

# Timed Gait Test: Normative Data for the Assessment of the AIDS Dementia Complex

KEVIN R. ROBERTSON,<sup>1</sup> THOMAS D. PARSONS,<sup>1</sup>  
JOHN J. SIDTIS,<sup>2</sup> TINA HANLON INMAN,<sup>1</sup>  
WENDY T. ROBERTSON,<sup>1</sup> COLIN D. HALL,<sup>1</sup> AND  
RICHARD W. PRICE<sup>3</sup>

<sup>1</sup>AIDS Neurological Center and Department of Neurology, School of Medicine, University of North Carolina at Chapel Hill

<sup>2</sup>Geriatrics Division, Nathan Kline Institute

<sup>3</sup>Department of Neurology, University of California, San Francisco

*The Timed Gait test is a standardized procedure assessing motor dysfunction of lower extremities and gait abnormalities associated with AIDS dementia complex. Heretofore, interpretations of Timed Gait results have been hampered by the lack of normative data. We provide results on this test derived from 1,549 subjects (HIV-seronegatives (HIV-) and seropositives (HIV+) classified according to ADC stage). Timed Gait was found to be a useful screening and assessment tool for evaluating ADC and correlated with clinical ADC staging as well as more extensive structured neurological and neuropsychological evaluations. Analysis of covariance results (with age and education as covariates) revealed symptomatic HIV+(SX) and AIDS groups having significantly slower Timed Gait scores than those in the HIV- and asymptomatic HIV+(ASX) groups. The SX group obtained significantly slower timed gait scores than those in the AIDS group. There was a significant increase in Timed Gait scores with each increase in dementia staging with the HIV- subjects having the fastest mean Timed Gait scores and the HIV+ dementia stage 2+ having the slowest. These normative data should prove useful in both recognition of ADC and treatment response. Given its minimal training requirements, the Timed Gait would have utility in resource limited settings.*

## Introduction

Because walking is a complex process involving the integration of a number of central nervous system (CNS) processes, its balance and speed are commonly altered by a range of CNS lesions and diseases, including many that also cause cognitive impairment (Nutt, Marsden, & Thompson, 1993). In this report we deal with decreased gait velocity associated with HIV infection and the AIDS dementia complex (ADC) (Lopez et al., 1994; Price, Sidtis, & Brew, 1991; Robertson & Hall, 1992; Tartaglione et al., 1991). In addition to studies finding a decrease in gait velocity in normal elderly (Ho, Woo, Yuen, Sham & Chan, 1997), gait slowing has been reported in a number of disorders sometimes aggregated as “subcortical” (Cummings & Benson, 1984) such as vascular dementia (Hennerici et al., 1994), Parkinson’s

This work was supported by the following NIH grants: R01 MH62690, AI-25868, RR00046, 9P30 AI 50410; NS 037660.

Address correspondence to Kevin R. Robertson, Ph.D., AIDS Neurological Center, 3114 Bioinformatics, Department of Neurology, University of North Carolina, School of Medicine, Chapel Hill, NC 27599-7025. E-mail: kevinr@neurology.unc.edu

disease (Canning, Alison, Allen & Groeller, 1997; Ebersbach et al., 1999; Goldman, Baty, Buckles, Sahrman & Morris, 1998), Huntington's disease (Haddad & Cummings, 1997; Koller & Trimble, 1985), and incident HIV dementia. (Stern et al., 2001).

The National Multiple Sclerosis Society's Clinical Outcomes Assessment Task Force identified gait velocity as one of the primary areas in need of assessment in multiple sclerosis clinical trials (Cutter et al., 1999; Rudick et al., 1996). The Timed 25-Foot test (T25-FW) is a quantitative timed gait measure based on a timed 25-foot walk. At the beginning of each Multiple Sclerosis Functional Composite (MSFC) evaluation visit, participants are directed to the starting point of a 25-foot course and are directed to walk 25 feet as quickly as possible. The score for the T25-FW is the average of the two completed trials. Several approaches have been taken to define a clinically significant change in this measurement. A range of values has been developed for the T25-FW to assess change in walk-time that occurs during an exacerbation of multiple sclerosis. Findings suggest that a greater than 20% increase in T25-FW may indicate a significant gait change (Kaufman, Moyer, & Norton, 2000). Further, the T25-FW has been found to be characterized by excellent intrarater and interrater reliability, indicating that patients may be assessed by different (but adequately trained) physicians in longitudinal studies (Cohen et al., 2000).

