Cardiorespiratory Stress is not Achieved During Routine Physiotherapy in Chronic Stroke

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Abstract

Background: Cardiorespiratory deconditioning is a well-established sequel of stroke and this may interfere with integration into community. In the chronic phase, when motor recovery has plateaued, rehabilitation should include cardiorespiratory training.

Objective: To determine whether physiotherapy rehabilitation in the chronic phase of stroke provides enough stress in terms of duration (>10 min) and intensity (>40% of heart rate reserve - HRR) to induce cardiorespiratory benefits.

Methods: Two physiotherapy sessions, at least one week apart, of 20 chronic stroke patients (mean time since the onset of the stroke of 26 months, mean age of 58 years, 45% male) were observed, in terms of duration (time) and intensity (40 %HRR). The activities were categorized as upper limb tasks, standing, stepping, basic walking, and advanced walking. Average duration and intensity for each participant across the two sessions were determined.

Results: Lower limb activities, such as standing and walking were undertaken for 25 (SD 5) minutes; comprising 57% of the total session. The remainder of the session was taken up with upper limb activities (27%) or inactivity (16%). None of the activities reached the target intensity, with the highest average intensity being achieved during advanced walking (mean 32% HRR, SD 2).

Conclusions: Routine physiotherapy did not provide sufficient duration or intensity to induce cardiorespiratory stress in this group of chronic stroke patients. The evidence practice gap needs to be closed for cardiorespiratory fitness to be trained.

Keywords: Cerebrovascular disorders; Physiotherapy (speciality); Exercise; Physical fitness; Cardiovascular deconditioning; Walking; Rehabilitation

Introduction

Significant cardiorespiratory deconditioning is a well-established sequel of stroke and contributes to disability [1]. The latest update of the Cochrane systematic review on physical fitness showed that cardiorespiratory training during both the acute/subacute and chronic phases improves walking performance [2]. Furthermore, it appears both feasible and safe [2] and, can therefore, be confidently included in physiotherapy rehabilitation for stroke survivors. Despite this, previous studies have demonstrated that the extent of cardiorespiratory stress induced by routine inpatient physiotherapy rehabilitation is low [3-5]. As people with chronic stroke are able to achieve minimum recommended exercise levels [6], it would seem reasonable to expect that cardiorespiratory fitness training would be a focus of physiotherapy rehabilitation in the chronic phase following stroke.

It has been found that the intensity of inpatient physiotherapy rehabilitation is not sufficient to provide cardiorespiratory benefit. In Canada, patients spent three (SD 1) minutes within the targeted heart rate zones per physiotherapy session, i.e., above 40% of the heart rate reserve (HRR) [3]. More recently, Prajapati et al. [5] found that things had not changed in 10 years; i.e., patients did not meet the minimum cumulative requirements of walking intensity (>40% HRR) and duration (>10 minutes) continuously. In Australia, patients spent only 22 minutes in standing and walking activities at 24% of their HRR per physiotherapy session [4].

In Brazil, stroke rehabilitation commences later and continues well into the chronic phase [7]. As a result, it is possible that these stroke survivors are even more deconditioned than the inpatient survivors [8, 9]. Targeting cardiorespiratory fitness during outpatient rehabilitation in the chronic phase is, therefore, of paramount importance. At this stage, recovery of motor impairments, such as weakness, has largely taken place with strength of large muscle mass enough to enable walking at an intensity sufficient to promote cardiorespiratory stress. The inclusion of cardiorespiratory training in this phase of stroke

recovery could positively influence the overall health [10], physical activity levels [11] integration into the community, and ultimately quality of life [12].

Therefore, the aim of this study was to determine whether physiotherapy rehabilitation in the chronic phase of stroke provided enough stress in terms of duration (>10 min) and intensity (>40% of HRR) to induce cardiorespiratory benefits.

Methods

Design

A cross-sectional observational study with repeated measures was carried out. Participants were a sample of convenience recruited from three metropolitan outpatient clinics, one public and two private. Two sessions of physiotherapy rehabilitation, at least one week apart, of at least 40 min duration were observed for each participant. There was no attempt to influence the content of physiotherapy intervention, ie, the sessions observed were of routine physiotherapy. While both patients and therapists were aware that they were being observed, they were blind to the objectives of the study, and were asked to carry on as normal. The duration (time) and intensity (%HRR) of activities undertaken by the participants during these sessions were collected. This study was approved by the Research Ethical Review Board of the Pontificia Universidade Católica de Minas Gerais and all participants provided written consent, prior to data collection.

