Exercise intervention in acquired brain injury rehabilitation

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Abstract

Physical activity is essential for health and wellbeing. The importance of an active lifestyle is increasingly being recognized in rehabilitation for the benefits to quality of life and the prevention and management of secondary disease resulting from disability. However, there is a paucity of published evidence for lifestyle exercise intervention in acquired traumatic brain injury. Most studies evaluate the impact of specific physical rehabilitation therapies or exercise intervention with physical fitness or body composition as outcomes. Few studies also consider the psychosocial benefits of exercise. This article presents the literature in this field together with future directions for intervention. Further research is needed which investigates the impact of exercise intervention on health and wellbeing of brain injured individuals and their families.

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Introduction

Traumatic brain injury (TBI) is a leading cause of death and disability resulting in 1.4 million accident and emergency department admissions in the UK per year (Moulton and Yates, 1999), which is likely to be underestimated since it is thought that only a quarter of all TBI cases are treated in hospital (Sosin et al, 1996). TBI can result in a range of temporary or permanent deficits, including motor and cognitive function, behavioural and emotional disturbance. Physical symptoms in mild to moderate TBI may include difficulties with balance and coordination (Basford et al, 2003) which may affect activities of daily living and engagement with premorbid activities (Masanic and Bailey, 1998; Quinn and Sullivan, 2000). Motor performance symptoms may be observed even in patients who appear physically well-recovered (Rinne et al, 2006). Therapeutic activity is essential in clinical neurorehabilitation and rehabilitation programmes can have encouraging outcomes. Programmes focusing on cognitive and perceptual remediation, problem-solving learning, personal counseling, physical exercise and relaxation, social skills, and prevocational training have shown positive outcomes for cognitive function post-treatment and a year later (Sherzer, 1986).

Disability in patients with brain injury may be a result of neurologic damage and experimental studies with animals have investigated early rehabilitation models and the relationship between neurotransmitter effects, brain impairment, behavioural outcome and functional recovery (Lippert-Grüner et al, 2007; Goldstein, 2006). However, disability may also be a result of secondary problems resulting from immobility such as altered muscle function or reduced aerobic capacity (Bateman et al, 2001) which have been shown to reduce fitness in other patient groups including arthritis (Harkom et al, 1985), multiple sclerosis (Petajan, 1986) and stroke (Macko et al, 1997). It is well known that sedentary lifestyles have negative effects on health

and increase the risk of chronic disease. Recent research has shown that specifically, patients with traumatic brain injury are significantly more deconditioned than sedentary people without a disability (Mossberg et al, 2007) and so promoting physical activity is therefore important in the prevention and management of secondary health issues in this group.

The benefits of physical activity for physical and psychological health are well-documented (Brooks et al, 2001; Biddle, 2001) and increasing activity nationwide is becoming increasingly important in current government policy (Dept Health, 2004). Further, the well-established positive effects of structured exercise intervention on social support, psychological well-being and feelings of autonomy may assist in long-term rehabilitation following brain injury. However, despite this knowledge, investigations into community and support services for long-term care for brain injury have revealed a lack of services for physical and psychological adjustment and have contributed to the development of the government National Service Framework for Long-Term Conditions. The literature is limited although a review of the evidence is needed to establish current knowledge and identify future direction in this field.

Methods

A literature search was undertaken of exercise interventions with adults with traumatic brain injury. Published research between 1990 and 2007 was considered, with the majority of studies published in more recent years reflecting policy developments in the area. The review included studies targeting brain injured adults in any setting, using exercise as the sole component, the main component or a partial component of intervention. Key search terms were: physical activity, exercise, brain injury, TBI, disabilities, rehabilitation. Databases searched included: MEDLINE, and CINAHL (nursing & allied health). References were only included where data

could be extracted and so some articles were not included if they were published in journals that were difficult to access or where abstracts were not readily available to the author.

Results

Exercise programmes for brain injury are not a new concept and have been identified from the 1950s (Torp, 1956). The majority of articles accessed included reports of physical therapy interventions to improve gait, ambulation or sitting balance or restore cognitive or motor function. Exercise is known to provide physiological benefits for brain injury and newer restorative activity-based therapies (ABTs) such as constraint-induced therapy, robotic therapy and treadmill training techniques are currently being developed and have been used to improve arm function and gait, although studies show mixed results and ABTs may not be more effective than equal amounts of existing compensatory strategies provided by traditional techniques (Dromerick et al, 2006). A detailed review of treatment strategies including exercise intervention is provided by Marshall et al (2007).

