

## **UKABIF MANIFESTO EVIDENCE-BASE**

### **Introduction**

The evidence-base for rehabilitation is now substantial. This document provides the evidence to address commonly asked questions such as: Is rehabilitation effective? Does the effectiveness of rehabilitation depend on the type of brain injury? Can key factors promoting positive outcome be identified? Are there factors that can be measured at time of injury to predict outcome? Is rehabilitation cost effective?

The studies detailed are not an exhaustive list of the research published. However, each section provides a snapshot into the array of research to support the answers to key questions.

### **Evidence for the effectiveness of brain injury rehabilitation**

This section presents a selection of papers providing evidence for the effectiveness of various approaches in neurorehabilitation, as measured by improved function, wellbeing or independence. Systematic reviews provide an examination of the quality and breadth of research executed.

**Cicerone KD, Mott T, Azulay J *et al.* Community integration and satisfaction with functioning after intensive cognitive rehabilitation for traumatic brain injury. *Archives of Physical Medicine and Rehabilitation* 2004;85(6):943-950.**

An intensive cognitive rehabilitation programme (cognitive and psychosocial interventions: physical therapy, OT, SALT, neuropsychological treatment) proved effective on the Community Integration Questionnaire and in overall neuropsychological functioning, compared to standard neurorehabilitation, after traumatic brain injury. Satisfaction with cognitive functioning made a significant contribution to post-treatment community integration, potentially reflecting the mediating effects of perceived self-efficacy on functional outcome.

**Cicerone KD, Mott T, Azulay J *et al.* A randomized controlled trial of holistic neuropsychologic rehabilitation after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation* 2008;89(12):2239-2249.**

The authors studied the effects of a comprehensive, holistic, neuropsychologic rehabilitation programme, consisting of individual and group therapies, emphasising metacognitive and emotional regulation for cognitive deficits, emotional difficulties, interpersonal behaviours and functional skills. Moderate to severe traumatic brain injured clients who attended the programme showed greater improvements in community functioning, productivity, self-efficacy and life satisfaction, compared to attendees of standard multidisciplinary rehabilitation. Both groups showed improvement in neuropsychologic functioning.

**Cicerone KD, Langenbahn DM, Braden C *et al.* Evidence-based cognitive rehabilitation: Updated review of the literature from 2003 through 2008. *Archives of Physical Medicine and Rehabilitation* 2011;92(4):519-530.**

A systematic review evaluating 370 interventions provides substantial evidence to support interventions for memory, social communication skills, executive function and comprehensive, holistic, neuropsychological rehabilitation after traumatic brain injury. The evidence also supports visuospatial rehabilitation and interventions for aphasia and apraxia

after stroke. The review suggests that there is sufficient information to support evidence-based protocols and implement treatments for cognitive disability after acquired brain injury. The authors concluded that cognitive rehabilitation is effective during the post-acute period, many years after initial injury. Studies on comprehensive, holistic, cognitive rehabilitation provides the best evidence for improvement in health-related outcomes, such as social participation and quality of life.

**Geurtsen GJ, van Heugten CM, Martina JD *et al.* Comprehensive rehabilitation programmes in the chronic phase after severe brain injury: A systematic review. *Journal of Rehabilitation Medicine* 2010;42(2):97-110.**

A systematic review on comprehensive rehabilitation programmes after severe brain injury provided evidence supporting the effectiveness of day-treatment programmes on daily life functioning and community integration. Other studies on residential treatment showed positive changes in daily life functioning, community integration, employment and social participation, with functional gains maintained at one-year follow-up. A neurobehavioural treatment programme showed improved functioning in living accommodation, employment and hours of care required.

**Gray DS and Burnham RS. Preliminary outcome analysis of a long-term rehabilitation program for severe acquired brain injury. *Archives of Physical Medicine and Rehabilitation* 2000;81(11):1447-1456.**

A long-term acquired brain injury programme for patients with severe TBI significantly improved functional outcomes after extended programme admissions. These patients were not candidates for more conventional forms of rehabilitation.

