BRAIN INJURY, 2003, VOL. 17, NO. 1, 25–37

Taylor & Francis healthsciences

Measurement of impaired self-awareness after traumatic brain injury: a comparison of the patient competency rating scale and the awareness questionnaire

MARK SHERER†‡, TESSA HART§¶ and TODD G. NICK‡

† Methodist Rehabilitation Center, Jackson, Mississippi, USA
‡ University of Mississippi Medical Center, Jackson, Mississippi, USA
§ Moss Rehabilitation Research Institute, Philadelphia, Pennsylvania, USA
¶ Department of Rehabilitation Medicine, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania, USA

(*Received 11 March 2002; accepted 20 June 2002*)

Primary objective: To compare the Patient Competency Rating Scale (PCRS) and the Awareness Questionnaire (AQ) in the measurement of impaired self-awareness (ISA) in persons with traumatic brain injury (TBI).
Research design: Prospective cohort of patients seen for inpatient rehabilitation following TBI.
Procedures: Measures of self-awareness were collected at resolution of post-traumatic amnesia and outcomes (rated employability) were collected at discharge from inpatient rehabilitation.
Outcomes and results: Subjects were 129 persons with TBI. Measures from the PCRS and AQ showed moderate correlations. Models using as predictors patient/clinician discrepancies for the PCRS and the AQ performed comparably in predicting employability (Nagelkerke $R^2 = 0.22$ and 0.20, respectively).
Conclusions: The PCRS and AQ showed only moderate correlations, but performed comparably as measures of ISA after TBI. Patient/clinician discrepancies appeared to be more valid measures of ISA early after TBI than patient/family discrepancies. Preliminary cutting points for severity of ISA were presented for the two scales.

Introduction

Impaired self-awareness (ISA) is a common neurobehavioural deficit in patients with traumatic brain injury (TBI) [1, 2]. Patients with ISA overestimate their neurobehavioural competencies, particularly with regard to cognitive and social/emotional functioning [3]. This inaccuracy of self-perception has been associated with poor motivation for treatment [4, 5] and poor early employability outcome [6] as well as poor long-term employment outcome [7, 8].

In response to the importance of ISA in outcome from TBI, a number of scales and other means of measurement have been developed to facilitate assessment of ISA. To date, there has been little comparison of these various measures. This paper presents a comparison of two of the more commonly used measures of ISA, the

Correspondence to: Mark Sherer, PhD, ABPP/Cn, Methodist Rehabilitation Center, 1350 E. Woodrow Wilson, Jackson, MS 39216, USA. e-mail: marks@mmrcrehab.org

Brain Injury ISSN 0269–9052 print/ISSN 1362–301X online
http://www.tandf.co.uk/journals
DOI: 10.1080/0269905021000010113

Patient Competency Rating Scale (PCRS) [2] and the Awareness Questionnaire (AQ) [9].

The PCRS was developed by Prigatano *et al.* [2] to facilitate comparison of patients' self-ratings of competencies as compared to ratings of family members and clinicians. The 30 PCRS items assess competencies in such areas as activities of daily living, cognitive functioning, interpersonal functioning and emotional regulation [10]. The patient's ability to perform various tasks is rated on a Likert scale ranging from 1 (can't do) to 5 (can do with ease). There are forms for patient self-ratings, family/significant other ratings and clinician ratings. Possible total scores range from 30–150, with higher scores indicating higher levels of competence. Degree of ISA is determined by comparing patient self-ratings to family or clinician ratings [11]. These comparisons can be made by calculating discrepancy scores by subtracting total family or clinician ratings from total patient self-ratings. Another method involves tallying the number of items rated as more competent by the patient as compared to the informant, the same by the patient and the informant, and as more competent by the informant than the patient. Patients with more items self-rated as more competent as compared to informant ratings are considered to have poor self-awareness.

Test–re-test reliability and internal consistency are excellent for all three forms of the PCRS with test-re-test reliability coefficients ranging from 0.85–0.97 and internal consistency coefficients (Cronbach's α) ranging from 0.91–0.95 [11, 12]. Various studies have shown the PCRS to be sensitive to differences in patient, family and clinician perceptions of patient functioning [13] and decreases in ISA with the passage of time post-injury [14]. Degree of ISA as measured by the PCRS is associated with injury severity [15], number of intracranial lesions on CT scans [16] and patient emotional distress [17, 18]. In addition to patient populations from the US, the PCRS has been used with patients with TBI from Australia [14], Japan [19], New Zealand [20] and Spain [15].