In spite of multiple reports documenting the importance of gait velocity as an indicator of these diseases, methodology for measuring gait velocity has varied widely and there are no established normative values for practical use in the clinic setting. While studies have been conducted using simple techniques, these have generally used varying or inconsistent approaches or have been unclear regarding the distance that the subject is instructed to walk (5 meters – 10 meters), the speed at which the subject should walk (normal walking speed vs. fastest walking speed), and the method of measuring of the gait velocity (total time vs. time per meter) (Canning et al., 1997; Lopez et al., 1994; Tanaka et al., 1995; Tartaglione et al., 1991).

The purpose of this study is to provide normative data on the Timed Gait test, a simple measure of gait speed that is now widely used in brief quantitative test batteries in AIDS clinical trials (Price & Sidtis, 1993). Originally developed by Sidtis and Price, Timed Gait is brief and simple to administer in the setting of HIV infection. The results are examined for significant associations of gait velocity with major demographic variables, including age and gender, which may modify gait speed, though previous studies have shown inconsistent effects of these variables (Blanke & Hageman, 1989; Hageman & Blanke, 1986; Ostrosky, Van Swearingen, Burdett & Gee, 1994). This study also documents the decrease in gait velocity among a sample of HIV seropositive (HIV+) patients who have been diagnosed with ADC and staged according to its severity (Price & Brew, 1988).

## Methods

### *Subjects*

Data were collected from a total of 1,549 individuals participating in studies of the effects of HIV on the nervous system in three different settings: Memorial Sloan-Kettering Cancer Center, New York City, ( $n = 367$ ), AIDS Clinical Trials Group (ACTG, 42 sites) protocol 193 ( $n = 937$ ), and the University of North Carolina at Chapel Hill ( $n = 245$ ). Given the extensive number of sites involved, analyses were completed without intracenter analyses. Individuals who were selected for inclusion were either HIV seronegative (HIV-) or HIV + and the latter were evaluated with respect to both systemic disease stage (asymptomatic, symptomatic, or AIDS) according to the Centers for Disease Control Criteria

(CDC, 1992) and ADC stage (Price & Brew, 1988; Price & Sidtis, 1993; Sidtis & Price, 1990). Subjects with confounding neurological disorders, including those unrelated or related to HIV infection were excluded. The only known CNS disorder included in this study was ADC.

### ***Procedure***

All subjects participating in these studies signed informed consent approved by local institutional human subjects review boards. Participants complete the Timed Gait task as part of a larger evaluation, which included medical and neurological examination and a group of neuropsychological tests, which varied somewhat among testing sites. Within the neuropsychology battery, Timed Gait was administered first. Protocols were administered by trained personnel across centers (neuropsychologists at Memorial Sloan-Kettering Cancer Center and University of North Carolina at Chapel Hill; and neuropsychologists and trained nurses at ACTG sites). It should be noted that ADC stage is based on subjects' functional status and was assigned on the basis of neurologic history and examination findings and not on neuropsychological test performance. The neuropsychological batteries generally measured the following domains: Gross Motor, Fine Motor, Mental Processing Speed, Executive Functions/Mental Flexibility, Verbal Recent Memory, Figural Recent Memory, Visuospatial/Constructional, and Verbal Fluency. Timed Gait was included as part of the neuropsychological evaluation with the general rationale of providing an index of gross motor function and assessing lower extremity ability which was not otherwise assessed by these tests.

A 10-yard (30 feet) course was measured and marked on a straight unobstructed area prior to test administration. Participants were instructed to walk the 10 yards as quickly as they could without running, cross the line, turn around, and walk back the 10 yards. This was repeated three times. Subjects were timed using a stopwatch and the time to complete each trial (from start to crossing the starting line) was recorded in seconds. Subjects' final scores were recorded as the average number of the three trials (see Appendix A).

*Data Analysis.* First, Timed Gait and demographic characteristics and frequencies of the normal sample were calculated. Next, correlational analyses were run in order to examine the association between Timed Gait scores and the demographic variables of age, sex, and education. After that, Timed Gait by HIV disease stage was calculated and outliers were excluded. Since demographic differences were found, correlational analyses were run to determine the possible effects of sex, age, and education on Timed Gait scores. Given our large sample size, even minimal effect sizes were significant, as such, a correlation of  $r = 0.10$ , which accounts for 1% of the variance, was set to indicate a clinically significant correlation. Subsequently, we performed an analysis of covariance (ANCOVA) with age and education as covariates.