Participants

Volunteers were included if they had at least six months after the onset of a unilateral stroke; were clinically stable; were undergoing physiotherapy rehabilitation; had no cognitive deficits, as defined by their Mini-Mental State Examination scores >24 [13]; and had no other neurological or orthopedic conditions. Characteristics such as age, sex, body mass, height, time since the onset of the stroke, side of hemiparesis, number and type of medications, walking speed (10-m Walk Test) [14,15], and levels of independence (Barthel Index) [16], were collected for characterization purposes.

Measurements

Duration of activity: The duration of the total session, of the activities undertaken during the sessions, and any periods of inactivity were timed with a digital stopwatch. The activities were categorized, according to Kuys et al. [4], as follows:

Standing: standing up, standing still, shifting weight from one leg to the other, and reaching while standing;

Stepping: single stepping practice or stepping onto and off individual blocks;

Basic walking: walking on flat, firm surfaces, regardless of the walked distance or how much assistance was required;

Advanced walking: walking backwards, on uneven surfaces, outdoors, climbing stairs, or walking on the treadmill.

Upper limb: any movement performed by the paretic limb, including passive and active movements in sitting or lying positions;

Inactive: resting or not engaged in any therapeutic activities;

Intensity of activity: The intensity of the activities was measured as the percentage of the HRR. A Polar heart rate strap was applied to the participants' chests, with the receiver placed on the non-paretic upper limb before the beginning of the sessions. Then, the resting heart rate was recorded for each participant after five minutes of sitting. Heart rate was continuously measured and manually recorded after the end of each performed activity [5]. If the activity continued for longer than 10 minutes, additional heart rate measures were recorded at 10-minute intervals. The average heart rate was calculated for each activity [4]. The 40%HRR, i.e., the minimal intensity to induce cardiorespiratory stresses, was defined by the Karvonen formula, as follows: $HR_{\text{target}} = [40\% (HR_{\text{max-pred}} - HR_{\text{rest}})] + HR_{\text{rest}}$. The maximal age-predicted heart rate was adjusted for those participants, who were taking beta-blocker medications, as follows: $(85\% [220 - \text{age}])$ [17].

Data analysis

Descriptive statistics (means, standard deviations) and tests for normality (Shapiro-Wilk) and homogeneity of variances (Levene) were performed for all outcomes. Since no differences in duration or intensity were observed between the sessions ($Z = -1.8$; $p > 0.05$ and $Z = -2.2$; $p > 0.05$, respectively) for any activity, the data were averaged across the two physiotherapy sessions. All statistical analyses were carried out using the SPSS software for Windows (version 17.0) with a significance level of 5%.

Results

Characteristics of the participants

Twenty individuals with chronic stroke, nine men, with a mean age of 58 (SD 16) years and a mean time since the onset of the stroke of 26 (SD 15) months, participated. All individuals were taking oral medications, including anti-hypertensive drugs and beta-blockers. Their characteristics are summarized in Table 1. Each participant was observed during two sessions. The mean time between the sessions was 14 (SD=7) days.

Characteristic	n=20
Age (years), mean (SD)	58 (16)
Sex, n male (%)	9 (45)
Body mass index (kg/m ²), mean (SD)	25 (4)
Time since stroke (months), mean (SD)	26 (15)
Side of hemiparesis, n right (%)	9 (45)
Number of medications, mean (SD)	3 (2)
Walking speed (m/s), mean (SD)	0.77 (0.31)
Barthel Index (scores: 0 to 20), mean (SD)	17 (3)

Table 1: Demographic, anthropometric, and clinical characteristics of the participants. SD: standard deviation.

Duration and intensity of activities

Forty sessions were observed, with a mean duration of 44 (Session 1) and 43 (Session 2) minutes, respectively. Table 2 provides the average duration and intensity (%HRR) of each activity across the two

sessions. Lower limb activities, such as standing and walking, were undertaken for 25 (SD 5) minutes; comprising 57% of the total session. The remainder of the sessions were taken up with upper limb activities (27%) or inactivity (16%). None of the activities was undertaken at 40% HHR (Figure 1). The highest intensity of 32% HHR (SD 2) was achieved during advanced walking.

Activity	Duration	Intensity
Total session	44 (5)	24 (5)
Lower limb activities	25 (5)	25 (5)
Standing	5 (4)	20 (3)
Stepping	5 (3)	19 (4)
Basic walking	6 (3)	26 (4)
Advanced walking	9 (5)	32 (2)
Upper limb activities	12 (5)	20 (4)
Inactive	7 (2)	24 (5)

Table 2: Mean (SD) duration (minutes) and intensity (% Heart rate reserve) of the activities averaged across the two sessions (n=40 sessions). SD=standard deviation; %HRR=percentage heart rate reserve.

Figure 1: Mean (SD) intensity (% Heart rate reserve - HHR) during advanced walking, basic walking, standing, stepping, and upper limb activities for session 1 (n=20) and session 2 (n=20). The dashed line represents the minimum intensity required to induce a cardiorespiratory training effect.