The AQ was developed by Sherer *et al.* [9] as an alternative to the PCRS for research on ISA after TBI. A difference between the AQ and the PCRS is that, on the 17 AQ items, the patient's current functional abilities are rated in comparison to his/her pre-injury abilities, while on the PCRS, the amount of difficulty that the patient would have with each task is rated. AQ items are rated on a Likert scale ranging from 1 (much worse) to 5 (much better). Scores can range from 17–85, with a score of 51 indicating that the patient is functioning 'about the same' as his/her pre-injury level. The capacity of the AQ to capture patient perceptions that they are functioning above their pre-injury levels is viewed as a strength of the AQ, as clinicians may encounter patients who report that they have been improved by their brain injuries. There are forms of the AQ for patient self-ratings as well as family/significant other and clinician ratings. Degree of ISA is calculated by subtracting family/significant other ratings or clinician ratings from patient self-ratings. These discrepancy scores can range from -68 to 68, although negative scores are rare. Higher discrepancy scores are associated with greater degrees of ISA.

Factor analysis of the AQ [9] has revealed three sub-scales. These are motor/sensory (four items), cognition (seven items), and behavioural/affective (six items). Reliability studies of the AQ have revealed internal consistencies (Cronbach's α) of 0.88 for both patient and family ratings. Test–re-test reliabilities have not been reported. Studies of the AQ have shown the expected pattern with both acute and post-acute patients with TBI rating themselves as more intact than they were rated by family members or clinicians [21]. AQ ISA discrepancy scores are correlated with injury severity [21] and are predictive of early employability [6] and late employment outcome [8].

The primary goal of the present investigation was to compare the PCRS and the AQ. Several analyses were performed to address this goal.

(1) Correlations were examined between the corresponding PCRS and AQ patient, family and clinician ratings.
(2) Correlations were examined between measures of ISA derived from the PCRS and the AQ.
(3) The abilities of measures of ISA derived from the PCRS and the AQ were compared to predict employability after TBI.

Previous investigations have used patient/clinician discrepancies or patient/family discrepancies to measure ISA. There has been little comparison of measures of ISA derived from patient/clinician discrepancies as opposed to patient/family discrepancies. A secondary goal of the investigation was to perform such a comparison and to further examine clinicians' perceptions of patient functioning as compared to family/significant others' perceptions of patient functioning. Analyses were performed to achieve this goal. (1) Correlations among patient self-ratings, clinician ratings and family ratings were calculated. (2) The abilities of ISA measures calculated as patient/clinician discrepancies vs patient/family discrepancies to predict employability were compared.

Method

Study population

The study population for the present study consisted of qualified subjects with TBI who were admitted to one of two inpatient brain injury rehabilitation programmes (Methodist Rehabilitation Centre and MossRehab). The majority of subjects were recruited as part of National Institute on Disability and Rehabilitation Research (NIDRR) TBI Model Systems programmes at the two sites. One site (MossRehab) also recruited persons with TBI who were not TBI Model Systems subjects. Inclusion criteria for the TBI Model Systems programme include: medically documented TBI; treatment at an affiliated Level I trauma centre within 24 hours of injury; receipt of inpatient rehabilitation within the Model System; admission to inpatient rehabilitation within 72 hours of discharge from acute care; aged at least 16 at the time of injury; and provision of informed consent by the person with injury or a legal proxy. TBI Model Systems subjects were recruited for participation in the TBI Model Systems programme at admission to inpatient rehabilitation, while non-system subjects were recruited when they met other qualifications required for the present study. Non-system subjects were similar to TBI Model Systems subjects, except that they received emergency and acute medical care at non-affiliated Level 1 trauma centres and, in a few cases, were sent home briefly or treated in sub-acute rehabilitation programmes before admission to acute rehabilitation at the study centre. To qualify for the present study, subjects were also required to have emerged from post-traumatic amnesia (PTA) prior to discharge from inpatient rehabilitation, speak English, be free from pre-morbid conditions such as stroke, mental retardation or severe psychiatric illness, and be free from severe language disorders that would compromise their ability to complete required questionnaires.

Data collection

Demographic information (age, gender, years of education) and injury severity data were collected through review of medical records and interview with patients and family members. Functional Independence Measure™ (FIM) scores were rated at admission to inpatient rehabilitation, while Disability Rating Scale (DRS) data were rated at discharge from inpatient rehabilitation. All patients had emerged from PTA prior to collection of PCRS or AQ self-ratings. Some patients had emerged from PTA prior to rehabilitation admission; for other patients, PTA resolution was determined prospectively by administration of the Galveston Orientation and Amnesia Test. Family/significant others and clinician PCRS and AQ ratings were obtained within a few days of patient self-ratings. Clinician ratings were completed by the neuropsychologist working with the patient. Chronicity of injury was calculated as the interval in days from date of injury to date of assessment with the AQ and PCRS.

