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Article

Hypertension associated with neurocognitive performance among persons with type 2 diabetes: a brief report

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ABSTRACT

Background Among persons with type 2 diabetes (T2DM) it is not known whether the presence of hypertension could have a detrimental effect on learning ability and whether repeated exposure to information changes the amount of information retained. The aim of this study was to determine cross-sectional evidence for a differential burden to cognitive functioning among persons with T2DM and comorbid hypertension (HTN).

Methods This study performed a cross-sectional, retrospective analysis, by medical chart review, of patients with a diagnosis of T2DM.

Results Medical records information for history of HTN, age, gender and cognitive performance scores were recorded and analysed for 112 T2DM patients, with an average age of 60 years (SD = 13.84). Differences in cognitive performance scores were compared between patients with and without a history of HTN. The results show that participants who were diagnosed with hypertension produced lower average Rey Auditory–Verbal Learning Test scores than individuals who are not diagnosed with hypertension. Trial 2 was the only trial to prove significant with a *P*-value of 0.041.

Conclusions Our results support previous studies showing that HTN is associated with increased risk to learning and memory functioning, although the degree of interference with these cognitive functions could not be determined from our research. Recognising that people diagnosed with HTN may be at risk for poorer learning and memory skills, future research can investigate how the length of time with the diseases affects learning and memory, and how medication management can attenuate cognitive learning and memory performance.

Keywords: cognitive function, hypertension, learning, memory, type 2 diabetes

Introduction

The evidence points to inadequate self-management of type 2 diabetes (T2DM) as the primary contributor to diabetes health-related complications, totalling an estimated $98 billion in annual costs.[1] The health burden from T2DM is primarily associated with complications due to inadequate disease management, including micro- and macro-vessel disorders and comorbid debilitating conditions such as kidney disease, cardiovascular disease, stroke, eye disease and premature mortality, and higher healthcare costs.[2] Approximately 50–80% of persons diagnosed with diabetes have knowledge and skill

deficits in self-care-related activities, and longer term glycemic control, e.g. > 6 months, is a national problem in this population.[3]

Uncovering the determinants of diabetes control is a national priority but remains elusive.[4] Previous studies have investigated the ties among mental ability, information-processing capacity, life course, health and disease processes.[5] Findings from cross-sectional and longitudinal research suggest that cognitive performance is correlated with health, longevity, job performance, socioeconomic advancement and health-reducing behaviours.[6–9] Because non-adherence increases the likelihood of premature mortality in chronic disease management, emerging lifespan perspectives suggest that prevention of mortality appears to have ties with cognitive functioning.[6,10–12] Although much remains unknown about how to best conceptualise cognitive abilities in the context of health literacy and diabetes education, some researchers speculate that mental ability processes (including learning, reasoning and planning) enhance opportunities for the prevention of adverse health behaviour and chronic disease while improving self-management behaviour when faced with ill-health.[13]

Research suggests that T2DM is linked to potential for alterations in cognitive ability,[14] that diabetes control is largely dependent on self-management behaviour[15,16] and that cognitive functioning plays some role in adherence behaviour.[17] As with other aspects of social living, learning and memory functioning can have significant impacts on activities of daily living, particularly diabetes care ranging from patient–provider interpersonal dynamics to patient self-management. It is not well understood what aspect of patients with T2DM are at higher risk for adverse changes in cognitive abilities, which would be of importance to health providers and the patients for whom they provide care. Given the health and economic burden of diabetes care, the aim of this research was to investigate whether hypertension (HTN) was associated with a worse learning performance among persons with T2DM. Emerging evidence suggests that medication self-management errors are a growing public health and patient safety concern.[18–20] Neurocognitive factors such as information acquisition, rate of learning, as well as forgetfulness may lead to increased risk for patient-based medication errors. Yet, there remains a limited understanding about the potential differences in neurocognitive abilities associated with medical comorbidity. This research hypothesised that the variability in neurocognitive performance on tasks of learning and memory would be differentially worsened as a function of HTN status.

Methods

Participants

This cross-sectional study is based upon review of an academic–medical setting affiliated clinic database, from which data extraction was restricted only to cases having a formal medical diagnosis for T2DM (n = 137). Data were not obtained from the primary care medical record which would have allowed for estimating diabetes severity. Retrieval of data was guided by a data abstraction protocol and restricted to persons without diagnoses of major depression, bipolar disorder, schizoaffective disorder, schizophrenia, traumatic brain injury and dementia. History of HTN, age, gender and cognitive performance scores were recorded. Those in the sample had a mean age of 60 years (SD = 13.8), 48.2% were male (n = 54) and around 70% (n = 75) of all participants were diagnosed with HTN. This study was approved by the institutional review board.

