Return to work after traumatic brain injury: Cohort comparison and economic evaluation

KATE RADFORD¹, JULIE PHILLIPS², AVRIL DRUMMOND³, TRACEY SACH⁴, MARION WALKER⁵, ANDY TYERMAN⁶, NASEER HABOUBI⁷, & TREvor JONES⁸

¹Rehabilitation Research, University of Nottingham, Nottingham, UK, ²Nottingham University Hospitals NHS Trust, Nottingham, UK, ³Healthcare Research, University of Nottingham, Nottingham, UK, ⁴Health Economics, University of East Anglia, Norwich, UK, ⁵Stroke Rehabilitation, University of Nottingham, Nottingham, UK, ⁶Cambourne Centre, Aylesbury, UK, ⁷Rehabilitation Medicine, University Hospitals NHS Trust, Nottingham, UK, and ⁸Service User Representative, Nottingham, UK

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Abstract

Background: Returning to work (RTW) in the UK is problematic following TBI. Vocational rehabilitation (VR) is limited and efficacy or costs seldom reported. This study aimed to determine whether a TBI specialist VR intervention (TBI VR) was more effective at work return and retention 12 months after injury than usual care (UC). Secondary aims were to explore the feasibility of collecting economic data to inform a definitive trial.

Method: Work outcomes of TBI-VR were compared to UC. Ninety-four participants (40 TBI-VR) with TBI resulting in hospitalization ≥48 hours, who were working at injury were followed up by postal questionnaire at 3, 6 and 12 months post-hospital discharge. Primary outcome was RTW. Secondary outcomes were functional ability, mood and quality-of-life. Health resource use was measured by self-report.

Results: At 12 months, 15% more TBI-VR participants (27% more with moderate/severe TBI) were working than UC (27/36, 75% vs. 27/45, 60%). Mean TBI-VR health costs per person (consultant, GP, therapy, medication) were only £75 greater at 1 year. Secondary outcomes showed no significant baseline differences between groups.

Discussion: More TBI-VR participants returned to work than UC. People with moderate/severe TBI benefitted most. This positive trend was achieved without greatly increased health costs, suggesting cost-effectiveness. This study justifies the need for and can inform a definitive Randomized Controlled Trial (RCT).

Keywords: Work, vocational rehabilitation, traumatic brain injury, job retention, community-based rehabilitation, occupational therapy, employment, activities of daily living

Background

Approximately 1 million people in the UK sustain traumatic brain injury (TBI) each year and up to 150,000 incur moderate or severe injury [1] resulting in cognitive and psychological problems, such as impaired insight, executive dysfunction, anxiety and fatigue that interfere with activities of daily living including work [2].

The societal cost of TBI in terms of lost time at work and dependency on benefits is estimated to be 2.8 Billion Euros per year [3]. It is also a known cause of personal bankruptcy [4]. Those who don’t return to work are also more likely to be depressed [5].

Returning to work is a primary rehabilitation goal, yet reported success varies widely (range 11–82%) [6, 7]. In a systematic review, van Velzen et al. [8]...
estimated that only a mean of 41% (range 0–85%) of TBI survivors who were working prior to their injury are in work at 1 and 2 years post-injury. Study heterogeneity and known difficulty in following TBI people up over time [8–10] explain some of the difference in reported outcomes, but ineffective rehabilitation cannot be excluded as a cause. Keeping TBI people in work is also problematic. Many TBI survivors return prematurely and drop out once the impact of the brain injury on their job is realized [11, 12].

Vocational Rehabilitation (VR), defined as whatever helps someone with a health problem return to or remain in work [13], involves helping people find work, helping those who are in work but having difficulty and supporting career progression in spite of illness or disability [14, 15]. Clinical guidelines stipulate that VR should be provided [16] and keeping people with long-term conditions in work is a recognized health outcome [17, 18]. Despite this, UK services supporting TBI people in returning to work are rare [19, 20].

Whilst there is evidence to suggest the cost benefits of state-funded vocational rehabilitation models for TBI people (when programme delivery costs are offset against lost wages, lost income tax and public assistance [21–24]) most of these are retrospective analyses of clients undergoing rehabilitation in a single centre and none make comparisons to alternative or no provision. As such they fail to qualify as formal economic analyses and make it difficult to conclude that VR programmes are cost-effective in supporting return-to-work following TBI.

Positive work outcomes following vocational rehabilitation interventions have been reported in a number of studies. In a systematic review, Fadyl and McPherson [25] identified three broad approaches to TBI VR; programme-based; derived from the New York University Medical Center Head Trauma model [26], involving pre-employment training in vocational skills, sometimes supplemented by transitional job coaching and follow-up at set time points; supported employment [24, 27, 28] (where TBI people with minimal pre-placement training are placed in competitive employment with one-to-one job coach support for training and advocacy that decreases as job competence is established) and vocational case co-ordination, characterized by early hospital-based identification, modular VR intervention, employer education and workplace support. However, despite clear descriptions of the models themselves, a lack of high quality evaluations and dearth of RCTs with robust economic evaluations means evidence to support their effectiveness or cost-effectiveness is weak [29, 30]. The strongest evidence favours an individually-tailored, case-coordination approach [31, 32] with early intervention to optimize employment outcomes [30, 31, 33–38].