For descriptive purposes, injury severity was determined by Glasgow Coma Scale (GCS) [22] scores. GCS ratings were obtained at admission to the Emergency Departments following TBI. Severity was classified in the usual way with scores from 3-8 indicating severe TBI, scores from 9–12 indicating moderate TBI, and scores from 13-15 indicating mild TBI [23]. Another common index of TBI severity is time to follow commands (TFC). For this study, TFC was defined as the interval, in days, from injury until the patient was able to follow instructions at two consecutive assessments within a 24 hour period. TFC has also been shown to be a powerful predictor of functional recovery after TBI [24, 25]. TFC, rather than GCS, was used in regression models to predict outcome, as it is expected that measures of injury severity collected at a later time post-injury will be more predictive of functional outcome [26].

The PCRS and AQ were used as measures of ISA. Totals were computed for the patient, family/significant other, and clinician forms of the PCRS and AQ. Four ISA scores were calculated for the PCRS and the AQ by subtracting the clinician total scores from the patient total scores (PCRS P-C and AQ P-C) and subtracting the family/significant other scores from the patient scores (PCRS P-F and AQ P-F).

Measures

Functional Independence Measure

The FIM [27] is an 18-item rating scale assessing patients' level of independence. Each item is rated on a scale of 1 (total assistance) to 7 (complete independence). The FIM assesses the level of independence in self-care, mobility, bowel and bladder management, communication, cognition and psychosocial adjustment. Rasch analysis has revealed two main factors or traits underlying FIM items: a motor and a cognitive factor [28, 29].

Disability Rating Scale

The Disability Rating Scale (DRS) [30, 31] was used to obtain the index of employability used as the outcome for Analysis 3. The DRS is a 30-point scale which rates eight areas of functioning: eye opening; verbalization; motor response; level of cognitive ability for daily activities of feeding, toileting and grooming; overall level of dependence; and employability. Each area of functioning is rated on a scale of 0–3, 4 or 5, with higher scores representing lower levels of functioning. Scores on each item are summed to yield a total score between 0–30, with a higher score indicating greater disability. DRS ratings in the present investigation were generally completed by the treating physician or by a consensus of the treating team. For the present analysis, only the DRS employability rating was used. A rating of 3 on this item indicates that the patient is not employable under any circumstances, while lower ratings indicate some degree of employability ranging from sheltered workshop to competitive employment. For the multivariable logistic regression analyses, subjects with DRS employability ratings of 3 were coded as not employable, while all others were coded as employable.

Analyses

Descriptive statistics (means, standard deviations, quartiles and ranges) were calculated for patient self-ratings, clinician ratings and family ratings for the PCRS and the AQ as well as for PCRS P-C, PCRS P-F, AQ P-C and AQ P-F. For both the PCRS and the AQ, Friedman's tests were computed to compare overall differences among the patient, family/significant other and clinician scores. Pairs of scores were compared using Wilcoxon's matched paired signed rank test. In order to examine associations between scores derived from the PCRS and the AQ, Spearman correlation coefficients (r_s) were computed for relationships of the PCRS patient, family/significant other and clinician scores and the AQ patient, family/significant other and clinician scores. Associations among the 4 ISA scores (PCRS P-C, PCRS P-F, AQ P-C and AQ P-F) were also examined using r_s.

Multivariable logistic regression analyses were calculated to compare the predictive strengths of the four ISA scores (PCRS P-C, PCRS P-F, AQ P-C and AQ P-F) for predicting employability at rehabilitation discharge. Four models were developed, one for each measure of ISA. Other predictors included in each model were age at time of injury, years of education, time to follow commands and total FIM score at rehabilitation admission. For the multi-variable logistic regression analyses, imputed values were used when data were missing on the predictor variables. For patients missing only one of the items for the PCRS or AQ measures, the medians of the completed items in the relevant sub-scales were used as the imputed values. For all other missing values, individual predictive models, utilizing the interrelationships among the other predictor variables and outcome, were used to impute the missing values for each predictor variable.

Finally, based on results of the multivariable logistic regression analyses, preliminary cutting points for degree of ISA were established for PCRS P-C and AQ P-C. Each set of scores was divided into groups with mild or no ISA, moderate ISA and severe ISA based on probabilities of employability at rehabilitation discharge. Scores indicating mild or no ISA were associated with $>50\%$ probability of employability, moderate ISA indicated 50–25% probability of employability, and severe ISA indicated $<25\%$ probability of employability. These cutpoints were established to provide clinicians with a preliminary guide to assist with interpretation of PCRS and AQ scores.

