

**Return to driving in the first 6 months of community integration after acquired
brain injury**

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Abstract

Background. Return to driving is a goal and milestone in the recovery process following acquired brain injury (ABI). Knowledge of whether and when a person is likely to return to driving is important to people with ABI, family members and clinicians. **Objective.** To determine the rates, timing, correlates, and predictors of return to driving in the first 6 months after discharge from hospital following ABI. **Methods:** Survey of 212 participants with ABI and 121 family members at discharge and 3 and 6 months later. Participants with ABI were grouped according to driving status (not driving, returned within 3 months, returned within 6 months). Groups were compared on demographics, injury severity, quality of life, functioning, psychosocial integration, depression, and carer well-being. **Results:** By 6 months post-discharge 62.3% had resumed driving. Between group differences existed on measures of injury severity, and psychosocial integration at 6 months, and carer depression and strain at discharge and 6 months. Whether and when someone returned to driving could be predicted by length of hospital stay, and level of community integration, and pain at discharge. **Conclusions.** Educating clients about their likelihood and timing of return to driving, and supporting non-drivers and their carers may improve psychosocial outcomes.

Keywords: community integration, rehabilitation, longitudinal studies, brain injuries, traumatic, automobile driving

Introduction

Driving is a complex and valued activity often suspended permanently or for a period of time following acquired brain injury (ABI) (Rapport, Hanks, & Bryer, 2006). Returning to driving is an important part of reintegration into community living following ABI (McCabe, Lippert, Weiser, Hilditch, Hartridge, & Villamere, 2007; Rapport et al., 2006), with the associated practical and symbolic losses heightening its importance as a rehabilitation goal (Liddle, Fleming, McKenna, Turpin, Whitelaw, & Allen, 2011; Liddle, Turpin, McKenna, Kubus, Lambley, & McCaffrey, 2009). Loss of driving has an impact not only on the individual with ABI but also contributes to carer burden for those required to become the providers of transport (Liddle et al., 2011; Turner et al., 2007). Driving however is a role with community safety implications, so adequate recovery for safe driving performance and negotiation of the steps associated with gaining medical clearance to drive are required (Brooks & Hawley, 2005; Tamietto, Torrini, Adenzato, Pietrapiana, Rago, & Perino, 2006). Therefore, the ‘whether’ and the ‘when’ of returning to drive is of great interest to people with ABI, their family members and rehabilitation teams.

Between 30 and 60% of people with a serious ABI return to driving (Coleman, Rapport, Ergh, Hanks, Ricker et al., 2002; Fisk, Owsley, & Pulley, 1997; Pietrapiana, Tamietto, Torrini, Mezzanato, Rago, & Perino, 2005; Tamietto et al., 2006). Return can occur from weeks to years after the ABI and may follow detailed and complex assessment processes or involve no formal testing depending on local health and licensing systems (Classen, Levy, McCarthy, Mann, Lanford, & Waid-Ebbs, 2009; Tamietto et al., 2006). A study of 72 people with traumatic brain injury (TBI) found that 30% of people with moderate TBI and 22.4% with severe TBI had

returned to driving at 6 months post-injury. By 12 months, 47.8% and 32.6% of those with moderate and severe TBI respectively were driving (Novack, Alderson, Bush, Meythaler, & Canupp, 2000).

Safe driving performance requires the integration of high level sensory, motor, perceptual and cognitive functions, occurring smoothly in a constantly changing environment (Classen et al., 2009; Petropiana et al., 2005). Driving requires a hierarchy of complex component abilities falling into strategic, tactical and operational categories (Michon, 1985; Petropiana et al., 2005). The strategic component involves decisions about driving made without time pressures (for example, what time of day and which route to take). The tactical aspect requires adaptation and flexibility for managing the changing context during a drive (for example, traffic conditions and weather). The operational component of driving refers to physically managing the vehicle and rapidly responding to the environment and the vehicle (Michon, 1985; Petropiana et al., 2005).