**Malec JF. Impact of comprehensive day treatment on societal participation for persons with acquired brain injury. *Archives of Physical Medicine and Rehabilitation* 2001;82(7): 885-895.**

A comprehensive day treatment programme consisting of group sessions, building cognitive and behavioral skills using a transdisciplinary approach, resulted in significant goal achievement and increased social participation at one-year follow-up for those treated post- acutely and many years after brain injury. Of the graduates, 72% were found to be living independently.

**National Institute on Disability and Rehabilitation Research. (In Progress). The traumatic brain injury model systems of care.**

This is a longitudinal multicentre study of a coordinated system of acute neurotrauma and inpatient rehabilitation and a multidisciplinary system designed to meet the needs of the individual. The average disability rating scale score was 12.4 (severe disability) at rehabilitation admission; 6.19 (moderate disability) at rehabilitation discharge; 2.46 (partial disability) two years post-injury. The Functional Independence Measure score averaged 52 (moderate assistance) at rehabilitation admission; 93 at rehabilitation discharge and 116 (modified independence) at two years (the highest possible is 126). Most improvement in the level of disability and functional ability occurred during inpatient rehabilitation. Continued improvement was seen one year post-injury and the level of disability and functional ability plateau between one and two years post-injury. The supervision rating scale indicated that about 40% individuals required some level of supervision at one and two years post-injury. Private residency increases from 84% at rehabilitation discharge to 93% two years post-injury. Employment at injury was 63% and at two years post-injury 28%.

**Pace GM, Schlind MW, Hazard-Haupt T et al. Characteristics and outcomes of a home and community-based neurorehabilitation programme. *Brain Injury* 1999;13(7):535-546.**

Coordinated, interdisciplinary, comprehensive home-based neurorehabilitation is an effective alternative approach, as measured by the percentage of objectives achieved and family satisfaction outcomes. Follow-up at six and 12 months indicated that the effects were maintained.

**Parente R and Stapleton M. Development of a cognitive strategies group for vocational training after traumatic brain injury. *NeuroRehabilitation* 1999;13:13-20.**

A group cognitive skills training model was shown to be effective in promoting return to work in 76% of clients.

**Semlyen JK, Summer SJ and Barnes M. Traumatic brain injury: Efficacy of multidisciplinary rehabilitation. *Archives of Physical Medicine and Rehabilitation* 1998;79(6):678-683.**

The authors compared a multidisciplinary (MD) rehabilitation programme at a regional rehabilitation unit to a single discipline approach within a general hospital. MD rehabilitation demonstrated significant gains throughout the study period which were maintained after input concluded. Caregivers of the MD group reported reduced levels of psychological distress. This study demonstrates the efficacy of comprehensive, specialist MD regional service.

**Turner-Stokes L, Paul S and Williams H. Efficiency of specialist rehabilitation in reducing dependency and costs of continuing care for adults with complex acquired brain injuries. *Journal of Neurology, Neurosurgery and Psychiatry* 2006;77:634-639.**

Following a specialist rehabilitation programme, acquired brain injury clients showed significant reduction in dependency at discharge, as measured by the Functional Independence Measure.

**Turner-Stokes L. Evidence for the effectiveness of multi-disciplinary rehabilitation following acquired brain injury: A synthesis of two systematic approaches. *Journal of Rehabilitation Medicine* 2008;40(9):691-701.**

A systematic review on the effectiveness of multidisciplinary rehabilitation, provided grade A evidence from five studies supporting early coordinated multidisciplinary rehabilitation in leading to better outcomes and a reduced length of stay in hospital. The review also demonstrated evidence for community, milieu-based rehabilitation for residential programmes in transitional units, day care programmes and outpatient programmes: eight studies provide grade A evidence for increased productivity, reduced levels of supervision, improved societal participation and neuropsychological adjustment. The stability of effects occurred for up to three years post-injury. Additionally presented grade A evidence from six studies for the effectiveness of specialist inpatient rehabilitation; and three studies of specialist vocational support programmes, provided evidence for the effectiveness of supported employment, achieving improved productivity and return to paid employment in a proportion of clients.