Measure

As one of the most common tools used to assess cognitive learning and memory skills,[21] the Rey Auditory–Verbal Learning Test (RAVLT)[22] was used in this study. Administering this test requires around 20–35 minutes. This procedure involves a researcher presenting a list of 15 words (list A) to a subject. Following the presentation of list A, the subject is instructed to freely recall these words; this occurs for five consecutive trials. On the sixth trial, a different word list (list B) is presented with the same instructions for the subject to follow for a single trial. Next, subjects are told to recall words from list A without being reminded of them by presentation. After a 20-minute delay, subjects are asked again to repeat words from list A. During the administration of the RAVLT, researchers are able to gain information about participants' memory span, proactive interference susceptibility (the degree to which old learning interferes with new learning), retroactive interference susceptibility (the degree to which new learning interferes with the recall of old information) and recognition memory. This test holds a high test–retest reliability.[23] Test–retest correlations have ranged from 0.61 to 0.86 with a retest interval of 1 month, and 0.38 to 0.70 for a retest interval of 1 year.[23]

Data analysis

Descriptive statistics, including frequencies and means, were used to analyse this data. Our independent variables were HTN, gender, education and age; the dependent variable was word-generation score. A comparison of mean levels was made between individuals with HTN and those without. Further analysis of average word-generation scores as well as significance of those scores was conducted controlling for participants gender and age. After collecting all of the data, our word-generation scores were examined in relationship to reported normative data. All analyses were performed using SPSS version 14.

Results

Of the 112 participants, 48.2% (n = 54) were male, 67% (n = 75) of the target population reported the presence of HTN and around 36% (n = 40) of the population had an education level above that of a high school diploma or its equivalent.

Word recall by age and education

As shown in Table 1, age categories were stratified to mimic the grouping order set by the normative sample.[22] To determine differences in word recall by age, data were analysed for likelihood of recalling words at or above five words from the 15-item word list, which was the overall sample average for both the reference sample and the target sample. For all trials, age was significantly correlated with word recall score. (Trial 1: r = –0.19, P = 0.05; Trial 2: r = –0.26, P = 0.01; Trial 3: r = –0.31, P = 0.01; Trial 4: r = –0.37, P = 0.01; Trial 5: r = –0.34, P = 0.01). For education level in Table 1, rate of word list learning in trial 1 (P = 0.025) and trial 3 (P = 0.021) were significantly higher for those participants with 13 years or more of education. As it relates to gender differences, males outperformed females, achieving higher scores on all word recall trials, except for trial 2.

Hypertension and word recall

Results from the independent samples t-test show that individuals without HTN produced higher RAVLT averages, compared with persons diagnosed with HTN. As shown in Figure 1, both groups experienced a gradual increase in memory recall scores with repeated exposure to the word list. However, the HTN group scores did not exceed the non-HTN group's memory recall scores for any of the five RAVLT trials.

Discussion

In our preliminary investigation based on cross-sectional, retrospective data analysis, it was observed

Table 1 Mean RAVLT performance by age, education and gender

Demographics	AVLT_1	AVLT_2	AVLT_3	AVLT_4	AVLT_5
Age (years)					
≤ 29	4.00	7.00	8.00	10.00	9.00
30–39	5.75	7.50	8.50	10.00	10.50
40–49	5.06	7.22	8.33	10.06	10.60
50–59	5.10	6.77	7.80	8.10	9.10
60–69	4.43	5.93	6.64	7.50	8.04
70–79	4.24	5.80	5.84	6.56	6.56
80–89	3.00	4.00	5.50	5.25	6.75
Education (means years completed)					
< 13	4.38	6.04	6.65	7.64	8.19
≥ 13	5.15	6.90	7.93	8.45	8.93
Gender					
Female	4.63	6.41	7.07	7.57	8.31
Male	4.70	6.28	7.11	8.31	8.57

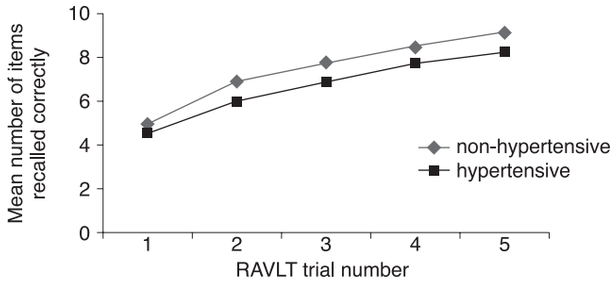

Figure 1 Hypertension effects on acquisition level

that the presence of HTN was associated with a lower rate at which persons learned words from a list. For individuals with less education, cognitive performance was significantly lower compared with people with higher education. More specifically, non-hypertensive individuals showed better acquisition and memory skills than those living with the disease. However, it was observed that with additional exposure to the word list both groups experienced modest improvements in their ability to recall learned information. The findings from this current research both validates and extends previous studies that HTN does in fact play a role in learning and memory performance.[24–27]

Conclusion

These preliminary findings suggest that persons with both T2DM and HTN may be at a differentially greater risk for experiencing information acquisition challenges. Hence, screening for learning efficacy may be advantageous in the overall care co-ordination of persons with diabetes, particularly persons with both diabetes and HTN.

Nevertheless, the generalisibility of these findings may be limited by lack of information on diabetes severity or whether participants were treated with medication to control their diabetes and/or HTN. However, this study sheds light on a potential benefit of mental ability assessment in identifying cognitive strengths and weaknesses. Currently, there is no well-accepted standard of neurocognitive care nested within diabetes primary care, which may inadvertently place persons diagnosed with T2DM at risk for self-care failure, including medication self-management safety issues. Identifying cognitive functioning areas of concern would support developing functional strategies to compensate for cognitive performance weaknesses that interfere with patient care planning, co-ordination and delivery.

In future studies, researchers will need to include information about other biomedical factors that could influence the relationship between HTN and cognitive performance in a population of persons diagnosed with T2DM. Once a foundation is laid detailing the exact effects of this HTN on learning and memory, researchers could investigate whether improving HTN control actually reverses adverse changes in cognitive functioning.

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