The purpose of this pilot study was to determine whether a TBI specialist VR intervention (TBI VR) delivered by an occupational therapist as part of a specialist TBI team approach to care was more effective at supporting work return and retention 12 months after injury in people with TBI than usual care (UC) and to explore the feasibility of economic data collection and evaluation for a definitive trial.

Method

Study setting

A specialist multidisciplinary TBI service, based in a large teaching hospital in Nottingham, UK, providing rehabilitation in the community.

Study design

Cohort comparison with follow-up by postal questionnaire at 3, 6 and 12 months.

Inclusion criteria

Patients admitted to Nottingham hospitals with a diagnosis of TBI that required them to be hospitalized for at least 48 hours and who were aged over 16 and in paid or voluntary work or education at the time of injury were recruited over a 22-month period.

Exclusion criteria

People with a documented medical history of current mental health, drug or alcohol problems, those living more than 1 hour by car from Nottingham, those unable to give informed consent or not intending to return to any form of paid or unpaid work or education.

Procedure

Potential participants were informed of the study by ward staff. Those expressing interest were visited on the ward by the OT (JP). A home visit to obtain consent and collect baseline data was arranged for 4 weeks post-hospital discharge (±5 days). This timing was consistent with existing clinical practice and interventions provided in other studies [38]. Visits were confirmed in writing and by telephone. Potential participants discharged before being seen by JP were invited to participate by letter.
Baseline data

Consent, pre-injury and baseline data including primary and secondary outcomes, resource use and demographic data (living arrangements, relationship status, educational level, employment or education status, gross level of pay, driving status and previous levels of activity) were obtained on the home visit. Participants' General Practitioners were informed by letter.

Group allocation

Those with moderate or severe injury (Glasgow Coma Score [GCS] ≤13), living in Nottingham city or South Nottinghamshire, were eligible for intervention from the Nottingham Traumatic Brain Injury Service (NTBIS), including VR delivered by an experienced occupational therapist (JP). People residing in the same area with minor injuries (GCS > 13) are not eligible for NTBIS but for the purposes of the study were seen only by the occupational therapist (OT-VR). This (NTBIS + OT-VR) was the intervention group (TBI VR). Those living in surrounding areas received usual care. This was the usual care group (UC).

Intervention

NTBIS is a specialist TBI interdisciplinary team comprising three case managers with professional backgrounds in occupational therapy, social work and intensive care nursing who met patients and families within 10 days of injury and work alongside other team members, including a Cognitive Behavioural Therapist (CBT), an Occupational Therapist (JP) and a neuro-psychologist, and see patients according to individual need. NTBIS Case managers co-ordinate the overall TBI care, providing support, education and advice to patients, family and others involved, e.g. NHS staff, social services, Headway (Charity for brain injury survivors) and solicitors. Patients are seen in hospital, but most intervention takes place at home, at work or in the community as often as is required within team resources. Contact ranges from a minimum of two appointments to several years. Frequency depends on individual needs. The team remains in contact with patients and families whilst there are achievable rehabilitation goals. The occupational therapist provided vocational rehabilitation based on a set of best practice guidelines [2, 16] and 10 years’ experience delivering TBI VR. It involved:

- Assessing the impact of TBI on the participant, family and their roles, e.g. as a worker or student.
- Educating participants and families about the effects of TBI and its impacts on work/education and finding acceptable strategies to lessen the impact, e.g. use of memory aids, pacing techniques.
- Community reintegration training, i.e. training in use of transport, increasing confidence to shop or re-use leisure activities when required.
- Pre-work training, i.e. helping participants establish structured routines with gradually increased activity levels and opportunity to practice skills necessary for work or education, e.g. use of computers to increase concentration, daily walks to increase physical stamina, cooking to practice multi-tasking.
- Liaison with employers, tutors or employment advisors to advise about the effects of TBI and to plan and monitor a graded work return.

Intervention was individually tailored to participants’ needs and commenced at 4 weeks post-discharge. Details of the intervention are reported elsewhere [39]. Participants outside NTBIS catchment received usual care. Local differences in service provision meant that this ranged extensively between participants, but potentially involved support from Headway (a voluntary organization providing advice and support to TBI people and their families), community OT or Physiotherapy and routine GP follow-up.

Outcome assessment

Follow-up was by postal questionnaire at 3, 6 and 12 months post-baseline. Telephone assistance from a researcher blinded to group allocation and postal reminders were used to improve response rates.

Primary outcome

The primary outcome was return to paid or voluntary employment of more than 1 hour a week or a return to full time education of ≥5 hours a week.

Secondary outcome measures

- The Brain Injury Community Rehabilitation Outcome (BICRO) scale [40]: a TBI-specific 39-item measure of function and participation in six domains: personal care, mobility, self-organization, socializing, productive employment and psychological well-being, that allows comparison between a person’s self-reported pre-injury and post injury abilities.
- The Hospital and Anxiety Depression Scale (HADS) [41]: a self-report measure of seven symptoms of depression and anxiety. Participants rate distress experienced in the previous week on a 4-point scale where 0 = no distress and 3 = much distress.
A cut-off of 8 was used for both depression and anxiety [42].