Determining whether and when a person can return to driving after ABI can be a complex process. There is no consensus about how best to assess driving potential, and procedures can differ according to the resources available within the health and rehabilitation system, and with the requirements of driver licensing authorities (Classen et al., 2009; Liddle & McKenna, 2003, Tamietto et al., 2006). A comprehensive on and off road assessment conducted by rehabilitation professionals with postgraduate qualifications has been widely accepted as the best means of evaluating driving performance (Dickerson, Reistetter, Davis, & Monahan, 2011; Korner-Bitensky, Gelinas, Man-Son-Hing, & Marshall, 2006), but is resource intensive (Dickerson et al., 2011; Schanke & Sundet, 2000). A driving assessment often takes place once a person has stabilized and recovered adequately to allow

optimal driving performance (Liddle et al., 2011). It provides an evaluation of current driving performance, and if required, informs the development of a driving rehabilitation program, but does not predict future driving performance (Dickerson et al., 2001).

Formal requirements of licensing may specify baseline health and sensory levels indicating medical fitness to drive including sufficient visual acuity and visual fields, and absence of seizure activity (Austroads, 2012; Hawley, 2001). In some regions, a period of recovery time, often prescribed by the treatment team, may be mandatory after a neurological incident (Austroads, 2012; Hawley, 2001). It can be challenging for the rehabilitation team to determine early post-injury whether future driving will be possible following sufficient time for recovery (Liddle et al., 2011). One longitudinal study of participants 1 to 16 years post-injury indicated that the severity of TBI measured by length of coma, was partially predictive of subsequent return to driving, whereas demographic variables, premorbid driving behaviours and experience, and functional measures at discharge did not predict return to driving (Pietripiana et al., 2005).

Beyond the functional requirements related to attaining medical fitness to drive, return to driving holds important symbolism for people in their recovery from ABI (Rapport et al., 2006; Turner et al., 2007). Driving is considered a concrete representation of returning to normality and also serves a practical purpose for enabling independent access to community venues and valued activities and roles (Liddle et al., 2009, 2011; Rapport et al., 2006). Qualitative investigations of the experience of interruption to and cessation of driving for people post TBI (Liddle et al., 2011; Liddle, Fleming, McKenna, Turpin, Whitelaw, & Allen, 2012) and post stroke (Liddle et al., 2009; Lister, 1999; White, Miller, Magin, Attia, Sturm, &

Pollack, 2011) indicate that it can be a highly stressful experience. Participants reported that the process of waiting to return to driving can be long and arduous (Liddle et al., 2009, 2011, 2012; White et al., 2011). Both groups reported distress from a lack of clarity about whether they would ever return to driving. They also described underestimating the length of time and processes required for return to driving and felt unprepared to cope with unspecified wait time which could range from months to years (Liddle et al., 2009, 2011).

Participants with TBI, their family members and health professionals described an “on hold period” where people were unable to move beyond a focus on driving in their rehabilitation, yet were not able to return to driving due to the need for recovery time, waiting periods, and assessment processes (Liddle et al., 2011). During this time, rehabilitation gains may be interrupted, rapport may be lost and unlicensed driving may occur (Liddle et al., 2011, 2012). Health professionals and family members recognized the need to carefully balance realistic information and hope in discussing driving rehabilitation and noted that education about possible outcomes and timeframes needed to occur from early in the recovery process. While it is difficult to make early predictions about driving outcomes and processes (Liddle et al., 2011), it was recommended individualized education about the process and timing each person might face with pursuing return to driving. Further evidence is needed to help health professionals ascertain the possible outcomes and timeframes for their clients in relation to driving from early in the recovery process (Liddle et al., 2012).

Therefore, understanding timeframes for resumption of driving and which early clinical factors relate to future driving status may be clinically useful. This study had the following aims: 1) To compare individuals with ABI who return to driving

early, later, and not at all in the first 6-months post-discharge on demographic variables, injury severity, quality of life, psychosocial function, depressive symptoms and carer strain, and 2) To identify predictors of return to driving and timing of return in individuals with ABI in the first 6-months post-discharge.

Methods

A prospective longitudinal cohort design was used, with data collected at hospital discharge and at 3 and 6 months later. This study was part of a larger, longitudinal investigation of the transition experiences related to acquired brain injury and other aspects of the study have been previously published (e.g., Nalder, Fleming, Cornwell, Foster, & Haines, 2012; Nalder, Fleming, Foster et al., 2012).