For the analysis of Timed Gait by ADC stage, subjects were segregated into one of five groups: HIV-; and HIV+ Stages 0, 0.5, 1, 2, 3, and 4. Outlying values were excluded from analyses by eliminating the 1st and 99th percentiles by group. Subsequent correlational analyses were run in order to determine the possible impact of these variables on Timed Gait scores. Next, we utilized ANCOVA to examine whether there were differences in Timed Gait scores according to ADC stage.

In further analyses we used ANOVA to examine Timed Gait's correlation with neurological and neuropsychological examinations. Neuropsychological tests were scored using age- and education-based norms and were converted to z scores.

In developing cutting scores and ADC classification, two possible cutting scores were chosen on the Timed Gait to indicate abnormal performance. These cutting scores were selected with regard to the type of classification desired. The first cutting score, set at the 75th percentile within the normative group, has a lower, more inclusive threshold and is intended to maximize sensitivity for the detection of HAD, while maintaining a reasonable level of specificity. This may be useful as a screening tool for ADC that would indicate a need for more comprehensive testing. Using this definition, 25 of subjects in the normative group received a Timed Gait score greater than 10.3 seconds. As such, using this cutting score, a Timed Gait score of less than 10.3 is considered normal, while a slower Timed Gait score is considered abnormal and would warrant further evaluation for dementia. The accuracy of this cutting score was measured by examining the percentage of subjects who were correctly classified into the dementia staging groups. A second cutting score of 11.22 seconds with a higher threshold (93% of the normative group) was selected to maximize both sensitivity and specificity, and was developed for purposes of diagnosis. While the lower cutoff score is appropriate for screening purposes to trigger further evaluation, a higher cutoff is warranted for diagnostic purposes.

## Results

### *Establishing 'Normal' Values for Timed Gait*

Subjects included in the normative sample were both HIV- ( $n = 87$ ) and that subset of the systemically asymptomatic HIV+ patients (ASX) with an ADC stage rated at 0 ( $n = 105$ ). This combined sample was used to define a conservative normal range for Timed Gait. In order to eliminate outliers, scores in the upper and lower one percentile of the distribution were excluded from the sample. Three subjects were eliminated resulting in a sample of 189 subjects. Subjects in the HIV- group had a significantly higher level of education ( $M = 15.8$ ,  $SD = 2.2$ ) than those in the ASX HIV+ group ( $M = 14.8$ ,  $SD = 2.7$ ). There were also a significantly higher number of women in the HIV- group (44% women) than in the ASX group (7% women). Timed Gait scores and demographic data for the combined HIV- and ASX groups encompassed 189 total subjects (77 percent male) with a mean age of 34.1 ( $SD = 8.9$ ; Range = 19 – 60), and a mean education of 15.3 years ( $SD = 2.5$ ; Range = 8 – 23). The mean Timed Gait of this control group of 189 subjects was 9.6 seconds, with a standard deviation of 1.2 seconds, and a range of 7.0–13.8 seconds.

HIV- and ASX subjects did not differ in Timed Gait scores or age. Timed Gait had a significant negative correlation with years of education,  $r = -0.33$ ,  $p < .0001$ , but no correlation with sex ( $r = 0.02$ ,  $p = 0.84$ ) or age,  $r = 0.08$ ,  $p = 0.25$ ). Although we found no effects of gender and age, we present mean values in Table 1 broken down by education, age, and sex in order to provide greater flexibility in scoring and data interpretation. These data show that subjects with 12 or fewer years of education were significantly slower on Timed Gait than those in the other education groups,  $F(2, 188) = 11.26$ ,  $p < .0002$ .

### *Timed Gait and Systemic HIV Disease Stage*

We next examined the Timed Gait results of the entire group of 1,526 subjects based upon their systemic disease classification using a Centers for Disease Control (CDC) HIV staging criteria (1992). Subjects were divided into four groups, HIV- ( $n = 87$ ), ASX ( $n = 169$ , CDC A1-2), symptomatic (SX) ( $n = 116$ , CDC B1-2), and AIDS ( $n = 1154$ , CDC A3, B3, C1-5). The upper 99th and lower 1st percentile of Timed Gait scores were eliminated from

**Table 1**  
Timed Gait in the combined HIV– and HIV+ ‘controls’ broken  
by education, age, and sex subgroups

Group	<i>n</i>	Timed Gait mean	<i>SD</i> (seconds)	Range	Statistic
Education < 13 years	32	10.25 <sup>a</sup>	1.36	8.00–13.80	$F(2, 188) = 9.00^*$
Education 13–15 years	60	9.69 <sup>b</sup>	1.16	7.30–13.29	
Education > 15 years	97	9.31 <sup>b</sup>	1.00	7.00–11.90	
Age 18–29 years	68	9.54	1.27	7.00–13.80	$F(2, 188) = 0.09$
Age 30–39 years	71	9.61	1.07	7.30–13.29	
Age 40–60 years	50	9.62	1.18	7.44–12.40	
Male	145	9.58	1.05	7.21–13.15	$\chi^2(79, n = 189) = 92.02$
Female	44	9.62	1.49	7.00–13.80	