- The EQ-5D [43]: a standardized, non-disease specific instrument for describing and valuing health states, widely used in economic evaluation [44]. Respondents tick whether they have ‘no problems’, ‘some problems’ or ‘severe problems’ on a given day, in five domains: ‘mobility’, ‘self care’, ‘usual activities’, ‘pain/discomfort’ and ‘anxiety/depression’. Part two enables participants to mark their current health state on a visual analogue scale (VAS), where 0 is the worst state imaginable and 100 the best. The EQ-5D is the National Institute for Health and Clinical Excellence (NICE) recommended health-related quality-of-life and cost utility tool [45] used in decisions regarding which treatments represent the best quality care and offer the best value for money for the NHS.

**Healthcare resource use and costs**

Questions on participant resource use were developed for the economic analysis based on the Steering Group’s experience and the Aberdeen Health Questionnaire [46]. Additional questions were devised to capture the potential effects of the VR intervention including whether a phased work return was undertaken, use of workplace adjustments, employer support and ability to cope at work [47]. Other questions included gross household income, benefit status, pursuit of compensation [48] and resumption of driving [49]. In total 32 questions captured primary and economic outcomes. Participants were asked to respond ‘yes’, ‘no’ or ‘not applicable’ for ease of completion. Resource use data was collected at baseline, 3, 6 and 12 months.

**Statistical analyses**

Baseline differences were assessed on pre-injury characteristic, injury severity, function, mood, well-being and length of hospital stay. Primary outcomes were compared at 3, 6 and 12 months post-baseline. Analysis was on an intention-to-treat basis. Descriptive statistics were used to identify differences between TBI VR and usual care groups’ scores on secondary outcomes. For nominal data, percentage differences, odds ratios with 95% confidence intervals and Chi-squared were used to determine statistical significance. For parametric data, paired t-tests were used for normally distributed and Mann-Whitney-U tests for non-normal and non-parametric data. Frequencies were used to report group differences on VR process-related items (e.g. graded return to work, workplace adaptations and adjustments) and other work-related factors (e.g. coping, employer support). Relationships between demographic variables (injury severity, length of hospital stay, age, education, job level, relationship status and whether or not they received TBI-VR support) and primary outcomes (working or not) were explored using multiple logistic regression. Data were analysed using SPSS version 16. A randomly selected 20% of data were independently checked for accuracy.

**Economic analysis**

The pilot economic analysis aimed to estimate the incremental cost-effectiveness of the TBI VR intervention compared to UC in terms of the incremental difference in costs and outcomes from a health and societal perspective for 12 months from baseline. Analysis consisted of a cost comparison, a cost effectiveness analysis (CEA) and a cost utility analyses (CUA) [50]. Work status and health-related quality-of-life (Quality Adjusted Life Years) were used as clinical outcomes in the economic analysis.

The cost comparison involved identifying, quantifying and valuing all relevant resource consuming activities to compare the TBI VR and UC groups in terms of frequency of resources used and their monetary value for the 12-month period from baseline. This was done from two perspectives; a Health and Social Care perspective (Health), which included TBI-VR intervention costs plus the cost of appointments with consultants, GPs, therapists, social workers and medication and a broader societal perspective (Societal). This included lost participant and carer wages, any additional personal expenses, employer costs and the costs of other statutory support services, e.g. Benefits Advisors and Disability Employment Advisors. The involvement of other professionals or services was individually recorded and costed. Full or part time work was accounted for. Work-related changes such as the need for more breaks, reduced productivity, reduced responsibilities, increased supervision or working from home was not included in the economic analysis due to difficulty in quantifying and costing these aspects. As using solicitors, private healthcare and self-help groups were ‘optional’ (i.e. people could choose whether or not to involve them), the costs attributed to this input were not included. No discounting was undertaken as a 1 year time period was used. Where possible, costs were participant-specific and, when not, average costs were used. Unit costs were derived from local and published sources using a common price year 2007 and UK pounds sterling. Details of the unit costs and sources from which they were derived are given in Tables I and II.
A cost-effectiveness analysis (CEA) combined the results of the cost comparison analysis with work outcomes to produce ratio statistics in terms of cost per unit of outcome (the percentage difference between groups of participants in work or education). The CUA combined the cost comparison analysis with the cost per Quality Adjusted Life Year (QALYs) (One QALY = 1 year of perfect health) to produce point estimate incremental cost effectiveness ratios (ICERs). QALYs were calculated using linear

