# Measurement of functional ability following traumatic brain injury using the Clinical Outcomes Variable Scale: A reliability study

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This study determined the inter-tester and intra-tester reliability of physiotherapists measuring functional motor ability of traumatic brain injury clients using the Clinical Outcomes Variable Scale (COVS). To test inter-tester reliability, 14 physiotherapists scored the ability of 16 videotaped patients to execute the items that comprise the COVS. Intra-tester reliability was determined by four physiotherapists repeating their assessments after one week, and three months later. The intra-class correlation coefficients (ICC) were very high for both inter-tester reliability (ICC > 0.97 for total COVS scores, ICC > 0.93 for individual COVS items) and intra-tester reliability (ICC > 0.97). This study demonstrates that physiotherapists are reliable in the administration of the COVS. **[Low Choy N, Kuys S, Richards M and Isles R (2002); Measurement of functional ability following traumatic brain injury using the Clinical Outcomes Variable Scale: A reliability study. *Australian Journal of Physiotherapy* 48: 35-39]**

Key words: Brain Injuries; Outcome Assessment (Health Care); Rehabilitation; Reproducibility of Results

## Introduction

Measurements of functional outcome following traumatic brain injury have been documented using the Functional Independence Measure (Corrigan et al 1997, Dodds et al 1993), the Functional Assessment Measure (Donaghy and Wass 1998), the Disability Rating Scale (Ashley et al 1997, Fleming and Maas 1994, Rappaport et al 1982) and the Modified Barthel Index (Fleming et al 1999). These scales may include a general measure of mobility but do not include many of the motor tasks retrained by physiotherapists. While physiotherapists may need to score the mobility measures on these scales and thus contribute to the measure of disability that such scales provide, it is important to use other specific tools so that targets can be set for clients and measurements of progress can be made for the motor tasks. A review of the available literature determined that only a few scales include measures of motor tasks that are retrained by physiotherapists following neurological disorders. Lennon and Hastings (1997) recommended the Motor Assessment Scale or the Rivermead Motor Assessment for use with neurological disorders such as stroke, while Seaby and Torrance (1989) developed the Clinical Outcomes Variable Scale (COVS) for use with clients who are aged or present with neurological or orthopaedic conditions. As there are no reported studies involving assessments with traumatic brain injury populations, it is necessary to examine each of these tools and select the one that most appropriately measures the range of abilities of the traumatic brain injury client group.

The Rivermead Motor Assessment has been used in the assessment of motor function following stroke (Collin and Wade 1990, Lincoln and Leadbetter 1979) and has been shown to be a reliable measure for gross motor function although the upper limb components of the tool have poor inter-tester reliability (Collen et al 1990). This tool includes a broad range of functional motor tasks but the scoring system is insensitive as it scores task performance as either “able” or “unable”. The Motor Assessment Scale is considered a valuable tool for evaluating functional outcome following stroke rehabilitation (Dean and Mackay 1992) and a high level of inter-tester reliability has been demonstrated (Carr et al 1985, Poole and Whitney 1988). However, this scale does not monitor wheelchair mobility or transfer skill, two tasks that may need to be retrained following traumatic brain injury.

The COVS (Seaby and Torrance 1989) includes a large range of motor tasks retrained by physiotherapists including a measure for transfer ability to and from bed and floor surfaces as well as wheelchair skill. This range of tasks, along with a scoring system that applies a range of performance indicators, was considered important for the traumatic brain injury group as a proportion of clients may remain wheelchair dependent following rehabilitation while others present with higher level balance problems (Olver et al 1996, Ashley et al 1997).

The value of the COVS (Seaby and Torrance 1989) for monitoring functional mobility in a geriatric population has been confirmed (Patrick et al 1996), while a study by Hajek et al (1997) demonstrated that the COVS could effectively

measure functional motor tasks following stroke. No such study has been undertaken for a traumatic brain injury group. Although a reliability study using four clients (Seaby and Torrance 1989) has demonstrated good inter-tester reliability of the COVS (ICC > 0.85), it has been suggested that a larger study should be undertaken (Huijbregts 1996). For these reasons, inter-tester reliability and intra-tester reliability were examined in this study as physiotherapists rated the videotaped performances of 16 traumatic brain injury clients while the range of motor tasks included on the COVS were executed.

## Method

***Subjects*** Fourteen physiotherapists with a range of experience working with neurological disorders (one to more than 10 years) participated in the initial study. Four physiotherapists participated in the test-retest stages of the study (one week and three months after the initial test period).

