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Estimation of post-traumatic amnesia in
emergency department attendees
presenting with head injury

&

Clinical Research Portfolio

Volume I

(Volume II bound separately)

Louise Richards (BSc Hons)

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Academic Unit of Mental Health and Wellbeing

Centre for Population and Health Sciences

Submitted in part fulfilment of the requirements for the degree
of Doctorate in Clinical Psychology (D Clin.Psy)

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Registration Number:

Candidate Number: 0702120r

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(D.Clin.Psy)

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CHAPTER 1

MAJOR RESEARCH PROJECT SYSTEMATIC REVIEW

The predictive value of post-traumatic amnesia duration in long-term outcome after traumatic brain injury

Written according to requirements for submission to Brain Injury
(Notes for contributors Appendix 1.1)

Address for Correspondence:
Academic Unit of Mental Health and Wellbeing
Centre for Population and Health Sciences
Gartnavel Royal Hospital
1055 Great Western Road
Glasgow, G12 0XH

Abstract

Objectives

This review assesses the evidence regarding the ability of post traumatic-amnesia (PTA) duration to predict long-term outcome after head injury (HI). It also summarises factors that might enhance the predictive ability of PTA duration.

Literature selection

A systematic literature search of Ovid MEDLINE, EBM Reviews, EMBASE, ERIC and PsycINFO was conducted. Only studies utilising standardised PTA and HI outcome assessments were included. Outcome measures were completed at least a year after injury.

Literature analysis

The methodological quality of each study was independently rated by two reviewers according to quality criteria. These criteria were based upon CONSORT guidelines and established criteria for prognostic studies.

Findings and implications

Only seven studies met inclusion criteria. These were of high methodological quality. Overall the evidence suggests that PTA duration is a strong predictor of outcome. Other variables found to predict outcome included educational status and several cognitive factors. The ability to generalise these findings to the HI population is restricted by methodological limitations such as differing inclusion criteria across studies which should be addressed in future research to allow more meaningful comparisons across studies.

Introduction

Predicting outcome after TBI

Accurate outcome prediction after traumatic brain injury (TBI) is important in order to enable appropriate rehabilitation planning and to provide prognostic information for patients and their families [1]. As the majority of those with TBI are injured at a young age, knowledge regarding long-term functional outcome is particularly vital to enable sufficient planning for future needs [2; 3]. Functional outcome can refer to an individual's capacity to independently perform activities of daily living [3].

A number of variables have been found to influence functional outcome including a range of demographic, injury related and cognitive factors with stronger associations having been found in those who experienced moderate to severe TBI than those with mild TBI. However, these studies have reported conflicting results, with some studies reporting certain variables to be predictive of outcome and others finding no such statistically significant predictive value. Generally, the literature suggests that cognitive deficits experienced by those having sustained mild TBI tend to resolve within 3 months. However, for those having sustained moderate to severe TBI, recovery is most rapid during the first 5 months post injury, slowing over the following 7 months, with slower gains continuing as long as 5 years after injury [4; 5].

Currently, estimation of post-traumatic amnesia (PTA) is viewed as the best indicator of injury severity and predictor of functional outcome following head injury [6; 3]. PTA can be defined as a temporary state of altered cognition and behaviour typically experienced following a head injury. Disorientation, confusion and amnesia are characteristic symptoms of PTA and this experience often includes the absence of continuous memory for events occurring after the injury took place [7; 8].

Standardized assessment of PTA

A number of standardized measures have been developed to measure PTA both prospectively and retrospectively (including the Galveston Orientation and Amnesia Test (GOAT), Westmead Post-traumatic Amnesia Scale (WPTAS), Rivermead Protocol, Modified Oxford Post-traumatic Amnesia Scale (MOPTAS) and Orientation Log (O-Log)), with high correlation reported between the two types of assessment [6]. There is now general agreement that the end of PTA can be defined as a return of continuous memory [3].

Retrospective measures involve assessment following the end of PTA, whereas prospective measures entail assessment during PTA, often as serial assessments until PTA is deemed to have ended. The Rivermead Protocol is a retrospective PTA assessment in which the examinee is asked to recall their post-injury memories in chronological order. The examinee is asked following each recollection what the next thing they remember is. This line of questioning is continued until the examiner is assured that normal continuous memory is illustrated. The examinee is also asked for their view of when continuous memory returned. This scale defines duration of PTA as the time between injury and return of continuous memory [9].

Early prospective PTA scales focused on the assessment of orientation, for example the O-Log [10]. This is a 10 item scale assessing orientation to time, place and circumstance. This scale can be used for serial assessment of changes in orientation over time. It does not include a memory component. The first standardised prospective PTA assessment scale to include orientation and memory items, the GOAT, was published in 1979 [11]. This 16 item scale assesses pre and post injury orientation and recall of events.

Later scales were developed which also included assessment of continuous memory due to criticism that patients may be orientated but for example, be unable to recall being asked these questions [9]. One such scale placing greater importance on memory assessment in addition to orientation items was the WPTAS (1986) [8]. This scale comprises 7 orientation items and 5 anterograde memory items. The memory items involve asking patients to recall both the examiners face and name along with 3 simple picture cards.

PTA is deemed to have ended on the first of the 3 consecutive days of achieving a maximum score. The MOPTAS, a scale very similar to the WPTAS, consists of 8 orientation items and 4 anterograde memory items. Memory items involve recall or recognition of a name and three pictures [12].

Assessment of functional outcome after TBI

A number of measures have been used to assess functional outcome with the Glasgow Outcome Scale (GOS) being the gold standard for predicting global functional outcome after TBI [1]. This has been replaced by the Glasgow Outcome Scale- Extended (GOS-E) which includes an addition three points and a structured interview format to address criticisms regarding sensitivity [9]. The GOS-E correlates highly with other outcome scales such as the Disability Rating Scale (DRS) [3]. The GOS-E assesses consciousness, independence in the home, independence outside the home, employment status and ability, ability to pursue (and current involvement in) social and leisure activities, social functioning, presence of epilepsy and return to normal functioning in terms of the individual's daily life prior to injury. This measure has been found to have good reliability (kappa coefficient = .85) and validity [13]. This scale categorizes individuals into upper good recovery, lower good recovery, upper moderate disability, lower moderate disability, upper severe disability, lower severe disability, vegetative state, or dead.

Another outcome scale frequently used in TBI research is the DRS which allows assessment during recovery. This scale assesses impairment, disability and handicap using 8 items in the areas of arousal, awareness and responsivity, cognitive ability for self-care activities, general level of psychosocial functioning and employability. This scale has been found to have good inter-rater reliability and validity [14; 15]. It correlates highly with the GOS [16].

Rational for systematic review

It is recommended that PTA duration is assessed as an indicator of both injury severity and likelihood of return of physical and cognitive functioning due to the reported relationship between PTA duration and outcome after head injury [17]. As a consequence, PTA duration is used to inform clinical

decisions, such as whether to discharge a patient and in rehabilitation planning. However, although PTA duration is currently viewed as the best indicator of outcome, the accuracy of these predictions varies between research studies. It is therefore important to review the quality and findings of available research evidence regarding PTA as an indicator of outcome and what accounts for any variability in its predicative value so that these factors can be considered when making decisions clinically.

Review objective

The review aims to identify all literature regarding post-traumatic amnesia and its relationship to long-term outcome after head injury. However, it will review only those papers which use either the DRS, GOS or GOS-E to assess outcome as these are standardised measures of global functional outcome after TBI which correlate highly [3; 13]. The review will identify the margins of error in the predictive value of PTA duration as reported in the literature. It will also identify which factors account for any variability in the predictive value of PTA duration and will assess the quality of the evidence assessed.

Review questions

- What margins of error are evident in predicting outcome after head injury by PTA duration?
- Which factors, in addition to PTA duration, account for variability in the prediction of outcome after TBI?

Methods

A systematic literature search of Ovid MEDLINE (1950- 2010), All EBM Reviews, EMBASE (1980-2010), ERIC (1965-2010) and PsycINFO (1967- 2010) was conducted. Database searches were limited from 1980 until 20th May 2010 as the outcome measures required to be utilised in the studies as part of the inclusion criteria were developed in 1981/82. The following search terms were used in Search A: {[head adj3 inju*] OR [head adj3 trauma*] OR [brain adj3 inju*] OR [brain adj3 trauma*] OR [concussion] OR [concussed*] OR [TBI]} AND {[posttraumatic amnesia] OR [post-traumatic amnesia] OR [PTA]} AND {[outcome*] OR [recover*] OR [improve*]}. A separate search

(Search B) was also conducted using the terms: {[head adj3 inju*] OR [head adj3 trauma*] OR [brain adj3 inju*] OR [brain adj3 trauma*] OR [concussion] OR [concussed*] OR [TBI]} AND [amnesia*] AND {[outcome*] OR [recover*] OR [improve*]}. These terms were searched for within the study titles, abstract or keywords. A hand search of the references of journal articles meeting inclusion criteria was also conducted to identify any further relevant articles for inclusion.

Inclusion and exclusion criteria

Studies were included if they investigated the relationship between PTA and outcome after head injury. Studies must have had human participants over the age of 15 years and been reported in English. To be included, studies must have used standardised PTA assessment measures (GOAT, WPTAS, Rivermead Protocol, MOPTAS or O-Log) and have assessed outcome using the GOS, GOS-E or DRS. Outcome scales must have been completed at least a year after injury in an outpatient or community setting. Single case studies, reviews, meta-analyses and dissertation abstracts were excluded.

Data extraction

Data extracted from each study included sample characteristics and methodological information. The methodological quality of each study was independently rated by two reviewers according to quality criteria (see Appendix 1.2) with scores in 100 % agreement on 7 of 8 studies. Disagreement was resolved by re-evaluating the item jointly. These criteria were based upon CONSORT guidelines [18] and established criteria for prognostic studies [19] and were then modified for use in assessing studies investigating PTA and long-term outcome after TBI. Each paper could score a maximum of 21 points.

Results

Search A produced 769 articles and Search B 1084 articles (see Figure 1). On removing duplicates and applying inclusion criteria, 1846 articles were excluded, leaving a combined total of 7 articles for review. These studies are

discussed with reference to the systematic review research questions and their methodological quality.

[INSERT FIGURE 1 HERE]

Predicting outcome after TBI using measures of PTA duration - what are the margins of error?

Below is a summary of the seven articles reviewed and the evidence they present in relation to the prediction of outcome after TBI by PTA duration. Table 1 provides a summary of this information. The quality scores were high for all seven studies. Five scored 17 or 18/21 and the remainder 19 and 20/21. Points were lost when scoring methodological quality because none of the studies justified their sample size and six did not consider power calculations. Injury severity is detailed according to GCS scores to allow comparison between studies. The TBI severity of participants in most studies was moderate to severe, with only one study's participants averaging within the mild range of injury severity. Attrition ranged from none to 33 %, with sample sizes ranging between 33 and 5250. All but one study found PTA to predict outcome at follow-up. The percentage of variance explained by variables predictive of outcome was known for four of the seven studies. Of those studies which found PTA to predict outcome, the percentage variance explained by this variable was similar, ranging between 48 and 52 %.

Brown et al. [20] assessed PTA and outcome after one year in 5250 individuals with TBI. PTA was assessed using the GOAT, the Revised GOAT or the Orientation Log (O-Log). The O-Log is a similar PTA estimate to the GOAT [10]. Outcome was assessed using measures of employment status, independent living, activity limitations and global outcome (the GOS-E). The GOS-E scores produced were dichotomized into two groups. The first consisted of those with lower good recovery and upper good recovery (scores of 7 or 8). The second group included those who had died or were in a vegetative state to upper moderate disability (scores below 7).

[INSERT TABLE 1 HERE]

GOS-E scores at one year follow-up were predicted with 58.1 % correct classification by PTA duration within the fourth week following injury (25 days). The authors note that this modest percentage of correct classification (41.9 % unaccounted for) is likely to be due to the predictive influence of additional clinical factors other than PTA. There were several different methods of PTA assessment utilised in this study. Although these have been found to produce similar PTA estimations, the variance generated by using different methods may have resulted in discrepancy in PTA estimation. Therefore analyses involving combined data from different methods of PTA estimation may not be reliable.

Hanks et al. [21] investigated the predictive value of a neuropsychological test battery at one year outcome in 176 participants with TBI. PTA duration was assessed using the GOAT or O-Log, with this data being collected from hospital records. However, these PTA estimations were used to provide demographic information only. The use of these PTA estimations in estimation of predictive value of outcome may have been valuable as this would have provided an indication of outcome prediction nearer the time of injury. However, the use of two different methods used to assess PTA may have generated inconsistency in PTA estimations as in the Brown et al. [20] study. PTA was again assessed one month after injury and the remainder of the neuropsychological battery was completed at this time. At this point PTA was assessed using the GOAT and scores for this assessment were entered into the analyses. Outcome measures of interest included the DRS and GOS-E which were completed one year post-injury. However, 23 % of participants are noted not to have cleared PTA at time of testing one month post injury but were able to follow test instructions and complete testing. Regression analyses revealed PTA not to be a significant predictor of level of handicap as measured by the DRS or overall level of functioning (GOS-E scores) at one year post injury, although exact data are not reported.

Hiekkanen et al. [4] examined associations between and the prognostic capacity of the Apo-E genotype, GCS scores, MRI results, PTA duration and outcome one year after TBI in 33 participants. Two outcome measures were used, one of which was the GOS-E. PTA duration was assessed using the

Rivermead Protocol one week and one month post injury. PTA duration data was separated into five groups; ≤ 1 hour, 1-24 hours, 1-3 days, 4-7 days or ≥ 7 days. PTA duration was found to be significantly correlated with GOS-E scores ($r = -.458$, $p = .007$). Multiple regression analyses revealed that PTA was predictive of GOS-E scores at one year outcome ($r^2 = .253$, $B = .557$; $p = .018$). When age at injury was adjusted for, PTA duration explained 52 % of the variance ($B = .524$; $p = .038$) and was found to be the best predictor of one year outcome of the variables investigated. Again, this study utilised a relatively small sample size raising issues with regard to power, which was not reported.

Ponsford et al. [3] conducted a study examining the association of injury severity factors (coma depth and PTA duration), sociodemographic factors, current cognitive functioning and emotional state with functional outcome ten years after initial injury. Participants were 60 patients who had attended hospital for rehabilitation following TBI. PTA (in days) was examined using the Westmead Post-Traumatic Amnesia Scale (WPTAS) and scores were retrieved from hospital records. Outcome at ten year follow-up was assessed using the GOS-E. The authors split outcome data into upper/lower good outcome and disability/poor outcome due to the skewed distribution of the participants' GOS-E scores. They found that those who were in the better recovery group ($M = 17.4$, $SD = 16.6$) had significantly shorter PTA duration than those in the disability/poor outcome group ($M = 35.8$, $SD = 28.5$, $d = 0.8$, $p = .007$). This shows a large effect of PTA duration on outcome. Logistic regression analysis revealed PTA to be significantly related to GOS-E ($B = .04$, $SE = .02$; Wald = 6.9; $p = .009$). This study also has a relatively small and heterogeneous sample; for example with PTA durations positioned within two comparatively extreme categories. The authors acknowledge that selection bias may have occurred due to a low recruitment rate (58 %) with the final sample consisting of those who were contactable and lived nearer to the interview location.

Sigurdardottir et al. [5] investigated the predictive value of a battery of neuropsychological assessments on the outcome of 115 participants with TBI

at 3 and 12 months post injury. They assessed PTA using the GOAT at three months post injury and outcome at 12 month follow-up using the GOS-E. The GOS-E was administered by two raters and satisfactory inter-rater reliability was found ($k = .85$). Regression analyses were conducted in a step-wise fashion with other predictor variables added along with PTA. This revealed a significant effect of PTA ($B = -.02$, $SE B = .01$, $B = -.51$, $p < .001$) on GOS-E scores. In addition, Pearson correlations showed PTA to be significantly correlated to GOS-E scores ($r = -.69$, $p < .001$). The results reported refer to only 96 of the study participants; however there is no explanation as to why this may be.

Tate et al. [22] interviewed 131 patients with TBI at admission to a rehabilitation program, then at 18 months and 3 years post injury. They estimated PTA duration using the WPTAS and Modified Oxford Post-Traumatic Amnesia Scale (MOPTAS) and then allocated participants into one of three groups according to these results; 1-2 weeks (mild; 14.5 % of sample), 2-4 weeks (moderate; 33.6 %), > 4 weeks (severe; 51.9 %). Outcome was assessed at 18 months and 3 years post injury within a 6 month window and included administration of the DRS. A multiple stepwise regression analysis with DRS total scores as the outcome variable revealed that of the predictor variables entered into the model, (PTA duration, GCS score at retrieval, presence of elevated intracranial pressure, skull fractures and length of stay in the acute wards) PTA duration was the only variable found to contribute to this statistically significant model ($F = 129.5$, $df = 130$, $p < .0005$, $R^2 = .50$).

Significant improvement on the DRS was apparent for all three subgroups of initial PTA duration (mild: Friedman $\chi^2 = 13.2$, $df = 2$, $p = .001$; moderate: Friedman $\chi^2 = 24.5$, $df = 2$, $p < .0005$; severe: Friedman $\chi^2 = 48.8$, $df = 2$, $p < .005$). However, only the moderate and severe groups showed improvement between rehabilitation admission and 18 month follow-up and between follow-up at 18 months and at 3 years. At 18 month follow up, 63 % of those in the mild group and 59 % of those in the moderate group rated no/mild/partial disability on the DRS. However, this rating applied for only 28 % of the severe group, with 25 % still experiencing at least moderately-severe disability at this time. The pattern of disability was similar across PTA

duration groups at 3 year follow-up, with 63 % of the mild group, 68 % of the moderate group and 32 % of the severe group rated as no/mild/partial disability. Although participants in both the moderate and severe PTA groups showed improvement in DRS scores between the 18 month and 3 year follow-up, 22 % of the severe group were still categorized as at least moderately-severely disabled 3 years after injury.