### Table I. Health perspective unit costs and sources (UK£2007).

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Unit cost (£)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation consultant (follow-up attendance, non-admitted face-to-face appointment)</td>
<td>£196</td>
<td>DH Reference costs 2007&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>GP (single consultation lasting 11.7 minutes)</td>
<td>£34</td>
<td>PSSRU unit cost book 2007&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Medication (cost per prescription as prescribed by GP)</td>
<td></td>
<td>BNF 2007&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSSRU 2007</td>
</tr>
<tr>
<td><strong>NTBIS (specialist brain injury service)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case manager</td>
<td>£83</td>
<td>Community Rehabilitation teams</td>
</tr>
<tr>
<td>CBT (per hour of face-to-face contact)</td>
<td>£67</td>
<td>DH Reference costs 2007–2008</td>
</tr>
<tr>
<td>OT (JP) (adult one-to-one services)</td>
<td>£69</td>
<td>PSSRU unit cost 2007</td>
</tr>
<tr>
<td>Neuro-psychology (per hour of face-to-face contact)</td>
<td>£67</td>
<td>DH Reference costs 2007–2008</td>
</tr>
<tr>
<td><strong>Additional therapy costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiotherapy (adult one-to-one services)</td>
<td>£40</td>
<td>Community Therapy Services</td>
</tr>
<tr>
<td>Speech therapy (adult one-to-one services)</td>
<td>£69</td>
<td>DH Reference costs 2007–2008</td>
</tr>
<tr>
<td>Adult social worker (per hour of face-to-face contact)</td>
<td>£126</td>
<td>PSSRU unit cost 2007</td>
</tr>
<tr>
<td>Case manager</td>
<td>£83</td>
<td>DH Reference costs 2007–2008</td>
</tr>
<tr>
<td>Neuro-psychology (per hour of face to face contact)</td>
<td>£67</td>
<td>PSSRU unit cost 2007</td>
</tr>
<tr>
<td>CBT (per hour of face-to-face contact)</td>
<td>£67</td>
<td>PSSRU unit cost 2007</td>
</tr>
<tr>
<td>OT (adult one-to-one services)</td>
<td>£69</td>
<td>Community Therapy Services</td>
</tr>
<tr>
<td>Other individual services received</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>As required</td>
<td>DH Reference costs 2007–2008</td>
</tr>
</tbody>
</table>

<sup>a</sup>Department of Health, 2009 [54].
<sup>b</sup>Personal Social Services Research Unit [55].
<sup>c</sup>British National Formulary V54, 2007 [56].

### Table II. Societal perspective—unit costs and sources (UK£2007).

<table>
<thead>
<tr>
<th>Cost item</th>
<th>Unit cost (£)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant and carer lost wages (number of weeks not working starting from date of injury)</td>
<td></td>
<td>Job category classified by Standard Occupational Classification (SOC) 2000 codes&lt;sup&gt;d&lt;/sup&gt; and Annual Survey of Household Income (ASHE) 2007 (gross weekly median wage adjusted for full/part time and male/female wages) or study questionnaire if gross wage was provided. Individual extra costs as reported on study questionnaire Jobcentre plus 2008&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Disability Employment Advisor (DEA) (per visit)</td>
<td>£37</td>
<td>Jobcentre plus 2008&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>New work focused claimant</td>
<td>£120</td>
<td>Jobcentre plus 2008&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Work focused interviews- existing claimant</td>
<td>£25</td>
<td>Jobcentre plus 2008&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Other services arranged by the DWP, i.e. access to work</td>
<td>£37</td>
<td>Assumed same costs as DEA as no data available.</td>
</tr>
<tr>
<td>Benefits advisor</td>
<td>£37</td>
<td>Individual extra costs as reported on study questionnaire</td>
</tr>
<tr>
<td>Employers costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>d</sup>Office for National Statistics, 2007 [57].
<sup>b</sup>Office for National Statistics, 2008 [58].
<sup>c</sup>Muirhead [59].
interpolation and area under the curve analysis for the EQ-5D utility estimates (using the York A1 tariff, [51]) over the 12 months follow-up period. All data was subject to statistical and sensitivity analyses using non-parametric bootstrapping methods [52, 53].

Results

Overall 34% of patients screened were eligible for recruitment. Ninety-four were recruited (40 TBI VR and 54 UC) with 15 (16%) dropouts by 12 months (see Figure 1). Drop-out was comparable in both groups (15% intervention vs. 17% non-intervention). Overall, 40 participants had sustained a minor TBI (43%), 38 severe (40%) and 16 moderate (17%). The group mean age was 34.3 (16–68 years) and 80% were men. Demographic details are given in Table III.

The main reasons for ineligibility were not working prior to the injury (83), admitted for less than 48 hours (43), living too far away (25), unable to consent before transfer to referring hospital (31) and documented mental health, drug or alcohol problems (32). Other reasons included non-traumatic or not new brain injury (11), not intending to return to productive activity (1) and death (5). A further 21 people were missed (two self-discharged against advice, 14 were discharged before being seen by the research team and five were identified prior to R&D approval). Eligibility was not clearly established in all of these cases.

Approximately equal proportions declined who were eligible for TBI-VR, 20 (56%) and UC, 16 (44%).
Baseline differences

There were no statistically significant differences between the groups at baseline in any pre-injury characteristic, injury severity, mood or well-being or on any secondary outcome measures (Table III). However, participants in UC remained in hospital significantly longer, irrespective of disability (TBI-VR median 6.5 days (IQR 2-104), UC, 17.00 days (IQR 3-75), \(\chi^2 = 689.0, p = 0.004\)). More UC participants had incurred minor TBI (13%), but this was not significant.