\* $p < .05$  by ANOVA; means with different letter superscripts are significantly different at  $p < .05$  by the Student-Newman-Keuls Test, i.e., the Education < 13 differs from the other 2 groups which do not differ from each other.

the analyses by group in order to exclude outliers. This resulted in the exclusion of 41 subjects. Table 2 contains Timed Gait and demographic data for each of these groups.

Individuals in the HIV– and ASX groups were younger than those in the SX and AIDS groups. The HIV– group had the highest level of education and a higher proportion of women. The AIDS group had the lowest mean level of education and had more women than did the SX group. Given these demographic differences, correlational analyses were run in order to determine the possible effects of sex, age, and education on Timed Gait scores. Due to the size of the sample, even minimal correlations were significant. Again, since our large sample size results in significant results for even minimal effect sizes, a correlation of  $r = 0.10$  was set to adjust for the possibility of capitalizing upon chance.

Using an analysis of covariance (ANCOVA) with age and education as covariates, subjects in the SX and AIDS groups obtained significantly slower Timed Gait scores than those in the HIV– and ASX groups. Subjects in the SX group obtained significantly slower timed gait scores than those in the AIDS group (see Table 2). The finding that individuals with symptomatic disease had slower Timed Gait scores than subjects with AIDS reflected the greater variability in the symptomatic group, and likely reflects the relatively smaller size of the symptomatic group compared to the AIDS group.

### ***Timed Gait by ADC Stage***

A subset of subjects were evaluated for ADC stage based on a neurological examination and, in some cases, neuropsychological evaluation. Eight-hundred and eight subjects were staged and grouped as follows: HIV– ( $n = 87$ ), Stage 0 ( $n = 391$ ), Stage 0.5 ( $n = 235$ ), Stage 1 ( $n = 63$ ), Stage 2 ( $n = 22$ ), Stage 3 ( $n = 8$ ), and Stage 4 ( $n = 2$ ). A total of 22 outlying values were excluded from analyses by eliminating the 1st and 99th percentiles by group. Given the small

**Table 2**  
Demographic data by HIV disease stage

	HIV- (n = 85)	ASX (n = 165)	SX (n = 113)	AIDS (n = 1122)	Statistics
Age (years)	M = 34.81 <sup>a</sup> SD = 10.26 Range = 19–60	M = 35.04 <sup>a</sup> SD = 8.72 Range = 20–66	M = 38.50 <sup>b</sup> SD = 8.97 Range = 20–61	M = 37.50 <sup>b</sup> SD = 7.91 Range = 19–74	F(3, 1481) = 7.57*
Education (years)	M = 15.87 <sup>a</sup> SD = 2.22 Range = 10–22	M = 14.76 <sup>b</sup> SD = 2.90 Range = 7–23	M = 14.96 <sup>b</sup> SD = 2.86 Range = 8–21	M = 13.74 <sup>c</sup> SD = 2.72 Range = 6–20	F(3, 1481) = 25.08*
Sex	56% <sup>a</sup> Male	91% <sup>b,c</sup> Male	96% <sup>b</sup> Male	87% <sup>b,c</sup> Male	$\chi^2(3, n = 1485) = 75.74^*$
Timed Gait (seconds)	M = 9.45 <sup>a**</sup> SD = 1.06 Range = 7–12	M = 9.79 <sup>a**</sup> SD = 1.46 Range = 7.30–16.50	M = 11.77 <sup>b**</sup> SD = 4 Range = 7.9–25	M = 11.14 <sup>c**</sup> SD = 2.44 Range = 6.10–23.30	

\* $p < .05$ , means with different letter superscripts are significantly different at  $p < .05$  by the Student-Newman-Keuls Test.

number of subjects in Stages 3 and 4, Stages 2, 3, and 4 were combined to form Stage 2+ ( $n = 31$ ). Table 3 contains the demographic data and Timed Gait for each of these groups.