The project had ethical clearance from a university and hospital ethics committee. Participants were recruited between February 2007 and November 2009 from two sites within a major tertiary hospital in South East Queensland, Australia: a brain injury rehabilitation unit and an acute neurosciences ward. Specific inclusion criteria included: a) diagnosis of non-progressive ABI in a medical report, b) aged between 18 and 65 years, c) discharged to the community (i.e., not to residential care or other treatment facility), d) adequate cognition for informed consent, and e) adequate communication to participate in data collection. Cognitive and communication levels were evaluated functionally through discussion with treating occupational therapists and speech pathologists. Participants were excluded if they had a mental health condition precluding participation in the informed consent process or they had been in hospital for less than four days. Following informed consent, each participant was asked to nominate a significant other to participate in

the project if possible. A significant other was defined as a family member or friend closely involved with the participant on a daily basis.

Participants

During the recruitment period, 1757 people with ABI, aged between 18 and 65 years were discharged from the two sites ($n = 315$ rehabilitation, $n = 1442$ acute care). Of these, 1326 did not meet the study criteria due to diagnoses, length of stay, cognitive or communication levels, or destination on discharge. In addition, 118 declined to participate, 46 discharged themselves prior to participation, 26 were unable to be contacted and 7 passed away in hospital. An additional 21 participants initially consented, then withdrew from the study. The remaining group of 212 people with an ABI formed the sample for this study and 121 of these had a consenting significant other. Participants who agreed or declined to participate were compared on age, gender, length of hospitalization and nature of ABI (traumatic or non-traumatic). The only statistically significant difference was that participants who declined to participate were significantly younger than those who consented to participate ($p < 0.01$).

The local context of the study was Queensland, Australia, where the public health system is the major provider of rehabilitation following ABI, including medical fitness to drive assessments. Waiting lists of up to 6 months exist for specialist neuropsychological and on and off road driving assessment appointments. Participants were recruited from a public hospital with a driving service providing driving assessments and rehabilitation programs. Costs for assessment and rehabilitation are largely funded through the health system, but clients pay for the driving school instructor and vehicle. Private driving assessments are also available

with a shorter waiting time in many areas, with costs being covered by the client or through relevant insurance or employment related funding. Driving licensing is regulated by the state licensing authority, which requires drivers to declare the onset of a medical condition that could affect driving performance. At the time of the study Austroads (2003) guidelines prescribed a mandatory break from driving after an ABI and return to driving required clearance from a medical practitioner. Cessation of driving was required if there was severe vision impairment, uncontrolled seizures or physical impairment that prevented safe operation of a vehicle (Austroads, 2003).

Measures

Demographic information and indicators of severity of illness and nature of hospital stay were collected from the participant and carer and checked in the medical chart. Information about driving status and the time of return to driving (in days since discharge) were collected as part of the Sentinel Events Questionnaire (SEQ), which was developed for recording the key events during the transition from hospital to home after ABI including return to work, achieving independence in the home, and returning to driving (Nalder, Fleming, Cornwell et al., 2012). The SEQ was administered as a semi-structured interview and participants were encouraged to be as specific as they could regarding dates. Where people were unsure or known to have difficulty with recall, proxy data were also collected to verify timing. For the current study, only item 8 which asked about the occurrence of return to driving defined as 'Having received medical clearance to return to driving' (Nalder, Fleming, Cornwell et al., 2012, p. 1386) was used.

The EQ-5D Health Questionnaire (The EuroQol Group, 1990) measures health related quality of life across five domains; mobility, personal care activities,

usual activities, pain or discomfort, and anxiety and depression. Participants rate their participation and performance in each domain on a three level scale. Higher scores on the subscales indicate poorer health related quality in that domain. An additional visual analogue scale has participants rate their overall health state between 0 (“My worst imaginable health state”) and 100 (“My best imaginable health state”).

The Mayo-Portland Adaptability Inventory-4 (MPAI-4) measured level of functioning and consists of three subscales (abilities, adjustment and participation) (Malec & Lezak, 2003). The MPAI-4 items are rated on a 5-point scale from 0 – 4, where 4 indicates greater participation restrictions (Malec & Lezak, 2003).