***Measurement*** The COVS was developed by Seaby and Torrance (1989) and includes a measure for 13 motor tasks as listed in Table 1. From this table it can be seen that the COVS monitors varying levels of performance in each motor task, allowing the performance to be rated from 1 (most dependent) to 7 (independent, efficient performance). As shown in Table 1, performance indicators denoted with an asterisk (*) were added to ensure seven options were available to describe the performance of each task. A total score is calculated by adding the scores from all items such that a minimum of 13 through to a maximum of 91 is recorded (Seaby and Torrance 1989).

A videotape was made of a senior physiotherapist administering the COVS to 16 traumatic brain injury clients. The traumatic brain injury clients represented a variety of levels in functional ability, ranging from total dependence (two clients scored 13) to independent, efficient movement (one client scored 91). Four clients required moderate assistance (COVS scores ranging from 26 to 35), four clients required assistance for all transfer and ambulation tasks (COVS scores between 40 and 65), and six clients had varying levels of ability on the motor tasks, ranging from supervision required to independently performed (COVS scores 70 to 91). All clients had been videotaped prior to the study period so that none of the participating physiotherapists had worked with the clients at the time of the video-taping.

***Procedure*** In preparation for the testing sessions a seminar was presented to all staff who had volunteered to participate in the study. The items included on the COVS were explained and the performance indicators were discussed. The staff could ask questions about the tool and were encouraged to practise using the tool prior to the commencement of the study one week after the seminar.

Three test sessions were conducted, with all physiotherapists attending the first to evaluate inter-tester reliability and four attending subsequent sessions to evaluate test-retest reliability as well as their inter-tester reliability. At each test session, the physiotherapists viewed the videotaped performance of the 16 clients over a two hour period. While the order of client presentation was the same for each session, traumatic brain injury clients of varying abilities presented in random order. Each physiotherapist independently rated the performance of the recorded clients for each item of the COVS throughout the session. An investigator controlled the viewing time, rewinding and providing a second opportunity to observe the client performance of each task. There was one exception to this procedure and this related to the scoring of the velocity of gait. The time taken to complete the 10m walk test was provided to each physiotherapist as it was difficult to see or hear the start and stop instructions of this test while watching the performance on the videotape. The physiotherapists each calculated gait speed as all clients walked 10 metres. Inter-tester reliability was determined by comparing the individual and total test scores obtained by the 14 physiotherapists at the initial test session, and by comparing the total test scores obtained by the four physiotherapists at the two subsequent test sessions. Intra-tester reliability was determined by comparing the total COVS scores of the four physiotherapists who attended the initial, one week and three month test sessions. At no time did the participating physiotherapists receive feedback about the accuracy of scoring from the initial or repeat testing sessions. Repeating the test session three months after the initial testing session ensured that memory alone could not be used to score the items on the COVS.

***Statistical methods*** As recommended by Maher (1993), ICCs were selected as the form of analyses to report the reliability findings in this study. There are several estimates that can be used depending on the type of correlation to be undertaken (Shrout and Fleiss 1979). As the present study was concerned with the consistency with which physiotherapists score items on the COVS, a two-way random effects model (consistency definition) was considered the most appropriate calculation to use (McGraw and Wong 1996, Shrout and Fleiss 1979).

Inter-tester reliability was determined from the average measure ICC by comparing the scores given by different physiotherapists for the individual items on the COVS, as well as the total COVS score gained at the initial test session and the sessions one week and three months after the initial one. Intra-tester reliability was determined from the single measure ICC by comparing the scores of the same examiner at the initial session with their scores at the subsequent testing sessions (one week and three months after the initial test session). These analyses allow the consistency with which physiotherapists used the COVS when scoring functional motor tasks to be determined.