As can be seen in Table 3, there were differences between the ADC groups in the demographic variables. Correlational analyses were run in order to determine the possible impact of these variables on Timed Gait scores. Sex was not significantly correlated with Timed Gait ( $r = -0.004$ ). Age was significantly correlated with Timed Gait, but accounted for only 0.81% of the variance in scores ( $r = 0.09$ ). Education accounted for 2.89% of the variance in Timed Gait scores ( $r = -0.17$ ). Since education accounted for a clinically significant amount of variance in Timed Gait scores, it was included as a covariate in the ANCOVA that examined if there were differences in Timed Gait scores according to dementia staging group.

There was a significant increase in Timed Gait scores with each increase in dementia staging with the HIV- subjects having the fastest mean Timed Gait scores and the HIV+ dementia stage 2+ having the slowest.

### ***Timed Gait Correlation with Neurological and Neuropsychological Examinations***

Five-hundred eighty-one subjects underwent neurological evaluations which were scored using standardized quantitative scoring criteria (Robertson et al., 1997). Total neurological scores were significantly correlated with Timed Gait ( $r = 0.66$ , 43.56% of variance). Scores greater than or equal to 95 on the neurological examination were considered to be abnormal. When subjects were divided into groups above and below the clinical cutoff score for the neurological examination, significantly different Timed Gait scores were obtained ( $F(1, 579) = 110.21, p < .0001$ ). Subjects with normal neurological scores ( $n = 439$ ) had a mean of 10.15 ( $SD = 2.09$ ) on the Timed Gait, while subjects with abnormal neurological scores ( $n = 142$ ) had a mean Timed Gait score of 13.32 ( $SD = 5.17$ ).

Timed Gait scores were also significantly different based on the overall neuropsychological testing score. Neuropsychological tests were scored using age- and education-based norms and were converted to z scores. The mean z-score across neuropsychological tests was significantly correlated with Timed Gait score ( $r = -0.48$ , 23.04% of variance). The lowest fifth percentile of scores on the neuropsychological tests within the normative sample fell below a mean z-score of  $-0.83$ . This score was chosen to indicate overall impaired neuropsychological functioning. Subjects scoring in the non-impaired range of neuropsychological functioning ( $n = 200$ ) had significantly better Timed Gait scores ( $M = 10.04, SD = 1.66$ ) than did those in the impaired group ( $n = 45, M = 12.07, SD = 3.24$ ) ( $F(1, 243) = 36.07, p < .0001$ ).

### ***Cutting Scores and Dementia Classification***

HIV- and Stage 0 subjects were considered 'normal', while Stage 1 (mild) and Stage 2+ (moderate – end stage) subjects were diagnosed as suffering ADC. Stage 0.5 subjects were classified independently as they had equivocal/subclinical findings (Price & Brew, 1988; Sidtis & Price, 1990). To help with the use of these results in screening and diagnosis, we explored definition of two 'cutting scores' for results to use either for screening or for diagnosis. A cutting score of 10.29 correctly classified 75% of HIV- subjects as non-ADC and 55% of Stage 0 subjects as non-ADC for an overall specificity of 59%. Seventy-four percent of Stage 1 subjects were correctly classified as ADC while 100% of Stage 2+ subjects were classified as ADC. The overall sensitivity was 83%. Among the Stage 0.5 subjects, 51% were classified as ADC using a cutting score of 10.29.

**Table 3**  
Demographic data by dementia staging group

	HIV- (n = 85)	Stage 0 (n = 382)	Stage 0.5 (n = 229)	Stage 1 (n = 61)	Stage 2+ (n = 31)	Statistics
Age	M = 34.81 <sup>a</sup> SD = 10.26 Range = 19-60	M = 35.84 <sup>a,b</sup> SD = 7.80 Range = 19-63	M = 38.48 <sup>b,c</sup> SD = 8.58 Range = 23-65	M = 40.34 <sup>c</sup> SD = 8.94 Range = 24-61	M = 39.39 <sup>c</sup> SD = 9.16 Range = 20-59	F(4, 783) = 7.97*
Educ	M = 15.87 <sup>a</sup> SD = 2.22 Range = 10-22	M = 14.29 <sup>b</sup> SD = 2.58 Range = 7-23	M = 14.32 <sup>b</sup> SD = 2.87 Range = 8-21	M = 15.03 <sup>a,b</sup> SD = 2.98 Range = 7-20	M = 14.45 <sup>b</sup> SD = 3.14 Range = 8-20	F(4, 783) = 6.89
Sex	56% <sup>a</sup> Male	88% <sup>b</sup> Male	89% <sup>b,c</sup> Male	97% <sup>c</sup> Male	94% <sup>b,c</sup> Male	$\chi^2(4, n = 788) = 69.91^*$
Timed	M = 9.45*	M = 10.23*	M = 10.58*	M = 11.96*	M = 20.01*	
Gait	SD = 1.06 Range = 7-12	SD = 1.67 Range = 6.5-17.31	SD = 1.64 Range = 7.7-16.7	SD = 2.73 Range = 8.1-25	SD = 5.61 Range = 11.3-25	

\* $p < .05$ , means with different letter superscripts are significantly different at  $p < .05$  by the Student Newman Keuls Test.