Primary outcomes

More people receiving TBI VR returned to work or education than UC at all time points. At 1-year post-baseline hospital discharge (~13 months post-injury), 15% more TBI-VR participants were working, 27/36 (75%) compared to UC 27/45 (60%) (See Table IV). This difference was more pronounced in participants with moderate or severe TBI; 27% more TBI-VR participants were in work, 16/23 (70%) compared with 9/21 in UC (43%)—although not statistically significant (Odds = 3.05, CI = 0.88, 10.52) (see Figure 2). TBI-VR group participants also started work sooner, particularly those with minor injuries; 13/14 (93%) TBI-VR group had returned to work by 3 months compared to only 14/25 (56%) in UC. This was statistically significant (Odds = 10.2, CI = 1.15, 90.53, Fischer’s exact test \(p = 0.03\)). However, most (75%) UC participants had returned by 12 months post-injury (85% in the TBI-VR group). Thirteen per cent fewer TBI-VR participants were claiming welfare benefits at 1 year.

Secondary outcomes

All secondary outcome measures reflected change over time, but there were no significant between-group differences on any measure (Table V). However, participants who were working, irrespective of group, were significantly less anxious and depressed and had significantly better health-related quality-of-life. There was no difference in return-to-work rates between those claiming and not claiming compensation. Thirteen per cent more people in UC (14/45 UC (31%) vs. 6/34 TBI-VR (18%)) reported state benefits as their only source of income at 12 months compared to TBI-VR.

More TBI VR group participants underwent a phased return to work and had more work place adjustments in situ, disclosed their injury to their employer (81% vs. 69%) and felt they had greater

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Table III. Pre-injury characteristics.

<table>
<thead>
<tr>
<th></th>
<th>TBI-VR group (n = 40)</th>
<th>Usual care group (n = 54)</th>
<th>Statisticsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause of injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>16 (40.0%)</td>
<td>18 (33.3%)</td>
<td>(\chi^2 = 2.47, df = 3, p = 0.48)</td>
</tr>
<tr>
<td>RTA</td>
<td>12 (30.0%)</td>
<td>24 (44.4%)</td>
<td></td>
</tr>
<tr>
<td>Assault</td>
<td>10 (25.0%)</td>
<td>11 (20.4%)</td>
<td></td>
</tr>
<tr>
<td>Otherb</td>
<td>2 (5.0%)</td>
<td>1 (1.9%)</td>
<td></td>
</tr>
<tr>
<td>Driver pre-injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>23 (57.5%)</td>
<td>40 (74.1%)</td>
<td>(OR = 0.48 (0.20, 1.14))</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married or with a long-term partner</td>
<td>17 (42.5%)</td>
<td>26 (48.1%)</td>
<td>(\chi^2 = 1.30, df = 2, p = 0.52)</td>
</tr>
<tr>
<td>Previous medical history</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous brain injury</td>
<td>4 (10.0%)</td>
<td>4 (7.4%)</td>
<td>(OR = 1.39 (0.33, 5.93))</td>
</tr>
<tr>
<td>Other neurological conditionc</td>
<td>1 (2.5%)</td>
<td>4 (7.4%)</td>
<td>(OR = 0.32 (0.34, 2.99))</td>
</tr>
<tr>
<td>Mental health problemsd</td>
<td>3 (7.5%)</td>
<td>2 (3.7%)</td>
<td>(OR = 2.11 (0.34, 13.25))</td>
</tr>
<tr>
<td>Drug problemsd</td>
<td>0 (0.0%)</td>
<td>1 (1.9%)</td>
<td>(\rho = 1.00)</td>
</tr>
<tr>
<td>Alcohol problemsd</td>
<td>1 (2.5%)</td>
<td>3 (5.6%)</td>
<td>(OR = 0.44 (0.04, 4.35))</td>
</tr>
<tr>
<td>Total with previous medical history</td>
<td>9/40 (22.5%)</td>
<td>14/54 (25.9%)</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White UK</td>
<td>37 (92.5%)</td>
<td>51 (94.4%)</td>
<td>(\chi^2 = 2.19, df = 3, p = 0.53)</td>
</tr>
<tr>
<td>White other</td>
<td>2 (5.0%)</td>
<td>3 (3.7%)</td>
<td></td>
</tr>
<tr>
<td>Asian (Indian)</td>
<td>1 (2.5%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Black (African)</td>
<td>0 (0.0%)</td>
<td>1 (1.9%)</td>
<td></td>
</tr>
</tbody>
</table>

*OR = Odds ratio (OR) and 95% confidence intervals, \(\chi^2 = \text{Chi}^2\).
*Other = car falling on person, being hit whilst cycling, industrial accident.
*Epilepsy (×3), long-term neurological conditions (×2).
*Past history but no longer using drugs or alcohol or receiving treatment.
employer support at 12 months (17/17, 100% vs. 19/23, 82%) than those in UC. They also reported feeling more able to cope at work (17/21, 81% vs. 18/26, 69%) Interestingly, many participants stated they returned to work because they perceived work to be beneficial to their recovery.

Logistic regression
Multivariate logistic regression analysis identified younger age (OR = 0.90 [0.84, 0.96]), less severe injury (GCS ≥ 13) (OR = 7.75 [1.64, 36.62]) and receiving TBI-VR support (OR = 3.75 [1.02, 13.70]) as significant predictors of being in work at 12 months. One outlier who spent 289 days in hospital because of multiple injuries was excluded from the analysis (Table VI).