Exercise rehabilitation programmes have shown mixed results. In a randomized controlled trial with 38 adults with TBI and significant gait problem, Wilson et al (2006) compared an eight week partial weight-bearing gait retraining intervention with standard physical therapy. Although ambulation improved in both groups, results showed that the intervention was no more effective than standard physical therapy. Studies using innovative methods for rehabilitation have addressed the problem of limited physical capability and fatigue which can hinder intensive physical and cognitive rehabilitation programmes.

Biofeedback has been applied to rehabilitation using virtual reality (Shultheis, 2001; and video games (Betker et al, 2007). Combining exercise with virtual reality has shown promising results with flat screen virtual reality (VR) technology proposed as an alternative to conventional exercise programmes for rehabilitation (Grealy et al, 1999; Shreistrub et al, 2003). These methods may prove effective in rehabilitating patients in regaining physical and cognitive function and simulate engaging in activities of daily living, particularly in severe cases. However, patients undergoing virtual reality training may not receive the benefits to health and psychosocial well-being that can be attained by *actual* engagement in physical activity.

Early research centred around physical conditioning suggested that there may be a role for physical activity in the development of physical work capacity through physical conditioning incorporated within a rehabilitation programme for people with brain injury (Sullivan et al, 1990). Early studies with late brain-injured patients have showed improvements in fitness although lacked standardized measures for outcomes and lacked a control comparison group (Jankowski and Sullivan, 1990; Hunter et al, 1990).

It has been suggested that specific functions and components of fitness can be improved with physical exercise. These include neuromuscular training (Jankowski and Sullivan, 1990), arm ability training (Platz et al, 2001), mobility training (Dordel, 1989), balance and coordination training (Dault and Dugas, 2002) and aerobic training (Hunter et al, 1990; Satiago et al, 1993; Lapier et al, 1998; Bateman et al, 2001). However, participants in these studies were recruited from hospital or residential care facilities and training was conducted in a laboratory environment rather than a community setting.

Some studies have been conducted which investigate the feasibility of exercise programmes early after injury. Research evidence has showed that brain injured patients with a range of disabilities are able to participate in an exercise programme during early inpatient rehabilitation (Jackson et al, 2001). In Jackson's intervention, patients in one of four neurological inpatient units cycled for up to 30 minutes three times weekly for 24-36 sessions over 12 weeks. Ninety patients started the intervention and 55 of these completed 24 sessions. The researchers measured mean cycling time and the number of sessions required to reach a 30 minute cycling time. They concluded that whilst participation is plausible early in rehabilitation, patients vary in the length of time it takes them to achieve adequate intensity aerobic exercise. Bhambhani et al (2005) found mixed findings in an evaluation of a twelve-week circuit-training program designed to enhance muscular strength, endurance and aerobic fitness in moderate to severe brain injured inpatients (n=14) in a community rehabilitation hospital. The authors looked at changes in peak cardiorespiratory function and body composition in a time-series design consisting of 32 one hour sessions. Whilst body composition did not alter significantly, peak cardiorespiratory responses improved but required more than six weeks of training.

Whilst early intervention in acute or rehabilitation facilities may be important, many patients with brain injuries live out in the community, adjusting to a range of physical, behavioural, cognitive and emotional impairments. Community facilities are therefore central in assisting with this adjustment and improving quality of life for brain injured individuals. However, studies incorporating exercise programmes for brain injured patients in the community are few, although have shown promising findings. In a randomized controlled trial (n=16), Driver et al (2004) evaluated the outcome of an eight week aquatic exercise intervention on cardiovascular endurance, body composition, muscular strength, endurance and flexibility. Physical fitness

increased in the intervention group, which in turn impacted on functional capacity and ability to complete activities of daily living. Exercise may therefore improve fitness in individuals with brain injury living in the community.