Walker et al. [1] investigated the relationship between PTA duration and probability thresholds for GOS scores at 12 months and 24 months post injury. PTA duration was assessed in 1332 participants with TBI using the GOAT and O-Log. Multivariate regression analysis showed PTA to be the strongest predictor of GOS scores at 12 month ($\chi^2 = 158.91$, $df = 2$, $p < .0001$) and 24 month follow-up ($\chi^2 = 95.37$, $df = 2$, $p < .0001$). Longer durations of PTA provided an incrementally decreasing probability of good recovery and an equivalent increase in the probability of Severe Disability as assessed by the GOS. The probability of good recovery was less than 10 % when PTA duration was 8 weeks or more. When PTA duration was under 40 days, the probability of severe disability 12 months post injury was less than 15 %. At 24 months, the probability of severe disability was less than 15 % and good recovery was most likely when PTA was less than 27 days.

Which variables account for any variability in the prediction of outcome after TBI by PTA duration?

As the studies to be reviewed in relation to this review question are those which have already been summarised above, the study details will not be described again in the following section, but the evidence they report relating to this second review question is presented.

Hanks et al. [21] conducted multiple regression analysis using injury severity variables and functional variables. Independent variables included the Functional Independence Measure (FIM), the DRS, and number of days taken to obtain a score of 6 on the motor subscale of the GCS (time to follow command) at time of admission to rehabilitation. The dependent variable was DRS scores at 1 year post injury. This model was found to significantly

predict DRS scores ($R^2 = .06$, $p = .02$), with FIM score at admission to rehabilitation being the only significant predictor, explaining 2 % of the variance. When neuropsychological variables assessed one month post injury (GOAT score, Californian Verbal Learning Test -II (CVLT-II), Trail Making Test-B (TMT-B), Grooved Pegboard, FAS, Animal Naming, Wechsler Test of Adult Reading (WTAR), and Wisconsin Card Sorting Test (WCST)) were added to the analysis, the predictive value of the model increased ($R^2 = .16$, $p = .000$). However, only WTAR scores were found to significantly predict outcome in isolation ($p = .000$), explaining 9 % of the variance with TMT-B approaching significance ($p = .065$). When these analyses were conducted once more with GOS-E scores one year post injury as the outcome variable, the model only became statistically significant on addition of the neuropsychological variables (R^2 change = $.011$, $p = .022$), with TMT-B being the only independently significant predictor of outcome ($p = .046$), explaining 2 % of the variance.

Hiekkanen et al. [4] used multiple regression analyses to investigate the predictive value of Apo-E genotype, GCS scores, PTA duration and MRI findings on GOS-E scores one year post injury. They found that traumatic axonal injury lesions (TAI) and PTA together explained 81 % of the variance, with none of the other predictor variables reaching statistical significance. However, after controlling for age, the effect of number of contusions was no longer significant, but PTA remained a significant predictor, explaining 52 % of the variance. Whilst this study provided evidence for the predictive value of PTA on outcome, and evidence of some of those values which did not show predictive quality, they do not explain which variables account for the remaining 48 % of variance.

Tate et al. [22] reported similar findings. They inputted the following variables into a stepwise regression analysis: PTA duration, GCS score, length of stay in acute ward, presence of elevated transcranial pressure and skull fractures. They found PTA duration to be the only variable contributing to the model, indicating that PTA duration was the only one of the variables investigated which had significant predictive value of DRS scores three years

post injury. They did not assess their data in terms of how much of the variance in prediction of DRS scores, PTA accounted for.

Ponsford et al. [3] found that in addition to longer PTA duration, less education ($B = -.37$, $ES = .16$, $Wald = 5.2$, $p = .02$) was a significant predictor of disability 10 years post injury. PTA duration and education were not found to be significantly correlated and together produced 69.5 % correct classification of dichotomised GOS-E scores. They also investigated several neuropsychological variables, however these were assessed at follow-up rather than time of injury. Therefore, this neuropsychological data did not provide information regarding the predictive value of these variables on outcome after TBI. They also conducted a logistical regression analysis using those tests of attention/processing speed which were significantly related to GOS-E scores as independent variables.

Sigurdardottir et al. [5] conducted regression analysis investigating the effect of age, education, gender, marital status, pre-injury employment, and alcohol/drug use showed only education to have a significant effect. This variable explained 9 % of the total variance (17 %) in GOS-E scores at 12 months post injury. Injury variables (GCS scores, PTA duration, Computed Tomography/ Magnetic Resonance Imaging (CT/MRI) results and Injury Severity scores (ISS)) were then added to the analysis which increased the amount of variance explained ($R^2 = .53$, $p < .001$). This resulted in PTA being the only significant predictor remaining.

Another regression analysis was conducted using the neuropsychological variables of Memory/Speed, Visual/Perception verbal/Reasoning, fatigue at 3 months, PTA duration and CT/MRI results. All of the variables significantly predicted GOS-E scores 12 months post injury ($R^2 = .61$, $p < .001$) except the Visual/Perception variables ($p = .47$). Although the neuropsychological variables were assessed at both 3 and 12 month follow-up, the further analyses reported by the authors relate to data produced at 12 month follow-up. Therefore, additional findings relating to the predictive value of these neuropsychological variables are not relevant to this review.

Neither Walker et al. [1] nor Brown et al. [20] presented data on the predictive value of variables other than PTA duration.

Discussion

Predicting outcome after TBI using measures of PTA duration - what are the margins of error?

The results of the studies reviewed provide evidence that PTA duration is a strong predictor of long-term outcome after TBI. Only the results reported by Hanks et al. [21] opposed this conclusion. They found that PTA duration did not significantly predict outcome at one year after injury according to DRS or GOS-E outcome measures. These authors do not discuss this finding as it does not relate to the primary study aims. This finding may perhaps relate to the PTA duration used in analyses being assessed one month post injury rather than prospectively from admission, daily or at least once during the first week of admission. This could have meant that those who were in PTA on admission but PTA had resolved by one month post injury were categorised as never in PTA, weakening the association between PTA and outcome. Only four studies reported the variance explained or percentage correct classification by PTA individually in their statistical models. Due to only these four studies discussing the degree of predictive value PTA contributed individually, it is difficult to determine whether these margins of error are representative of current research findings. However, five of the studies do, in addition, investigate the predictive value of variables other than PTA.

Which variables account for any variability in the prediction of outcome after TBI by PTA duration?

The studies described identify several different variables in addition to PTA as significantly predictive of long-term outcome after TBI. Ponsford et al. [3] found less education to be a significant independent predictor of disability 10 years after TBI. However, they did not report the amount of variance explained by this variable alone. Sigurdardottir et al. [5] also found

education to be a significant predictor of outcome after TBI, with this variable explaining 9 % of the variance in GOS-E scores a year after injury.

The studies reviewed provide evidence for the predictive value of a number of neuropsychological variables in relation to outcome after TBI. Hanks et al. [18] found WTAR scores to independently predict DRS scores one year post injury, explaining 9 % of the variance. However, TMT-B scores did approach significance as a predictor variable in this analysis. When GOS-E scores were used as the dependent variable, only TMT-B scores significantly predicted outcome, explaining 2 % of the variance. The WTAR assesses premorbid intellectual functioning and this finding suggests that cognitive reserve, the ability of the brain to cope with cerebral damage, is an aspect which may be important to assess when predicting outcome after TBI. The TMT-B requires the use of cognitive abilities such as executive control, set-shifting abilities, psychomotor speed, sequencing and attention, suggesting that these may also be important variables to consider in prognosis after TBI. However, it is not clear which of these abilities or which in combination produce the predictive effect found.

Sigurdardottir et al. [5] provided further evidence for the predictive value of tests of executive function, as well as tests in the areas of verbal/reasoning. However, the authors did not report which of the individual tests within these groupings had the most predictive power, perhaps because many of these tests measure overlapping constructs. They also found level of fatigue at 3 months post injury to be predictive of outcome at 12 months post injury but did not report the variance explained by this variable. Thus the level of predictive value this variable provides is not known.

Evidence of the predictive value of intracranial pathology (CT and MRI results) to be predictive of outcome at 12 month follow-up was presented by Sigurdardottir et al. [5]. Hiekkanen et al. [4] also found evidence for the predictive value of intracranial pathology. They reported that TAI and PTA duration in combination predicted outcome but that this effect no longer remained when age was controlled for, with only PTA then being predictive.

Therefore, the level of the predictive value of intracranial pathology is not clear from these results.

Methodological limitations of studies

Several methodological weaknesses were apparent in reviewing the studies above. In nearly all studies, selective attrition may have influenced results at follow-up and therefore these results may not be representative of the TBI population. Attrition was reported as being due to a variety of factors including participants not being contactable at follow-up, participants living far away, missing data, participants declining to participate, participants being excluded due to remaining in PTA at rehabilitation discharge or follow-up and participants having passed away. Several authors attempted to determine whether there were statistically significant differences between those who were included in study analyses and those who were lost to attrition. All of these studies reported no significant differences in age, gender or injury severity between the groups.

Nonetheless, variables such as substance misuse, disability, mental health difficulties or psychiatric difficulties may have prevented participants taking part in follow-up. Although studies may exclude those with difficulties such as alcohol misuse this may result in the exclusion of a cohort of individuals who are representative of those presenting with TBI. Indeed, Corrigan [23] found that 44-46 % of those with TBI had a history of alcohol misuse. In addition, the disabilities and mental health difficulties which may have caused attrition or exclusion may also be related to the individuals TBI and thus this may again result in a sample which is not representative of the population of those with TBI.

As identified previously, some studies excluded those participants who remained in PTA at discharge from rehabilitation or follow-up which again results in a bias in selection criteria. Hanks et al. [21] make the case for including such participants, as in their study. They comment that this would provide information regarding the prediction of outcome in the early course of recovery. In addition, this may provide further knowledge regarding the

outcome of those more severely injured. Walker et al. [1] report that individuals who were excluded due to still being in PTA after rehabilitation discharge, had significantly lower GCS scores and poorer GOS scores at one and two year post injury follow-up. Therefore had these individuals been prospectively followed until no longer in PTA, it is likely that these longer PTA durations would have been associated with poorer outcome. Thus it is likely that the 90 % probability of those with PTA \geq 8 weeks being disabled on the GOS at one year post injury would have been even greater. As some studies include those still in PTA and others do not, this makes comparison of results more difficult.

In addition, further differences in inclusion criteria included, for example, some studies requiring a particular duration of PTA or loss of consciousness, or admission for treatment within a particular time after injury, whereas others did not. Due to the wide differences in inclusion criteria, the characteristics of the samples differed between studies. It was also difficult to compare samples due differences in description of the sample. For example, injury severity across studies was reported in different ways (LOC, PTA, GCS, length of hospital stay; see table 1). Despite this it appears that the study samples varied in terms of injury severity, indicating that their results may be relevant to differing TBI injury severity populations.

None of the studies justified their sample size and these seemed to represent convenience samples. The sample sizes reported across the seven studies varied from 33 to 5250. Those with smaller sample sizes acknowledged this as a limitation, therefore it is difficult to know how representative they were of the study population and how meaningful their analyses were. In addition, only two studies reported a power calculation, however these referred to only one analysis in each study and these were reported as only 45 % [3] and 57 % [5]. Therefore, the confidence with which the results of these studies can be endorsed may be limited.

Four studies [1; 20; 21; 22] used several methods to assess PTA duration and this may have introduced variability in their results as described previously.

In addition, although all of the studies used standardised methods of PTA assessment, they used different methods from each other, making the validity of comparison of PTA duration between studies arguable as each method may have produced slightly differing estimates. Only one study, Sigurdardottir et al. [5], reported inter-rater reliability, however this related only to the administration of the GOS-E and not the PTA assessment. This lack of assessment of inter-rater reliability for administration of PTA assessments and outcome assessments means that ratings may not have been reliable.

Several studies report the use of a dichotomized split of outcome scores in their analysis. However, there can be limitations of using this approach. Firstly, the split generated was not reported in Walker et al. [1] so it is not known whether this was the same as in the other two studies using this method with GOS-E scores; with one category being Lower and Upper Good Recovery, the other category including all other GOS-E scores. This makes the comparison of results more difficult. In addition, information regarding the level of disability experienced by participants is lost. For example, there is a lot of variability within the second category commonly used; Dead, Vegetative State, Lower Severe Disability, Upper Severe Disability, Lower Moderate Disability and Upper Moderate Disability. Thus using dichotomized categories in this way also results in information regarding the predictive value of independent variables on different levels of functional outcome being lost.

Limitations of review

The main limitation of this review was the lack of studies meeting the pre-determined inclusion criteria whose primary aim was relevant to this review. This led to difficulty in comparing the results of the studies included as they utilised differing designs and had different aims to one another. In addition, studies were included if they utilised either the GOS-E or DRS to measure outcome. However, comparing studies utilising differing outcome measures is problematic as they assess outcome slightly differently. For example, the GOS-E assesses social and leisure activities whereas the DRS does not. In addition, the DRS is known to be somewhat insensitive to changes in

functioning from mild to moderate disability, with ceiling effects evident at the higher range of functioning [22]. This makes comparison of outcome predictions on the two scales less meaningful.

Conclusions and implications for future research

Whilst PTA duration appears to be a strong predictor of long-term outcome following TBI, accounting for a large proportion of the variance, there are margins of error with the percentage of variance explained by PTA ranging from 48-52 %. This suggests that other factors are also likely to be important. However, the extent of these margins of error is less clear as few studies report this information. Therefore, future research would benefit from reporting not only the strength of prediction PTA duration provides, but the degree of variation it does or does not explain.

In addition, efforts are required to increase the degree to which the samples of studies in this research area are representative of the wider population with TBI. The use of sample size and power calculations to justify the size of sample used and inclusion of those participants remaining in PTA at rehabilitation discharge would increase the level to which results can be generalised. More robust conclusions could be drawn if only one method of PTA assessment was used along with tests of inter-rater reliability to reduce error. As the inclusion criteria and methods of dealing with attrition vary widely between studies, introduction of a uniform approach to these issues would increase the degree to which results can be compared between studies and to which they can be generalised.

Several neuropsychological variables, along with educational status and to a lesser extent, intracranial pathologies and fatigue were identified as predictive of long-term functional outcome after TBI, thus explaining some of the variability in prediction unaccounted for by PTA duration. However, many of the neuropsychological tests found to be predictive involved several neuropsychological functional domains. Further research is needed to elucidate which neuropsychological functions, or collective functions have the strongest predictive value. Generally, replication of these results would

be of benefit, as for example, once again, the tests used varied between studies, making comparison of results difficult.

Whilst several methodological limitations of these studies were identified, they were found to be of high quality according to the methodological quality rating criteria employed. However, due to the small number of studies meeting the strict inclusion criteria for this review, further research of high methodological quality is required to support the current findings presented in the literature and to identify further variables which may be predictive of long-term functional outcome after TBI. Nonetheless, currently PTA duration remains the best predictor of functional outcome following TBI.

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Figure 1: Flow diagram of inclusion decisions

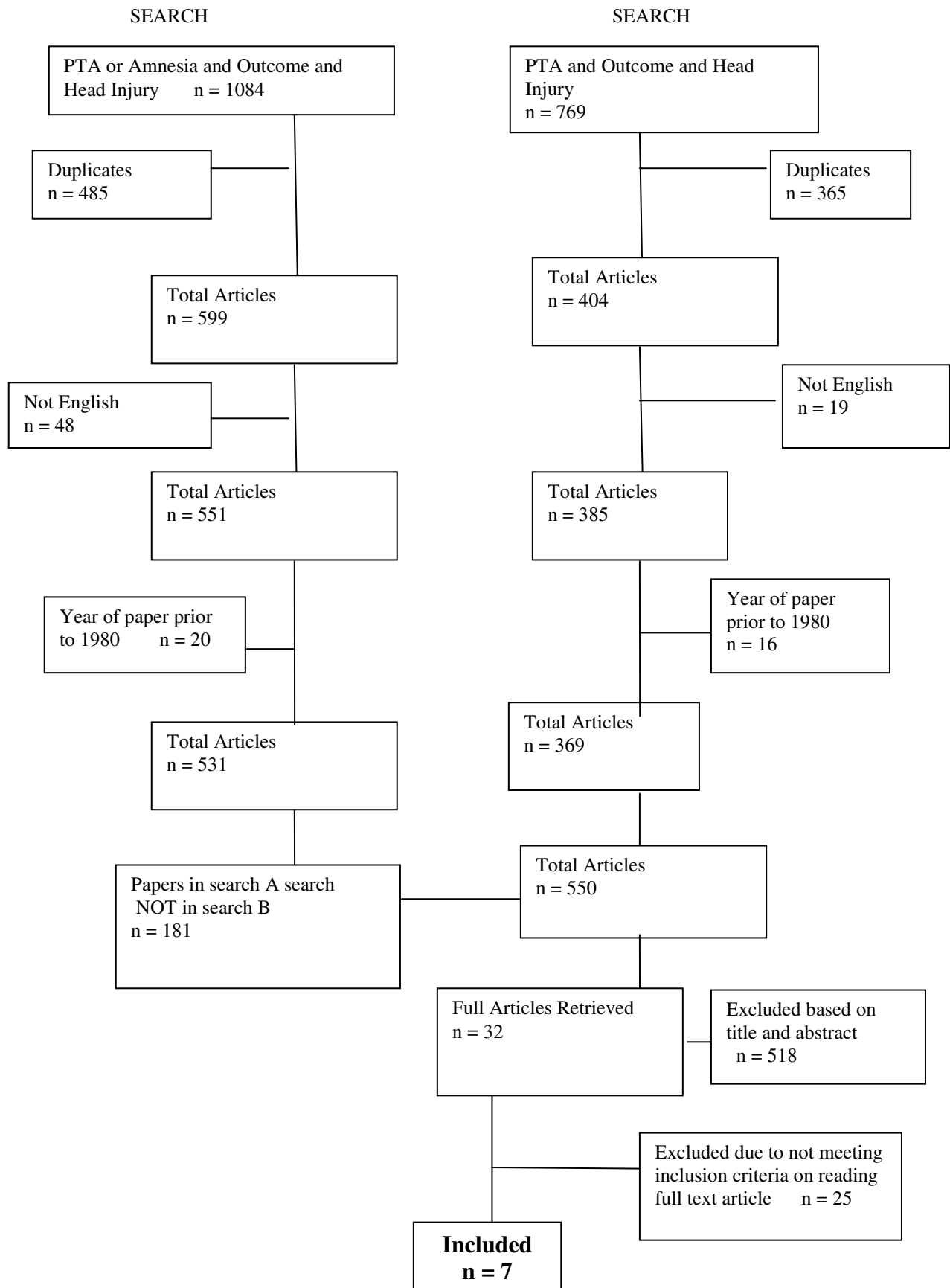


Table 1: Summary of included studies

| Study | Methodological Quality Score | Study Type & Injury Severity | Relevant Outcome Measure | PTA Assessment Used | Timing of Follow-up | Sample Size/ Study sample attrition | Main Finding(s) For PTA | Other Main Finding(s) | Percentage of variance explained by predictor variable |
|-----------------------|---|--|--------------------------|----------------------------------|---------------------|--|--|--|--|
| Brown et al. 2010 | 18/21 <ul style="list-style-type: none"> Diagnostic criteria of participant injury severity not explained Did not justify sample size Power calculation not considered | Prospective cohort Mean GCS 11.2 | GOS-E | GOAT Revised GOAT O-Log | 1 year | 5250 Attrition: None | PTA duration 25 days after injury predicted GOS-E scores with 58.1% correct classification as predicted by Odds Ratio. | None | Not known |
| Hanks et al. 2008 | 18/21 <ul style="list-style-type: none"> Did not justify sample size. Power calculation not considered Outcome known for only 74% of sample | Inception cohort study Median GCS 9 SD 4.17 | GOS-E DRS | GOAT O-Log | 1 year | 239, only 176 used in analyses due to attrition. Attrition: 26% did not complete follow-up. | PTA duration did not significantly predict outcome. | Performance on TMT-B individually predictive of outcome. | PTA = Not applicable TMT-B = 2% |
| Hiekkanen et al. 2009 | 19/21 <ul style="list-style-type: none"> Did not justify sample size Power calculation not considered | Prospective Study GCS Mean 13.5 SD 2.2 | GOS-E | Rivermead Protocol | 1 year | 33 Attrition: None | PTA duration significant predictor of outcome after controlling for age – explains 52% of variance. | | PTA = 52% when controlling for age |
| Ponsford et al. 2008 | 20/21 <ul style="list-style-type: none"> Did not justify sample size | Prospective Study Mean GCS 7.38 SD 4.29 | GOS-E | WPTAS | 10 years | 60 Attrition: None | PTA duration significant predictor of outcome. | Education significant predictor of outcome. | Not known |