**Turner-Stokes L, Nair A, Sedki I et al. Multi-disciplinary rehabilitation for acquired brain injury in adults of working age 2011 (Review). *The Cochrane Library*, 1.**

This review of multidisciplinary rehabilitation for mild traumatic brain injured patients presented strong evidence that most patients made a good recovery, with provision of appropriate information, without need for an additional specific intervention. There was strong evidence supporting the use of formal interventions in moderate to severe brain injured patients (PTA up to seven days). The review offered strong evidence that more

intensive programmes are associated with earlier functional gains in moderate to severe patients already in rehabilitation, and that continued outpatient therapy could help sustain gains made in early post-acute rehabilitation.

**Willer B, Button J and Rempel R. Residential and home-based post-acute rehabilitation of individuals with traumatic brain injury: A case control study. *Archives of Physical Medicine and Rehabilitation* 1999;80(4):399-406.**

Patients attending a post-acute residential rehabilitation showed significant increases in functional abilities and community integration, when compared to limited services in homes/out-patient. Home-based services appear more effective at maintaining community integration.

**Wood RL, McCrea JD, Wood LM *et al.* Clinical and cost effectiveness of post-acute neurobehavioural rehabilitation. *Brain Injury* 1999;13(2):69-88.**

A social and behavioural post-acute rehabilitation programme substantially decreased the hours of care required by clients, suggesting rehabilitation can effectively increase a brain injured person's capacity for independent social activity.

**Worthington AD, Matthews S, Melia Y *et al.* Cost-benefits associated with social outcome from neurobehavioural rehabilitation. *Brain Injury* 2006;20(9):947-957.**

Significant gains in social outcomes were present at discharge from a neurobehavioural rehabilitation programme, and at follow-up.

## **Rehabilitation outcomes for different types of acquired brain injury**

Little research has been published on the aetiological differences in outcomes for brain-injured clients. However studies investigating this area have shown clients may respond differently to rehabilitation, depending on their type of brain-injury.

**Fish J, Manly T, Emslie H *et al.* Compensatory strategies for acquired disorders of memory and planning: Differential effects of a paging system for patients with brain injury of traumatic versus cerebrovascular aetiology. *Journal of Neurology, Neurosurgery and Psychiatry* 2008;79:930-935.**

A paging system for traumatically brain-injured (TBI) patients showed carry over effect after removing the pager. Stroke patients' behaviour returned to baseline after removal of the pager. Maintenance of treatment effects was associated with executive functioning, where stroke patients had poorer executive functioning. The cognitive symptoms frequently reported post-TBI reflect direct damage to the frontal and temporal lobes, plus diffuse axonal injury, resulting principally in memory, attention and executive problems. The focal damage resulting from stroke is more diverse, therefore cognitive deficits differ according to lesion location. The demographics of TBI and stroke are divergent: Stroke primarily affects people over the age of 65 years, whereas TBI incidence is highest in the 15-24 age group.

**Goodwin R and Bateman A. (in press). Abstract: Service Evaluation of holistic neuropsychological rehabilitation: Impact on dysexecutive symptoms and carer strain following traumatic and non-traumatic brain injuries. *Brain Impairment*.**

A holistic neuropsychological rehabilitation programme benefited clients and carers in 5/6 Dysexecutive Questionnaire (DEX/DEX-I), and 2/3 Carer Strain Index subscales. Results showed significant improvement in items sampling e.g. clients' planning and insight, and carers' personal upset and lifestyle adjustments. However items covering e.g. clients' aggression and carers' financial strain did not improve. Secondary analysis showed an effect of aetiology on rehabilitation, demonstrated on DEX-I metacognitive scale; traumatic clients significantly improved, non-traumatic showed no benefit.

Neuropsychological rehabilitation is effective in reducing client and carer reports of dysexecutive behaviours and carer strain. Rehabilitation can benefit ABI clients and their families, even after the spontaneous recovery period. Also implicated is the importance of considering aetiology in practice as results on the DEX-I metacognitive scale were masked by aetiological group differences.