A second cutting score with a higher threshold was selected to maximize both sensitivity and specificity. While the lower cutoff score is appropriate for screening purposes to trigger further evaluation, a higher cutoff is warranted for diagnostic purposes. A cutting score of 11.22 correctly classified 93% of the normative sample as non-ADC. It had a specificity of 96% among HIV- subjects and 77% among Stage 0 subjects. The overall specificity was 81%. It correctly classified 59% of the Stage 1 subjects as ADC and 100% of the Stage 2+ as ADC for an overall sensitivity of 73%. Among Stage 0.5 subjects, 28% were classified as ADC.

## Discussion

Gait disturbance has been noted as a feature of many neurological illnesses with accompanying cognitive abnormalities. However a simple, well-normed procedure for measuring gait velocity has not been established. Other studies have measured gait velocity in a very detailed manner using sophisticated equipment in order to determine specific gait characteristics (Ebersbach et al., 1999; Goldman et al., 1998; Goldman, Baty, Buckles, Sahrman & Morris, 1999; Hennerici et al., 1994). While these techniques may be useful in studying gait changes in depth, they are unrealistic for practitioners without access to special computer or video equipment. This limitation applies to most busy HIV clinics and is especially true for evaluations done in resource-limited countries where relatively simple measurements may be particularly helpful as part of a neuropsychological or neurological evaluation. The Timed Gait procedure is simple and requires no specialized equipment and limited training.

Gait changes at different ADC stages correspond to pathological changes in subcortical neurotransmitter systems and subcortical structures or frontosubcortical connections in the origin of the syndrome (Cummings & Benson, 1984). Further, gait is progressively slowed relative to various musculoskeletal syndromes that occur in HIV-infected patients, such as manifestations of reactive arthritis, Reiter's syndrome, infectious arthritis, myositis, and drug toxicity (Calabrese, 1993; Goldenberg, 1991; Rodgers, Yodlowski, & Mintzer, 1993; Winchester et al., 1987). Following the ADC Staging System, the degree of functional incapacity of motor activities resulting from pathological changes in subcortical systems and musculoskeletal syndromes ranges in severity from mild motor impairment to paraplegia. In Stages 0.5 and Stage 1, gait and strength are normal. In Stage 2, persons are ambulatory, but may require a single prop. In Stage 3, persons have major motor disability and need assistance walking. Finally, in Stage 4, persons become paraparetic (Price & Brew, 1988; Sidtis & Price, 1990).

A small number of studies have examined the effects of age and gender on gait velocity with mixed results. Hageman and Blanke (1986) compared young women ( $n = 13$ ) with older women ( $n = 13$ ) and found the older women to have slower gait speed. They found no difference in gait speed in a similar study with male subjects (Blanke & Hageman, 1988). Ostrosky et al. (1993) compared a mixed-sex group of younger ( $n = 30$ ) and older ( $n = 30$ ) subjects and found a trend toward significant differences in gait velocity. These studies each employed a fairly complicated measure of gait which requiring videotaping and an in depth analysis of gait characteristics. In addition, they included a fairly small number of subjects per group which makes conclusions regarding the effects of age and sex on Timed Gait uncertain.

This study now provides a normative base for Timed Gait test in the age range of most HIV subjects, although as individuals with this infection age, it will be necessary to extend this beyond the range studied here. It also establishes Timed Gait scores across

ADC stages, documenting slower performance with each increase in stage. Abnormal Timed Gait scores were also significantly correlated with abnormal scores on neurological and neuropsychological evaluations. Cutting scores on the Timed Gait procedure resulted in reasonably good classification rates of ADC staging, especially for use as a screening tool.

Further research may develop normative data and cutting scores for use with other neurological disorders with motor features, such as Parkinson's disease, as well as for application to older populations (Hageman & Banke, 1986; Ostrosky et al., 1994). The normative data from this study should allow one to establish the presence of abnormal Timed Gait in other HIV- populations. Overall, the Timed Gait test provides a simple and useful addition to motor skills assessment in any neuropsychological or neurological evaluation.