Table 1: Continued

| Study | Methodological Quality Score | Study Type & Injury Severity | Relevant Outcome Measure | PTA Assessment Used | Timing of Follow-up | Sample Size/ Attrition | Main Finding(s) For PTA | Other Main Finding(s) | Percentage of variance explained |
|----------------------------|---|--|--------------------------|---------------------|---------------------|--|---|--|--|
| Sigurdardottir et al. 2009 | 19/21 <ul style="list-style-type: none"> Did not justify sample size Power calculation not considered | Prospective Study GCS score 13-15 =34.8% GCS score 9-12 =29.6% GCS score 3-8 =35.7% | GOS-E | GOAT | 1 year | 115 Attrition: 7.8% | PTA duration significantly correlated with GOC-E scores. Regression analyses = significant effect of PTA duration on outcome. | Education found to significantly predict outcome, explaining 9% of the variance. Better performance on range of cognitive measures related to better outcome. Lower Fatigue Severity Scale score 3 months post injury significantly predicted GOS-E scores 12 month post injury. | PTA = 48% Education = 9% Variance due to cognitive measure not reported individually. Variance due to fatigue as assessed at 3 months post injury not reported. |
| Tate et al. 2006 | 17/21 <ul style="list-style-type: none"> Did not justify sample size Power calculation not considered Implications for future research not discussed Outcome only known for 66% of sample | Inception cohort study GCS score 13-15 =18% GCS score 9-12 =17% GCS score 3-8 =64% | DRS | WPTAS MOPTAS | 18 months + 3 years | 198, although only 131 used in analyses due to attrition. Attrition:33% | PTA found to significantly predict outcome. | None | PTA = 50% |
| Walker et al. 2010 | 18/21 <ul style="list-style-type: none"> Did not justify sample size Power calculation not considered Implications for future research not discussed | Prospective design GCS scores not reported | GOS | GOAT O-Log | 1 year + 2 year | 1332 Attrition: None | PTA duration of 8 weeks = 10% probability of Good Recovery. PTA duration of around 4 weeks = probability of Severe Disability less than 15% at 12 month outcome. | None | Not known |

CHAPTER 2

MAJOR RESEARCH PROJECT

Estimation of post-traumatic amnesia in emergency department attendees presenting with head injury

Written according to requirements for submission to Brain Injury
(See notes for contributors Appendix 1.1)

Address for Correspondence:
Academic Unit of Mental Health and Wellbeing
Centre for Population and Health Sciences
Gartnavel Royal Hospital
1055 Great Western Road
Glasgow, G12 0XH

ABSTRACT

Objectives

To explore whether a semi-structured post-traumatic amnesia (PTA) assessment interview (PTA-I) provides a practicable but equivalent estimation of PTA in patients attending the Emergency Department (ED) with head injury (HI) compared to the established Westmead PTA Scale Revised (R-WPTAS).

Procedure

PTA was assessed using the R-WPTAS (includes a visual memory component) and the PTA-I (includes retrospective and verbal memory components), in patients attending an ED with (n=30) or without (n= 30) HI. Outcome measures were the Post-concussion Syndrome Checklist (PCSC) and the Glasgow Coma Scale (GCS). McNemar's Tests and Chi-square analyses were used to determine the results.

Results

The verbal memory component overestimated PTA in the control group by 24 %. Overall, the PTA-I did not discriminate between HI and control participants. However the retrospective PTA assessment embedded within the PTA-I did, with 100 % accuracy.

Conclusions

The use of a verbal memory component to assess PTA in the ED is not supported by the results of this study. A retrospective PTA assessment appears to allow more accurate decision making regarding the admission criteria used in the ED and has advantages over the R-WPTAS: fewer test materials and no repeat assessments required to achieve an estimate of PTA duration.

INTRODUCTION

Defining PTA

Post-traumatic amnesia (PTA) is defined as a temporary state of altered cognition and behaviour typically experienced following a head injury. Whilst PTA often involves a number of characteristic symptoms for example, confusion, disorientation, distress and anxiety, amnesia is perhaps the most renowned [1]. This often includes the absence of continuous memory for events occurring after the injury took place [1, 2]. Russell originally conceived PTA duration as an indicator of HI severity in 1932 [1, 3]. At that time, PTA was viewed as inclusive of loss of consciousness (LOC), thus including coma. Later a distinction was made between loss of consciousness and impaired consciousness, with Symonds defining PTA as impairment in cerebral functioning following the recovery of consciousness [4]. In 1943 Symonds and Russell further defined PTA to include return to 'normal orientation' [1, 5]. In 1946 Russell and Nathan emphasised the importance of return of continuous memory in defining the end of PTA duration. Since then numerous studies have confirmed the association between PTA duration and injury severity first proposed by Russell [4].

The importance of PTA

Estimation of PTA duration is thought to be the best indicator of severity of brain injury and the best predictor of functional outcome following head injury [4, 6]. As a consequence, accurate assessment of PTA is of clinical importance as underestimation of PTA could result in the discharge of patients who should be admitted for observation and may otherwise be at risk. According to SIGN 46 [7] admission is recommended if amnesia continues for five minutes or more after injury. Overestimation may lead to needless admission. Underestimation of PTA may lead to patients not receiving appropriate advice and access to rehabilitation services following discharge. There is risk of further injury and adverse consequences at work or socially during recovery from mild head injury especially where the head injury has not been recognised and advice has not been given [7]. In

addition, forms of rehabilitation and therapy which involve patients retaining new information are not appropriate whilst patients are still in PTA as PTA is associated with impairment in committing new information to memory [1].

Assessment of PTA

Several tools for assessing PTA have been developed, broadly divided into prospective and retrospective measures. Retrospective measures involve assessment following the end of PTA, whereas prospective measures entail assessment during PTA, often as serial assessments until PTA is deemed to have ended. McMillan et al. [6] compared retrospective (telephone interview 3.5-6 years after injury) and a prospective measure (the Galveston Orientation and Amnesia Test (GOAT)) in people with severe head injury. They found a high correlation (0.89) between measures of PTA duration and a significant correlation with other measures of injury severity and outcome. However, retrospective measurements have been criticised. As described by Symonds and Russell [5], assessment of PTA duration may be influenced by 'islands of memory', which can be incorrectly identified as the end point of PTA. These are periods where memory appears restored but is quickly followed by the return of amnesia and disorientation. Retrospective measures rely on the subjective accounts of patients and their families which may often be inaccurate due to confabulation by the patient, the patient's attempts to 'fill in the gaps' within information from other sources and the stressful nature of the events.

Levine and co-workers published the first standardised prospective PTA assessment scale, the GOAT, in 1979 [8]. This consisted of 16 items assessing orientation and recall for events, both pre and post injury. Gronwall and Wrightson, [9], and Jackson et al. [10], developed further methods of assessing PTA prospectively with a focus on orientation. Along with the GOAT these methods have been criticised because of their emphasis on orientation rather than continuous memory [4]. For example, underestimation of PTA has been identified when patients can give correct responses to orientation questions, but later do not remember being asked these questions [11]. This led later scales placing greater importance on memory assessment, for

example the Westmead Post-Traumatic Amnesia Scale (WPTAS) (1986) and the Julia-Far Centre PTA Scale (1994) incorporate assessment of both orientation and memory [1].

The WPTAS was originally designed for use in assessing PTA duration in patients with moderate to severe head injury, as were most other PTA assessment methods. The WPTAS has a high level of inter-rater reliability and is a strong predictor of outcome 1, 2, and 5 years after injury [4]. In 2004 Ponsford and co-workers developed a revised version of the WPTAS (R-WPTAS; 2 items shorter) which was found to provide a valid measurement of PTA duration in patients in an ED with mild head injury (MHI), defined as a PTA duration of less than 24 hours [4]. The patients were assessed on an hourly basis and R-WPTAS scores significantly correlated with Glasgow Coma Scale (GCS) scores [12].

Further support for the R-WPTAS was provided recently by Shores et al, [13]. Administration of this scale in addition to the GCS improved detection of cognitive impairment in patients with mild TBI. In addition, the R-WPTAS correlated more highly with neuropsychological measures than the GCS.

Andriessen et al. [14] compared the sensitivity and specificity of visual and verbal stimuli within a PTA assessment. Participants were 64 patients admitted to an ED with head injury, 22 orthopaedic injury patients and 26 healthy controls. They administered the GOAT and WPTAS, and a 3-item visual or verbal memory test to which participants were randomly assigned. The memory tests involved a short delay free recall, short delay recognition, long delay free recall and long delay recognition components. The study concluded that the specificities of the verbal and visual memory tests were equivalent (i.e. for short delay recognition, specificity was 100 % for both words and pictures), but the verbal test showed higher sensitivity (21 %) than the visual test (1 %) thus categorising brain injured patients and controls more accurately. Free recall was more effortful for all participants and a longer delay between presentation and recall resulted in fewer items recalled within the brain injured group only. This study provides evidence for

an alternative and potentially more practicable method of assessing memory within an ED setting.

ED assessment of PTA

Despite the large evidence base describing the value and importance of assessing PTA duration, currently EDs in the UK do not routinely assess PTA systematically. Often there is no assessment of PTA, or an approximation is produced based on symptoms of disorientation and confusion if apparent during assessment. Assessment of PTA must not only be valid, but also practical if it is to be conducted routinely in busy EDs, (i.e. rapid and simple to administer). Therefore it is important to consider the practical use of PTA assessments in this setting. Whilst the R-WPTAS is a valid measure of PTA duration in patients with mild head injury in EDs, the picture recall component may not be practical because of the need to source and store test materials. An equally sensitive and specific test not requiring the need for extra materials may therefore be more practical for use in this setting. A more robust method of assessing PTA in the ED would allow patients who may still be in PTA and therefore potentially at risk, to be identified. Consequent decisions as to whether these patients should then be admitted, discharged and followed-up or provided with access to rehabilitation services can then be made.

The identification of a potentially larger group of patients still in PTA need not necessitate the allocation of large amounts of hospital resources to following up these patients. Telephone follow-up is accepted as a useful method enabling exchange of information, symptom management and the early recognition of complications after hospital discharge [15]. Numerous studies support the beneficial impact and feasibility of telephone follow up - for example, Wade et al. [16] found that telephone support offered by a specialist service significantly reduced social morbidity and severity of post-concussion (PC) symptoms six months following head injury. A study by Bell et al. [17] demonstrated the feasibility of using telephone follow-up to provide information and support to patients who had sustained moderate to severe TBI. Telephone follow-up has been found to provide additional

benefits such as improving the quality of life of A&E attendees following road traffic accidents [15].

AIMS AND HYPOTHESES

Aims

The central aim of this study is to explore whether a semi-structured PTA assessment interview (PTA-I) incorporating both verbal memory and retrospective memory components provides similar estimations of PTA to the R-WPTAS in this population. In addition, this study will examine whether the PTA assessments used in the study discriminate head injured patients from controls.

Hypotheses

1. The PTA-I and R-WPTAS will be in high agreement in their categorisations of PTA.
2. The PTA-I (3-item verbal component) will be more sensitive than the R-WPTAS picture component (visual).
3. Both the R-WPTAS and PTA-I will categorise more people as cognitively impaired (in PTA) than will the GCS (i.e. scoring < 15/15).

METHOD

The site chosen to carry out the present study was Glasgow Royal Infirmary (GRI) which is the main receiving ED in the East of Glasgow. In 1998, 5084 patients with a head injury were treated at the GRI ED which accounts for almost 8 % of attendees. Of these patients, 1221 were admitted for further observation [18]. Similar numbers of head injuries were seen in 2006, with

370 patients attending with head injury but not being admitted between April and October 2006 [19]. This site was believed to be an appropriate choice due to the number of patients attending and because the ED department at this hospital adheres to current good practice guidelines regarding the management of patients with head injuries [7, 20], including those relating to assessment of PTA and admission decision making [19].

The present study compares the R-WPTAS and a semi-structured PTA (PTA-I) interview incorporating the 3-item verbal memory test [14], a retrospective memory assessment and elements of the R-WPTAS in patients with head injury and controls. A control group was implemented in order to confirm that the PTA assessments utilised discriminate between head injured patients and controls. The PTA-I consists of both orientation and continuous memory assessment elements, thus hoping to provide an accurate estimation of PTA. However this assessment does not require any further test materials, such as picture cards, and is easier to administer in an ED than the R-WPTAS.

Ethical issues

Ethics approval was obtained from the NHS Greater Glasgow and Clyde West of Scotland Research Ethics Committee and the NHS Greater Glasgow and Clyde Research and Development Management (see Appendices 2.1 and 2.2).

Participants

Participants comprised individuals attending the Emergency Department at Glasgow Royal Infirmary between November 2009 and May 2010. The experimental group consisted of individuals who presented with a head injury, and control participants presented with any complaint except HI. All participants were aged 16 or over and were able to communicate in English sufficiently to take part. Those presenting with a head injury and another significant injury, with a Glasgow Coma Scale Score of less than 9 (i.e. in coma), requiring neurosurgery or with a penetrating head injury were

excluded. Patients were only invited to take part at the point they were deemed ready for discharge.

Sample size

There is currently no research data regarding the PTA-I as this is a new assessment, designed for the purposes of this study. Therefore, data from the Shores et al. [13] study was used as an estimate due to the similarities between the R-WPTAS and PTA-I and the use of a similar study population. Shores et al. [13] established the specificity and sensitivity of the R-WPTAS by comparing 82 head injured patients and 88 non-head injured controls. The differences in scores between the head-injured and control groups on the R-WPTAS, with $p=.05$ and $\text{power}=.8$ gave an effect size of 1.07. This data was used to estimate the required sample size required for this study using GPower [21].

Hypothesis 1: the sample size required to detect a difference between the proportions of people categorised by the PTA-I and R-WPTAS as in or not in PTA within the head injured and control groups was estimated using data from Shores et al. [13]. With $\text{power} = 0.8$ and $\alpha = 0.05$ a required sample size of 24; 12 in each group was estimated.

Hypothesis 2: there is no data available on the accuracy of the individual memory components of the PTA assessments used in this study in categorising PTA. It is assumed that numbers are likely to be similar to those required for the entire R-WPTAS PTA assessment.

Hypothesis 3: the sample size required to detect differences between PTA measures and the GCS using chi square analysis was estimated using data from Shores et al. [13]. With $\text{power} = 0.8$ and $\alpha = 0.05$ a required sample size of 48 was estimated; 24 in each group.

Based on these estimations it was proposed to recruit 60 participants, 30 into each group (experimental and control).

Recruitment

Patients attending the ED with a head injury or who were admitted from there for observation to Wards 52/53 at GRI during the study period and who met the study inclusion criteria were invited to take part. Patients were recruited near to the point of discharge (when deemed fit to return home and hence able to provide informed written consent).

Settings and equipment

Interview/testing was carried out in GRI ED or Ward 52. Measures were three assessment tools (The R-WPTAS, The Post-traumatic Amnesia Interview (PTA-I), The Post-concussion Syndrome Checklist (PCSC; to provide details of injury symptoms, intensity and duration) [22]), and in addition consent forms, information sheets, a data collection sheet, access to GRI Head Injury Assessment Form and access to hospital records for patient background information.

Design

This study employs a prospective cross-sectional between groups design (see Figure 1). It is impossible to estimate the number of GRI ED attendees who were invited to participate by GRI staff other than the researchers as no record of this was kept. It is unknown how many may have declined to take part at this point. It is unlikely that all attendees meeting recruitment criteria would have been invited to take part due to staff time constraints and the unreliability of head injury diagnostic coding [23].