Results

Study population

During the study period, 144 TBI Model Systems subjects were enrolled at the two study sites. Of these patients, 58 failed to meet the additional criteria for inclusion in the present study. Reasons for exclusion were failure to emerge from PTA prior to rehabilitation discharge ($n = 33$), discharged before data could be collected ($n = 11$), non-English speaking ($n = 4$), pre-existing conditions ($n = 4$), severe aphasia ($n = 3$) and declined to participate ($n = 3$). An additional 58 non-system subjects met all inclusion criteria and were asked to consent to participate in the study; 15 of these declined to participate. As a result, the final study population consisted of 129 subjects (86 TBI Model Systems subjects and 43 non-system subjects). Characteristics of the study sample are presented in table 1. This group of patients was previously reported on in another investigation of impaired self-awareness [6]. DRS at rehabilitation discharge was missing for six subjects. These subjects were excluded from the multivariable logistic regression analyses for predicting employability at rehabilitation discharge. Most subjects were males (84%) who sustained severe TBI (63%). Forty-six per cent of subjects were rated as having some degree of employability at rehabilitation discharge.

Analyses

Descriptive statistics for PCRS and AQ scores are shown in table 2. Friedman's tests for both the PCRS and AQ showed significant differences overall among the patient, family/significant other and clinician scores (both $p < 0.001$). Wilcoxon's

Table 1. Description of the study sample on demographics and predictors other than awareness scores ($n = 129$)

Descriptors	Missing (%)	*n* (%)	Median [25th, 75th percentile]
Categorical			
Sex	0		
Male		108 (84%)	
Female		21 (16%)	
GCS total	6 (5%)		
3–8		77 (63%)	
9–12		23 (18%)	
13–15		23 (18%)	
Employable	6 (5%)		
Yes		56 (46%)	
No		67 (54%)	
Continuous			
Age	0		33 [22, 45]
Education	1 (0.8%)		12 [10, 13]
Duration of PTA	44 (34%)		28 [16, 47]
Time to follow commands	4 (3%)		3 [1, 14]
Chronicity	0		35 [23, 59]
FIM total at rehabilitation admittance	16 (12%)		54 [38, 72]
Time from injury to rehabilitation discharge	0		42 [32. 77]

Table 2. Descriptive statistics for PCRS and AQ scores

Measures		M (SD)	25th, 50th, 75th Percentiles	Minimum, maximum
PCRS	Patient self-ratings	115.0 (18.4)	104.5, 116, 127	36, 150
	Clinician ratings	89.0 (17.0)	75.5, 91, 102.5	38, 127
	Family ratings	104.9 (19.2)	94.5, 107, 117	34, 145
	Patient–clinician	26.0 (24.6)	10, 24, 43.5	−33, 84
	Patient–family	10.1 (24.5)	−5, 9, 25	−43, 80
AQ	Patient self-ratings	48.5 (11.4)	43, 48, 53	17, 85
	Clinician ratings	32.2 (5.9)	27, 32, 37	20, 47
	Family ratings	39.8 (11.1)	31, 39, 47.5	17, 74
	Patient–clinician	16.4 (13.0)	7.5, 14, 23	−7, 55
	Patient–family	8.8 (15.7)	0.0, 7.0, 17.5	−30, 60

matched paired signed rank tests showed for both the PCRS and AQ that the clinician scores had observed values significantly lower (more impaired) than the family/significant other scores (PCRS medians of 91 and 107, respectively; AQ medians 32 and 39, respectively; both $p < 0.001$). Additionally, the family/significant other scores had observed values significantly lower than the patient scores for both the PCRS and AQ (PCRS medians of 107 and 116, respectively; AQ medians of 39 and 48, respectively; both $p < 0.001$).

Spearman correlation coefficients for the patient, family/significant other and clinician ratings for the PCRS and the AQ are presented in table 3. Among PCRS scores and among AQ scores, patient self-ratings were not correlated with clinician or family/significant other ratings, while clinician ratings were moderately correlated with family/significant other ratings ($r_s = 0.36$ and 0.44, respectively). Examination of correlations between the PCRS and the AQ revealed that for each PCRS patient, clinician and family/significant other score the highest correlation was with the corresponding AQ score. These correlations ranged from 0.50–0.69.

Spearman correlation coefficients for the four ISA scores are presented in table 4. The two PCRS scores (PCRS P-C and PCRS P-F) were significantly associated, as were the two AQ scores (AQ P-C and AQ P-F) ($r_s = 0.64$ and 0.65, respectively). Examination of Spearman correlation coefficients between ISA scores from the two measures reveals that the strongest associations are between the corresponding ISA measures; PCRS P-C with AQ P-C, $r_s = 0.61$, and PCRS P-F with AQ P-F, $r_s = 0.50$.

Table 3. Spearman correlation coefficients for PCRS and AQ scores

	PCRS Family	PCRS Clinician	AQ Patient	AQ Family	AQ Clinician
PCRS Patient	0.11	−0.02	0.50**	0.12	0.08
PCRS Family	—	0.36**	0.06	0.62**	0.35**
PCRS Clinican		—	0.06	0.21*	0.69**
AQ Patient			—	0.06	−0.06
AQ Family				—	0.44**

* $p < 0.05$; ** $p < 0.01$.