### **Key factors promoting positive outcome**

A variety of studies have provided evidence for key factors promoting positive outcomes in rehabilitation, such as increased intensity, a multidisciplinary rehabilitation team and earlier time-since-injury at admission. Few have explicitly studied whether a particular element of a rehabilitation programme promotes positive outcome.

**Bakheit AMO, Shaw S, Barrett L *et al.* A prospective, randomized, parallel group, controlled study of the effect of intensity of speech and language therapy on early recovery from post-stroke aphasia. *Clinical Rehabilitation* 2007;21(10):885-894.**

The intensity of speech and language therapy had no effect on standard assessment of aphasia, when comparing a two-hour/week against a five-hour/week programme. However there was an effect of amount of treatment (1.6 hours/week against 0.6 hours/week). The authors suggested there could be a critical threshold of intensity required to improve acute recovery after stroke.

**Cicerone KD, Mott T, Azulay J *et al.* A randomized controlled trial of holistic neuropsychologic rehabilitation after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation* 2008;89(12):2239-2249.**

This study showed the effectiveness of comprehensive holistic neuropsychological rehabilitation for improving community functioning and quality of life after traumatic brain injury compared with standard rehabilitation.

**Cicerone KD, Langenbahn DM, Braden C *et al.* Evidence-based cognitive rehabilitation: Updated review of the literature from 2003 through 2008. *Archives of Physical Medicine and Rehabilitation* 2011;92(4):519-530.**

Treatment intensity should be considered a key factor in the rehabilitation of language skills after left hemisphere stroke.

**Hildebrandt H, Bussmann-Mork B and Schwendemann G. Group therapy for memory impaired patients: A partial remediation is possible. *Journal of Neurology* 2006;253(4):512-519.**

The authors examined the type and intensity of memory training for mild memory impairment after stroke, comparing process-oriented training (20 hours), strategy training (20 hours) and process-oriented training (seven hours). The authors concluded the frequency and intensity of training were critical in improving memory performance.

**Kirk M. *Acquired Brain Injury: Rehabilitation costs, savings, progress measures and value for money.* 2011. Derbyshire: Freedom From Want? Ltd.**

The report states that gains from specialised intensive rehabilitation must be maintained by support schema and plans in two years post-injury. Research indicates that the optimal time for commencing post-acute, specialised rehabilitation is 12 months post-injury for cognitive gains.

**New Zealand Guidelines Group. *Traumatic brain injury: Diagnosis, acute management, and rehabilitation.* 2006. Wellington (New Zealand): New Zealand Guidelines Group.**

Rehabilitation is most effective when delivered by a coordinated, multidisciplinary team of people from a range of different disciplines, taking an interdisciplinary approach. The Group also proposes the benefit of individual 'case managers' to support individual and family throughout the course of recovery.

**Reid-Arndt SA, Schopp L, Brenneke L et al. Evaluation of the traumatic brain injury early referral programme in Missouri. *Brain Injury* 2007;21(12):1295-1302.**

Clients who had attended an early referral programme in the acute stages of recovery had significantly better social integration, emotional well-being and vocational functioning than individuals receiving services later in recovery, despite having greater functional limitations upon entry.

**Ruff RM and Niemann H. Cognitive rehabilitation versus day treatment in head-injured adults: Is there an impact on emotional and psychosocial adjustment? *Brain Injury* 1990;4(4):339-347.**

The authors compared cognitive rehabilitation to a day-treatment programme. Day treatment was found to improve emotional adjustment, cognitive rehabilitation was thought to be more challenging, possibly confronting.

**Semlyen JK, Summer SJ and Barnes M. Traumatic brain injury: Efficacy of multidisciplinary rehabilitation. *Archives of Physical Medicine and Rehabilitation* 1998;79(6):678-683.**

The authors compared a multidisciplinary (MD) rehabilitation programme at a regional rehabilitation unit to a single discipline approach within a general hospital. MD rehabilitation demonstrated significant gains throughout the study period, maintained after input concluded. Caregivers of the MD group reported reduced levels of psychological distress. This study demonstrates the efficacy of comprehensive, specialist MD regional service.