[INSERT FIGURE 1 HERE]

Procedure and measures

Background information (age, sex, relevant medical history, history of learning difficulties, current medications, substance use at time of injury, admission and assessment, injury specifics-cause and when this occurred,

GCS score and the results of PTA estimation currently employed within the department) was gathered from either hospital records, the GRI head injury assessment form or during patient interviews.

In addition, information was collected regarding the time when the GCS assessment was carried out by ED staff and how long after injury the researcher interviewed the patient.

As it was not possible to ensure that the same researcher completed administration each time, the Modified WPTAS was used as it does not require the name and face of the examiner to be recalled but instead a photograph of another individual.

The researchers were two final year trainee clinical psychologists and the lead Consultant in Emergency Medicine (EM). The Consultant in EM agreed to take part in the recruitment of participants and in administration of the study to enhance the sample size obtained. To ensure inter-rater reliability, three mock interviews were recorded and the two researchers were required to score these to identify any discrepancy in the scoring of responses (the Consultant in EM did not take part in any scoring).

The Modified Westmead Post-traumatic Amnesia Scale (WPTAS; [4])

This scale (see Appendix 2.3) contains 10 items assessing orientation in time and place (items 1-6) and anterograde memory (items 7-10). The memory component involving pictures of objects is given at the start and end of the interview to allow assessment of recall at a single assessment. The patients are shown 3 pictures of objects (line drawings of a cup, keys and bird) and asked to recall these later. If the patient is unable to recall all of these, he/she is asked to choose from the full set of 9 cards; three target pictures and 6 distracter pictures. If patients do not spontaneously respond to orientation questions, a multiple choice is given. For example, for the question 'What time of day is it?' they would then be asked 'Is it morning, afternoon or evening?' The memory component includes an assessment of the ability of the patient to recall a photograph of a face, identify this face

from a set of 6 photographs of faces after an hour. The photographs were (4'' x 6'') close headshots of the head and face with identical lighting and background. They were of individuals who were of the same sex and similar in features. If the patient is unable to recall the face, they are given a choice from the set of photographs.

The operational definition of the endpoint of PTA is that patients must score 10 out of 10 for 3 consecutive days [4]. It is not possible to utilise this traditional definition of PTA endpoint in this study as it is not practical to repeat tests over 3 days in a 24 hour ED. The maximum score possible using the R-WPTAS is 10/10 which for the purpose of this study, if obtained at a single assessment, indicates that the patient is no longer in PTA.

The Post-traumatic Amnesia Interview (PTA-I)

This is a semi-structured PTA assessment interview (see Appendix 2.4) incorporating elements of The Westmead PTA Scale and a memory component procedure adapted from those used by McMillan et al, [6] and Andriessen et al. [14]. Items 1-7 assess orientation, whereas items 8-10 provide a memory assessment component. The orientation questions are identical to those in the R-WPTAS and thus participants will only be required to answer these items once, with the same data being utilised in analysis of both PTA tests. The first part of the memory component consists of asking patients to recall their memories after the injury in chronological order [6]. Patients will be reminded that they should attempt to convey facts they can remember rather than any information which they may have been told since injury by others regarding these events. Whilst the PTA-I memory component asks specific questions regarding memories after injury, it is acknowledged that not all questions may be relevant to each patient. For example, they may not remember the journey to hospital. To allow for this discrepancy in experience, patients will be asked 'What is the next thing you remember' after each event in addition to the specific questions contained within the PTA-I.

The last part of the memory component consists of a 3-item verbal memory test [14]. At the beginning of PTA assessment, participants will be asked to memorise three words. Immediately after presentation they will be asked to repeat these back to the researcher. If these are not repeated correctly, the words are presented a second time. Following administration of the rest of the PTA assessment, participants are asked to recall the three words they had been asked to memorise. If recall of these items is not perfect, the participants will be presented with nine words (three target items and six distracter items) and asked to specify which three of these nine they remembered from the initial presentation. Patients are categorised as not in PTA if they obtain a score of 10/10 on the PTA-I.

The Post-concussion Syndrome Checklist (PCSC ; [22])

This provides a self-report measure of symptom frequency, intensity and duration after injury (see Appendix 2.5). The symptoms assessed are those that have been found to be most commonly associated with post-concussion syndrome (PCS). Patients are requested to rate their symptoms on a Likert-like scale from 1 “not at all” to 5 “all the time”. Scores for frequency total, intensity total, duration total and a total score across the three dimensions are calculated.

Data analysis

Analyses were carried out using SPSS Version 18.0 [25]. Descriptive statistics and Chi-square tests were used to investigate patient background variables including self-reported symptoms experienced by participants as assessed by the PCSC. Results relating to the hypotheses were determined using Chi Square analysis. More specifically McNemar’s Test was used to determine agreement in the categorisation of each patient by each test and which components of the PTA-I and R-WPTAS were most sensitive to PTA status.

RESULTS

Description of sample (see table 1)

Two groups of 30 participants were recruited. However, data produced by one individual within the Control Group was excluded as he probably experienced a 'mild' head injury on the basis of PTA duration. This individual fell down stairs and described memory gaps following the event. It is not clear whether this resulted from the influence of alcohol at the time of the injury and it is possible that a head injury was sustained given the cause of injury, thus this participant was removed from further analysis as it was likely that he may not have fulfilled the inclusion criteria.

[INSERT TABLE 1 HERE]

Age ranged from 17 to 86 and 53 were male and 6 female. There were no significant differences in age or gender between the HI and control groups (age: $t(57) = .250, p = .804$) or (gender $\chi^2(1) = .820, p = .365$).

All in the HI group presented at hospital with head injury as the primary complaint. The control group presented with a variety of complaints and injuries (see table 2).

[INSERT TABLE 2 HERE]

Table 3 shows duration of admission for participants in the HI group. Control participants were not admitted. Data produced by Question 7 of the PTA-I (see Appendix 2.4) provided an estimation of PTA duration (see figure 2). The correlation between duration of admission and duration of PTA was not significant ($r(30) = 0.729, p = 0.066$).

[INSERT TABLE 3 HERE]

One participant in the HI group was assessed as being within the severe range of PTA duration using the retrospective PTA assessment, with all other participants in the HI group assessed as being in the mild to moderate range. All control group participants were assessed as not having been in PTA.

[INSERT FIGURE 2 HERE]

Relationships between PTA estimations using the R-WPTAS and the prospective elements of the PTA-I

McNemar's Test was used to determine the level of agreement in categorising participants as being in or not in PTA on the PTA-I and R-WPTAS. Question 7 of the PTA-I was not included in the analyses below because it concerns whether the person has been in PTA rather than their current presentation. All questions in the R-WPTAS reflect current presentation. The R-WPTAS and PTA-I agreed on 73.3 % of classifications of all participants in both samples combined (see table 4). All disagreements bar one were due to the PTA-I classifying participants as being in PTA and the R-WPTAS as not ($\chi^2(1, N = 59) = 9.600, p = .001$).

[INSERT TABLE 4 HERE]

When classification of participants in HI and control groups was considered separately (see tables 5 and 6), the two tests agreed on 70 % of classifications in the HI group ($\chi^2(1, N = 30) = 4.00, p = .039$) and 77 % in the control group ($\chi^2(1, N = 29) = 4.167, p = .031$). All cases of disagreement (bar one in the HI group) were due to the PTA-I classifying participants as in PTA when the R-WPTAS classified them as not in of PTA.

[INSERT TABLE 5 HERE]

[INSERT TABLE 6 HERE]

Consideration of visual and verbal learning in PTA assessments (prospective assessments)

As items 1-6 of the R-WPTAS and PTA-I are identical, differences in classification cannot have arisen from these items. Item 7 of the R-WPTAS involves recognition of a face but only one participant in the HI group failed to recognise this picture, hence disagreements in classification are not explained by this item. Differences in classification between the R-WPTAS and PTA-I arose because one scale uses a 3-item visual memory assessment and the other a 3-item verbal assessment (items 8-10). Note, the individual who failed the face recognition item remembered all 3 verbal and visual item components.

The results of the McNemar's Tests reported in tables 5 and 6 compare the PTA-I (3-item verbal component) and the R-WPTAS picture component (visual) because other items included in the analysis are identical. These analyses reveal that the PTA-I classifies more participants in the HI and control groups as being in PTA than the R-WPTAS.

Participants were presented with the visual memory component first 67 % of the time and the verbal memory component first 33 % of the time. Of those who were presented with verbal memory items first, 70 % (14/20) remembered the verbal items. Of those who were presented with visual items first, 65 % (26/40) managed to remember the verbal memory items. This indicates no evidence of an order effect on memory scores.

Relationships between PTA estimations using the R-WPTAS prospective element of the PTA-I and retrospective element of the PTA-I

PTA classification using the retrospective PTA assessment was then compared to that produced by the prospective measures to determine whether the retrospective assessment identifies individuals who have been in PTA but who may not currently be in PTA, but who should be admitted according to SIGN 46 [7].

These comparisons suggested an over-sensitivity of the prospective elements of the PTA-I in assessing control participants as in PTA. All disagreements in control participant classification were due to the retrospective measure assessing individuals as not in PTA when the prospective measures did. The prospective elements of the PTA-I identified 7 control group participants as in PTA ($\chi^2 (1, N = 29) = 5.143, p = .016$) and the R-WPTAS assessed 1 participant as in PTA ($\chi^2 (1, N = 29) = 1.000, p = .000$).

When these comparisons were repeated for the HI group, all disagreements were due to the retrospective measure assessing participants as in or having been in PTA when the prospective measures assessed them as not currently in PTA (due to the retrospective measure assessing all participants in the HI group as in PTA). The PTA-I identified 13 people in the HI group as not currently in PTA and all but one of these were assessed by the retrospective assessment as having been in PTA for 5 minutes or more and having mild or moderate PTA duration ($\chi^2 (1, N = 30) = 15.059, p = .000$). The R-WPTAS identified 6 people in the HI group as not in PTA and all of these were assessed by the retrospective assessment as either in mild or moderate PTA.

Comparison of PTA and GCS assessments of injury severity

Although the GCS provides a general indication of injury severity it was not appropriate to compare these scores to the results of the prospective PTA estimations as the GCS was completed at different points in time by medical staff, and at a different time to the PTA assessments. GCS scores were categorised as in PTA (a GCS score <15) or not in PTA (a GCS score of 15) to

allow comparison with the retrospective PTA assessment. This comparison was conducted to assess level of agreement as to whether the participants had ever been in PTA (see table 7). This is important, as if only GCS scores are predominantly used to assess injury severity in the ED, patients who should be admitted according to SIGN 46 criteria may not be [7].

[INSERT TABLE 7 HERE]

Agreement was found in only 38 % of classifications (χ^2 (1, $N = 59$) = 19.048, $p = .000$). Disagreements were due to the retrospective PTA assessment identifying participants as being in PTA when the GCS did not. The retrospective PTA assessment suggests that these 21 individuals had experienced PTA of moderate duration or greater as a result of their injury. However, assessment using the GCS alone would not have identified them as requiring admission.

PCS symptom self-reporting (see table 8)

A Mann Whitney-U test indicated no significant difference between groups in total PCSC scores ($z = -1.155$, $p = 0.248$), in Intensity scores ($z = -1.030$, $p = 0.303$), in Duration scores ($z = -1.141$, $p = 0.254$), or in Frequency scores ($z = -1.114$, $p = 0.265$).

[INSERT TABLE 8 HERE]

According to the DSM-IV patients must have 3 or more symptoms in order to be classified as having PCS. A Chi-square analysis with figures derived from this criterion for clinical ‘caseness’ revealed that the HI and control groups did not differ in terms of numbers with 3 or more symptoms reported (χ^2 (1, $N = 59$) = 0.094, $p = 0.759$) (see table 9).

[INSERT TABLE 9 HERE]

There was no difference in the duration of PTA (as assessed by the retrospective PTA assessment) between those who met DSM-IV criteria for PCS and those who did not ($z = 0.149, p = 0.882$).

Symptom presence on the PCSC was defined as symptom frequencies greater than 'seldom' [19]. Using this criterion, a McNemar's test showed that there was a significant difference between those who were categorised as in or not in PTA according to retrospective PTA assessment ($\chi^2 (1, N = 59) = 13.793, p = 0.000$). All participants in the HI group were classified as in PTA and 25 were classified as having symptom presence, 5 were not. All individuals in the control group were classified as not in PTA according to the retrospective PTA assessment. Of these, 25 were classified as having symptom presence and 4 were not.

McNemar's tests showed that there were no differences found in the HI group between those who had PCSC symptoms or not and categorisation as in or not in PTA by the R-WPTAS ($\chi^2 (1, N = 30) = 4.267, p = 0.035$) or the GCS ($\chi^2 (1, N = 30) = 2.083, p = 0.146$). Again no significant differences were found when repeating the analyses with control group data: for R-WPTAS ($\chi^2 (1, N = 29) = 0.800, p = 0.375$); for GCS ($\chi^2 (1, N = 29) = 2.250, p = 0.125$).

PTA duration as assessed by the retrospective assessment was split into two groups; 'Mild' including no PTA to mild PTA durations, and 'severe' including moderate to extremely severe PTA durations. A McNemar's test revealed no significance between those who met criteria for symptom presence or did not and those who were assessed as having experienced 'mild' or 'severe' PTA durations ($\chi^2 (1, N = 59) = 3.375, p = 0.064$) see table 10 .

[INSERT TABLE 10 HERE]

DISCUSSION

PTA estimation using a verbal (PTA-I) or visual memory (R-WPTAS) component (prospective assessment)

The high level of agreement that was expected between PTA-I and R-WPTAS was not found. Although there was 75 % agreement between the two scales overall there was a significant disagreement in classification of controls. Disagreement in classification was due to the PTA-I categorising control participants as in PTA.

As items 1-6 in the R-WPTAS and PTA-I are identical and the retrospective PTA assessment of the PTA-I (item 7) was excluded from this analysis, it was therefore the visual and verbal memory components which accounted for this difference in classification. The results of item 7 of the R-WPTAS (face recognition) did not influence classification agreement as only one participant in the HI group could not recall the face presented with all other participants in both groups recalling this item correctly.

The verbal memory assessment categorised more participants as in PTA than the visual memory assessment as expected, but this was not due to greater classification accuracy. This finding contradicts that of Andriessen et al. [14], who found equal specificity of visual and verbal memory assessments of PTA duration. Andriessen et al. [14] note that during the visual memory task, participants are required to verbally acknowledge that they have registered the visual material with which they have been presented. This may result in the visual task being less effortful as these items may have been encoded both visually and verbally leading to better recall/recognition ability.

It is possible that the memory task in the current study was more difficult for participants as they had both words and pictures to memorise whereas in Andriessen et al.'s, [14] study participants were required to memorise either words or pictures. This may have produced a larger difference in the level of difficulty in the current study between the verbal and visual tasks conducted. For example, the average digit span for adults has been established as seven plus or minus two [26]. In the current study,

participants were requested to hold 7 items of information in working memory (3 words, 3 pictures and a photograph of a face). This may therefore have made this memory assessment a more difficult task. However, although this may have affected the recall aspect of the memory assessment, it does not explain the participant's inability to recognise words or pictures as capacity for recognition memory is believed to be much larger with studies finding subjects able to remember several hundred items of information [27].

Several studies have found that the ability to memorise new verbal information recovers more slowly after HI than memory for visual information [28]. Schwartz et al, [29] investigated the ability of 91 TBI patients and 27 control subjects to learn and retain new information. They administered the GOAT, a three word recognition and recall test and a three picture recognition and recall test. They found that return of the ability to recognise and recall pictures returned approximately one day before that of words. Stuss et al. [30] assessed the recovery of attention and memory abilities in 108 TBI patients and again found that the ability to recall visual items returned before that of verbal items. This may help to explain why HI participants in the current study were categorised by the PTA-I (containing a verbal memory task) as in PTA when the R-WPTAS (containing a visual memory task) assessed them as not in PTA. However, this does not explain the poor performance by control group participants on the verbal memory task of the PTA-I.

The control group in the Andriessen et al. [14] study consisted of 22 orthopaedic and 26 healthy participants who performed at a ceiling level on both verbal and visual memory tasks. However, this was not the case in the current study. There are several possible explanations for this finding. The control group in the current study consisted of ED attendees without HI. At time of assessment, many patients were experiencing pain and fatigue due to the nature of their injuries. This may have affected their attentional capacity or ability to complete more effortful tasks, both of which are known to impact cognitive task performance [28]. It is possible that the orthopaedic controls recruited in Andriessen et al.'s study [14] were in relatively less pain and less fatigued. They do not explain how these 22 orthopaedic

controls were selected and do not detail whether a specific sampling technique was used. In addition, other contaminants such as anxiety or depression may have been present.

Comparison of retrospective and prospective PTA assessments

The retrospective component of the PTA-I discriminated between HI and control participants. When these classifications were compared to those of the R-WPTAS and the prospective component of the PTA-I, the results suggested over-estimation of PTA in the control group. In addition, the retrospective assessment identified participants in the HI group as meeting criteria for admission according to SIGN 46 guidelines [7] which the prospective measures did not. Previous studies comparing prospective and retrospective PTA assessments have found high correlation [6]. However, McMillan et al. [6] found that in 6 of the 9 cases of disagreement between the assessments, PTA was assessed as greater by the retrospective assessment but less in the other 3. None of these cases were assessed as brief PTA by one assessment and severe PTA by the other. It was not possible to establish from their data which assessment was more accurate. Data from the current study suggests that for decision making in the ED regarding whether to admit patients, the retrospective memory assessment provides more useful data than the prospective measures.

Comparison of PTA and GCS assessments of injury severity

As hypothesised, the PTA-I (prospective component) and the retrospective PTA assessment of the PTA-I (item 7) classified more individuals as cognitively impaired than did the GCS. All disagreements in classification with the retrospective PTA assessment and 14/17 cases of disagreement with the prospective PTA-I assessment were due to the GCS classifying individuals as not in PTA when the other measures classified them as in PTA. As discussed previously, it is possible that the prospective PTA-I assessment overestimated the number of participants in PTA due to oversensitivity of the memory components. However, the retrospective assessment identified 28 of the 30 participants in the HI group as having been in PTA for more than

5 minutes (whether they still were or not), which indicates that they should all be admitted according to SIGN 46 guidelines [7]. If only the GCS estimation of injury severity were used, only 9 of these participants would have been admitted, potentially missing 19 individuals who would have met criteria for admission.