Depression was measured using the Depression subscale of the DASS-21, a short form of the Depression, Anxiety, Stress Scales (DASS)(Lovibond & Lovibond, 1995). The DASS-21 contains 21 items rated on a 5-point scale, with higher scores indicating greater levels of emotional distress. The subscale is scored out of 21, with a higher score indicating higher levels of depressive symptomatology (Lovibond & Lovibond, 1995).

The Sydney Psychosocial Re-integration Scale (SPRS) is a 12-item measure of psychosocial integration (Tate, Hodgkinson, Veerabangsa, & Maggiotto, 1999). Each item is rated on a 7-point scale, with lower scores indicating a greater degree of change in psychosocial functioning (Tate et al., 1999).

Carer strain was measured using the Carer Strain Index (CSI) (Robinson, 1983). A higher score indicates the caregiver has experienced difficulty in care provision over a range of areas of health and lifestyle. The CSI has a total score of 13 and a score of 7 or higher reflects a high level of stress (Robinson, 1983).

All measures have good psychometric properties (e.g. EQ-5D, Brazier, Jones, & Kind, 1993; Henry & Crawford, 2005; MPAI-4, Malec & Lezak, 2003; DASS-21, Ownsworth, Little, Turner, Hawkes, & Shum, 2008; Robinson, 1983; SPRS, Tate, Simpson, Soo, & Lane-Brown, 2011) and have either been developed for or previously used with people with ABI (Algurén, Fridlund, Cieza, Sunnerhagen, & Christensson, 2011; McPherson, Pentland, & McNaughton, 2000; Townend, 2001).

Procedure

Measures were completed at the time of discharge from hospital and at 3 and 6 months follow up. Data were collected using separate interviews of the participant with ABI and their carer at each timepoint. Interviews involved administering via structured interview the SEQ, EQ-5D, MPAI-4, DASS-21 and SPRS to the person with ABI. The carer provided proxy data on the SEQ, MPAI-4 and SPRS, and also described their own experiences using the EQ-5D, CSI and DASS-21. Initial interviews were mostly conducted at the hospital prior to discharge and follow-up interviews were mostly conducted via telephone, however, if requested by participants, face to face and postal questionnaires were also offered.

Data Analysis

Data were cleaned, checked and analyzed using STATA software (Stata Statistical Software, Release 10). Descriptive statistics were used to describe the sample. Basic comparative univariate statistics were used to compare the sample according to when they returned to driving (early, later or not at all), with sample size, types of data and distribution of scores being considered in the choice of statistical tests (Portney & Watkins, 2009). Frequencies and chi squared analyses were used to compare categorical variables; means and ANOVAs were used to compare

continuous variables with normal distributions, and medians and the Kruskal Wallis test were used to compare continuous variables with non-normal distributions (Pevalin & Robson, 2009; Portney & Watkins, 2009). Assumptions were checked and met (Lang & Secic, 2006; Portney & Watkins, 2009). Where significant differences existed post hoc tests were used to examine where the differences were (Scheffe test for ANOVA, Mann Whitney U comparison for Kruskal Wallis, and 2x2 chi square comparisons for chi square tests) (Pevalin & Robson, 2009; Portney & Watkins, 2009). To account for the multiple comparisons, the p value was adjusted using a simple Bonferroni adjustment to 0.025 for post hoc comparisons (Portney & Watkins, 2009).

To address the second research question, models were developed which examined the best way of predicting driving outcomes, using baseline information about the person, their injury and functional status at the time of discharge. Logistic regression models (random effects logistic regression in STATA) were fitted to driving outcome at 6 months for participants (classified as returned to driving or not). For those who had returned to driving, a linear regression model (regression model in STATA) was fitted to predict the number of days between discharge from hospital and return to driving. Both sets of models began with the simultaneous entry of all potentially relevant variables (age, gender, length of stay in hospital, traumatic or non-traumatic brain injury, and subscales of MPAI and EQ5D). The variables contributing least to the model were then removed one by one until the strongest possible model using these variables was achieved. The assumptions were checked and met for all reported models (Pevalin & Robson, 2009; Portney & Watkins, 2009). Significance level was set at 0.05 for the regression analyses.