**Turner-Stokes L. Evidence for the effectiveness of multi-disciplinary rehabilitation following acquired brain injury: A synthesis of two systematic approaches. *Journal of Rehabilitation Medicine* 2008;40(9):691-701.**

The study recommends early intensive rehabilitation, with specialist programmes for those with complex needs and specialist vocational programmes for those with potential to return to work.

**Turner-Stokes L, Nair A, Sedki I et al. Multi-disciplinary rehabilitation for acquired brain injury in adults of working age 2011 (Review). *The Cochrane Library*, 1.**

More intensive rehabilitation is associated with more rapid function gains once the patient is fit to engage. Highly dependent patients with severe traumatic brain injury still made sufficient functional gains, but required longer lengths of stay and more intensive treatment. Therefore the rehabilitation programme needs to be molded to the severity of the injury. With regard to the stability of milieu-based rehabilitation outcomes for up to three years post-injury, patients continued to make gains in independence and community integration between two to five years post-injury and productivity gains were less maintained. The drop off of employment two to five years post-injury suggests the need for community support even a decade post injury.

**Wood RL, McCrea JD, Wood LM et al. Clinical and cost effectiveness of post-acute neurobehavioural rehabilitation. *Brain Injury* 1999;13(2):69-88.**

A residential social and behavioural rehabilitation programme was effective in decreasing the number of care hours required, and therefore increasing the brain injured person's capacity for independent social activity. This benefit reduced with the passage of time, demonstrated by a significant relationship between immediacy of rehabilitation and its efficacy. Clients up to two years post-injury showed a 54% reduction in care hours required, compared to pre-admission; clients two to five years post-injury showed a 33% reduction, and clients over five years post-injury showed a 21% reduction. Clients who demonstrated

the greatest number of cognitive and behavioural problems required longer and more complex rehabilitation programmes.

**Willer B, Button J and Rempel R. Residential and home-based postacute rehabilitation of individuals with traumatic brain injury: A case control study. *Archives of Physical Medicine and Rehabilitation* 1999;80(4):399-406.**

Patients attending a post-acute residential rehabilitation showed significant increases in functional abilities and community integration, when compared to limited services in homes/out-patient. Home-based services appear more effective at maintaining community integration.

### **Predictors of rehabilitation outcomes**

A limited number of studies have examined the predictors of rehabilitation outcome, measured at time of injury. However, evidence has proposed that factors such as socio-economic, age at admission and duration of post-traumatic amnesia are related to improved rehabilitation outcomes.

**Brooks N, Campsie L, Symington C *et al.* The effects of severe head injury on patient and relative within seven years of injury. *Journal of Head Trauma Rehabilitation* 1987;2(3):1-13.**

Patients' cognitive and dependency deficits are related to the duration of post-traumatic amnesia.

**Gray DS and Burnham RS. Preliminary outcome analysis of a long-term rehabilitation program for severe acquired brain injury. *Archives of Physical Medicine and Rehabilitation*, 2000;81(11):1447-1456.**

The authors proposed that patients' functional status at admission, age at admission, length of time between injury and admission, and length of stay on their rehabilitation programme, significantly correlated with functional improvement.

**Kirk M. *Acquired Brain Injury: Rehabilitation costs, savings, progress measures and value for money*. 2011. Derbyshire: Freedom From Want? Ltd.**

This paper suggests that patients who do not receive compensation payout are less likely to receive suitable rehabilitation, paid for at the appropriate time and are less likely to be supported in the future. These assumptions are supported by professional experiences since 1993.

**Christensen AL and Uzzell BP. *Brain Injury and Neuropsychological Rehabilitation: International Perspectives*. 1994. New Jersey: Lawrence Erlbaum Associates Inc.**

This paper presents the relationship between socio-economic and cultural status (SECS) and rehabilitation prognosis, where a higher SECS promotes greater responsibility and better outcome.