Table 4. Spearman correlation coefficient for ISA measures

	PCRS P–F	AQ P–C	AQ P–F
PCRS P–C	0.64*	0.61*	0.34*
PCRS P–F	—	0.37*	0.50*
AQ P–C		—	0.65*

* $p < 0.01$.

Results of multivariable logistic regression analyses are presented in tables 5 and 6. Table 5 compares the predictive powers of PCRS P-C and AQ P-C for predicting employability at rehabilitation discharge, while table 6 compares the predictive powers of PCRS P-F and AQ P-F for predicting employability at rehabilitation discharge. All effects are interquartile-range coefficients. Interquartile-range coefficients (or odds ratios) are the effects (changes in predicted likelihood of employability) of increasing each predictor variable from its lower quartile to its upper quartile. The measures of ISA derived from patient/clinician discrepancies made independent contributions to predicting employability, while measures of ISA derived from patient/family discrepancies did not. Patients with

Table 5. Comparison of multivariable logistic regression models for predicting employability with patient–clinician discrepancies

	PCRS			AQ		
Predictors	25th, 75th comparison	Effect (95%CI)	*p*-value	25th, 75th comparison	Effect (95%CI)	*p*-value
Age	22, 45	0.61 (0.35, 1.06)	0.08	22, 45	0.56 (0.31, 1.02)	0.06
Education	10, 13	1.60 (1.02, 2.51)	0.04	10, 13	1.55 (1.00, 2.40)	0.05
TFC	1, 12	0.83 (0.55, 1.25)	0.37	1, 12	0.86 (0.59, 1.27)	0.45
FIM	38, 71	1.11 (0.55, 2.24)	0.77	38, 71	1.02 (0.51, 2.04)	0.96
Patient–clinician	10, 43	0.36 (0.19, 0.67)	0.004	8, 23	0.48 (0.26, 0.90)	0.03

All effects are interquartile-range coefficients. Interquartile-range coefficients are the effects (changes in probability of employability) of increasing each predictor variable from its lower quartile to its upper quartile.

Table 6. Comparison of multivariable logistic regression models for predicting employability with patient–family discrepancies

	PCRS			AQ		
Predictors	25th, 75th comparison	Effect (95%CI)	*p*-value	25th, 75th comparison	Effect (95%CI)	*p*-value
Age	22, 45	0.63 (0.37, 1.08)	0.10	22, 45	0.66 (0.36, 1.19)	0.16
Education	10, 13	1.46 (0.96, 2.23)	0.08	10, 13	1.48 (0.96, 2.27)	0.07
TFC	1, 12	0.80 (0.55, 1.17)	0.26	1, 12	0.82 (0.57, 1.19)	0.29
FIM	38, 71	1.16 (0.60, 2.27)	0.65	38, 71	1.20 (0.61, 2.35)	0.59
Patient–family	−5, 25	0.73 (0.45, 1.20)	0.43	0, 17	0.86 (0.53, 1.39)	0.36

All effects are interquartile-range coefficients. Interquartile-range coefficients are the effects (changes in probability of employability) of increasing each predictor variable from its lower quartile to its upper quartile.

lower patient/clinician discrepancies (more accurate self-awareness) were more likely to be rated as employable at rehabilitation discharge than those with higher patient/clinician discrepancies (less accurate self-awareness). Figure 1 shows the relationships of PCRS P-C and AQ P-C scores to probability of employability at rehabilitation discharge. The interquartile-range odds ratios for PCRS P-C and AQ P-C were 0.36 and 0.48, respectively, indicating that patients scoring at the 75th percentile on PCRS P-C were only 0.36 times as likely to be employable as those scoring at the 25th percentile, and patients scoring at the 75th percentile of AQ P-C were only 0.48 times as likely to be employable as those scoring at the 25th percentile. In other words, patients showing more accurate self-awareness on the PCRS were 2.8 times as likely to be employable as those showing poor awareness, while patients showing more accurate self-awareness on the AQ were 2.1 times as likely to be employable. The PCRS P-C model accounted for 22% (Nagelkerke R^2) of the variability in employability, while the AQ P-C model accounted for 20% of the variability in employability.

In two of the four regression models, there was a significant education effect. Patients with higher education levels were more likely to be rated as employable at rehabilitation discharge than those with lower education levels. Surprisingly, neither time to follow commands nor FIM at rehabilitation admission made independent contributions to predicting employability in any of the models.