Economic evaluation
Complete resource use data was available for 17/40 (42.50%) TBI-VR group and 32/54 (59.26%) UC group participants and, as such, a complete case analysis was undertaken to estimate costs. Sensitivity analyses imputed missing data in two ways (one using the last observed value carried forward method and one using mean costs for use in the sensitivity analysis).

Cost comparison analysis
The cost of providing TBI-VR was calculated from a health and social care perspective over a 12-month period from baseline. The mean per person cost difference was £75.23 (95% CI = £1199.82, £1350.28) (mean cost = £2106.94, SD = £1542.83 for TBI-VR, compared to £2031.71, SD = £2352.24 for UC) or about the cost of one therapy session. This additional cost was attributable to greater OT input in TBI-VR (Table VI) than UC. TBI-VR participants received on average one more OT session at baseline and 4.6 more OT sessions over 12 months compared to UC. UC participants reported receiving similar amounts of input from GPs and physiotherapists as the TBI-VR group.
When the broader perspective was considered, higher costs were borne by UC participants. The mean cost difference was £1863 (95% CI: £9000.00, £5275.00) per person (mean TBI-VR group cost £8786; mean UC group cost £10,648.00), i.e. an average cost saving of £1862.00 per person in the TBI-VR group. Loss of wages and personal expenses incurred by participants and carers accounted for most of these costs. These amounted to £6434.16 per family for TBI-VR and £8533.02 per family for UC.

Cost effectiveness analyses

Incremental cost effectiveness ratio (ICER). The cost of returning a person to work at 12 months was calculated as:

Mean health and social care cost per TBI – VR participant − Mean health and social care cost per UC participant

Percentage of TBI – VR participants in work at 12 months − Percentage of UC participants in work at 12 months (£2106.94 – £2031.71) = £75.23 = £501.53 (0.75% − 0.60%) = 0.15%

Therefore, it cost £501.53 extra to return a person in TBI-VR to work than for UC. Dividing this by the percentage difference in the number of participants in work at 12 months (£75.23/15) resulted in a cost of £5.02, i.e. the cost per 1% increase in the probability of a person returning to work with TBI-VR.

To increase robustness, sensitivity analysis was conducted by imputing missing data in the health and social care perspective using the last observed value carried forward (LOCF) method. This showed that it cost £3255.80 more to return a participant to work with TBI-VR than UC (TBI-VR £8786.04 – UC £10,648.77/0.15). When re-run using imputed means, this showed that it cost £1254.67 more to return a participant to work with TBI-VR than UC (TBI-VR £1878.71 – UC £1690.51 = £188.20/0.15%) using the same return-to-work figures.

However, when the broader perspective for cost was used, it cost £12 418.20 less (−£1862.73/0.15) to return a person to work with TBI-VR than UC (TBI-VR £8786.04 – UC £10 648.77/0.15). Sensitivity analysis using imputed data (LOCF) indicated that it cost substantially less, i.e. £19,795.80 (−£2969.37/0.15) to return a person to work.

Incremental cost utility ratio (ICUR). The mean difference in QALYs (as measured using the EQ-5D) over a 12-month period from baseline was 0.0175 (95% CI: 0.0175, 0.1065) with a mean of 0.1938 per participant in the TBI-VR group and 0.1763 for UC. Combined with the mean 12-month health and social care costs per participant (TBI-VR £2106.94, UC £2031.71) produced an ICUR of £4298.86 (cost per QALY) from a health and social care perspective. The bootstrapped ICUR was £1731.60 per participant. Both were within NICE recommended guidelines for cost effectiveness [36].
However, sensitivity analysis using imputed data (LOCF) showed that the invention was effective but more expensive at £35,873.38 per participant (above the NICE recommended threshold of £20–30,000 (QALY + Costs per TBI-VR participant = 0.1804, £2021.00 [three participants’ costs were omitted due to missing EQ5D scores], QALY + costs per UC participant 0.1735, £1772.92). Using the imputed means showed that TBI-VR was both slightly less effective and more expensive (QALY + costs per TBI-VR participant 0.1814, £1878.71, QALY + costs per UC participant 0.1880, £1690.51). However, from a societal perspective, the specialist group was always cheaper and more effective, irrespective of the method used.

Cost of hospital stay
Between-group cost differences were calculated using mean or median costs (whichever were the most conservative) per hospital bed day for severe, moderate and minor TBI [45] (Table VIII). The average cost of a day in hospital due to TBI in 2007 ranged between £380–£440 [45] and the difference in length of hospital stay between the groups was between 8–13 days depending on severity. As can be seen from Table VII, being in Usual Care resulted in increased healthcare costs of between £3520 and £5044 per participant.

Discussion
Regional differences in health and social care provision for people with TBI provided an opportunity to prospectively compare work outcomes in two cohorts of TBI people. One who received input from a specialist TBI service with dedicated OT vocational rehabilitation and another receiving usual care. More people returned to and remained in

### Table VII. Participant costs at 12 months from a health and social care perspective (complete data set: mean cost (UK£2007) per participant).