## References

- Blanke, D. & Hageman, P. (1989). Comparison of gait of young men and elderly men. *Physical Therapy*, 69, 144–148.
- Calabrese, L.H. (1993). Human immunodeficiency virus (HIV) and arthritis. *Rheum Dis Clin North Am.*, 19(2), 477–485.
- Canning, C., Alison, J., Allen, N., & Groeller, H. (1997). Parkinson's disease: An investigation of exercise capacity, respiratory function, and gait. *Archives of Physical Medicine and Rehabilitation*, 78, 199–207.
- Centers for Disease Control. (1992) 1993 revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. *Morbidity and Mortality Weekly Report*, 41, 1–19.
- Cohen, J.A., Fischer, J.S., Bolibrush, D.M., Jak, A.J., Kniker, J.E., and L.A. Mertz et al. (2000). Intrarater and inter-rater reliability of the MS functional composite outcome measure. *Neurology*, 54, 802–806.
- Cummings, J.L., & Benson, D.F. (1984). Subcortical dementia. Review of an emerging concept. *Arch Neurol*. 41(8):874–9.
- Cutter, G.R., Baier, M.L., Rudick, R.A., Cookfair, D.L., Fischer, J.S., Petkau, J., Syndulko, K., Weinschenker, B.G., Antel, J.P., Confavreux, C., Ellison, G.W., Lublin, F., Miller, A.E., Rao, S.M., Reingold, S., Thompson, A., Willoughby, E. (1999). Development of a multiple sclerosis functional composite as a clinical trial outcome measure. *Brain*, 122, 871–82.
- Ebersbach, G., Sojer, M., Valldeoriola, R., Wissel, J., Muller, J., Tolosa, E., & Poewe, W. (1999). Comparative analysis of Gait in Parkinson's disease, cerebellar ataxia and subcortical arteriosclerotic encephalopathy. *Brain*, 122, 1349–1355.
- Goldenberg, D.L. (1991). Septic arthritis and other infections of rheumatologic significance. *Rheum Dis Clin North Am.*, 17, 149–156.
- Goldman, W., Baty, J., Buckles, V., Sahrman, S., Morris, J. (1998). Cognitive and motor functioning in Parkinson disease: Subjects with and without questionable dementia. *Archives of Neurology*, 55, 674–681.
- Goldman, W., Baty, J., Buckles, V., Sahrman, S., & Morris, J. (1999). Motor dysfunction in mildly demented AD individuals without extrapyramidal signs. *Neurology*, 53, 956–962.
- Haddad, M. & Cummings, J. (1997). Neuropsychiatry of the basal ganglia: Huntington's Disease. *Psychiatric Clinics of North America*, 20, 791–807.
- Hageman, P. & Blanke, D. (1986). Comparison of gait of young women and elderly women. *Physical Therapy*, 66, 1382–1386.
- Hennerici, M., Oster, M., Cohen, S., Schwartz, A., Motsch, L., & Daffertshofer, M. (1994). Are gait disturbances and white matter degeneration early indicators of vascular dementia? *Dementia*, 5, 197–202.
- Ho, S., Woo, J., Yuen, Y., Sham, A., & Chan, S. (1997). Predictors of mobility decline: the Hong Kong old-old study. *Journal of Gerontology*, 52A, M356-M362.

