kibel A, Pisters LL, Kuban D, Kaplan I, Wood D, Ciezki J, Shah N, Wei JT. Quality of life and satisfaction with outcome among prostate-cancer survivors. N Engl J Med. 2008; 358:1250–1261. [PubMed: 18354103]
8. Ulloa EW, Salup R, Patterson SG, Jacobsen PB. Relationship between hot flashes and distress in men receiving androgen deprivation therapy for prostate cancer. J Consult Clin Psychol. in press.
9. Keating NL, O'Malley AJ, Smith MR. Diabetes and cardiovascular disease during androgen deprivation therapy for prostate cancer. J Clin Oncol. 2006; 24:4448–4456. [PubMed: 16983113]
10. Salminen E, Portin R, Korpela J, Backman H, Parvinen LM, Helenius H, Nurmi M. Androgen deprivation and cognition in prostate cancer. Br J Cancer. 2003; 89:971–976. [PubMed: 12966411]
11. Green HJ, Pakenham KI, Headley BC, Yaxley J, Nicol DL, Mactaggart PN, Swanson C, Watson RB, Gardiner RA. Altered cognitive function in men treated for prostate cancer with luteinizing hormone-releasing hormone analogues and cyproterone acetate: a randomized controlled trial. BJU Int. 2002; 90:427–432. [PubMed: 12175403]
12. Green HJ, Pakenham KI, Headley BC, Yaxley J, Nicol DL, Mactaggart PN, Swanson CE, Watson RB, Gardiner RA. Quality of life compared during pharmacological treatments and clinical monitoring for non-localized prostate cancer: a randomized controlled trial. BJU Int. 2004; 93:975–979. [PubMed: 15142146]
13. Jenkins VA, Bloomfield DJ, Shilling VM, Edginton TL. Does neoadjuvant hormone therapy for early prostate cancer affect cognition? Results from a pilot study. BJU Int. 2005; 96:48–53. [PubMed: 15963119]
14. Bussiere JR, Beer TM, Neiss MB, Janowsky JS. Androgen deprivation impairs memory in older men. Behav Neurosci. 2005; 119:1429–1437. [PubMed: 16420147]
15. Cherrier MM, Aubin S, Higano CS. Cognitive and mood changes in men undergoing intermittent combined androgen blockade for non-metastatic prostate cancer. Psychooncology. 2008
16. Salminen EK, Portin RI, Koskinen AI, Helenius HY, Nurmi MJ. Estradiol and cognition during androgen deprivation in men with prostate carcinoma. Cancer. 2005; 103:1381–1387. [PubMed: 15717315]
17. Almeida OP, Waterreus A, Spry N, Flicker L, Martins RN. One year follow-up study of the association between chemical castration, sex hormones, beta-amyloid, memory and depression in men. Psychoneuroendocrinology. 2004; 29:1071–1081. [PubMed: 15219659]
18. Salminen EK, Portin RI, Koskinen A, Helenius H, Nurmi M. Associations between serum testosterone fall and cognitive function in prostate cancer patients. Clin Cancer Res. 2004; 10:7575–7582. [PubMed: 15569988]
19. Joly F, Alibhai SM, Galica J, Park A, Yi QL, Wagner L, Tannock IF. Impact of androgen deprivation therapy on physical and cognitive function, as well as quality of life of patients with nonmetastatic prostate cancer. J Urol. 2006; 176:2443–2447. [PubMed: 17085125]
20. Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc. 1975; 23:433–441. [PubMed: 1159263]
21. Benedict R, Schretlen D, Groninger L, Brandt J. Hopkins Verbal Learning Test Revised: normative data and analysis of inter-form and test-retest reliability. Clin Neuropsychologist. 1998; 12:43–55.
22. Brandt J. The Hopkins Verbal Learning Test: development of a new memory test with six equivalent forms. Clin Neuropsychologist. 1991; 5:125–142.
23. Benton, A.; Hamsher, K. Multilingual Aphasia Examination. AJA Associates; Iowa City, IA: 1989.
24. Benedict, R. Brief Visuo-Spatial Memory Test-Revised (BVMT-R). Psychological Assessment Resources; Odessa, FL: 1997.
25. Ekstrom, RB.; French, JW.; Hartman, HH. Manual for kit of factor-referenced cognitive tests. Educational Testing Service; Princeton, N.J: 1976.