**Turner-Stokes L. Evidence for the effectiveness of multi-disciplinary rehabilitation following acquired brain injury: A synthesis of two systematic approaches. *Journal of Rehabilitation Medicine* 2008;40(9):691-701.**

The severity of injury and co-morbidity were confounders in the effectiveness of rehabilitation in outcomes and length of stay in hospital.

**Worthington AD, Matthews S, Melia Y *et al.* Cost-benefits associated with social outcome from neurobehavioural rehabilitation. *Brain Injury* 2006;20(9):947-957.**

On a neurobehavioural rehabilitation programme, patients admitted within the first year post-injury made most progress, but improvements were made regardless of time of since injury. Admission duration can often be determined by whether the patient has an established family network to provide care at home or longer-term residential facilities.

## **Costs and savings of rehabilitation**

This section presents a collection of papers studying the costs and savings of a variety of rehabilitation programmes. The majority of the evidence suggests rehabilitation costs are outweighed by the subsequent savings in societal, care and health costs, many provide a timeline for costs being offset by savings.

### **Cope DN, Cole JR, Hali, KM *et al.* Brain injury: Analysis of outcome in a post-acute rehabilitation system. Part 2: Subanalyses. *Brain Injury* 1991;5(2):127-139.**

The estimated savings in care costs for a group of 145 patients, following rehabilitation for severe brain injury, exceeded £27,000 per year. The number of people requiring 24 hour day care dropped from 23% to 4% after rehabilitation.

### **Faul M, Wald MM, Rutland-Brown W *et al.* Using a cost-benefit analysis to outcomes of a clinical treatment guideline: Testing the Brain Trauma Foundation guidelines for the treatment of severe traumatic brain injury. *Journal of Trauma* 2007;63:1271-1278.**

The use of treatment guidelines for severe traumatic brain injury clients resulted in substantial savings in costs and acute care, with the majority of savings being societal costs.

### **Gustavsson A, Svensson M, Jacobi F *et al.* Cost of disorders of the brain in Europe 2010. *European Neuropsychopharmacology* 2011;21(10):718-779.**

The cost of traumatic brain injury (TBI) in Europe in 2010 was €33 billion PPP. Disorders of the brain are likely to constitute the number one economic challenge for European healthcare, now and in the future. The cost of TBI in the UK in 2010 was €5085 million PPP (excluding indirect costs), with 1.2 million subjects. TBI cost distribution was 32% in direct healthcare costs, 11% direct non-medical costs and 57% indirect costs.

The estimated costs of TBI patients was presented: Mild: direct healthcare costs €1016, direct non-medical €0, indirect costs €5764. Moderate: direct healthcare costs €15,980, direct non-medical €278, indirect €7294. Severe: direct healthcare costs €18,437, direct non-medical €278, indirect €8306.

### **Homaifar B, Harwood J, Wagner T *et al.* Description of outpatient utilization and costs in group of veterans with traumatic brain injury. *Journal of Rehabilitation Research and Development* 2009;46:1003-1010.**

The authors suggest there is a wide array of outpatient services used over time, with considerable variation in cost. Therefore generalisation of costs of care for brain injury is not possible since the population and forms of care provided are heterogeneous and not comparable. It is concluded that a common element could be the study of societal costs.

### **Kirk M. *Acquired Brain Injury: Rehabilitation costs, savings, progress measures and value for money.* 2011 Derbyshire: Freedom From Want? Ltd.**

This report concludes that patients need post-rehabilitation support to maintain the benefits of rehabilitation, and that it is not clear whether the cost savings projected rely on gains made being maintained by ongoing support at a specified level. Family support is assumed up to the age of 45, with a built-in adjustment of 5% per annum increase in costs from 45-65 years, due to the aging of carers. However, there is no attempt to allocate costs post 65 years, despite an increase in the average, due to the risk of onset of Alzheimer's. Therefore after 45 years the care costs increase with the age of the person with traumatic brain injury.