Results

Data from people following an acquired brain injury and a nominated family member/carer were collected at baseline (discharge) from 212 people with ABI and 121 caregivers. At 3 months data were available from 189 people with ABI and 105 caregivers, and at 6 months there was 170 and 94 in each group respectively. The sample of people with ABI was predominantly male ($n=160$, 69.26%). The mean age was 39.9 years (sd 12.6) and ranged from 17 to 63 years. The length of stay in hospital ranged from 4 to 776 days, with a mean of 66.2 days (sd 82.4). Initial Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) scores were available for 162 participants, with a mean of 10.8 (sd 4.5), ranging from 3 to 15. The majority of the sample 65.4% (151) had a TBI, with the remaining 34.6% (80) having an acquired brain injury of other aetiology, most commonly non trauma related subarachnoid haemorrhage (55%) or cerebrovascular accident (CVA) (24%). Road traffic accident (41%), fall (32%) and assault (16%) were the most common causes of TBI in the sample.

The carer sample had 92 (78.4%) female carers. For the majority, the carer was the spouse or partner of the person with ABI ($n=86$, 71.1%). Other carers were parents ($n=24$, 19.8%) or less commonly siblings ($n=4$, 3.31%), ex-spouses or partners ($n=4$, 3.31%) or offspring ($n=2$, 1.65%). The mean age of carers was 45.0 years (sd 11.34, range 20-81).

By 6 months, return to driving had occurred for 62.3% ($n=86$) of the sample. Participants who had returned noted how many days since discharge return had occurred, with a mean of 101 days (sd 79.6, range 1-225 days). Participants were grouped according to whether and when they had returned to driving: not returned by 6 months (Group 1, $n= 52$), prior to 3 months post-discharge (Group 2, $n=55$), and between 3 and 6 months (Group 3, $n= 31$).

Groups were compared on the basis of sociodemographic variables and indicators of injury severity and impairment according to time of return to driving. The results are summarized in table 1. The three groups differed statistically in ward (rehabilitation or acute), length of hospital stay, length of post traumatic amnesia (for people with TBI only), initial GCS score, Carer Strain Index at baseline, and carer depression at baseline and 6 months later. In addition, despite not being statistically different at baseline in level of functioning (MPAI-4) and psychosocial reintegration (SPRS), statistical differences existed 6 months later.

Insert Table 1 about here

Post hoc tests revealed Group 1 (did not return to driving) had a significantly longer length of hospital stay than Group 2 (returned by 3 months) and Group 3 (returned by 6 months), whilst the difference between Group 2 and Group 3 approached significance. For participants with TBI, there was a significance difference in length of PTA between Group 1 and Group 2, and between Group 1 and Group 3 with Group 1 having longer PTA in both cases. Similarly, Group 1 had significantly lower initial GCS scores than both Group 2 and Group 3. Those in Group 1 were significantly more likely to be from the rehabilitation ward than those in Group 2, whilst the difference in distribution of rehabilitation and acute care patients between Group 1 and 3 also approached significance.

At the 6 month follow-up, post hoc (Scheffe) tests showed that Group 1 had significantly lower levels of community integration on the SPRS than Group 3 ($F=8.97$, $p<0.01$) and lower levels of functioning on the MPAI-4. Group 1 had slightly higher depression scores than the other groups but this was not significant. Carer depression at discharge was significantly higher in Group 1 compared to Group

2 and Group 3. Carer strain at discharge showed a similar pattern with higher scores in Group 1 compared to Group 2 and Group 3. These differences remained at the 6 month follow-up with carers in Group 1 showing significantly higher depression scores than Group 2 and Group 3). Carer strain at 6 months was significantly higher for Group 1 compared to Group 3 and approached significance for Group 2 approached significance ($F=5.1$, $p=0.029$).

Logistic regression models were fitted to driving outcome at 6 months for participants (whether or not a participant had returned to driving). See Table 2. The model indicated that people less likely to return to driving by 6 months had longer periods of hospitalization, and lower levels of functioning (MPAI-4) at discharge as reported by the patient. Adding to the model, but not independently predicting return to driving by 6 months was age with older participants more likely to return to driving.