<table>
<thead>
<tr>
<th>Health perspective</th>
<th>TBI-VR (n = 17)</th>
<th>Usual care (n = 32)</th>
<th>Mean difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean £ SD £</td>
<td>Mean £ SD £</td>
<td>Mean £ 95% CI £</td>
</tr>
<tr>
<td>Specialist team</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case manager</td>
<td>346.65 601.56</td>
<td>111.53 340.99</td>
<td>235.12 (−92.62, 562.85)</td>
</tr>
<tr>
<td>CBT</td>
<td>78.82 277.50</td>
<td>14.66 71.67</td>
<td>64.17 (−80.23, 208.57)</td>
</tr>
<tr>
<td>Psychologist</td>
<td>86.71 176.89</td>
<td>129.81 242.43</td>
<td>−43.11 (−177.33, 91.11)</td>
</tr>
<tr>
<td>OT (NTBIS)</td>
<td>385.59 468.65</td>
<td>n/a n/a</td>
<td>n/a n/a</td>
</tr>
<tr>
<td>Total NTBIS</td>
<td>897.76 1171.01</td>
<td>n/a n/a</td>
<td>n/a n/a</td>
</tr>
<tr>
<td>Other health costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultant</td>
<td>449.65 483.91</td>
<td>637.00 613.78</td>
<td>−187.35* (−533.24, 158.54)</td>
</tr>
<tr>
<td>GP</td>
<td>216.00 162.59</td>
<td>290.06 371.75</td>
<td>−74.06 (−265.13, 117.01)</td>
</tr>
<tr>
<td>Medication</td>
<td>46.53 132.00</td>
<td>99.18 278.67</td>
<td>−52.65 (−196.93, 91.68)</td>
</tr>
<tr>
<td>OT (other)</td>
<td>109.59 279.28</td>
<td>176.81 415.83</td>
<td>−67.22 (−293.62, 159.17)</td>
</tr>
<tr>
<td>Physio</td>
<td>287.06 422.43</td>
<td>317.50 933.34</td>
<td>−30.44 (−511.69, 450.80)</td>
</tr>
<tr>
<td>SALT</td>
<td>24.35 100.41</td>
<td>155.25 552.83</td>
<td>−130.90 (−404.2, 142.48)</td>
</tr>
<tr>
<td>Social worker</td>
<td>0.00 0.00</td>
<td>35.44 111.94</td>
<td>−35.44 (−75.80, 4.92)</td>
</tr>
<tr>
<td>Other appts</td>
<td>76.00 313.36</td>
<td>64.47 202.02</td>
<td>11.53 (−136.79, 159.85)</td>
</tr>
<tr>
<td>Total health and social care costs</td>
<td>2106.94 1542.83</td>
<td>2031.71 2352.24</td>
<td>75.23 (−1199.82, 1350.28)</td>
</tr>
<tr>
<td>Total OTb</td>
<td>495.18 470.03</td>
<td>176.81 415.83</td>
<td>318.36 (55.70, 582.08)</td>
</tr>
</tbody>
</table>

*Minus mean difference score = greater costs in the usual care group.

**Total OT appointments are listed separately because NTBIS OT (JP) appointments are included in NTBIS total, allowing calculation of total for therapy and health appointments.

### Table VIII. Differences in costs attributable to length of hospital stay.

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Mean LOS</th>
<th>Median difference in LOS (days)</th>
<th>Mean difference in LOS (days)</th>
<th>LOS used to calculate costs (days)</th>
<th>Cost of hospital bed day</th>
<th>Cost of difference in LOS per person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire cohort (n = 94)</td>
<td>12.33</td>
<td>10.6</td>
<td>10.5</td>
<td>11</td>
<td>380</td>
<td>£4180</td>
</tr>
<tr>
<td>Moderate/severe TBI (n = 54)</td>
<td>17.66</td>
<td>12.91</td>
<td>14.5</td>
<td>13</td>
<td>388</td>
<td>£3044</td>
</tr>
<tr>
<td>Minor TBI (n = 40)</td>
<td>4.17</td>
<td>10.99</td>
<td>7.5</td>
<td>8</td>
<td>440</td>
<td>£3520</td>
</tr>
</tbody>
</table>

However, sensitivity analysis using imputed data (LOCF) showed that the invention was effective but more expensive at £35,873.38 per participant (above the NICE recommended threshold of £20–30,000 (QALY + Costs per TBI-VR participant = 0.1804, £2021.00 [three participants’ costs were omitted due to missing EQ5D scores], QALY + costs per UC participant 0.1735, £1772.92). Using the imputed means showed that TBI-VR was both slightly less effective and more expensive (QALY + costs per TBI-VR participant 0.1814, £1878.71, QALY + costs per UC participant 0.1880, £1690.51). However, from a societal perspective, the specialist group was always cheaper and more effective, irrespective of the method used.
work at all time points with TBI-VR and fewer were financially dependent on welfare benefits at 12 months. Although non-randomized, no baseline demographic differences were found in age, injury severity, ethnicity, social class, job type or past medical history between the groups to explain these differences. Unemployment was also higher in the TBI-VR intervention area at the start and end of the study period. Logistic regression analysis indicated that younger age, having minor TBI and receiving TBI-VR increased the odds of being in work at 12 months, findings consistent with other studies [30].