A post-injury care pathway breakdown can be found in this paper. Progress measurement against baseline and towards a targeted level of functional independence is crucial to obtaining value for money in rehabilitation, as it is critical to show progress to payees and for rehabilitation providers to show effectiveness.

**McDonald A. Outcomes and value in neurological rehabilitation. *Primary Care Today* 2012. February/March:25.**

Case study: TBI at 19 years old. The estimated community care costs to meet the static needs from original hospital admission were £8,291,002. The cost of remaining in continuing care placement for life was £3,939,000. The cost of an active goal-focused neuropsychological rehabilitation programme and the likely costs once resettled in community was £1,520,388, assuming continuation of progress.

**McLaughlin AM and Peters S. Evaluation of an innovative cost-effective programme for brain injury patients: Response to a need for flexible treatment planning. *Brain Injury* 1993;7:71-75.**

A step-up programme for brain injured patients residing in a transitional living setting during the last weeks of inpatient rehabilitation was more cost-effective than the inpatient alternative.

**Munasinghe S. Report on investigation of treatment referrals to Oliver Zangwill Centre, Ely. 2010. Unpublished manuscript.**

The cost of a full Oliver Zangwill Centre programme is £30,000 (including care and accommodation).

**O'Connor RJ, Beden R, Pilling A *et al.* What reductions in dependency costs result from treatment in an inpatient neurological rehabilitation unit for people with stroke? *Clinical Medicine* 2011;11(1):40-43.**

Care costs reduced from £1,900 to £1,100 per week following an inpatient multidisciplinary rehabilitation programme. Total annual care costs reduced from £3,358,056 to £1,807,208. The median time to repay the rehabilitation costs was 21 weeks. The savings occurred in those with moderate and severe disabilities, and had potential to accrue for over 12 years.

**Turner-Stokes L, Paul S and Williams H. Efficiency of specialist rehabilitation in reducing dependency and costs of continuing care for adults with complex acquired brain injuries. *Journal of Neurology, Neurosurgery and Psychiatry* 2006;77:634-639.**

High dependency patients showed a mean reduction in weekly costs of £639 per week following a longer-stay, specialist rehabilitation programme. The time taken to offset the cost of rehabilitation was 16.3 weeks. Medium dependency patients had a mean reduction in weekly costs of £323, offset in 21.5 months and low dependency patients showed a mean reduction of £111 per week, offset in 38.8 months. Functional Independence Measure (FIM) efficiency was greatest in the medium dependency groups and floor effects of FIM could lead to an underestimation of efficiency of rehabilitation in higher dependency patients.

**Turner-Stokes L. Cost-efficiency of longer-stay rehabilitation programmes: Can they provide value for money? *Brain Injury* 2007;21(10):1015-1021.**

The cost of highly dependent patients on admission to a longer stay rehabilitation programme (125 days+) would be offset by mean weekly savings in care costs within 36 months.

**Turner-Stokes L. Evidence for the effectiveness of multi-disciplinary rehabilitation following acquired brain injury: A synthesis of two systematic approaches. *Journal of Rehabilitation Medicine* 2008;40(9):691-701.**

This review presents grade A evidence that specialist inpatient services and specialist behavioural units together reduce the needs for ongoing care, with potential savings that offset the initial investment in rehabilitation programmes, especially in dependent groups. Also it collates grade A evidence for the cost-benefits of return to paid employment. Salaries from paid employment exceed cost of intervention, resulting in an overall gain to the tax payer. There is moderate evidence of savings through the reduction in length of stay, due to early, intensive rehabilitation.