26. Smith, A. Symbol Digit Modalities Test (SDMT) Manual (Revised). Western Psychological Services; Los Angeles, CA: 1982.
27. Brandt, J.; Benedict, RHB. Hopkins Verbal Learning Test Revised. Psychological Assessment Resources; Lutz, FL: 2001.
28. Benedict, RHB. Brief Visuospatial Memory Test Revised. Psychological Assessment Resources; Lutz, FL: 1997.
29. Spreen, O.; Strauss, E. A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary. 2. Oxford University Press; New York: 1998.
30. Wefel JS, Lenzi R, Theriault RL, Davis RN, Meyers CA. The cognitive sequelae of standard-dose adjuvant chemotherapy in women with breast carcinoma. Cancer. 2004; 100:2292–2299. [PubMed: 15160331]
31. Chinn S. A simple method for converting an odds ratio to effect size for use in meta-analysis. Statistics in Med. 2000; 19:3127–3131.
32. Cohen, J. Statistical power analysis for the behaivoral sciences. 2. Lawrence Erlbaum; Hillsdale, NJ: 1988.
33. Lunenfeld B. Androgen therapy in the aging male. World J Urol. 2003; 21:292–305. [PubMed: 14576959]
34. Cherrier MM, Asthana S, Plymate S, Baker L, Matsumoto AM, Peskind E, Raskind MA, Brodkin K, Bremner W, Petrova A, LaTendresse S, Craft S. Testosterone supplementation improves spatial and verbal memory in healthy older men. Neurology. 2001; 57:80–88. [PubMed: 11445632]
35. Moffat SD, Zonderman AB, Metter EJ, Blackman MR, Harman SM, Resnick SM. Longitudinal assessment of serum free testosterone concentration predicts memory performance and cognitive status in elderly men. J Clin Endocrinol Metab. 2002; 87:5001–5007. [PubMed: 12414864]

Table 1

Sample Sociodemographic and Clinical Characteristics.

	Patients (n=48)	Comparison subjects (n=48)	Statistic
Age – M (range)	69 (51–87)	71 (47–86)	t = −.83
Ethnicity (% non-Hispanic)	48 (100%)	44 (94%)	χ^2 = 3.16
Race (% Caucasian)	45 (94%)	47 (98%)	χ^2 = 1.04
Marital status (% married)	39 (81%)	35 (73%)	χ^2 = .94
Education			χ^2 = 1.09
≤ 9 years	2 (4%)	1 (2%)	
10–12 years	8 (17%)	6 (13%)	
13–16 years	30 (62%)	30 (62%)	
> 16 years	8 (17%)	11 (23%)	
Annual household income (% ≥ $40k)	34 (72%)	35 (76%)	χ^2 = .17
Patient recruitment site			
MCC	40 (83%)		
JAHVAMC	8 (17%)		
Years since diagnosis – M (SD)	5.11 (4.54)		
LHRH Type			
Lupron (leuprolide)	30 (63%)		
Zoladex (goserelin)	18 (37%)		
Continuous months on LHRH agonist – M (SD)	23.25 (19.30)		
Prior prostatectomy (% yes)	20 (43%)		
Prior brachytherapy (% yes)	11 (23%)		
Prior external beam radiotherapy (% yes)	26 (55%)		

Table 2

Means, Standard Deviations, and Rates of Clinically-Significant Cognitive Impairment in Patients and Non-Cancer Comparison Group.

	Patients (n=48)		Comparison subjects (n=48)		Effect size
	Mean (SD)	**Impaired**	**Mean (SD)**	**Impaired**	
HLVT Immediate Recall	43.96 (11.20)	12 (25%)	45.69 (9.73)	7 (15%)	.37
HVLT Delayed Recall	45.04 (9.87)	9 (19%)	46.98 (9.86)	6 (13%)	.26
BVMT Immediate Recall	45.15 (12.34)	12 (25%)	47.88 (11.71)	7 (15%)	.37
BVMT Delayed Recall	49.49 (13.48)	10 (21%)	50.94 (11.45)	5 (10%)	.45
COWA Total	44.02 (11.15)	12 (25%)	45.47 (12.44)	7 (15%)	.37
Symbol Digit Items Completed	51.12 (9.35)	4 (8%)	50.01 (10.00)	5 (10%)	−.14
Card Rotations Test	49.42 (6.99)	0 (0%)	48.07 (5.91)	2 (4%)	--
Overall Impairment	--	20 (42%) [a]	--	9 (19%) [a]	.62
Number of Impaired Tests	1.23 (1.44)	--	.81 (1.30)	--	.31

[a] Difference between patients and comparison subjects at p<.01

Note: t scores are displayed. Effect sizes refer to differences in rates of impairment.

Table 3

Correlations Between Cognitive Impairment and Clinical Characteristics in Patients (n=48)

	Time on LHRH	Type of LHRH[a]	Concurrent anti-androgen[b]	Prior prostatectomy[b]	Prior brachytherapy[b]	Prior radiotherapy[b]
HLVT Immediate Recall[c]	.13	−.05	−.15	.29*	−.09	−.06
HVLT Delayed Recall[c]	.13	−.04	−.12	.35*	−.27	.11
BVMT Immediate Recall[c]	.10	−.05	.05	−.01	.14	−.06
BVMT Delayed Recall[c]	.01	−.20	.08	−.04	.23	−.18
COWA Total[c]	−.10	−.05	.05	.09	.25	.04
Symbol Digit Items Completed[c]	−.08	−.08	−.08	−.11	.01	−.03
Card Rotations Test[c]	--	--	--	--	--	--
Overall Impairment[c]	−.02	.04	−.04	.22	.03	−.09
Number of Impaired Tests – M (SD)	.06	−.13	−.04	.18	.08	−.05

[a] 0= leuprolide, 1= goserelin,

[b] 0=no, 1=yes,

[c] 0=no impairment, 1=impairment

* $p<.05$