As with the PTA-I, it was hypothesised that the R-WPTAS would correctly identify participants as in PTA when the GCS generated a false negative as found by Shores et al. [13]. However, the R-WPTAS did not classify more people as cognitively impaired. This unexpected finding may be the result of a sampling effect: the narrow range of PTA duration exhibited by the participants in this study, mainly mild to moderate. Although it is thought that the R-WPTAS is a more sensitive estimation of PTA duration than the GCS, if participants are mostly within the mild range of PTA, it is more likely that they will agree as there are less potential false negatives. Therefore, the more participants who have PTA durations in the severe range, the larger the expected difference between GCS and R-WPTAS PTA estimations. However even if the sample been larger, a wider range of PTA duration may not have been found due to this narrow range being typical of this ED presenting population.

These findings suggest that the retrospective PTA assessment is the most suitable assessment for judging whether a patient should be admitted according to SIGN 46 guidelines (PTA of more than 5 minutes duration) [7]. The other PTA assessments considered assess PTA duration prospectively and as a consequence appear to miss participants who may have been in PTA for more than 5 minutes who may no longer be in PTA at the time of assessment.

PCS symptom reporting

There were no significant differences in the number of symptoms reported, symptom severity or symptom duration reported using the PCSC between the HI and control groups. This may seem surprising as it would be expected that those in the HI group would report more symptoms on this checklist. These results indicate that the PCSC does not reliably differentiate between HI and

control participants. These findings are contrary to those of Ponsford et al. [31] who found a significant difference between the PCSC scores of patients with mild TBI (n = 84) and controls (n = 53) who had suffered minor injuries but no HI. They found that frequency of headaches, dizziness, irritability, fatigue, and sleeping difficulty correctly classified 83 % of cases, with headache alone correctly classifying 72 % of cases. However, the 'mild' TBI sample used within this study had a mean PTA duration of 107 minutes which ranged from a few seconds to 24 hours. Therefore this 'mild' TBI group may have differed in terms of injury severity from those in the HI group in the current study. None of the participants were given CT or MRI scans as their injuries were not felt to be of sufficient severity to warrant this action and it is not clear whether they were admitted during their period of observation.

Landre et al. [32] conducted a study during which they compared the PCSC scores of trauma patients with and without HI, finding no significant difference in PCSC total, severity, frequency or duration symptom reporting between the two groups. In addition, Gouvier et al. [22] also found no significant difference in number of symptoms reported using the PCSC between students who had sustained a HI and those who had not. Other studies have also found PCS to be prevalent in non-neurological populations such as those in the 'normal' population, college students, chronic pain patients and personal injury claimants [29, 32-34].

It is possible that this lack of difference between HI and control groups in their symptom reporting may be because many of the symptoms assessed are those which may also be experienced by those without HI (e.g. individuals in pain or suffering from the variety of injuries of those in the control groups). Landre et al. [32] found no significant associations between PCSC symptom reporting and pain ratings and suggest that this may be due to patients in their study experiencing acute pain rather than chronic pain, where such associations have previously been established. The injuries that participants in the current study presented with may have caused acute pain but they were not subjected to chronic pain and thus pain may indeed have acted as a confounding factor. In addition, in the HI groups some patients had been prescribed analgesics which may have reduced their symptom reporting. A

study conducted by Sawchyn et al. [35], assessing PSC symptom reporting in 326 students, some of whom had experienced previous HI, found no main effect of head injury on PCSC scores. However, they did find a significant association between PCSC scores and Beck Depression Inventory (BDI; a measure of depression symptomology) scores. Landre et al. [32] also found a strong association between PSCS scores and emotional distress which involved assessment of mood state. Additionally, King [36] found a relationship between self-reported PCS symptoms and emotional difficulties such as self-reported anxiety and depression. Therefore emotional difficulties may also have represented a confounding variable in symptom reporting.

Given the lack of difference in symptom reporting between HI and control groups it is not surprising that there were no significant differences found between symptom reporting and PTA duration according to the retrospective PTA assessment or the R-WPTAS. When symptom presence was defined as frequency of symptoms greater than 'seldom', again there was no significant difference in symptom reporting between HI and control groups, hence symptom presence is not a useful diagnostic criterion.

Limitations

One possible limitation of this study is that almost all HI participants were assessed as having mild to moderate PTA, thus it may not be possible to generalise these results to participants with more severe PTA. As mentioned previously, several confounding variables may have influenced symptom reporting and PTA assessment such as the level of pain and emotional distress experienced by participants. In addition, the large number of memory items participants were asked to remember may have impacted on their ability to remember items.

Implications for future research

Future studies would benefit from assessment of confounding variables such as pain so that these can be controlled for during analyses. In order to

reduce the large number of items participants were requested to remember, it may be useful to randomise participants to either verbal or visual memory procedures in future research.

Conclusions

The PTA-I does not provide similar estimations of PTA duration to the R-WTAS and the results of this study suggest that it is oversensitive in assessing individuals as in PTA. Comparison of verbal and visual memory assessments concluded that this oversensitivity was due to verbal memory components not discriminating between HI and control participants. Therefore the use of an assessment using a verbal memory component such as the PTA-I in assessing PTA in the ED is not supported by the results of this study.

However, the retrospective PTA assessment did discriminate between HI and control participants with 100 % accuracy, higher than any of the other assessments investigated. This rapid assessment would be useful in identifying whether individuals had been in PTA for more than 5 minutes, therefore requiring admission according to current guidelines [7]. This retrospective PTA assessment may provide a practical alternative to other PTA estimations and allow more accurate decision making regarding SIGN 46 [7] admission criteria in the ED.

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Figure 1: Diagram of Study Procedure

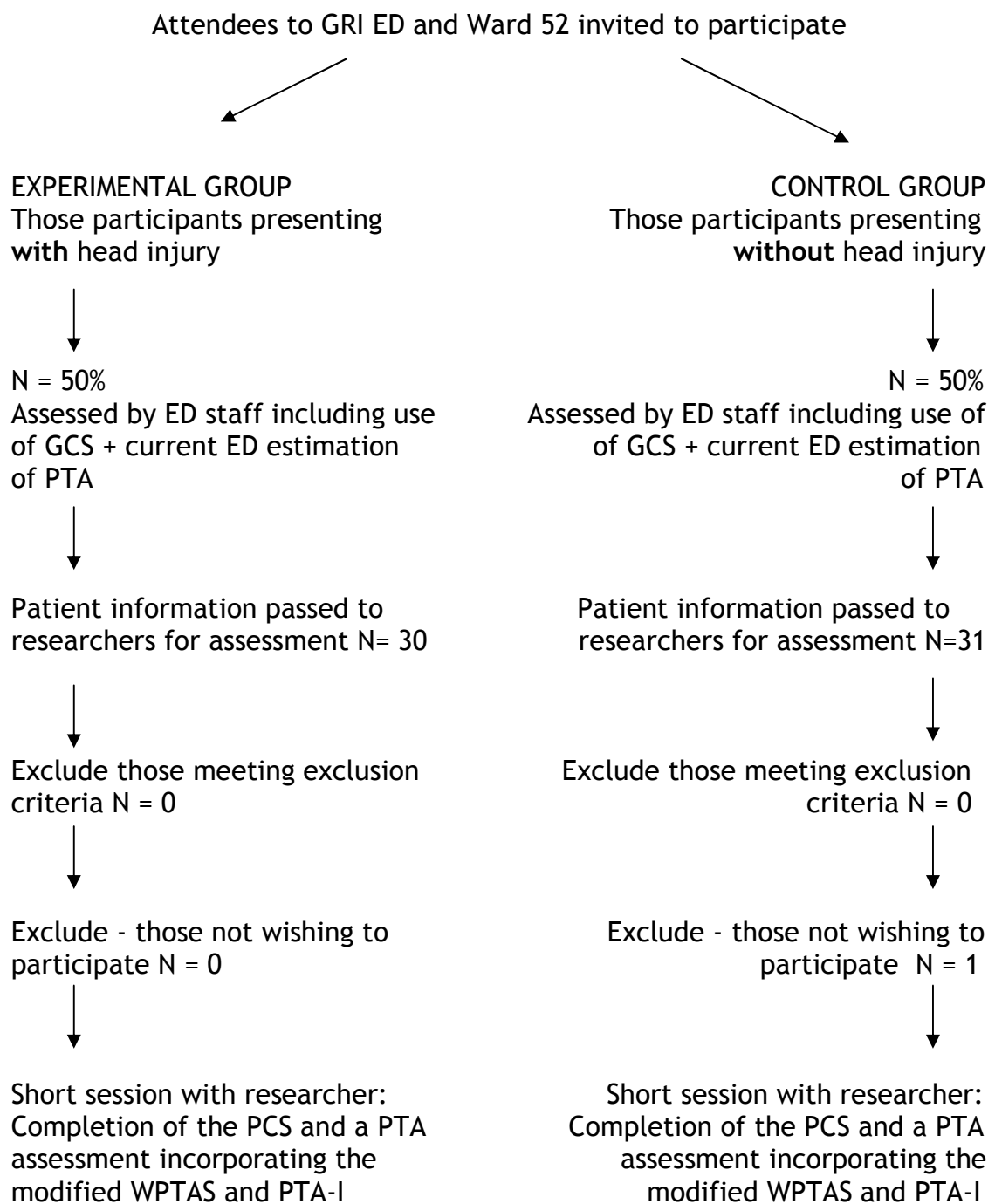


Table 1: Characteristics of the Samples

| | <i>Male</i> | <i>Female</i> | <i>Mean Age (Years)</i> | <i>Maximum Age (Years)</i> | <i>Minimum Age (Years)</i> | <i>GCS Score 15</i> | <i>GCS Score 14</i> |
|----------------|-------------|---------------|---------------------------------|------------------------------------|------------------------------------|-----------------------------|-----------------------------|
| HI | 28 | 2 | 43 (22.45) | 86 | 17 | 21 | 9 |
| Control | 25 | 4 | 42 (19.35) | 85 | 18 | 29 | 0 |

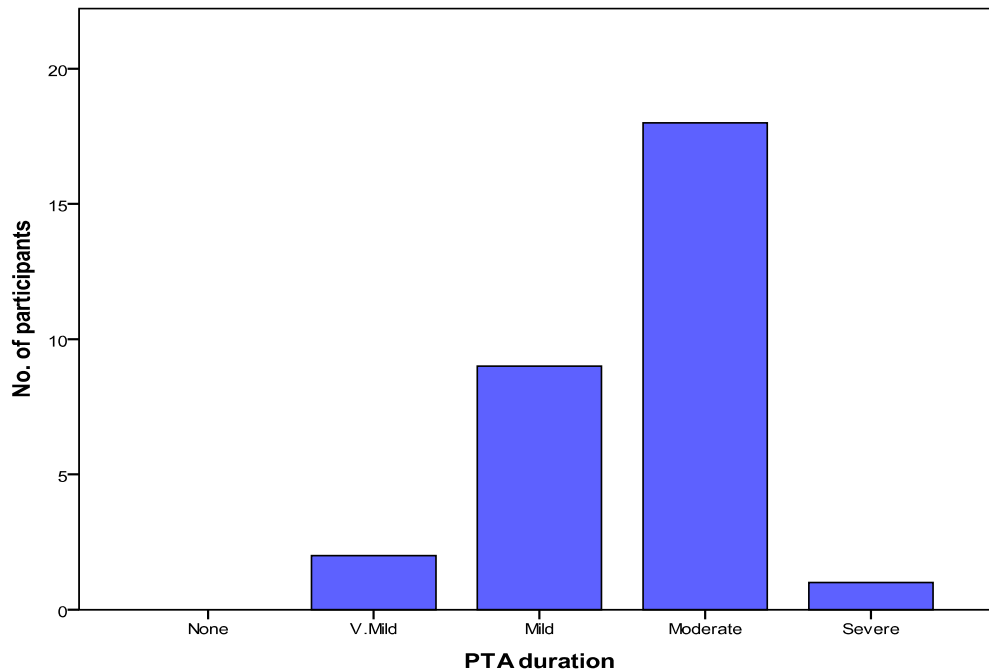
Table 2: Injuries and Complaints in the Control Group

| <i>Injury</i> | <i>Ankle</i> | <i>Hand</i> | <i>Arm</i> | <i>Leg</i> | <i>Eye</i> | <i>Wrist</i> | <i>Back, Chest</i> | <i>Heel, Knee, Foot</i> | <i>Groin, Shoulder, Tooth</i> |
|--------------------------------|--------------|-------------|------------|------------|------------|--------------|------------------------|---------------------------------|---------------------------------------|
| No. of Participants | 4 | 8 | 3 | 2 | 2 | 2 | 1 each | 1 each | 1 each |

Table 3: Duration of admission (days) for the HI group

| <i>Days Admitted</i> | <i>Frequency</i> | <i>Percent</i> |
|----------------------|------------------|----------------|
| 0 | 12 | 40.00 |
| 1 | 14 | 46.67 |
| 2 | 1 | 3.33 |
| 3 | 1 | 3.33 |
| 4 | 0 | 0 |
| 5 | 1 | 3.33 |
| 6 | 1 | 3.33 |
| Total | 30 | 100 |

Figure 2: Estimated PTA Duration¹ in the Head Injured Group on Question 7 of the PTA-I



¹ PTA Duration = None: 0 mins.; Very Mild: <5 mins, Mild: 5-60 mins; Moderate; 1-24 hours; Severe: 1-7 days; Very Severe: > 4 weeks.

Table 4: PTA Assessment using R-WTPAS and PTA-I: HI and Controls Combined

| | <i>PTA-I: In PTA</i> | <i>PTA-I: Not in PTA</i> |
|----------------------------|----------------------|--------------------------|
| <i>R-WPTAS: In PTA</i> | 6 | 1 |
| <i>R-WPTAS: Not in PTA</i> | 14 | 38 |

Table 5: R-WTPAS and PTA-I for the HI Group

| | <i>PTA-I: In PTA</i> | <i>PTA-I: Not in PTA</i> |
|----------------------------|----------------------|--------------------------|
| <i>R-WPTAS: In PTA</i> | 5 | 1 |
| <i>R-WPTAS: Not in PTA</i> | 8 | 16 |

Table 6: R-WTPAS and PTA-I for the Control Group

| | <i>PTA-I: In PTA</i> | <i>PTA-I: Not in PTA</i> |
|----------------------------|----------------------|--------------------------|
| <i>R-WPTAS: In PTA</i> | 1 | 0 |
| <i>R-WPTAS: Not in PTA</i> | 6 | 22 |

Table 7: Comparison of the Retrospective PTA Assessment and GCS

| | <i>GCS: In PTA</i> | <i>GCS: Not in PTA</i> |
|-----------------------------|--------------------|------------------------|
| <i>PTA (Q7): In PTA</i> | 9 | 21 |
| <i>PTA (Q7): Not in PTA</i> | 0 | 29 |

Table 8: Means and Standard Deviations for HI and Control Group PSCS Scores

| | <i>Total PCSC</i> | <i>Total Intensity</i> | <i>Total Duration</i> | <i>Total Frequency</i> |
|----------------|-------------------|------------------------|-----------------------|------------------------|
| <i>Mean</i> | | | | |
| <i>HI</i> | 42.33 | 13.60 | 14.63 | 14.10 |
| <i>Control</i> | 38.21 | 12.31 | 13.14 | 12.76 |
| <i>SD</i> | | | | |
| <i>HI</i> | 14.11 | 4.41 | 5.22 | 4.72 |
| <i>Control</i> | 11.33 | 3.23 | 4.16 | 4.06 |

Table 9: Chi-square test for PCSC Symptom Reporting in HI and Control Groups

| | <i>PCSCC: Yes</i> | <i>PCSC: No</i> |
|----------------------------|-------------------|-----------------|
| <i>Group: Head Injured</i> | 25 | 5 |
| <i>Group: Control</i> | 25 | 4 |

Table 10: Symptom Presence and Mild or Severe PTA Classification according to the Retrospective PTA Assessment

| | <i>Symptom Presence: Yes</i> | <i>Symptom Presence: No</i> |
|----------------------------|----------------------------------|---------------------------------|
| <i>Mild PTA Duration</i> | 33 | 7 |
| <i>Severe PTA Duration</i> | 17 | 2 |

CHAPTER 3

ADVANCED PRACTICE I REFLECTIVE ACCOUNT

Experiences of multi-disciplinary team-working

Address for Correspondence:
Academic Unit of Mental Health and Wellbeing
Centre for Population and Health Sciences
Gartnavel Royal Hospital
1055 Great Western Road
Glasgow, G12 0XH

*Submitted in partial fulfilment of the requirements for the
degree of Doctorate in Clinical Psychology (D. Clin. Psy)*

Abstract

Introduction

This account describes the reflective process in relation to my recent experiences of working within a multidisciplinary team. I chose these experiences to reflect upon as I felt that this team represented a truly multidisciplinary team who worked together in an integrated way rather than acting as a team purely in name as has been the case when working in other teams. I felt these experiences to be important due to the relevance of teamworking as part of the professional role of a clinical psychologist.

Reflection

From my experience of working in a multidisciplinary team, I identified three areas which I felt represented both difficulties and opportunities for learning/development: integrating into an MDT whilst retaining the identity of my professional role; transparency of salary differences and disharmony this may create; conflict between teams / individuals. Each of these was investigated using an adapted version of Gibbs (1988) Model of Reflection to guide this process.

Reflective Review

I found that the use of a reflective model allowed deeper, more detailed reflection on experiences and was useful when feeling stuck or experiencing strong emotions. However, I found that the model could be quite restrictive. I felt that in future, I would use bi-directional stages to allow non-linear movement representative of the fluid nature of the reflective process. I identified reflecting as a team on issues of teamworking as a potentially more complex reflective process in which I have yet to gain experience.