Future Developments

Therapeutic physical activity has a crucial role in the rehabilitation of brain injured patients. Tai Chi Chuan, an ancient form of Chinese martial arts, has been utilized as an effective intervention for patients with brain injury and has shown to have a positive influence on patient mood (Shapira et al, 2001; Gemmell and Leathem, 2006). However, Tai Chi requires precise movements that, with normal coordination abilities, can take many years to master and so may not be appropriate for a short-term intervention in brain injury. Chi Kung, an ancient form of Chinese therapeutic exercise uses simplified movements to facilitate balance and awareness of mind and body. This method has been employed with older adults to increase coordination and flexibility for the prevention of falls (Dupoy et al, 2002). It is proposed that Chi Kung may be a suitable method of exercise intervention for individuals with brain injuries since it involves less complex movement and will therefore be accessible to a wider brain injured population over a set study period. A randomized controlled trial is currently underway in the UK to compare an eight-week Chi Kung exercise intervention with a non-exercise discussion group in individuals with >1 year brain injury living in the community. Outcome measures will include standardized assessment of mood, self-esteem, flexibility, coordination, physical activity and social support pre and post-intervention, and at follow-up six and twelve months later. Caregivers of participants in the trial will be assessed on measures of strain and mood. If the intervention is successful it may be implemented permanently within local rehabilitation services in the community.

Discussion

The UK National Service Framework for Long-Term Conditions has ensured government support for the improvement of services for people with brain injury. However, there is a paucity of literature in the field of brain injury which reports the outcomes of exercise or physical activity programmes targeted at the engagement of physical activity for fitness, general health and psychosocial reasons, rather than for physical therapy of specific motor impairment. The Choosing Health White Paper (Dept Health, 2004) raised national awareness of the benefits of promoting physical activity for health. Only recently has there been a focus on the impact of 'exercise for health' programmes for people with chronic disabilities. As a result, health promotion programmes are now developing which aim to improve patient quality of life and reduce occurrence of negative effects of secondary health conditions resulting from a sedentary lifestyle (Rimmer, 1999; Powell and Blair, 1994). Further, community-based support centres are focusing more on increasing and maintaining independence and reducing further disability through engagement in exercise activities to promote strength building, flexibility, coordination and self-reliance.

Exercise interventions may be feasible early after brain injury, however, many patients are left living in the community for many years with long-term disabilities and impairments. Intervention is required which would be appropriate for long-term rehabilitation and participation in activity. Existing studies are difficult to compare as they are limited in number and measure different outcomes. The primary outcome of previous exercise intervention studies is change in physical fitness, time taken to engage in activity or body composition. Few studies have included psychosocial outcomes of exercise intervention and those that have concentrate on mood state but do no consider other factors such as self-esteem or social support. However, psychosocial outcomes are important as engaging in activity with others is beneficial

to mental health and it is well documented that psychological factors can play a role in recovery from illness. Further, it has been suggested that the type and source of social support changes post brain injury (Driver, 2005) and that in this group, social influence from family, friends and caregivers is important and can impact on physical activity participation (Driver, 2007). In addition to the influence of the caregiver on the patient and their participation in exercise programmes, few studies have explored the actual impact of caring for adults with brain injury. Caregivers of any individual with chronic disability may be under considerable stress and at risk of depression. Studies conducted with carers of stroke patients suggest that carer strain is common and carers are at risk of low mood (Blake and Lincoln, 2000; Blake et al, 2003), which is important as mood of the carer can also negatively impact on patient recovery from illness. Future research should consider the impact of patient intervention on the primary caregiver.

To advance our understanding of exercise behaviours in certain marginalised populations, exercise interventions should be based on sound theory (Taylor et al, 1998). There are many theoretical models for physical activity behaviour and determinants. The Physical Activity for People with Disability Model (Van der Ploeg et al, 2004) was developed to address the relationships between physical activity behaviours and determinants and the functioning specifically for people with disabilities. This model is appropriate as a framework for the development of physical activity intervention with people with brain injury and has recently been applied in the design of a Chi Kung exercise intervention for brain injury, the results of which are yet to be published. This article is by no means an exhaustive review and there may be additional work which is not known to the author. However, it provides an overview of previous and current interventions, future developments and most importantly, highlights the need for more research on the impact of exercise

interventions on both physical and psychosocial outcomes in people with acquired brain injury.

Clinical Messages

- Exercise is important for health and well-being of all adults
- Adults with brain injury may suffer secondary disability from inactive lifestyles
- Increasing activity may help with coordination, flexibility and psychosocial outcomes
- Future research should evaluate the impact of theory-driven exercise intervention with people with brain injury and their carers

Conflict of Interest

None to declare.

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