Visual inspection of regression plots in figure 1 showing the relationships of PCRS P-C and AQ P-C to probability of employability indicated that low levels of ISA were not associated with decreases in probability of employability. This finding suggested that tentative cutting points for severity of ISA could be established based on decreases in probability of employability associated with certain

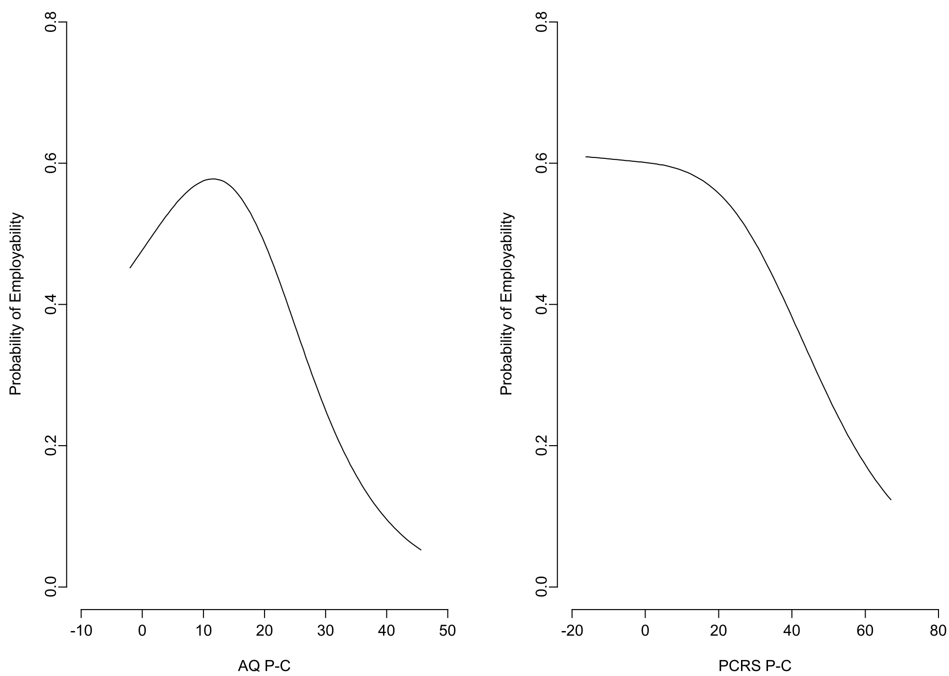

Figure 1. Simple (adjusted) relationships of PCRS P-C and AQ P-C to rated employability.

ranges of PCRS P-C and AQ P-C scores. Noting that $\sim 50\%$ of subjects were rated as having some degree of employability at rehabilitation discharge, tentative cutting points were derived for mild or no ISA, moderate ISA and severe ISA for PCRS P-C and AQ P-C, by determining which scores were associated with $>50\%$ predicted probability of employability (mild or no ISA), 50–25% probability of employability (moderate ISA), and $<25\%$ probability of employability (severe ISA). Using this methodology, for the PCRS P-C, scores <28 indicated mild or no ISA, scores from 28-51 indicated moderate ISA, and scores >51 indicated severe ISA. For the AQ P-C, scores <20 indicated mild or no ISA, scores from 20–29 indicated moderate ISA, and scores >29 indicated severe ISA.

Discussion

On both measures of patient competency used in the current investigation, the PCRS and the AQ, patients with acute TBI rated themselves as functioning better, overall, compared to the ratings of their therapists and family members. The average patient self-rating was equivalent to an overall item rating just below the 'fairly easy to do' level on the PCRS, and just below the 'about the same (as before injury)' level on the AQ. In contrast, clinicians provided an average rating equivalent to just below 'can do with some difficulty' on the PCRS, and just below 'a little worse' on the AQ. Thus, consistent with previous research, patients rated themselves as more capable than therapists rated them whether the rating was compared to pre-injury function or to an absolute competency scale. Family ratings were intermediate between patient and therapist ratings, but were significantly correlated with clinician ratings for both scales; in contrast, the patient self-ratings were not related to either collateral score. Although there is no direct external validation of the ratings in this investigation, the observed set of relationships supports the notion that family and clinician ratings are based on some 'reality' of deficits and impairments and that patient ratings reflect, at least in part, impaired awareness of those deficits.

The intermediate position of the family rating between the other two in this investigation is of interest and would be worthy of further exploration. This finding in light of the significant correlation between the two sets of raters suggests that the family and clinician ratings were based upon similar observations, but that the family raters adopted a less severe standard for rating a behaviour as problematic. Possibly, clinicians rated deficits and behaviours as more severe because their past experience allowed them to appreciate the future impact of those problems, whereas family members were experiencing TBI-related impairments for the first time. Alternatively, clinicians may have had more opportunity to observe patients' deficits as all patients in this study were rated while they were in inpatient rehabilitation. Family/significant other perceptions of patient behaviours may change after discharge, when family members have more opportunity to directly experience patients' deficit in the home environment.