- Kaufman, M., Moyer, D., & Norton, J. (2000). The significant change for the Timed 25-foot Walk in the multiple sclerosis functional composite. *Multiple Sclerosis*, 6(4), 286–390.
- Koller, W. & Trimble, J. (1985). The gait abnormality of Huntington's Disease. *Neurology*, 35, 1450–1454.
- Lopez, O., Becker, J., Dew, M., Banks, G., Dorst, S., & McNeil, M. (1994). Speech motor control disorder after HIV infection. *Neurology*, 44, 2187–2189.
- Nutt, J.G., Marsden, C.D., & Thompson, P.D. (1993). Human walking and higher-level gait disorders, particularly in the elderly. *Neurology*, 43, 268–279.
- Ostrosky, K., VanSwearingen, J., Burdett, R., & Gee, Z. (1994). A comparison of gait characteristics in young and old subjects. *Physical Therapy*, 74, 637–643.
- Price, R., & Brew, B. (1988). The AIDS Dementia Complex. *J of Infect Dis*, 158, 1079–1083.
- Price, R.W., & Sidtis, J.J. (1993). Evaluation of the AIDS dementia complex in clinical trials. *JAIDS*, 3 (Suppl 2): 551–560.
- Price R.W. Sidtis J.J. & Brew B.J. (1991). AIDS dementia complex and HIV-1 infection: A view from the clinic. *Brain Pathology*, 1(3):155–62.
- Robertson, K. & Hall, C. (1992). Human immunodeficiency virus-related cognitive impairment and the acquired immunodeficiency syndrome dementia complex. *Seminars in Neurology*, 12, 18–27.
- Robertson, K., Kapoor, C., Price, R., Sidtis, J., Robertson, W., van der Horst, C., & Hall, C. (1997). The Neurological Examination in AIDS: Functional Domains and Quantitative Scoring. American Academy of Neurology Meeting, Boston, MA.
- Rodgers, W.B., Yodlowski, M.L., & Mintzer, C.M. (1993). Pyomyositis in patients who have the human immunodeficiency virus. Case report and review of the literature. *J Bone Joint Surg [Am]*, 75(4), 588–592.
- Rudick, R., Antel, J., Confavreux, C. et al. (1996). Clinical outcomes assessment in multiple sclerosis. *Ann Neurol* 40, 469–479.
- Sidtis, J.J., & Price, R.W. (1990). Early HIV-1 infection and the AIDS dementia complex. *Neurology*, 40, 323–6.
- Stern, Y., McDermott, M.P., Albert, S., Palumbo, D., Selnes, O.A., McArthur, J., Sacktor, N., Schifitto, G., Kieburtz, K., Epstein, L., Marder, K.S. and Dana Consortium on the Therapy of HIV-Dementia and Related Cognitive Disorders. (2001). Factors associated with incident human immunodeficiency virus-dementia. *Archives of Neurology*, 58(3), 473–479.
- Tanaka, A., Okuzumi, H., Kobayashi, I., Murai, N., Meguro, K., & Nakamura, T. (1995). gait disturbance of patients with vascular and alzheimer-type dementias. *Perceptual and Motor Skills*, 80, 735–738.
- Tartaglione, T., Collier, A., Coombs, R., Oheim, K., Cummings, D., Mackay, R., Benedetti, J., & Corey, L. (1991). Acquired immunodeficiency syndrome: Cerebrospinal fluid findings in patients before and during long-term oral zidovudine therapy. *Archives of Neurology*, 48, 695–699.
- Winchester, R., Bernstein, D.H., Fischer, H.D., et al. (1987). The co-occurrence of Reiter's syndrome and acquired immunodeficiency. *Ann Intern Med.*, 106, 19–26.

## Appendix A

### Timed Gait

**Description:** The Timed Gait is a standardized clinical neurological examination procedure assessing motor dysfunction of the lower extremities and gait abnormalities associated with AIDS dementia complex. Subjects are timed at their fastest walking speed for a 10-yard distance, turn and return for a total of 20 yards. The task is immediately administered again by having the patient walk back the same distance.

**Materials:** Stopwatch, clipboard, Timed Gait Record Form, clearly marked distance of 10 yards in an unobstructed area.

**Discontinue:** If participant requires more than 45 seconds to complete the first trial, STOP the test and do not administer subsequent trials. If subject requires more than 45 seconds or if non-ambulatory, SCORE using the scoring rules for incomplete tests. Be sure to exclude participants with significant neuropathy and/or myelopathy. Also, ensure that participants are wearing adequate footwear. If the patient runs during the trial, stop the trial, remind the patient not to run, and redo the trial.

**Instructions:** For each trial participants begin at the starting line. Make sure there is adequate room past the start and end of the course for the subject to turn around, without having to slow down. Ensure that the stopwatch is set to 0:00. Point out where the 30-foot course ends, then instruct the patient as follows: Start by saying:

**“Walk as fast as possible without running to the line. Cross the line; then quickly turn and walk quickly back to the starting line. Ready? Go!”**

Timing is started when the participant’s lead foot is lifted and crosses the starting line. The examiner stops timing when the participant’s lead foot crosses the finish line. Next, the examiner records the participant’s walk time (in seconds), rounding each score to the nearest tenth of a second. Repeat for two additional trials.

**Scoring:** The score is the average of the three trials in seconds, accurate to 1/10th of a second (e.g., 10.7 or 11.6).

If a trial was repeated, indicate the reason on the Record Form. Record any factors that may have affected the trial but did not necessitate repetition of the trial. If the participant was unable to complete one or both of the trials, record this on the Record Form. If the test was not done, record 99. If the patient was unable to complete the test due to disability unrelated to neurological disease, record 98. If the patient was unable to complete the test due to neurological disease disability, record 97.