CHAPTER 4

ADVANCED PRACTICE II REFLECTIVE ACCOUNT

Experiences of service-related difficulties

Address for Correspondence:
Academic Unit of Mental Health and Wellbeing
Centre for Population and Health Sciences
Gartnavel Royal Hospital
1055 Great Western Road
Glasgow, G12 0XH

*Submitted in partial fulfilment of the requirements for the
degree of Doctorate in Clinical Psychology (D. Clin. Psy)*

Abstract

Introduction

I chose to reflect upon my experiences of service-related difficulties whilst working with client's who have Alcohol Related Brain Damage (ARBD). I felt that these experiences allowed me the opportunity to reflect upon how many of the indirect roles of the clinical psychologist are relevant in practice and how I might develop these roles in my own practice. I used a modified version of Gibbs' (1988) Model of Reflection to guide this process in light of my experience of using this model.

Reflection

I identified three areas which I felt generated the most strength of feeling for me and which would provide opportunity for development of my understanding of service needs, planning and provision. These were; the stigma associated with excess alcohol consumption, lack of understanding of the effects of ARBD and lack of appropriate service provision.

Reflective Review

I found the bidirectional and fluid nature of the adapted model made the process of reflection flow more easily. By using a model in this way I learned more about my own individual process of reflection in which the order of stages varied. I found it difficult to identify individual salient experiences on which to reflect for this topic as a whole but felt that using a model of reflection with these isolated examples allowed deeper analysis of my experiences. This account has provided me with the opportunity to consider more carefully the importance of service development, communication between services within systems and the dissemination of government policy.

APPENDICES

Appendix 1.1

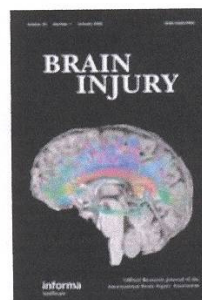
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Authors should prepare and upload two versions of their manuscript. One should be a complete text, while in the second all document information identifying the author(s) should be removed from files to allow them to be sent anonymously to referees. When uploading files authors will then be able to define the non-anonymous version as "File not for review".

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General Guidelines

Please write clearly and concisely, stating your objectives clearly and defining your terms. Your arguments should be substantiated with well reasoned supporting evidence.

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For all manuscripts, gender-, race-, and creed-inclusive language is mandatory.

Use person-first language throughout the manuscript (i.e., persons with brain injury rather than brain injured persons).

Ethics of Experimentation: Contributors are required to follow the procedures in force in their countries which govern the ethics of work done with human subjects. The Code of Ethics of the World Medical Association ([Declaration of Helsinki](#)) represents a minimal requirement.

Abstracts are required for all papers submitted, they should not exceed 200 words and should precede the text of a paper. [See below](#) for further information.

Authors should include telephone and fax numbers as well as e-mail addresses on the cover page of manuscripts.

File preparation and types

Manuscripts are preferred in Microsoft Word format (.doc files). Documents must be double-spaced, with margins of one inch on all sides. Tables and figures should not appear in the main text, but should be uploaded as separate files and designated with the appropriate file type upon submission. References should be given in Council of Science Editors (CSE) Citation & Sequence format (see [References](#) section for examples).

Manuscripts should be compiled in the following order: title page; abstract; main text; acknowledgments; Declaration of Interest statement; appendices (as appropriate); references; tables with captions (on separate pages); figures; figure captions (as a list).

Title Page

A title page should be provided comprising the manuscript title plus the full names and affiliations of all authors involved in the preparation of the manuscript. One author should be clearly designated as the corresponding author and full contact information, including phone number and email address, provided for this person. Keywords that are not in the title should also be included on the title page. The keywords will assist indexers in cross indexing your article. The title page should be uploaded separately to the main manuscript and designated as "title page – not for review" on ScholarOne Manuscripts.

Abstract

Structured abstracts are required for all papers, and should be submitted as detailed below, following the title and author's name and address, preceding the main text.

For papers reporting original research, state the primary objective and any hypothesis tested; describe the research design and your reasons for adopting that methodology; state the methods and procedures employed, including where appropriate tools, hardware, software, the selection and number of study areas/subjects, and the central experimental interventions; state the main outcomes and results, including relevant data; and state the conclusions that might be drawn from these data and results, including their implications for further research or application/practice.

For review essays, state the primary objective of the review; the reasoning behind your literature selection; and the way you critically analyse the literature; state the main outcomes and results of your review; and state the conclusions that might be drawn, including their implications for further research or application/practice.

The abstract should not exceed 200 words.

Tables, figures and illustrations

The same data should not be reproduced in both tables and figures. The usual statistical conventions should be used: a value written 10.0 ± 0.25 indicates the estimate for a statistic (e.g. a mean) followed by its standard error. A mean with an estimate of the standard deviation will be written $10.0 \text{ SD } 2.65$. Contributors reporting ages of subjects should specify carefully the age groupings: a group of children of ages e.g. 4.0 to 4.99 years may be designated 4 +; a group aged 3.50 to 4.49 years $4 \pm$ and a group all precisely 4.0 years, 4.0.

Tables and figures should be referred to in text as follows: figure 1, table 1, i.e. lower case. 'As seen in table [or figure] 1 ...' (not Tab., fig. or Fig).

The place at which a table or figure is to be inserted in the printed text should be indicated clearly on a manuscript:

Insert table 2 about here

Each table and/or figure must have a title that explains its purpose without reference to the text. Tables and/or figure captions must be saved separately, as part of the file containing the complete text of the paper, and numbered correspondingly. The filename for the tables and/or figures should be descriptive of the graphic, e.g. table 1, figure 2a.

Tables

Tables should be used only when they can present information more efficiently than running text. Care should be taken to avoid any arrangement that unduly increases the depth of a table, and the column heads should be made as brief as possible, using abbreviations liberally. Lines of data should not be numbered nor run numbers given unless those numbers are needed for reference in the text. Columns should not contain only one or two entries, nor should the same entry be repeated numerous times consecutively. Tables should be grouped at the end of the manuscript on uploaded separately to the main body of the text.

Figures and illustrations

Figures must be uploaded separately and not embedded in the text. Avoid the use of colour and tints for purely aesthetic reasons. Figures should be produced as near to the finished size as possible. Files should be saved as one of the following formats: TIFF (tagged image file format), PostScript or EPS (encapsulated PostScript), and should contain all the necessary font information and the source file of the application (e.g. CorelDraw/Mac, CorelDraw/PC). All files must be 300 dpi or higher.

Please note that it is in the author's interest to provide the highest quality figure format possible. Please do not hesitate to contact our Production Department if you have any queries.

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All authors are asked to take account of the diverse audience of *Brain Injury*. Clearly explain or avoid the use of terms that might be meaningful only to a local or national audience.

Some specific points of style for the text of original papers, reviews, and case studies follow:

- *Brain Injury* prefers US to 'American', USA to 'United States', and UK to 'United Kingdom'.
- *Brain Injury* uses conservative British, not US, spelling, i.e. colour not color; behaviour (behavioural) not behavior; [school] programme not program; [he] practises not practices; centre not center; organization not organisation; analyse not analyze, etc.
- Single 'quotes' are used for quotations rather than double "quotes", unless the 'quote is "within" another quote'.
- Punctuation should follow the British style, e.g. 'quotes precede punctuation'.
- Punctuation of common abbreviations should follow the following conventions: e.g. i.e. cf. Note that such abbreviations are not followed by a comma or a (double) point/period.
- Dashes (M-dash) should be clearly indicated in manuscripts by way of either a clear dash (-) or a double hyphen (- -).
- *Brain Injury* is sparing in its use of the upper case in headings and references, e.g. only the first word in paper titles and all subheads is in upper case; titles of papers from journals in the references and other places are not in upper case.
- Apostrophes should be used sparingly. Thus, decades should be referred to as follows: 'The 1980s [not the 1980's] saw ...'. Possessives associated with acronyms (e.g. APU), should be written as follows: 'The APU's findings that ...', but, NB, the plural is APUs.
- All acronyms for national agencies, examinations, etc., should be spelled out the first time they are introduced in text or references. Thereafter the acronym can be used if appropriate, e.g. 'The work of the Assessment of Performance Unit (APU) in the early 1980s ...'. Subsequently, 'The APU studies of achievement ...', in a reference ... (Department of Education and Science [DES] 1989a).
- Brief biographical details of significant national figures should be outlined in the text unless it is quite clear that the person concerned would be known internationally. Some suggested editorial emendations to a typical text are indicated in the following with square brackets: 'From the time of H. E. Armstrong [in the 19th century] to the curriculum development work

associated with the Nuffield Foundation [in the 1960s], there has been a shift from heurism to constructivism in the design of [British] science courses'.

- The preferred local (national) usage for ethnic and other minorities should be used in all papers. For the USA, African-American, Hispanic, and Native American are used, e.g. 'The African American presidential candidate, Jesse Jackson...'. For the UK, African-Caribbean (not 'West Indian'), etc.
- Material to be emphasized (italicized in the printed version) should be underlined in the typescript rather than italicized. Please use such emphasis sparingly.
- n (not N), % (not per cent) should be used in typescripts.
- Numbers in text should take the following forms: 300, 3000, 30 000. Spell out numbers under 10 unless used with a unit of measure, e.g. nine pupils but 9 mm (do not introduce periods with measure). For decimals, use the form 0.05 (not .05).

Acknowledgments and Declaration of Interest sections

Acknowledgments and Declaration of interest sections are different, and each has a specific purpose. The Acknowledgments section details special thanks, personal assistance, and dedications. Contributions from individuals who do not qualify for authorship should also be acknowledged here. Declarations of interest, however, refer to statements of financial support and/or statements of potential conflict of interest. Within this section also belongs disclosure of scientific writing assistance (use of an agency or agency/ freelance writer), grant support and numbers, and statements of employment, if applicable.

Acknowledgments section

Any acknowledgments authors wish to make should be included in a separate headed section at the end of the manuscript preceding any appendices, and before the references section. Please do not incorporate acknowledgments into notes or biographical notes.

Declaration of Interest section

All declarations of interest must be outlined under the subheading "Declaration of interest". If authors have no declarations of interest to report, this must be explicitly stated. The suggested, but not mandatory, wording in such an instance is: *The authors report no declarations of interest.* When submitting a paper via ScholarOne Manuscripts, the "Declaration of interest" field is compulsory (authors must either state the disclosures or report that there are none). If this section is left empty authors will not be able to progress with the submission.

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Examples are provided as follows:

Journal article: [1] Steiner U, Klein J, Eiser E, Budkowski A, Fetters LJ. Complete wetting from polymer mixtures. *Science* 1992;258:1122-9.

Book chapter: [2] Kuret JA, Murad F. Adenohypophyseal hormones and related substances. In: Gilman AG, Rall TW, Nies AS, Taylor P, editors. *The pharmacological basis of therapeutics*. 8th ed. New York: Pergamon; 1990. p 1334-60.

Conference proceedings: [3] Irvin AD, Cunningham MP, Young AS, editors. *Advances in the control of Theileriosis*. International Conference held at the International Laboratory for Research on Animal Diseases; 1981 Feb 9-13; Nairobi. Boston: Martinus Nijhoff Publishers; 1981. 427 p.

Dissertations or Thesis: [4] Mangie ED. A comparative study of the perceptions of illness in New Kingdom Egypt and Mesopotamia of the early first millennium [dissertation]. Akron (OH): University of Akron; 1991. 160 p. Available from: University Microfilms, Ann Arbor MI; AAG9203425.

Journal article on internet: [5] De Guise E, Leblanc J, Dagher J, Lamoureux J, Jishi A, Maleki M, Marcoux J, Feyz M. 2009. Early outcome in patients with traumatic brain injury, pre-injury alcohol abuse and intoxication at time of injury. *Brain Injury* 23(11):853-865. <http://www.informaworld.com/10.1080/02699050903283221>. Accessed 2009 Oct 06

Webpage: [6] *British Medical Journal* [Internet]. Stanford, CA: Stanford Univ; 2004 July 10 - [cited 2004 Aug 12]; Available from: <http://bmj.bmjournals.com>

Internet databases: [7] *Prevention News Update Database* [Internet]. Rockville (MD): Centers for Disease Control and Prevention (US), National Prevention Information Network. 1988 Jun - [cited 2001 Apr 12]. Available from: <http://www.cdcnpi.org/>

Appendix 1.2

Methodological quality criteria

| Study Feature | Study Quality Sought | Rating Yes (1) No (0) |
|-----------------------------|---|-----------------------------|
| Rationale /Aims | 1. Study rationale clearly explained 2. Hypotheses, aims and research questions clear | |
| Sample of Participants | 3. Sample selection explained 4. Inclusion criteria defined 5. Clinical and demographic characteristics described | |
| Definitions | 6. Definition of PTA: defined as a return to continuous memory 7. Diagnostic criteria of participant injury severity explained | |
| Method | 8. Method described so as to allow replication 9. PTA assessed according to standardised procedures: GOAT, WPTAS, Rivermead Protocol, MOPTAS or O-Log. 10. Sample size reported and justified 11. Power calculations considered 12. Outcomes clearly defined 13. Outcomes relevant to study aims 14. Outcome known for all or high proportion of sample (90%) | |
| Analysis | 15. Dropout reported and missing data appropriately managed 16. Analysis of data described 17. Analysis appropriate to research question and data 18. Consideration of confounding variables | |
| Discussion | 19. Study limitations acknowledged and described 20. Conclusions drawn justified by the results 21. Implications for future research discussed | |
| Total out of maximum of 21= | | |



Greater Glasgow
and Clyde

R&D Management Office
Western Infirmary
Tennent Institute
1st Floor, 38 Church Street
Glasgow, G11 6NT

Coordinator/administrator: Darren Gibson/Elaine O'Donnell
Telephone Number: 0141 211 6208
Fax Number: 0141 211 2811
E-Mail: Darren.Gibson@ggc.scot.nhs.uk

04 February 2010

Miss Louise E Richards
Trainee Clinical Psychologist
Psychological Medicine
Gartnavel Royal Hospital
1055 Great Western Road
Glasgow G12 0XH

R&D Management Approval

Dear Miss Richards,

Project Title: Estimation of Post-traumatic amnesia in Emergency Department attendees presenting with head injury.

Chief Investigator: Miss Louise E Richards

R&D Reference: GN09CP582

Protocol: Version 5 20/09/09

I am pleased to confirm that Greater Glasgow & Clyde Health Board is now able to grant **Management Approval** for the above study.

As a condition of this approval the following information is required during the lifespan of the project:

1. SAES/SUSARS – If the study is a **Clinical Trial** as defined by the Medicines for Human Use Clinical Trial Regulations, 2004 (CTIMP only)
2. Recruitment Numbers on a quarterly basis (not required for commercial trials)
3. Any change of Staff working on the project named on the ethics form
4. Change of CI
5. Amendments – Protocol/CRF etc
6. Notification of when the Trial / study has ended
7. Final Report
8. Copies of Publications & Abstracts

Please add this approval to your study file as this letter may be subject to audit and monitoring.

Yours sincerely

Dr Darren Gibson
Research Co-ordinator

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Appendix 2.2

WoSRES
West of Scotland Research Ethics Service

NHS
Greater Glasgow
and Clyde

West of Scotland REC 5
Ground Floor,
Tennent Institute,
Western Infirmary,
38 Church Street,
Glasgow G11 6NT

Telephone: 0141-211-6270
Facsimile: 0141-211-1847

29 January 2010

Miss Louise E Richards
Trainee Clinical Psychologist
Psychological Medicine,
Gartnavel Royal Hospital,
1055 Great Western Rd,
Glasgow
G12 0HX

Dear Miss Richards

Study Title: Estimation of PTA in emergency department attendees
REC reference number: 09/S1001/71
Protocol number: Version 5

Thank you for your letter of 12 January 2010, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

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For NHS research sites only, management permission for research ("R&D approval") should be obtained from the relevant care organisation(s) in accordance with NHS research governance arrangements. Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>. Where the only involvement of the NHS organisation is as a Participant Identification Centre, management permission for research is not required but the R&D office should be notified of the study. Guidance should be sought from the R&D office where necessary.

Sponsors are not required to notify the Committee of approvals from host organisations.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

| Document | Version | Date |
|---|-----------|-------------------|
| REC application | 2.5 | 04 November 2009 |
| Protocol | Version 5 | 20 September 2009 |
| Investigator CV | | 03 November 2009 |
| Participant Consent Form | Version 1 | 23 October 2009 |
| Supervisor's CV Prof T McMillan | | 01 July 2009 |
| CV Dr A Ireland | | |
| Covering Letter | | 20 January 2010 |
| Participant Information Sheet | Version 2 | 12 January 2010 |
| Response to Request for Further Information | | 12 January 2010 |

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Service website > After Review

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

The attached document "*After ethical review – guidance for researchers*" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nres.npsa.nhs.uk.

09/S1001/71

Please quote this number on all correspondence

Yours sincerely


Dr Greg Ofili
Chair

Email: sharon.jenner@ggc.scot.nhs.uk

Enclosures: "After ethical review – guidance for researchers" [SL-AR1 for CTIMPs, SL- AR2 for other studies]

Copy to: Darren Gibson, Research and Development Office, NHS Greater Glasgow and Clyde

Appendix 2.3

The Westmead Post-traumatic Amnesia Scale Revised (R-WPTAS; Ponsford et al., 2004)

DATE OF INJURY..... S = SCORE (1 or 0)
TIME OF ADMINISTRATION

For questions 4, 7, 8, 9, 10, 11 and 12 test free recall first then give prompts as in brackets

1. How old are you?
 2. What is your date of birth?
 3. What month are we in?
 4. What time of day is it? (morning, afternoon or night)
 5. What year are we in?
 6. What is the name of this place? (Home, Geelong Hospital, Western Hospital)
 7. Face. On first admin. Show photo, ask pt to remember face. Subsequently ask "Can you identify which of these faces have you seen before?" (from choice of 6. Always use photo 4.)
 8. Picture 1 (cup) (On first admin, show 3 pictures. Thereafter ask pt to identify pictures from series and present correct pictures again).
 9. Picture 2 (keys)
 10. Picture 3 (bird)
- TOTAL

Appendix 2.4

Post-traumatic Amnesia Interview (PTA-I)

Orientation Questions;

1. How old are you?
2. What is your date of birth?
3. What month are we in?
4. What time of day is it? (prompt morning, afternoon or night)
5. What year are we in?
6. What is the name of this place? (If no answer, prompt by providing names of 3 hospitals)

Memory Component;

7. What's the first thing you remember after being injured?
 - a. What's the next thing you remember?
 - b. What happened next?
 - c. Ask relevant question about today (i.e. What did you have for breakfast? Did anyone visit you today?)