Insert table 2 about here

For those who returned to driving, the length of time (in days) between discharge and return to driving was predicted in a linear regression model (see Table 3). Longer time until return to drive was predicted by a longer length of stay, and higher discharge levels of pain and discomfort (EQ5D). Adding to the models, but not independently predictive of a longer time until return were having a TBI, greater restrictions to mobility (EQ5D), lower level of functioning (MPAI-4) and higher scores on the EQ5D visual analogue scale at discharge (as reported by the patient).

Insert Table 3 about here

Discussion

Differences on a range of variables were found to exist at discharge between people who returned to driving prior to 6 months post-discharge and those who had not returned to driving in this time-frame. Psychosocial outcome of participants with ABI and emotional well-being of carers at 6 months post-discharge also differed according to driving status. Prediction of whether return to driving occurs within 6 months and when it occurs was attributed to indicators of severity (LOS), community integration and wellbeing, and demographic variables. The differences between groups according to driving status support previous findings that driving outcomes are related to injury severity (Petrapiana et al., 2005).

The sample in the current study differs from other driving after ABI studies, as it covers a broad spectrum of severity of ABI including people who had acute hospital care only through to longer inpatient rehabilitation stays. Unlike some studies investigating driving outcomes, this study followed a single cohort through a period of time in the early part of rehabilitation and recovery, rather than surveying a cross sectional cohort that extended up to many years post injury (e.g. Pietrapiana et al., 2005). A comparatively higher return to driving by 6 months (62.3%) compared with less than a third in another study of early driving outcomes (Novack et al., 2000), possibly reflected differences in type and severity of injury and services available. The carer sample was similar in gender, relationship and age patterns to other caregiver studies (e.g. Perlesz, Kinsella, & Crowe, 2000).

Approach to return to driving, for example whether the participant received a formal driving assessment or driving rehabilitation program, was not recorded and this is a limitation to understanding the data. While some participants, particularly those with severe brain injury who had received inpatient rehabilitation, would have been referred for an occupational therapy on-road driving assessment at the hospital,

others would have just been given medical clearance from a medical consultant or general practitioner. Furthermore some people with ABI may lack self-awareness of impairments and may think they are ready to drive when they are not (Fleming & Strong, 1999). Previous research has also demonstrated that individuals with ABI and their carers report a lack of knowledge about the processes involved for returning to driving (Liddle et al., 2011) causing some individuals to resume driving without seeking rehabilitation or assessment services, or without obtaining formal medical clearance. Consequently the self-reported rate of clearance to drive may be inflated in this study, which would constitute a significant safety concern for both the individual and the community.

The median depression scores of carers at 6 months were equivalent to a moderate level of clinical depression (Lovibond & Lovibond, 1995) and were similar to other research on family members of people with TBI (e.g. Anderson, Simpson, Morey, Mok, Gosling, & Gillett, 2009). Previous research indicates that the experience of interruption to and cessation of driving can be highly stressful for carers as providing transport and emotional support and preventing unlicensed driving contributes to carer burden (Liddle et al., 2012). However the finding that driving status is associated with carer strain and depression may also reflect the greater injury severity and higher support needs of the non-driving group. These findings raise the important question of how well carers are supported on the issue of return to driving. Previous research suggests that carers generally received little in the way of formal support following discharge from rehabilitation and that transport is an area where practical support is needed (Nalder et al., 2012; Turner et al., 2007). The period of transition from hospital to home after brain injury is a time when carers seek a definitive prognosis (Conneeley, 2012) and providing clear information about return

to driving could be one way to meet this need. Similarly, providing practical supports such as taxi vouchers may reduce some of the stress placed on carers who may feel a responsibility to facilitate the community access needs of individuals with ABI who are unable to drive.

Between group comparisons of participants based on the timing of driving return also suggests that return to driving may have a role in promoting community engagement and participation. While the three groups did not differ in psychosocial integration or level of functioning at discharge, significant differences were apparent at 6 months. Although this may reflect a steeper trajectory of recovery for some individuals allowing them to return to driving as well as other activities and roles, other research has suggested driving has an important role in community integration (Rapport et al., 2006; Turner et al., 2007). This association suggests that further research investigating the impact of the loss of the driving role for people with ABI is needed. Interventions to assist with adjustment to this loss and to develop strategies to assist carers to manage the associated stressors and practical implications also need to be developed and evaluated.