**van Heugten CM, Geurtsen GJ, Derksen RE *et al.* Intervention and societal costs of a residential community reintegration for patients with acquired brain injury: A cost analysis of the brain integration programme. *Journal Rehabilitation Medicine* 2011;43:647-652.**

This research evaluated a residential community re-integration programme, consisting of three modules: independent living, social-emotional and work. Prior to admission, brain injured patients demonstrated social problems, emotional disturbances and problems with community integration. Rehabilitation costs were €68,400 (hospital days, nursing hours, treatment hours and indirect costs). Following discharge from the programme, informal care and productivity losses reduced significantly, healthcare consumption increased significantly, and societal costs per patient significantly reduced from €48,449 to €39,773, with a break-even point of eight years which therefore advocates the allocation of resources and reimbursement of BIP costs by healthcare insurance companies. Greater cost-effectiveness was found in other studies where patients started rehabilitation within 12 months post-injury (Worthington *et al* 2006) or two years (Wood *et al* 1999), than for medium-longer term admissions. Therefore earlier admission to this programme may lead to greater cost-savings.

**West M, Wehman P, Kreutzer J *et al.* Costs of operating a supported work program for traumatically brain-injured individuals. *Archives of Physical Medicine and Rehabilitation* 1991;72(2):127-131.**

TBI patients who had attended a supported work programme earned more than the programme cost after 58 weeks of supported employment. After 2.5 years there was a net gain to tax payers and this did not include indirect savings, e.g. from the family returning to work.

**Wilson BA, Scott H, Evans J *et al.* Preliminary report of a Neupage service within a health care system. *Neurorehabilitation* 2003;18(1):3-8.**

The Neupage Project was shown to save money for the NHS and Social Services. One client received one week respite care every three months at a cost of £4000 per annum. Since having the pager she has never needed respite and therefore her health authority has saved £20,000.

**Wood RL, McCrea JD, Wood LM *et al.* Clinical and cost effectiveness of post-acute neurobehavioural rehabilitation. *Brain Injury* 1999;13(2):69-88.**

Rehabilitation for brain injured individuals with severe neurobehavioural deficits in the first two years post-injury will save care costs over a lifetime of £1,350,000 (with inflation). Using hours of care as an indicator of social independence can predict costs. The study suggests that it is still worthwhile, in terms of clinical and cost effectiveness, to offer rehabilitation more than two years post-injury. The cost of a 65-week rehabilitation programme was £113,280 (with inflation). Costs rise and savings projections fall the longer the payee waits

post-injury to start rehabilitation. Post rehabilitation, clients are three times more likely to be able to live in the community.

**Worthington AD, Matthews S, Melia Y *et al.* Cost-benefits associated with social outcome from neurobehavioural rehabilitation. *Brain Injury* 2006;20(9):947-957.**

The initial costs of a neurobehavioural rehabilitation programme were offset by savings in care costs within two years, and the cohort was expected to live for another 30-35 years on average, therefore the long-term benefits of rehabilitation were evident. The savings demonstrated were restricted only to care costs; therefore additional savings in societal costs were not included in the estimation. The authors concluded that initial costs of rehabilitation should not be prohibitive for insurers or health funders.

### **Summary**

The research presented supports early, specialist, multidisciplinary rehabilitation as being the most clinically and cost-effective management of acquired brain-injured patients.

### **Further Research**

There is a need for further research across the field of neurorehabilitation e.g a series of systematic reviews should be performed to ensure all valid research is taken into account when evaluating the questions addressed above. There are also gaps in the literature; for example there are multiple studies evaluating the effectiveness of cognitive rehabilitation for stroke patients, however research for clients with other types of brain injury are lacking. Studies that included both stroke and traumatic clients commonly did not separate the two groups during analysis. Evidence suggests that different client groups respond differently to rehabilitation, future research would benefit from aetiology specific research.

The field of neurorehabilitation research would also benefit from studies evaluating the comparative effectiveness of different interventions, and studies with large numbers of clients, employing functional outcome measures and long-term follow-ups. Further research should investigate the influence of patient characteristics on treatment effectiveness, and examine specific aspects of rehabilitation programmes associated with positive outcomes, such as timing and dosage. Cost-analysis should be related to clinical effectiveness and the balance between e.g. intensity and cost-effectiveness should be determined. Perhaps the assessment of individual elements of rehabilitation programmes could be evaluated, rather than whole programmes, to uncover which components are most clinically and cost-effective.

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