Discussion

This cross-sectional study found that routine outpatient physiotherapy for people with chronic stroke did not generate enough cardiorespiratory stress to induce training effects. The mean maximum intensity reached was 32% HRR, which occurred during advanced walking for about 10 minutes. Interestingly, the mean intensity of the standing and stepping activities did not exceed that of the upper limb.

Similar duration and intensity of routine physiotherapy were found by previous studies [3-5]. For example, maximum average HRR achieved in the present study (32%) was similar to 35% reported by

Kuys et al. [4] for stepping. Duration was also similar; 25 minutes for standing and walking activities. It may be that the emphasis in the early stages of rehabilitation has been more on the quality of the movement, than on cardiorespiratory fitness.

It is difficult, soon after stroke, to make newly ambulatory patients, walk fast enough to raise their heart rate sufficiently to induce cardiorespiratory stresses. However, in the present study, the participants were chronic, i.e., at least two years after stroke. At this stage, it would seem reasonable to concentrate on improving cardiorespiratory fitness as a way of reducing activity limitations and participation restrictions [18], given that it is unlikely that motor impairments, such as muscle weakness, will be amenable to changes. Furthermore, the participants in the present study were functionally independent, i.e., modified Barthel index of 17/20 and walked quite well (0.8 m/s) at about 2/3 of normal speed [19]. Therefore, it would appear to be feasible to increase the intensity of the exercises, either by increasing walking speeds or walking loads or introducing activities, which require higher physical demands, such as ascending and descending stairs [20].

Stroke clinical practice guidelines [21] inform us that exercises should be intense enough to promote cardiorespiratory stress. There are now four international studies [3-5], including the present one (Canada, Australia, Brazil) that informed us that physiotherapists do not do it. Why? There are two potential explanations. First, perhaps physiotherapists are afraid to push their patients too hard, in case there is a negative effect on the quality of walking. However, this fear is unfounded, since Kuys et al. [22] reported that even when walking newly ambulatory stroke patients at speeds on a treadmill that induced intensities up to 60% HRR for six weeks, the training was not detrimental to walking patterns.

Second, although the scientific evidence supporting stroke rehabilitation in physiotherapy has been growing over recent decades [23], the transfer of evidence into clinical practice remains a challenge. The most commonly observed barriers to implementation of evidence-based practice are the lack of confidence and knowledge to interpret, synthesize and apply research findings, negative attitudes, and habitual ways of practicing [24].

In this sense, although the scientific literature supports the importance of interventions, which incorporate aerobic training to induce cardiorespiratory benefits even during the acute stages [2,8,25], the results of this study demonstrated that like their international counterparts [3-5] Brazilian physiotherapists do not employ exercises with sufficient intensity nor duration to induce cardiorespiratory stress during routine physiotherapy rehabilitation. This, in turn, highlights the fact that physiotherapists are not currently directing their efforts to three of the main goals of stroke rehabilitation, i.e., to prevent complications related to prolonged inactivity, to decrease the risk of recurrent stroke or cardiovascular events [26], and to improve cardiorespiratory fitness [27]. It appears that cardiorespiratory training is not being targeted in acute and subacute settings [3-5], possibly due to the focus being on other aspects of recovery and shorter lengths of stay [28]. If this is the case, then perhaps, the focus of rehabilitation post discharge from acute and subacute services, as stroke survivors enter the chronic phase, should include cardiorespiratory training.

The evidence gap exists pertaining to cardiorespiratory training, regardless of the phase of stroke recovery. Clinicians are often aware of the content of clinical practice guidelines, but specific strategies to help

facilitate implementation of research findings into clinical practice need to be tailored to the individuals' contexts and settings [29].

The results of the current study and previous work in this area continue to highlight that cardiorespiratory fitness training must be planned in order to be included in physiotherapy interventions. The lack of physical activity undertaken by stroke survivors [30] cannot be ameliorated, until cardiorespiratory fitness is improved.

Conclusions

The findings of this study demonstrated that routine physiotherapy did not provide the appropriate duration and intensities to induce cardiorespiratory stress in people with chronic stroke. The individuals did not achieve their minimal target heart rate zones. The loss of conditioning is an important impairment observed in post-stroke patients, which could lead to serious consequences including preventing individuals returning to their social activities, i.e., going to church, supermarkets, and practicing sports. The evidence gap around implementation of cardiorespiratory training during stroke rehabilitation needs to be addressed. Activities which provide appropriate intensities to induce cardiorespiratory stress should form part of the physiotherapists' checklist during the planning of the intervention.

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Ethical Approval

Pontifícia Universidade Católica de Minas Gerais (#0xxx.0.213.000-06).

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