This study found no difference in return-to-work rates between participants in pursuit of compensation and those who were not. These findings are similar to those of Deutsch et al. [60], who found no effect of litigation on employment outcomes in a retrospective study of 43 people with moderate and severe TBI involved in litigation and contrary to North American evidence to suggest litigation negatively impacts work return [61, 62], particularly among those with mild TBI who have the cognitive ability to understand the potential consequences of their actions [63]. Differences in the type and source of compensation in the UK (In the UK, workers compensation does not exist. Payments for sick leave and disability are provided by the state and referred to as state benefits. ‘Compensation’ refers to litigation, which can only be applied if a person is involved in a road traffic accident, the victim of a criminal act or injured through the negligence of a third party) and in compensation cultures between the UK and North America may explain the discrepancy in findings. However, these findings may also have been influenced by local implementation of best practice guidance, produced by the Association of Personal Injury Lawyers [64], which promotes the need for vocational rehabilitation, early intervention and joint working between stakeholders to help maximize a person’s recovery.

TBI-VR had the greatest impact on people with moderate or severe TBI. The fact that at 3 months there was only a small difference (8%) between the group in the numbers of people in work, but by 6 and at 12 months this difference had increased to 27% in favour of TBI-VR, suggests that people able to return to work without specialist support will do so by 4 months following discharge from hospital, but that those needing support may fail without it. This may be attributable to the TBI specialist multidisciplinary nature of NTBIS and its expertise in treating people with moderate and severe TBI, results are supported by findings from a Cochrane review and North American literature indicating people with moderate and severe TBI benefit from formal rehabilitation [65–67].

Although most UK TBI rehabilitation services target only those with moderate and severe TBI, people classified with minor TBI also benefitted. They returned to work sooner (37% more in work at three months) and remained in work; 10% more were working at 12 months. This suggests that a proportion of people classified with minor TBI have problems affecting work, which might respond to early intervention. As most required only minimal educational input [39] this may be attributable to greater understanding of TBI and its effect on work. These findings also illustrate the complexity of TBI classification. People with ‘minor’ brain injuries are known to report problems at 12 months that affect their ability to participate in ADL, including work [68].

While increased length of hospital stay in UC may be due to lengthy discharge planning and transfer arrangements, the possibility that earlier discharge for TBI-VR participants resulted from greater confidence in the aftercare provided by NTBIS cannot be excluded; thus inferring cost savings potentially attributable to the intervention. The organized and specialist nature of NTBIS support is characteristic of Early Supported Discharge services post-stroke. It is possible that organized care of this kind results not only in better outcomes but additional cost savings to health, which future studies should explore. If these additional healthcare costs (between £3520–£5044 per participant) had been included in the ICER in this study, the TBI-VR group (in both the complete and imputed LOCF data sets) becomes cheaper and more effective than UC. Future economic evaluations might consider including them in the analysis.

Providing specialist intervention such as vocational rehabilitation is often seen as an expensive addition to usual care [69]. However, it was found that, from a Health perspective at 12 months, TBI-VR only cost on average about the cost of one extra therapy session to deliver. This was because UC participants received roughly the same amount of input but from a range of non-coordinated services.

The ICER indicated that the intervention was likely to be cost-effective if the complete case analysis was used but not when missing data was imputed—indicating the need for an adequately powered randomized controlled trial to reduce uncertainty and a compelling need to collect as complete data as possible.

Returning TBI people to work not only has the potential for short-term impact on a person’s working life and ability to contribute to the economy, but also on their longer term health and well-being and that of family members [70]. Health commissioning should consider not only immediate cost savings to health, but the potential for health interventions to...
impact in the longer term and offset savings made in non-health budgets. The known long-term effects of worklessness [13] and evidence for people with other long-term conditions suggest keeping people in work has important consequences for health. In this study people who were working were significantly less anxious and depressed and had a better quality-of-life.

This study examined only one TBI specialist service and the interventions of a single OT on TBI survivors intending to return to work. It relied on self-reported pre-injury and follow-up data, which may be limited by over-rated pre-morbid functioning [71]. As with other studies in a TBI population, missing data from incomplete follow-up limited the analysis [72, 73]. This was not a RCT and was inadequately powered, resulting in wide confidence intervals and uncertainty, which now needs to be tested in a randomized controlled trial. However, it remains one of the largest observational studies with a comparator group that examined not only efficacy but also costs of TBI VR rehabilitation in the UK. The real life question of whether the intervention can be implemented in practice has been answered. The next step is to determine whether TBI-VR can be replicated elsewhere.

Conclusion

Returning TBI people to work following early targeted TBI specialist vocational rehabilitation is likely to be cost-effective and may result in improved work outcomes. However, uncertainty about the true effects and cost-effectiveness of the TBI-VR intervention remains and this needs to be tested in a randomized controlled trial.

Clinical messages

This is the only UK prospective cohort comparison evaluating cost and effectiveness of TBI vocational rehabilitation (TBI-VR) delivered by an Occupational Therapist. More people returned to and remained in work at 12 months post-hospital discharge with TBI-VR than Usual Care. Over 12-months TBI-VR cost only £75 more per participant—suggesting real gains from specialist health-based vocational rehabilitation targeted early after TBI.

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References