Although discharge measures of injury severity, functioning, integration and quality of life helped to predict driving outcomes, the models did not predict a large proportion of the driving outcomes. This indicates that driving is likely to be fairly variable and influenced by many factors that were not included in the model. More specific assessment of physical and cognitive function may have enabled more accurate prediction. Driving outcomes (whether and when someone returns to driving) is likely to be affected by recovery, which is known to be variable (Liddle et al., 2011), external factors including resources and waiting lists, and individual factors, such as the personal meaning of driving (Liddle et al., 2009, 2011). This suggests that

there is no standard recommended timeframe for return to driving in this population and decisions about readiness should be made on a case-by-case basis.

Limitations of the study should be considered in applying the findings. The sample was drawn from a major metropolitan hospital which has associated driving services, so may not reflect the outcomes for regions and areas where driving rehabilitation support is not available. Participation was voluntary, and although care was taken to reduce strain associated with participation, it is possible that those who were coping less well following their ABI may have declined to participate or been lost to follow up. Finally, measures used relied on self report which may be influenced by social desirability bias (Mortel, 2008). Given this study only examined driving issues in the first 6 months, caution should be taken with extrapolating the findings to whether people return to driving at all. As driving requires a high level of functioning, it is often a later achievement in recovery and community integration (Rapport, 2008). Tamietto and colleagues (2005) caution that driving safety related research should allow for a longer follow up time post TBI, at least a full 12 months.

While there is a need for caution when making individual predictions these findings could help provide clinicians with a starting point for educating people about their potential driving outcomes and its timeframe. Other research has suggested that being aware of the possibility that return to driving may not happen or may not happen for some time, might help people attain realistic expectations and accept alternatives to driving (Liddle et al., 2009; White et al., 2011). The waiting time may also be used actively to promote use of alternative transportation and life planning (Liddle et al., 2011). The carers of people not returning to driving in the first 6 months may need to be monitored for strain and depression and given assistance to manage

the additional burden associated with providing transport to the person with ABI (Liddle et al., 2012; Anderson et al., 2009).

Conclusion

Driving outcomes in the first 6 months post ABI were related to injury severity and levels of community integration and quality of life. Carers of those not returning to driving in this period had higher levels of depression. Individuals with ABI who did not return to driving in the first 6 months had poor psychosocial outcomes, and while this may be attributed to greater severity of injury, this finding also suggests that adjustment to the loss of driving is an important issue to address in rehabilitation.

Declaration of interest

The authors declare no conflict of interest.

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Table 1. Univariate comparisons between groups according to timing of return to driving.

	Group 1	Group 2	Group 3	χ^2 or F	p
	Did not return to driving n = 52	Returned to driving by 3 months n = 55	Returned to driving 3 -6 months n = 31		
Marital status					
Partner	25 (49.0%)	35 (63.3%)	20 (64.5%)	$\chi^2= 2.9451$	0.229
Single	26 (51.0%)	20 (36.4%)	11 (35.4%)		
Gender					
Female	16 (30.8%)	16 (29.1%)	12 (38.7%)	$\chi^2= 0.8923$	0.640
Male	36 (69.2%)	39 (70.9%)	19 (61.3%)		
Discharge destination					
Rural	22 (43.1%)	19 (38.0%)	14 (46.7%)	$\chi^2= 0.624$	0.732
Metropolitan	29 (56.9%)	31 (62.0%)	16 (53.3%)		

Age	M = 37.67 (sd =12.59)	M = 41.96 (sd=12.85)	Mean = 43.3 (sd = 12.6)	F = 2.43	0.092
Length of stay (days)	Median = 72 (Range 4-776)	Median = 13 (Range 4-115)	Median = 33 (Range 6-100)	Kruskal Wallis $\chi^2 = 27.41$	0.001**
Length of PTA (days) TBI only	Median = 20 (Range 0-107)	Median = 5 (Range 0-42)	Median = 1.5 (Range 0-57)	Kruskal Wallis $\chi^2 = 13.85$	0.001**
Initial GCS n = 96	Median = 12 (Range 3-15)	Median = 14 (Range 3-20)	Median = 15 (Range 3-20)	Kruskal Wallis $\chi^2 = 14.39$	0.0007**
Cause of injury					
TBI	37 (71.2%)	32 (58.2%)	19 (61.3%)	$\chi^2 = 2.0530$	0.358
Non-traumatic	15 (28.8%)	23 (41.8%)	12 (38.7%)		