## Results

Inter-tester reliability results are summarised in Table 2. The ICCs were very high for the total COVS scores at the

**Table 1.** The modified Clinical Outcome Variables Scale (COVS): Test items and performance indicators.

Item 1: Roll to right from supine lying
Item 2: Roll to left from supine lying

1. Dependent – two assistants required
2. One person assistance, plus device (eg bed rail)
3. One person assistance, no device *
4. Rolls unaided, requires assistance for comfortable position
5. Independent with device
6. Independent, no device, slow, awkward, requires effort
7. Independent, no effort, coordinated and efficient

Item 3: Supine lying to sitting over bed edge

1. Dependent – requires two assistants
2. One person assistance, plus device (eg bed rail)
3. One person assistance, no device *
4. Supervision with instructions for safety, may use device
5. Independent with device
6. Independent, no device, slow, awkward, requires effort
7. Independent, no effort, coordinated and efficient

Item 4: Sitting balance

1. Unable to sit unsupported
2. Able to sit unsupported (10 seconds)
3. Able to move head/trunk within base of support
4. Able to lift arm/leg within base support *
5. Able to reach outside base of support and return
6. Tolerates external displacement, slow reactions
7. Tolerates external displacement, efficient reactions

Item 5: Horizontal transfer

1. Dependent – requires two assistants
2. One person assistance, plus device (eg sliding board)
3. One person assistance, no device
4. Supervision/instructions required (may use device)
5. Independent with device (eg sliding board)
6. Independent, no device, slow, awkward, requires effort
7. Independent, no effort, coordinated and efficient

Item 6: Vertical transfer – stands up from lying on the floor (floor to chair or floor to stand on firm or soft surface)

1. Dependent – requires two assistants or hoist
2. One person assistance, plus device (eg chair)
3. One person assistance, no device
4. Supervision/instructions (verbal cues), may use device
5. Independent with/without device (requires effort, slow)
6. Independently stands up on a firm surface, no device (slow, awkward, requires effort)
7. Independently stands up on a soft surface (mat), no effort, co-ordinated and efficient

Item 7: Performance of ambulation

1. No functional ambulation
2. One person continuous assistance
3. One person intermittent assistance
4. Supervision required with verbal cues for safety
5. Independent, level surfaces, assistance with other surfaces and stairs
6. Independent with all surfaces, stairs require rail
7. Efficient ambulation, normal speed, stairs without rail

Item 8: Performance of ambulation – use of walking aids

1. Not walking
2. Parallel bars required or two continuous assist
3. Walker or hopper
4. Two aids required (eg crutches, two 4-point sticks)
5. Uses one 4-point stick or crutch
6. Uses a single stick only
7. Walks without an aid

Item 9: Performance of ambulation - endurance

1. Not walking
2. Walks < 10m
3. Walks < 50m
4. Walks < 100m
5. Walks < 200m*
6. Walks < 500m
7. Walks > 500m

Item 10: Performance of ambulation – velocity

1. Not walking/0m/s
2. Walks < 0.1m/s
3. Walks < 0.3m/s
4. Walks < 0.5m/s*
5. Walks < 0.7m/s
6. Walks < 0.9m/s
7. Walks > 0.9m/s

Item 11: Performance of wheelchair mobility

1. Dependent
2. Able to move chair < 10m (requires assistance)
3. Able to move chair < 30m (requires intermittent assistance)
4. Supervision only required on flat surfaces, assistance for barriers such as doors
5. Independent indoors all surfaces, manages doors
6. Independent outdoors, except grass and kerbs
7. Independent outdoors, all conditions and surfaces

Items 12 and 13: Left and right arm function

1. Unable to actively move arm
2. Able to move arm actively, no useful movement
3. Able to use arm as a stabiliser in weight bearing
4. Able to use arm as a stabiliser in function
   (eg hold a jar while lid is removed with other hand)
5. Able to bring a cup to mouth
6. Functional fine movement but clumsy/awkward
   (eg slides coin to table edge to pick up, then inserts coin)
7. Efficient fine motor skill (eg picks up a coin/inserts in money box quickly and accurately)

(The * denotes the addition of a performance indicator. Modified from Seaby and Torrance, 1989).

**Table 2.** Inter-tester reliability: Intra-class correlation coefficients for total COVS and each item of the COVS when administered to TBI clients.

| | ICC (2,1) and 95% CI | |
|---|---|---|
| Total COVS (Initial test session) | 0.97 | (0.95 to 0.99) |
| Total COVS (1 week and 3 months) | 0.99 | (0.98 to 0.99) |
| Individual Item (Initial test session only) | | |
| Item 1 | 0.95 | (0.912 to 0.978) |
| Item 2 | 0.93 | (0.875 to 0.969) |
| Item 3 | 0.98 | (0.970 to 0.993) |
| Item 4 | 0.98 | (0.972 to 0.993) |
| Item 5 | 0.98 | (0.959 to 0.990) |
| Item 6 | 0.97 | (0.945 to 0.987) |
| Item 7 | 0.98 | (0.964 to 0.991) |
| Item 8 | 0.99 | (0.996 to 0.999) |
| Item 9 | 0.99 | (0.987 to 0.997) |
| Item 10 | 0.99 | (0.991 to 0.998) |
| Item 11 | 0.99 | (0.987 to 0.997) |
| Item 12 | 0.97 | (0.945 to 0.987) |
| Item 13 | 0.98 | (0.961 to 0.991) |