Few previous studies have performed direct comparisons between different collateral respondents in studies of ISA. In Fleming and Strong's [14] longitudinal study of ISA, family and therapist ratings on the PCRS were compared when patients were 3 months post-TBI. Fleming and Strong reported that the two sets of ratings were nearly identical, at a mean level very close to the mean family rating level in the current study. While not clearly stated, it appears that some of Fleming and Strong's subjects were still in inpatient rehabilitation at the time of the 3 months post-injury ratings, while others may have been outpatients. In the present study, with a median time of 35 days post-injury, all subjects were still in inpatient rehabilitation. The greater agreement in clinician and family/significant other ratings obtained in the Fleming and Strong study may have been related to increased family exposure to patients' deficits, due both to the longer time post-injury and the likelihood that some patients were living at home by the time they were rated. Additional investigation is needed to determine if family/significant other and clinician ratings of patient functioning generally become more similar as the time since injury increases.

Even though scores from the PCRS and the AQ were only moderately correlated, the two instruments performed very similarly in prediction of a short-term outcome (rated employability at hospital discharge). That is, the patient–clinician discrepancy scores based on both scales made independent contributions to predicting employability ratings on the DRS. However, for neither of the scales did the patient–family discrepancy scores contribute to that prediction. As noted above, this finding may indicate that clinician ratings were based on a more accurate appreciation of patients' deficits due to more opportunity to observe these deficits as well as a better appreciation of the long-term functional impact of cognitive and behavioural deficits after TBI. While one might expect that scores derived from one clinician rating (the AQ and PCRS) should predict another (employability ratings on the DRS), AQ and PCRS ratings were obtained independently from DRS employability ratings. That is, they were obtained at different points in time from different clinicians. Even thought the clinician ratings were obtained independently, the clinicians who made these ratings may have shared similar notions regarding the impact of neurobehavioural deficits on long-term outcome. It is possible that family members were not as sensitive to deficits that, in clinicians' experience, have an impact on employability.

Tentative cutting points for severity of ISA were derived for the PCRS and the AQ based on different probabilities of employability associated with different ranges of ISA scores. For both instruments, the lowest levels of ISA were not associated with decreases in rated employability, while higher ISA scores were associated with significant decreases in rated employability. These cutting points are quite tentative and should not be used for clinical decision making unless validated in subsequent investigations. However, they may provide some preliminary indication of the differential significance of ISA scores of different magnitudes. It is noted that these ranges were established based solely on the probability of being rated as employable. Low levels of ISA may have some other negative consequence that was not assessed in this investigation. For example, even low levels of ISA may increase family discord after discharge by contributing to arguments between patients and family members. Other possible impacts of low and higher levels of ISA should be investigated.

Acknowledgements

This investigation was supported by funding from the National Institute on Disability and Rehabilitation Research for the Collaborative Study on Impaired Self-awareness after Traumatic Brain Injury (NIDRR Grant #H133A980067), by funding for TBI Model Systems programs at Methodist Rehabilitation Center

(NIDRR Grant #H133A980035) and Moss Rehabilitation Research Institute (NIDRR Grant #H133A97033).