Ward					
Acute	17 (32.7%)	41 (74.5%)	17 (54.8%)	$\chi^2 = 18.8749$ $p < 0.0001^{**}$	<0.0001**
Rehabilitation	35 (67.3%)	14 (25.5%)	14 (45.2%)		
Discharge SPRS	M = 52.89 (sd = 9.70)	M = 55.68 (sd = 6.53)	M = 54.2 (sd = 8.03)	F = 1.44 p = 0.24	0.24
Discharge MPAI-4	M = 43.06 (sd = 7.34)	M = 41.34 (sd = 7.30)	M = 42.50 (sd = 8.21)	F = 2.02	0.14
Discharge DASS Depression	Median = 6 (Range 0-38)	Median = 2 (Range 0-36)	Median = 2 (Range 0-26)	Kruskall Wallis $\chi^2 = 1.77$	0.413
6 month SPRS	M = 55.46 (sd = 12.84)	M = 64.43 (sd = 8.84)	M = 60.48 (sd = 9.91)	F = 8.39	0.0004**

6 month MPAI-4	M = 41.96 (sd = 10.46)	M = 33.56 (sd = 14.71)	M = 39.77 (sd = 10.30)	F = 6.11 p = 0.0029*	0.0029**
6 month DASS Depression	Median = 4 (Range 0-32)	Median = 2 (Range 0-40)	Median = 2 (Range 0-24)	Kruskall Wallis $\chi^2 = 3.60$	0.165
Discharge Carer DASS Depression	n=17, Median = 8 (Range 0-34)	n=16, Median = 2 (Range 0-20)	n=25, Median = 2 (Range 0-12)	Kruskall Wallis $\chi^2 = 9.51$	0.0086**
Discharge CSI n = 58	M = 9.13 (sd = 2.56)	M = 5.47 (sd = 3.91)	M = 5.69 (sd = 2.37)	F = 9.86	0.0002**
6 month Carer DASS Depression	n=24, Median = 6 (Range 0-34)	n=17, Median = 0 (Range 0-21)	n=24, Median = 2 (Range 0-16)	Kruskall Wallis $\chi^2 = 14.07$	0.0009**

** p < 0.01

Note: PTA= post traumatic amnesia; GCS= Glasgow Coma Scale; TBI= traumatic brain injury; SPRS= Sydney Psychosocial Reintegration Scale; MPAI = Mayo-Portland Adaptability Index; DASS= Depression Anxiety and Stress Scales; CSI= Carer Strain Index

Table 2: Logistic regression model predicting return to driving in the first 6 months based on scores at discharge

Variables	Coeff	z	p	OR	95% C.I.
Length of stay*	1.54	3.42	0.001	4.66	1.93 to 11.25
MPAI participation*	0.08	2.61	0.009	1.08	1.02 to 1.14
Age	0.48	-1.69	0.091	0.48	0.20 to 1.13
Wald chi2 (3) = 16.87 p = 0.0008					

OR= Odds Ratio

*p<0.05

Table 3. Linear regression model predicting length of time (in days) until return to driving (for those who returned in the first 6 months post-discharge)

Variables	Coeff	t	p	95% C.I.
Length of stay	43.65	3.41	0.001*	18.17 to 69.13
EQ5D Pain discomfort	21.48	2.10	0.039*	1.06 to 41.89
TBI or other ABI	-21.25	-1.79	0.078	-44.93 to 2.43
EQ5D mobility	-22.28	-1.70	0.094	-48.40 to 3.85
MPAI participation	1.17	1.63	0.108	1.06 to 41.89
EQ5D VAS	0.39	1.24	0.218	-0.24 to 1.02

F(6, 75) = 5.28 p = 0.0001, Adj R-squared= 0.2408

*p<0.05