**Table 3.** Intra-tester reliability using intra-class correlation coefficients for total COVS scores for TBI clients.

| | ICC (2,1) and 95% CI | |
|---|---|---|
| Initial scores compared with scores after a week | | |
| Tester 1 | 0.98 | (0.975 to 0.984) |
| Tester 2 | 0.98 | (0.982 to 0.988) |
| Tester 3 | 0.97 | (0.965 to 0.979) |
| Tester 4 | 0.99 | (0.987 to 0.992) |
| Initial scores compared with scores after three months | | |
| Tester 1 | 0.99 | (0.994 to 0.999) |
| Tester 2 | 0.99 | (0.995 to 0.999) |
| Tester 3 | 0.99 | (0.991 to 0.999) |
| Tester 4 | 0.99 | (0.997 to 0.999) |

initial testing session (ICC > 0.97) which demonstrated that there was a very high level of consistency between the physiotherapists who used this tool in this study. This level of consistency was also determined when the total COVS scores of the four physiotherapists who continued in the study were compared at one week (ICC > 0.99) and three months after the initial test session (ICC > 0.99). The ICC for the individual test items were also high, with the variance between the physiotherapists ranging from 0.88 to 0.99. The greatest variance in individual item scores was gained in the rolling tasks (Items 1 and 2) and to a lesser extent when scoring upper limb function (Items 12 and 13). Items 7 to 11 relating to ambulation ability (walking and wheelchair tasks) demonstrated a very high level of consistency between the physiotherapists when these items were scored using the COVS.

Table 3 summarises the results of the intra-tester reliability analyses. It is clear that there is a high level of consistency when the scores of the individual physiotherapist are compared across the three test sessions (ICC > 0.97 at one week, ICC > 0.99 at three months) which demonstrates that physiotherapists reliably administer the COVS.

## Discussion

Scores yielded by physiotherapy assessments of traumatic brain injured clients with the COVS were highly reliable. There was a high level of consistency for scoring each item on the COVS as well as the total COVS scores at all stages of the study. The intra-tester reliability was also high. It is evident that physiotherapists who have had a clear explanation of the tool can administer and score the COVS with a high degree of reliability. This finding allows for confident use of this tool by physiotherapists in clinical studies of functional motor outcome following traumatic brain injury.

The reliability levels established in this study were similar to those determined in reliability studies involving the Motor Assessment Scale (Carr et al 1985, Poole and Whitney 1988) and higher than the levels determined in the initial study by Seaby and Torrance (1989). In the initial study, inter-tester reliability for the total COVS scores were above 0.70 but a greater range of variance for each individual item was determined (ICC 0.65 to 0.96). The higher level of consistency gained for each item on the COVS in this study could be explained by the participation of all physiotherapists in the initial seminar, where there were opportunities to ask questions and clarify any points of confusion related to the performance indicators. The investigators also ensured that each item on the scale had a clear performance description for the seven scores that could be allocated, and that an opportunity to practise using the scale was available before the study commenced. These aspects were included in the current study following the recommendations of an editorial review of the initial reliability study (Huijbregts 1996). In addition, the current study is considered to be more representative, as a greater number of physiotherapists were involved in scoring a larger cohort of clients. Intra-tester reliability was above 0.85 in the original study (Seaby and Torrance 1989), and

confirmed as above 0.97 in the current study. It is clear that a high level of reliability is achievable.

A limiting factor associated with the current study was the quality of the videotape recording, which made it difficult to hear the start and stop instructions for the timed walking test. Indeed the provision of the time taken to walk 10 metres as a basis for calculating the velocity of gait may have contributed to the very high correlation in this variable.

## Conclusion

Physiotherapists can reliably use the COVS to measure the progress and functional motor outcomes of traumatic brain injury clients undertaking rehabilitation. The demonstrated inter-tester and intra-tester reliability allows for confident use of this tool in the clinical setting. Familiarity with the items on the COVS, an understanding of the range of performance indicators for each item on the scale and regular use of the tool may be important contributors to this reliability.

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