Prompts: Do you remember; Coming to hospital? Being in casualty? Being in intensive care unit? Being on ward NSU/DHG/rehab? Being taken to another hospital? Going home from hospital? Special event (birthday/XMAS)?

8. Do you remember;
The 3 words I asked you to memorise earlier? If recall is not perfect ask - Can you tell me which three words I asked you to remember from a list I will read to you?
Word 1 (sock)
 9. Word 2 (mirror)
 10. Word 3 (umbrella)
- TOTAL

Appendix 2.5

Postconcussion Syndrome Checklist (Gouvier et al, 1992; PCSC)

NAME DATE

Please rate the frequency, intensity and duration of each of the following symptoms based on how they have affected you today according to the following scale:

| | FREQUENCY | INTENSITY | DURATION |
|--------------------------|------------------|---------------------|-------------------|
| | 1 = Not at all | 1 = Not at all | 1 = Not at all |
| | 2 = Seldom | 2 = Vaguely present | 2 = A few seconds |
| | 3 = Often | 3 = Clearly present | 3 = A few minutes |
| | 4 = Very often | 4 = Interfering | 4 = A few hours |
| | 5 = All the time | 5 = Crippling | 5 = Constant |
| Headache | ----- | ----- | ----- |
| | | - | ---- |
| Dizziness | ----- | ----- | ----- |
| | | - | -- |
| Irritability | ----- | ----- | ----- |
| | | - | -- |
| Memory Problems | ----- | ----- | ----- |
| | | - | -- |
| Difficulty Concentrating | ----- | ----- | ----- |
| | | - | -- |
| Fatigue | ----- | ----- | ----- |
| | | - | ---- |
| Visual Disturbances | ----- | ----- | ----- |
| | | - | -- |
| Aggravated by Noise | ----- | ----- | ----- |
| | | - | -- |
| Judgment Problems | ----- | ----- | ----- |
| | | - | -- |
| Anxiety | ----- | ----- | ----- |
| | | - | -- |

Thank you for your time and effort in the completion of this form.

Appendix 2.6

PARTICIPANT INFORMATION SHEET

Memory after head injury

Introduction

You are being invited to take part in a research study. This information sheet explains why the research is being done and what taking part involves. Please take time to read this information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

Who is carrying out the study?

The research is being carried out by Louise Richards, Trainee Clinical Psychologist (Main Researcher) and Kirsty Bell, Trainee Clinical Psychologist from the Department of Psychological Medicine, Gartnavel Royal Hospital. If you would like more information about the study after today please contact me using the contact details at the end of this sheet.

What is the purpose of the study?

The memory problems people sometimes experience after hitting their head can give doctors a good idea of how bad the injury is. Measurement of these memory problems can help medical staff to make decisions about how best to treat patients and how well they are likely to recover. This study aims to explore whether a new questionnaire can help doctors measure memory problems more accurately than before. This study is also being carried out as part of an academic qualification.

Why have I been asked to take part?

You have been asked to take part in this study as you have attended the Emergency Department. In total, about 60 people in Glasgow will take part in this study.

Do I have to take part?

It is up to you to decide whether you take part or not. You will be given this information sheet to keep. If you decide to take part, you will be asked to sign a consent form. You will be given a signed copy of this to keep. You are free to pull out of the study at any time, without giving reason and any information collected from you will be destroyed. A decision to stop at any time or not to take part will not affect the standard of care you receive or your future treatment.

What does taking part involve?

You have already been asked several questions by medical staff about what you can remember from before and after your injury. If you choose to take part in this study you will be asked some more questions today asking similar things about what you remember and about any head injury related symptoms you have experienced. This will take about 7 minutes.

What happens to the information?

All of the information collected will be strictly confidential and stored securely. Only the research team will have access to this information.

What are the possible benefits of taking part?

Although it is unlikely that there are any direct benefits to you from taking part in this study, the results will be shared with your doctor and this may help them with making decisions about your care. It is hoped that the results of this study will help similarly injured people in the future

What are the possible disadvantages of taking part in this study?

You may find it difficult to concentrate during the interview or you may find some of the questions difficult to answer. You do not have to answer any questions you do not want to and can stop at any time.

Who has approved the study?

This study has been approved by Glasgow University and the NHS Greater Glasgow and Clyde Research Primary Care Ethics Committee to ensure that it meets approved standards.

What if you have a complaint?

If you have a concern about any part of the study, you can contact the researcher. If you remain unhappy and wish to make a formal complaint, you can do this through the NHS Greater Glasgow and Clyde complaints procedure at the following address:

Complaints Office
Dalian House
350 St Vincent Street
GLASGOW
G3 8YZ
Tel: 0141 201 4477

If you have any further questions?

If you would like more information about the study and wish to speak to someone about it, please contact us using the contact details below:

Researcher Contact Details:

| | |
|--|--|
| Louise Richards, Trainee Clinical Psychologist | Professor Tom McMillan |
| Department of Psychological Medicine | Department of Psychological Medicine |
| Academic Centre, Gartnavel Royal Hospital | Academic Centre, Gartnavel Royal Hospital |
| 1055 Great Western Road, G12 0XH | 1055 Great Western Road, G12 0XH |
| Tel: 0141 2113920 | Tel: 0141 2113920 |
| l.richards.1@research.gla.ac.uk | t.m.mcmillan@clinmed.gla.ac.uk |

Thank-you for your time and co-operation

Appendix 2.7

Department of Psychological Medicine
 Academic Centre, Gartnavel Royal Hospital
 1055 Great Western Road, G12 0XH

Subject number:

Assessing amnesia after head injury in the Emergency Department

Consent Form

Please initial the box

I confirm that I have read and understand the information sheet dated 12/01/2010 (version 2) for the above studies and have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.

I understand that sections of my medical notes may be looked at by the research team where it is relevant to my taking part in the research. I give my permission for the research team to have access to my records.

I agree to take part in the above studies

 Name of Participant

Date

Signature

 Name of Witness

Date

Signature

1 copy to the patient, 1 copy to the researcher, 1 Original for the patients' notes

Appendix 2.8

University of Glasgow/ West of Scotland
Doctorate in Clinical Psychology

MAJOR RESEARCH PROJECT PROPOSAL

**Estimation of Post-traumatic amnesia in
Emergency Department attendees presenting
with head injury**

Date – 20/09/09

Word Count – Approx 3958

Version No. – 5

Contents:

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1) Abstract

Background

Post-traumatic amnesia (PTA) can be described as a temporary state of altered cognition and behaviour typically experienced following a head injury often including the absence of continuous memory. Despite the large evidence base describing the value and importance of assessing PTA duration, currently EDs in the UK do not routinely assess PTA systematically. Estimation of PTA is viewed as clinically important as it is currently viewed as the best indicator of injury severity and predictor of functional outcome following head injury.

Aims

The aim of this study is to explore whether a semi-structured PTA assessment interview (PTA-I) will provide more precise estimations of PTA in this population than methods currently used in the ED whilst remaining practical to apply in the ED setting.

Methods

The participants will comprise of individuals attending the ED at Glasgow Royal Infirmary. Specificity and sensitivity of two PTA assessments will be compared in patients presenting with head injury and in a control group not presenting with head injury. All participants will complete a modified version of the Westmead Post-Traumatic Amnesia Scale (R-WPTAS), the Post-concussion Syndrome Checklist (PCSC) and the PTA-I.

Applications

The PTA-I is practical and rapid to apply in busy EDs. If this measure was found to produce greater precision in the estimation of PTA than methods currently employed in EDs with equivalent performance to the WPTAS, then its use would be of clinical benefit to patients.

2) Introduction

Defining PTA

Post-traumatic amnesia (PTA) can be described as a temporary state of altered cognition and behaviour typically experienced following a head injury. Whilst PTA often involves a number of characteristic symptoms for example, confusion, disorientation, distress and anxiety, amnesia is perhaps the most renowned (Ahmed et al., 2000). This often includes the absence of continuous memory for events occurring after the injury took place (Ahmed et al., 2000; May et al., 1992). W. Ritchie Russell was first to advocate PTA duration as an indicator of injury severity in 1932 (Ahmed et al., 2000; Russell and Nathan, 1946), however at this time PTA was viewed as synonymous with full loss of consciousness (LOC), thus including coma. Later a distinction was made between loss of consciousness and impaired consciousness, with Symonds defining PTA as impairment in cerebral functioning following the recovery of consciousness (Ponsford et al., 2004). In 1943 Symonds and Russell further defined PTA to include return to 'normal orientation' (Symonds and Russell, 1943 in Ahmed et al., 2000). In 1946 Russell and Nathan emphasised the importance of return of continuous memory in defining the end of PTA duration. Since then numerous studies have confirmed the association between PTA duration and injury severity first proposed by Russell (Ponsford et al., 2004).

The importance of PTA

Estimation of PTA is viewed as clinically important as it is currently viewed as the best indicator of injury severity and predictor of functional outcome following head injury (McMillan et al., 1996; Ponsford et al., 2004). As a consequence, accurate assessment of PTA is of clinical significance as underestimation of PTA could result in the discharge of patients who should be admitted for observation and may otherwise be at risk according to SIGN Guideline 110 (2009); admission being recommended if continuing amnesia for at least five minutes after injury is present. Underestimation of PTA may lead to patients not receiving

appropriate advice and access to rehabilitation services following discharge. In addition, forms of rehabilitation and therapy which involve patients retaining new information are not appropriate whilst patients are still in PTA. This is due to PTA being associated with impairment in committing new information to memory (Ahmed et al., 2000).

Assessment of PTA

Several methods of assessing PTA have been developed over the years. These can broadly be divided into prospective and retrospective measures. Retrospective measures involve assessment following the end of PTA, whereas prospective measures entail assessment during PTA, often as serial assessments until PTA is deemed to have ended. McMillan, Jongen and Greenwood (1996) compared retrospective (telephone interview 3.5-6 years after injury) and prospective measures (the Galveston orientation and amnesia test (GOAT)). They found a high correlation between measures (0.89) of PTA duration and significant correlation with other measures of injury severity and outcome. However, retrospective measurements have been criticised. As Symonds and Russell first described in 1943, assessment of PTA duration may be influenced by 'islands of memory', which can be incorrectly identified as the end point of PTA. These are periods where memory appears restored but quickly followed by the return of amnesia and disorientation. Retrospective measures rely on the subjective accounts of patients and their families which may often be inaccurate due to confabulation by the patient, the patient's attempts to 'fill in the gaps' within formation from other sources and the stressful nature of the events.

Levine et al. published the first standardised prospective PTA assessment scale, the GOAT, in 1979. This consisted of 10 items assessing orientation and recall for events, both pre and post injury. Gronwall and Wrightson, in 1980, and Jackson, Novack and Dowler, in 1998, developed further methods of assessing PTA prospectively with a focus on orientation. Along with the GOAT these methods have been criticised for their emphasis on orientation rather than continuous memory (Ponsford et al., 2004). For example, underestimation of PTA has been identified when patients can seem to be out of PTA following their correct responses to

orientation questions, however they may not actually remember being asked these questions (King et al. 1997). This led future scales to place greater importance on memory assessments, for example the Westmead Post-Traumatic Amnesia Scale (WPTAS) in 1986 and the Julia-Far Centre PTA Scale in 1994 incorporate assessment of both orientation and memory.

The WPTAS was originally designed for use in assessing PTA duration in patients with moderate to severe traumatic brain injury (TBI), as were most other PTA assessment methods. This scale has shown a high level of inter-rater reliability and to be a strong predictor of outcome 1, 2, and 5 years after injury (Ponsford et al., 2004). In 2004 Ponsford et al., reported findings of a study using a revised version of the WPTAS (R-WPTAS; 2 items shorter) was found to provide a valid measurement of PTA duration in patients in an ED with mild head injury (MHI), defined as a PTA duration of less than 24 hours. The patients were assessed on an hourly basis and R-WPTAS scores significantly correlated with Glasgow Coma Scale (GCS) scores.

Further support for the WPTAS was provided recently by Shores et al. (2008) who described a study employing a further revised version of the WPTAS (R-WPTAS). Administration of this scale in addition to the GCS was found to significantly improve diagnostic precision of the detection of cognitive impairment in patients with mild TBI. In addition, the R-WPTAS showed higher correlations than the GCS with neuropsychological measures. In addition the superior diagnostic accuracy of the R-WPTAS was confirmed using Receiver Operating Curve analysis.

Andriessen et al (2009) completed a study comparing the sensitivity and specificity of using visual (pictures) and verbal (words) stimuli as memory components within a PTA assessment. Participants included 64 patients admitted to the ED with traumatic brain injury, 22 orthopedically injured patients and 26 healthy controls. They administered a combined version of the GOAT and WPTAS, along with the 3-item visual or verbal memory test to which participants were randomly assigned. The memory test involved short delay free recall, short

delay recognition, long delay free recall and long delay recognition components. The study concluded that whilst the specificity of the two tests was equivalent (i.e. for short delay recognition, specificity was 100% for both words and pictures), the verbal test showed higher sensitivity (21%) than the visual test (1%) thus categorising brain injured patients and controls more accurately. Free recall was found more effortful for all participants and a longer delay between presentation and recall resulted in fewer items recalled within the brain injured group only. This study provides evidence for an alternative and potentially more practicable method of assessing memory within an ED setting.

Assessment of PTA in the ED

Despite the large evidence base describing the value and importance of assessing PTA duration, currently EDs in the UK do not routinely assess PTA systematically. Often an approximation is produced based on symptoms of disorientation and confusion if apparent during assessment. Assessment of PTA must be practical if it is to be conducted routinely in busy EDs, that is rapid and simple to administer. Therefore it is important to consider the practical use of PTA assessments in this setting. Whilst the R-WPTAS has been found to be a valid measure of PTA duration in patients with mild head injury in EDs, the picture recall component may not be practical because of the need to source and store test materials. An equally sensitive and specific test not requiring the need for extra materials may therefore be more practical for use in this setting. A more robust method of assessing PTA in the ED would allow patients who may still be in PTA and therefore potentially at risk, to be identified. Consequent decisions as to whether these patients should then be admitted, discharged and followed-up or provided with access to rehabilitation services can then be made.

The identification of a potentially larger group of patients still in PTA need not necessitate the allocation of large amounts of hospital resources to following up these patients. Telephone follow-up is accepted as a useful method enabling exchange of information, symptom management and the early recognition of complications after hospital discharge (Rao, 1994). Numerous studies support the beneficial impact and feasibility of telephone follow up for

example, Wade et al, 1998 found that telephone support offered by a specialist service was found to significantly reduce social morbidity and severity of post-concussion symptoms six months following head injury. A study by Bell et al, 2004 demonstrated the feasibility of using telephone follow-up to provide information and support to patients who had sustained moderate to severe TBI. Telephone follow-up has been found to provide additional benefits such as improving the quality of life of A&E attendees following road traffic accidents (Rao, 1994).

Current Study

The present study will be carried out at Glasgow Royal Infirmary (GRI) which is the main receiving ED in the East of Glasgow. In 1998, 5084 patients with a head injury were treated at the GRI ED which accounts for almost 8% of attendees. Of these patients, 1221 were admitted for further observation (Hall, Riley and Swann, 2005). Similar numbers of head injuries were seen in 2006, with 370 patients attending with head injury but not being admitted between April and October 2006 (McMillan et al., 2009). The ED department at this hospital adheres to current good practice guidelines regarding the management of patients with head injuries (SIGN 46), including those relating to assessment of PTA and admission decision making (McMillan et al., 2009).

This study will compare current ED assessment of PTA duration, the WPTAS and a semi-structured PTA (PTA-I) interview incorporating the 3-item verbal memory test (Andriesen et al, 2009) and elements of the R-WPTAS both in patients with head injury and controls. A control group is implemented in order to confirm that the PTA assessments utilised discriminate between head injured patients and controls. The PTA-I will consist of both orientation and continuous memory assessment elements, thus hoping to provide an accurate estimation of PTA. However this assessment will not require any further test materials, such as picture cards, therefore it will be easier to administer practically in an ED than the R-WPTAS.

3) Aims and Hypotheses

Aims

The central aim of this study is to explore whether a semi-structured PTA assessment interview (PTA-I) will provide similar estimations of PTA to the R-WPTAS in this population than methods currently used in the ED whilst remaining practical to apply in the ED setting. In addition, this study will examine whether the PTA assessments utilised during the study discriminate between head injured patients and controls.

Research questions

1. Do the PTA-I and R-WPTAS agree in their categorisation of people as being either in or out of PTA?
2. Are there differences in the sensitivity of the memory components of the PTA-I and R-WPTAS?
3. How does categorisation in terms of cognitive impairment (i.e. in or out of PTA) using the R-WPTAS and PTA-I compare with GCS categorisation?
4. Do the PTA-I and R-WPTAS agree in their categorisation of people as being either in or out of PTA in both the head injured and control groups?

Hypotheses

1. The PTA-I and R-WPTAS will be in high agreement in their categorisation of people as being either in or out of PTA.
2. The PTA-I (3-item verbal component) will be more sensitive than the R-WPTAS picture component (visual).
3. Both the R-WPTAS and PTA-I will categorise more people as cognitively impaired (in PTA) than will the GCS (i.e. scoring < 15/15).
4. The PTA-I and R-WPTAS will be in high agreement in their categorisation of people as being in either or out of PTA in both the head injured and control groups.

4) Plan of Investigation

▪ *Participants*

The participants invited to take part in the study will comprise individuals attending the Emergency Department at Glasgow Royal Infirmary from October 2009 to April 2010 whilst researchers are in attendance. The experimental group will consist of individuals who present with head injury. Patients will only be invited to take part at the point they are deemed ready for discharge. The control group will consist of ED attendees without head injury.