References

1. Ben-Yishay, Y., Rattok, J., Lakin, P. *et al.*: Neuropsychologic rehabilitation: quest for a holistic approach. *Seminars in Neurology,* **5**: 252–259, 1985.
2. Prigatano, G. P., Fordyce, D. J., Zeiner, H. K. *et al.*: Neuropsychological rehabilitation after brain injury (Baltimore: Johns Hopkins University Press), 1986.
3. McKinlay, W. W. and Brooks, D. N.: Methodological problems in assessing psychosocial recovery following severe head injury. *Journal of Clinical Neuropsychology,* **6**: 87–99, 1984.
4. Lam, C. S., McMahon, B. T., Priddy, D. A. *et al.*: Deficit awareness and treatment performance among traumatic head injury adults. *Brain Injury,* **2**: 235–242, 1988.
5. Malec, J. F. and Moessner, A. M.: Self-awareness, distress, and postacute rehabilitation outcome. Rehabilitation Psychology, **45**: 227–241, 2001.
6. Sherer, M., Hart, T., Nick, T. G. *et al.*: Early impaired self-awareness after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation,* in press.
7. Ezrachi, O., Ben-Yishay, Y., Kay, T. *et al.*: Predicting employment in traumatic brain injury following neuropsychological rehabilitation. *Journal of Head Trauma Rehabilitation,* **6**: 71–84, 1991.
8. Sherer, M., Bergloff, P., Levin, E. *et al.*: Impaired awareness and employment outcome after traumatic brain injury. *Journal of Head Trauma Rehabilitation,* **13**: 52–61, 1998.
9. Sherer, M., Bergloff, P., Boake, C. *et al.*: The Awareness Questionnaire: factor analysis structure and internal consistency. Brain Injury, **12**: 63–68, 1998.
10. Leathem, J. M., Murphy, L. J. and Flett, R. A.: Self-and informant-ratings on the Patient Competency Rating Scale in patients with traumatic brain injury. *Journal Clinical and Experimental Neuropsychology,* **20**: 694–705, 1998.
11. Fleming, J. M., Strong, J. and Ashton, R.: Self-awareness of deficits in adults with traumatic brain injury: how best to measure. *Brain Injury,* **10**: 1–15, 1996.
12. Prigatano, G. P., Altman, I. M. and O'Brien, K. P.: Behavioral limitations that traumatic-brain-injured patients tend to underestimate. *The Clinical Neuropsychologist,* **4**: 163–176, 1990.
13. Fordyce, D. J. and Roueche, J. R.: Changes in perspectives of disability among patients, staff, and relatives during rehabilitation of brain injury. *Rehabilitation Psychology,* **31**: 217–229, 1986.
14. Fleming, J. and Strong, J.: A longitudinal study of self-awareness: functional deficits underestimated by persons with brain injury. *Occupational Therapy Journal of Research,* **19**: 3–17, 1999.
15. Prigatano, G. P., Bruna, O., Mataro, M. *et al.*: Initial disturbances of consciousness and resultant impaired awareness in Spanish patients with traumatic brain injury. *Journal of Head Trauma Rehabililitation,* **13**: 29–38, 1998.
16. Prigatano, G. P. and Altman, I. M.: Impaired awareness of behavioral limitations after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation,* **71**: 1058–1064, 1990.
17. Malec, J., Zweber, B. and Depompolo, R. W.: The Rivermead Behavioral Memory Test, laboratory neurocognitive measures, and everyday functioning. *Journal of Head Trauma Rehabilitation,* **5**: 60–68, 1990.
18. Wallace, C. A. and Bogner, J.: Awareness of deficits: emotional implications for persons with brain injury and their significant others. *Brain Injury*, **14**: 549–562, 2000.
19. Prigatano, G. P., Ogano, M. and Amakusa, B.: A cross-cultural study on impaired self-awareness in Japanese patients with brain dysfunction. *Neuropsychiatry, Neuropsychology, Behavioral Neurology,* **10**: 135–143, 1997.
20. Prigatano, G. P. and Leathem, J. M.: Awareness of behavioral limitations after traumatic brain injury: a cross-sectional study of New Zealand Maoris and non-Maoris. *The Clinical Neuropsycholgist,* **7**: 123–135, 1993.
21. Sherer, M., Boake, C, Levin, E. *et al.*: Characteristics of impaired awareness after traumatic brain injury. *Journal of the International Neuropsychological Society,* **4**: 380–387, 1998.
22. Teasdale, G. and Jennett, B.: Assessment of coma and impaired consciousness: a practical scale. *Lancet,* 81–83, July 13, 1974.
23. Levin, H. S. and Eisenberg, H. M.: Neurobehavioral outcome. *Neurosurgery Clinics of North America,* **2**: 457–472, 1991.

24. DIKMEN, S., MCLEAN, A., TEMKIN, N. R. *et al.*: Neuropsychologic outcome at one-month postinjury. *Archives of Physical Medicine and Rehabilitation,* **67**: 507–513, 1986.
25. KATZ, D. I. and ALEXANDER, M. P.: Traumatic brain injury: predicting course of recovery and outcome for patients admitted to rehabilitation. *Archives of Neurology,* **51**: 661–670, 1994.
26. WHYTE, J., CIFU, D., DIKMEN, S. *et al.*: Prediction of functional outcomes after traumatic brain injury: a comparison of 2 measures of duration of unconsciousness. *Archives of Physical Medicine and Rehabilitation,* **82**: 1355–1359, 2001.
27. HAMILTON, B. B., GRANGER, C. V., SHERWIN, F. S. *et al.*: A uniform national data system for medical rehabilitation. In M. J. Fuhrer (editor) *Rehabilitaton outcomes: Analysis and measurement (Baltimore: Brookes),* pp. 135–147, 1987.
28. HALL, K. M., HAMILTON, B. B., GORDON, W. A. *et al.*: Characteristics and comparisons of functional assessment indices: Disability Rating Scale, Functional Independence Measure, and Functional Assessment Measure. *Journal of Head Trauma Rehabilitation,* **8**: 60–74, 1993.
29. HEINEMANN, A. W., LINACRE, J. M., WRIGHT, B. D. *et al.*: Relationships between impairment and physical disability as measured by the Functional Independence Measure. *Archives of Physical Medicine and Rehabilitation,* **74**: 566–573, 1993.
30. RAPPAPORT, M., HALL, K. M., HOPKINS, K. *et al.*: Disability Rating Scale for severe head trauma: coma to community. *Archives of Physical Medicine and Rehabilitation,* **63**: 118–123, 1982.
31. HALL, K. M. and JOHNSTON, M. V.: Outcomes evaluation in TBI rehabilitation. Part II: measurement tools for a nationwide data system. *Archives of Physical Medicine and Rehabilitation,* **75**: SC10–SC18, 1994.