▪ *Justification of Sample Size*

Shores et al (2008) established the specificity and sensitivity of the R-WPTAS, comparing 82 head injured patients and 88 non-head injured controls. This gave an effect size of 1.07

assessing differences on the R-WPTAS between the head-injured and control groups. Data from their study was used to estimate the required sample size required for this study using GPower (Faul et al., 2007).

Hypothesis 1: it is difficult to estimate the numbers needed in order to find no difference in the proportions of people the PTA-I and R-WPTAS categorise as being in or out of PTA.

Hypothesis 2: there is no data available specifically on the sensitivity of the memory components of the PTA assessments to be utilised, thus we assume that the numbers are likely to be similar to those required for the entire PTA assessment.

Hypothesis 3: the sample size required to detect differences between PTA measures and the GCS using chi square analysis was estimated using data from Shores et al, (2008). A power of 0.8 and alpha of 0.05 was set from which a total sample size of 48 was calculated; 24 in each group.

Hypothesis 4: the sample size required to detect a difference between the proportions of people categorised by the PTA-I and R-WPTAS as in or out of PTA within the head injured and control groups was estimated again using data from Shores et al (2008). A power of 0.8, alpha of 0.05 was set which yielded a total sample size of 24; 12 in each group.

Based on these estimations the plan is to recruit 60 participants, 30 into each group (experimental and control). The lead clinician assessing head injury within the ED (Consultant in Emergency Medicine) has agreed to take part in the recruitment of participants as well as in administration of the study which will enhance the sample size obtained. The reliability of this input will be established (see below).

- *Inclusion and Exclusion Criteria*

Exclusion criteria for the experimental group include;

1. Those under the age of 16
2. Those who have a significant injury other than head injury
3. Patients with a GCS score of less than 9
4. Those who require neurosurgery
5. Those who have sustained a penetrating head injury
6. Those who have been in hospital for a duration of more than 2 months
7. Those unable to communicate or unable to speak and understand English

The above criteria will be implemented in order to ensure that the individuals taking part in this study are able to; provide consent, communicate sufficiently in order to take part, provide data that is not influenced by other difficulties likely to invalidate interpretation of the data provided, and produce data which will lead to findings which can be generalised to the target population.

Inclusion criteria include all other patients attending the Emergency Department at Glasgow Royal Infirmary from October 2009 to April 2010 whilst researchers are in attendance, who present with head injury.

The exclusion and inclusion criteria for the control group will be identical to those outlined for the experimental group except that they will not have presented to the ED with a head injury.

- *Recruitment Procedures*

Patients attending the GRI ED or Ward 52 with a head injury during the study period who meet the study inclusion criteria will be invited to take part by GRI staff, or by the researchers if present. Patients presenting with head injury who are admitted for observation from the ED

are admitted to Ward 52, therefore participants may be assessed on Ward 52 and/or in the ED. Patients will be recruited near to the point of discharge (when deemed fit to return home and hence able to provide informed written consent). For participants who are admitted to hospital, consent will also be requested retrospectively from the patient at point of discharge. If as a result of PTA assessment the decision to discharge is changed (i.e. the patient is admitted to hospital) consent will be obtained retrospectively, again near to point of discharge or after discharge.

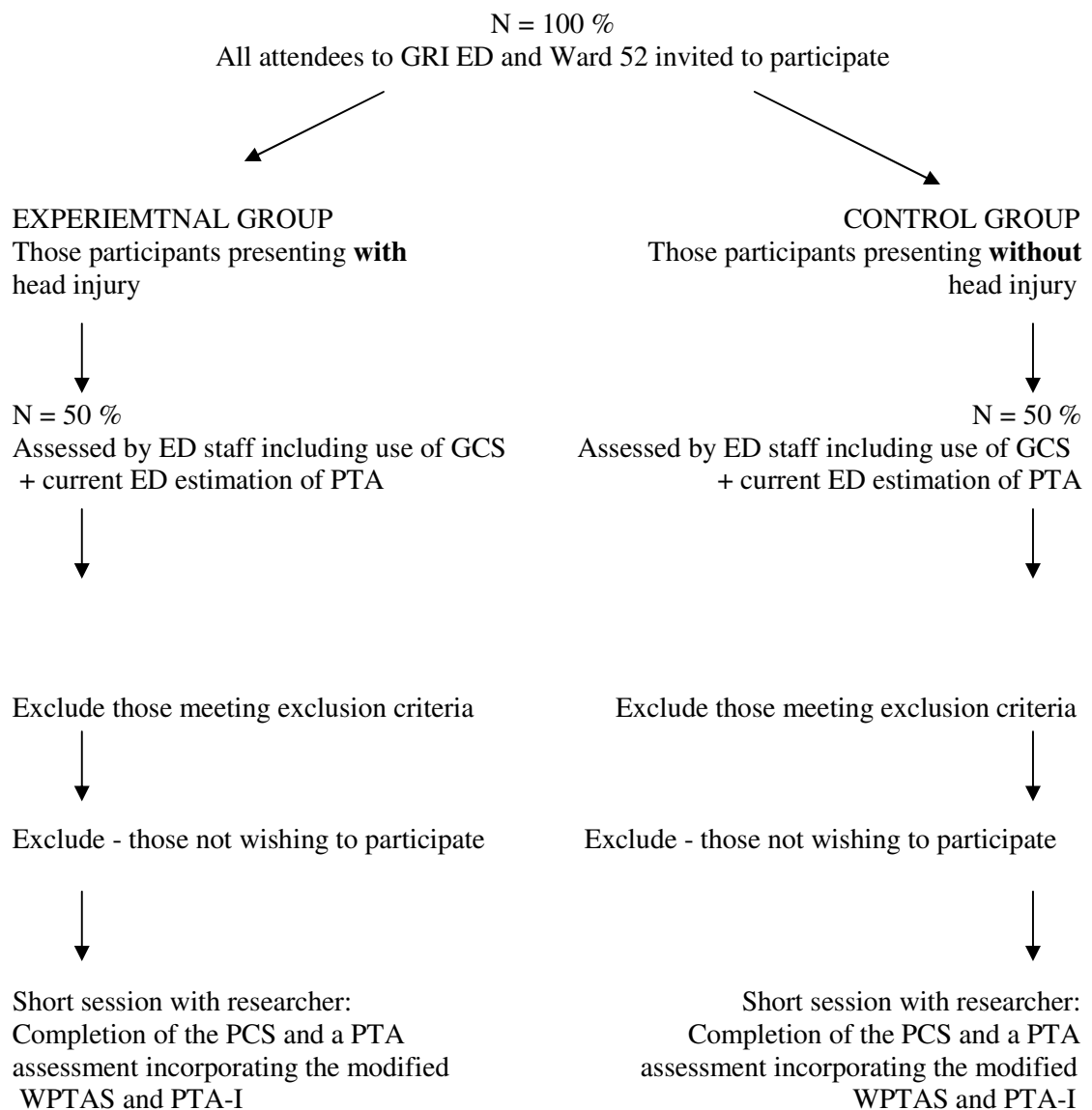
- *Settings and Equipment*

Interviews/testing will be carried out in GRI ED or Ward 52. The equipment needed will include three assessment tools (The Modified Westmead Post-traumatic Amnesia Scale, The Post-traumatic Amnesia Interview and The Post-concussion Syndrome Checklist), consent forms, information sheets, a data collection sheet, access to GRI Head Injury Assessment Form and access to hospital records for patient background information.

- *Design*

This study employs a prospective cross-sectional design. All recruited patients will complete the PCSC (to provide details of injury symptoms, intensity and duration) and a PTA assessment. This assessment will include both the Modified WPTAS and the PTA-I.

Figure 1: Diagram of Study Design



▪ *Procedure and Measures*

Background information (age, sex, relevant medical history, history of learning difficulties, current medications, substance use at time of injury, admission and assessment, injury specifics-cause and when this occurred, GCS score and the results of PTA estimation currently employed within the department) will be gathered from either hospital records, the GRI head injury assessment form or during patient interviews.

In addition information will be collected about the time when the GCS assessment was carried out by ED staff and how long after injury the researcher interviewed the patient.

It is not possible to ensure that the same researcher completed administration each time, the Modified WPTAS will be used as it does not require the name and face of the examiner to be recalled but instead a photograph of another individual.

The researchers will be two final year trainee clinical psychologists and the Consultant in Emergency Medicine. To ensure inter-rater reliability, 3 mock interviews will be recorded and the researchers will be required to score these to identify any discrepancy in the scoring of responses.

The Modified Westmead Post-traumatic Amnesia Scale (WPTAS; Ponsford et al, 2004)

This scale (see Appendix) contains 12 items assessing orientation in time and place (items 1-7) and anterograde memory (items 8-12). The memory component involving pictures of objects will be given at the start and end of the interview to allow assessment of recall at a single assessment. The patients are shown 3 pictures of objects (line drawings of a cup, keys and bird) and asked to recall these later. If the patient is unable to recall all of these, he/she is asked to choose from the full set of 9 cards; three target pictures and 6 distracter pictures. If patients do not spontaneously respond to orientation questions, a multiple choice is given for example, for the question 'What time of day is it?' they would then be asked 'Is it morning, afternoon or evening?'. The memory component includes an assessment of the ability of the patient to recall a photograph of a face whose name they are told upon first presentation, identify this face from a set of 6 photographs of faces after an hour and recall the name. The photographs were (4'' x 6'') close headshots of the head and face with identical lighting and background. They were of individuals who were of the same sex and similar in features. If the patient is unable to recall the face, they are given a choice from the set of photographs.

The operational definition of the endpoint of PTA is that patients must score 12 out of 12 for 3 consecutive days (Ponsford et al, 2004). It is not possible to utilise this traditional definition of PTA endpoint in this study as it is not practical to repeat tests over 3 days in a 24 hour ED. The maximum score possible using the R-WPTAS is 12/12 which for the purpose of this study, if obtained at a single assessment indicates that the patient is no longer in PTA.

The Post-traumatic Amnesia Interview (PTA-I)

This is a semi-structured PTA assessment interview (see Appendix) incorporating elements of The Westmead PTA Scale and a memory component incorporation procedures adapted from those used by McMillan, Jongen and Greenwood (1996) and Andriessen et al, (2009). Items 1-7 assess orientation, whereas items 8-9 provide a memory assessment component. The orientation questions are identical to those in the R-WPTAS and thus participants will only be required to answer these items once, with the same data being utilised in analysis of both PTA tests. The first part of the memory component consists of asking patients to recall their memories after the injury in chronological order (McMillan, Jongen and Greenwood, 1996). Patients will be reminded that they should attempt to convey facts they can remember rather than any information which they may have been told since injury by others regarding these events. Whilst the PTA-I memory component asks specific questions regarding memories after injury, it is acknowledged that not all questions may be relevant to each patient. For example, they may not remember the journey to hospital. To allow for this discrepancy in experience, patients will be asked 'What is the next thing you remember' after each event in addition to the specific questions contained within the PTA-I. The last part of the memory component consists of a 3-item verbal memory test (Andriessen et al, 2009). At the beginning of PTA assessment, participants will be asked to memorise three words. Immediately after presentation they will be asked to repeat these back to the researcher. If these are not repeated correctly, the words are presented a second time. Following administration of the rest of the PTA assessment, participants are asked to recall the three words they had been asked to memorise. If recall of

these items was not perfect, the participants will be presented with nine words (three target items and six distracter items) and asked to specify which three of these nine they remembered from the initial presentation. Patients are categorised as out of PTA if they obtain a score of 9/9 on the PTA-I.

The Post-concussion Syndrome Checklist (Gouvier et al, 1992; PCSC)

This provides a self-report measure of symptom frequency, intensity and duration after injury (see Appendix). The symptoms assessed are those that have been found to be most commonly associated postconcussion syndrome. Patients are requested to rate their symptoms on a likert-like scale from 1 “not at all” to 5 “all the time”. Scores for frequency total, intensity total, duration total and a total score across the 3 dimensions are calculated.

- *Data Analysis*

Analyses will be carried out using SPSS for Windows version 15.0. Descriptive statistics and Chi-square tests will be used to investigate patient background variables including self-reported symptoms experienced by participants as assessed by the PCSC.

Hypotheses 1, 3 and 4: The number of patients that the PTA-I, R-WPTAS and GCS agree in their categorisation of people as being in or out of PTA (cognitively impaired) will be determined using Chi Square analysis. More specifically McNemar’s Test will be used to determine agreement in the categorisation of each patient by each test.

Hypothesis 2: Chi square analysis will be used to determine which components of the PTA-I and R-WPTAS are most sensitive to PTA status.

5) Health and Safety Issues

▪ *Researcher Safety Issues*

Researchers will be invited to assess participants by ED staff, who will have assessed whether interviewing the participant is appropriate in terms of the safety of the researcher. Researchers will carry out interviews/testing in the GRI where there are always staff present either on the Ward or in the Department. If any difficulties arise ward staff must be notified immediately. Further hospital and ED safety policies will be discussed with hospital staff prior to carrying out any patient assessments and these will be adhered to.

▪ *Participant Safety Issues*

Interviews/testing will only be conducted if researchers are given consent by the patients. Advice should be sought and followed regarding whether ward staff feel this is appropriate in relation to the patient's condition in order to avoid causing undue distress. The participants will be informed they can take breaks and stop at any time.

5) Ethical Issues

Ethics approval will be obtained from a West of Scotland Research Ethics Committee.

Issues;

- Informed written consent is required from patients to take part in the study. Patients will be assessed near to the point of discharge, when they are deemed safe to discharge and are seen as fit to give consent.

- The present study involves initial routine collection of PTA assessment data on presentation to the ED as required by SIGN Guideline 110 (2009), however the methods used are not currently in routine operation at GRI. The assessment is not dangerous for the patient, is of low risk, is not time consuming and is clinically useful for staff as if patients are identified as still being in PTA staff can be alerted and patients may be admitted as a result of a change in medical decision regarding discharge safety.

- If patients are admitted they may not have the capacity to give consent. In this situation, consent will be requested retrospectively (as well as at the time of testing) from the patient near to the point of discharge at which point they are deemed fit to give consent.

- Patient identity will be protected as per the Data Protection Act (1998).

- Patients will be made aware that they can withdraw from participation at any time.

- Advice from staff members responsible for each patient will be sought and followed as to whether and when it is appropriate to interview patients.

4) Financial Issues

A costing form has been completed (see Appendix) which estimates the cost of the study to total £62.00.

5) Timetable

Submit for ethical approval September-October 2009

Data Collection November 2009 – April 2010

Analyse data April- May

Drafts June-July

Submit end July

5) Practical Applications

Accurate assessment of PTA is of clinical importance for several reasons; to inform decisions about acute care/treatment, to inform long-term prognosis and to inform rehabilitation access/planning. If the PTA-I were more robust than the current PTA assessment used within the ED whilst still retaining the qualities of speed and ease, then this assessment measure would be of clinical benefit to patients.

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7) Appendix

Post-traumatic Amnesia Interview (PTA-I)

Orientation Questions;

11. How old are you?
12. What is your date of birth?
13. What month are we in?
14. What time of day is it? (prompt morning, afternoon or night)
15. What year are we in?
16. What is the name of this place? (If no answer, prompt by providing names of 3 hospitals)

Memory Component;

17. What's the first thing you remember after being injured?
 - d. What's the next thing you remember?
 - e. What happened next?
 - f. Ask relevant question about today (i.e. What did you have for breakfast? Did anyone visit you today?)

Prompts: Do you remember; Coming to hospital? Being in casualty? Being in intensive care unit? Being on ward NSU/DHG/rehab? Being taken to another hospital? Going home from hospital? Special event (birthday/XMAS)?

18. Do you remember;
The 3 words I asked you to memorise earlier? If recall is not perfect ask – Can you tell me which three words I asked you to remember from a list I will read to you?
Word 1 (sock)
 19. Word 2 (mirror)
 20. Word 3 (umbrella)
- TOTAL

The Westmead Post-traumatic Amnesia Scale Revised (R-WPTAS; Ponsford et al., 2004)

DATE OF INJURY..... S = SCORE (1 or 0)

TIME OF ADMINISTRATION

For questions 4, 7, 8, 9, 10, 11 and 12 test free recall first then give prompts as in brackets

1. How old are you?
 2. What is your date of birth?
 3. What month are we in?
 4. What time of day is it? (morning, afternoon or night)
 5. What year are we in?
 6. What is the name of this place? (Home, Geelong Hospital, Western Hospital)
 7. Face. On first admin. Show photo, ask pt to remember face. Subsequently ask “Can you identify which of these faces have you seen before?” (from choice of 6. Always use photo 4.)
 8. Picture 1 (cup) (On first admin, show 3 pictures. Thereafter ask pt to identify pictures from series and present correct pictures again).
 9. Picture 2 (keys)
 10. Picture 3 (bird)
- TOTAL

Postconcussion Syndrome Checklist (Gouvier et al, 1992; PCSC)

NAME DATE

Please rate the frequency, intensity and duration of each of the following symptoms based on how they have affected you today according to the following scale:

| | FREQUENCY | INTENSITY | DURATION |
|--------------------------|------------------|---------------------|-------------------|
| | 1 = Not at all | 1 = Not at all | 1 = Not at all |
| | 2 = Seldom | 2 = Vaguely present | 2 = A few seconds |
| | 3 = Often | 3 = Clearly present | 3 = A few minutes |
| | 4 = Very often | 4 = Interfering | 4 = A few hours |
| | 5 = All the time | 5 = Crippling | 5 = Constant |
| Headache | ----- | ----- | ----- |
| Dizziness | ----- | ----- | ----- |
| Irritability | ----- | ----- | ----- |
| Memory Problems | ----- | ----- | ----- |
| Difficulty Concentrating | ----- | ----- | ----- |
| Fatigue | ----- | ----- | ----- |
| Visual Disturbances | ----- | ----- | ----- |
| Aggravated by Noise | ----- | ----- | ----- |
| Judgment Problems | ----- | ----- | ----- |
| Anxiety | ----- | ----- | ----- |

Thank you for your time and effort in the completion of this form.