Balance and Stability–Focused Exercise Program Improves Stability and Balance in Patients After Acute Stroke in a Resource-poor Setting

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Objective: To compare the effect of a balance and stability–focused outpatient community-based rehabilitation and a regular physiotherapy program on balance, stability, and perceptions of improvement after acute stroke.

Design: A randomized controlled trial in a community-based therapy center.

Participants: Fifty consecutive patients with a first stroke, who reported to a community-based therapy center over a 7-month period were allocated to the control group (regular physiotherapy) or the experimental group (balance and stability–focused rehabilitation).

Intervention: A program of physiotherapy focused on balance and stability exercises. The control group received the regular physiotherapy program.

Main Outcome Measurements: The Postural Assessment Scale for Stroke Patients (PASS) and the Berg Balance Scale (BBS) monitored stability and balance. The normalized data (PASS and BBS) were analyzed by using analysis of covariance. Qualitative data were thematically described.

Results: Internal consistency of baseline PASS and BBS scores was high (Cronbach α, .964 and .974, respectively). PASS overall pretest scores increased from 21.96 ± 21.41 (mean ± standard deviation) and 21.52 ± 8.43 to 67.67 ± 28.42 and 80.16 ± 22.60 posttest in the control and experimental groups, respectively. Posttest scores were significantly different ($P = .004$). The effect size was medium (.490). The overall BBS scores showed overall mean (standard deviation) increases from 44.71 ± 22.24 and 43.43 ± 17.11 pretest to 48.71 ± 23.18 and 59.71 ± 18.20 posttest for the control and experimental groups, respectively. The effect size was considered medium (.532).

Conclusion: The balance and stability–focused community-based rehabilitation program was more effective in improving stability and balance in patients with stroke compared with the regular physiotherapy program in resource-poor settings.

PM R 2014;6:1081-1087

INTRODUCTION

Bryer et al [1] identified stroke as the leading cause of death and disability in South Africa, with the potential to further increase due to increased exposure to risk factors. In the same country, Bradshaw et al [2] noted that almost 13% and 18% of men and women, respectively, over the age of 65 years die from stroke. Stroke patients who survive experience varying degrees of loss of function. The loss of function is directly related to the degree of impairment resultant from the primary event. Direct consequences of brain damage and indirect consequences due to time lapse between medical treatment and rehabilitation add to the functional loss that accompanies the stroke. Impairments in stability and balance affect the ability to perform voluntary movements and function.

Balance training for stroke has received wide attention, including its effects on gait and function [3], training strategies to improve balance and stability [4-6], and feedback [7-10], all in an effort to improve function [11-14] or reduce the restrictions in participation [15,16]. The restoration of function is a function of neural plastic changes that should occur as a result of repetitive movements in functional patterns. Hocherman and

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Disclosure: nothing to disclose

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Disclosure: nothing to disclose

Presented at the 7th World Congress of the International Society of Physical and Rehabilitation Medicine, Beijing, China, June 16-20, 2013.

Peer reviewers and all others who control content have no relevant financial relationships to disclose.

Submitted for publication January 16, 2013; accepted June 15, 2014.

Dickstein [4] saw the need for training to ensure improved balance in stroke patients. Physiologically, with normal human development, stability precedes mobility, and, if retraining does not follow this sequence and abnormal patterns of movement are allowed to be fostered as a means to adapt to enable function, then optimal function will not be achieved. Often, stroke survivors learn to live with the disability, which affects their participation in a variety of activities.

In many countries of the world, a shortage of rehabilitative therapists means that patients who rely on subsidized health care, and especially those who live in rural areas, are forced to be as functional as they can without expert advice or care [14,17,18]. In South Africa, in an attempt to provide access to health services to all, district hospitals serve nearby community clinics. The limited services offered to outpatients once every 2 weeks provides some access to rehabilitation. The effectiveness of these programs is not known [19,20]. The changing lifestyle adopted by South Africans is reflected in the increased morbidity and mortality associated with lifestyle-related diseases, such as cardiovascular diseases and diabetes, which culminate in stroke [21]. The burden associated with stroke has increased in the face of increased exposure to risk factors and age range at which stroke occurs [21]. Improved medical care has increased life expectancy, with the result that there now are older people in our communities, with the associated burden of care increasing.

Postural control reflected in stability and balance is important to improve independence, social participation [12], and quality of life. Although a traditional physiotherapy program focuses on the individual needs of a patient based on assessment, it may not be sufficient to improve function. The purpose of this study was to quantify the effect of a balance and stability exercise program on balance and stability in stroke patients and to compare it with a traditional program of physiotherapy. Both programs have been included in the Methods section. In addition, qualitative information in the form of actual feelings and opinions about barriers to functionality was explored. Although quality of life is an important variable in rehabilitation research, this was not explored in this study.

METHODS

Design

The aims of this study were achieved by using a randomized controlled trial. The population for this study consisted of all patients with stroke who reported for therapy at a community-based assessment and therapy center over a period of 7 months. The patients were diagnosed by general practitioners in private practices and physicians at public clinics or hospitals.

Population

The sample was a consecutively selected subset of the population who presented to the center for the period of 7 months from the date on which ethics approval was obtained. Only patients who had a first stroke as diagnosed by a medical physician, were cognitively functional with or without communication impairment, and signed fully informed consent forms were included in the computer-generated randomization process for inclusion in either the control group or the experimental group. Patients were excluded if they had had more than 1 stroke, had any previous lower limb fractures, or were unable to participate in low-intensity exercise programs due to severe complications from comorbidities or were positive for human immunodeficiency virus, due to its neurologic sequelae.

Setting

The community-based assessment and therapy center is a state-run facility that operates as a satellite of a district hospital also located in the community. This outpatient facility operates 5 days a week, from 7:30 AM to 4 PM. The facility serves patients from a prescribed area, and patients are referred via one of the provincial hospitals, clinics, or nearby general practitioners. The physiotherapy program for patients with stroke is an individualized 1-hour session offered once every 2 weeks, which comprises individual therapy by therapists or standardized group therapy administered by therapists or assistants. Patients who are mobile, either with or without an assistive device, and who require minimal individual attention are treated in the stroke group. At the end of each session, each patient is given his or her next appointment date. To reduce variability in this study, the participants in both groups received individual treatments by a therapist. All the patients were requested to perform the exercises at home.

Sample

A sample size (50) that was logistically practical for implementation in the specific setting given the constraints of the availability of participants was identified. The therapy center appointment book for stroke patients at the physiotherapy department was used to identify patients for recruitment. All patients were screened by using inclusion and exclusion factors. Twenty-five patients were randomly allocated to each of the control and experimental groups. The control group received the regular physiotherapy sessions (Table 1) offered by the facility for 30 minutes with 3 breaks of 2 minutes every 10 minutes in each session. The experimental group was rehabilitated by using the intervention program that focused on the stability and balance exercises (Table 1). The duration of exercise session and number of breaks were the same for both groups.

Table 1. *Program of exercises offered to the control and experimental groups*

Control Group	Experimental Group
Auto-assisted upper limb exercise for shoulder flexion and extension	Sitting upright with 2 feet on the ground and reaching for objects with upper limbs
Auto-assisted upper limb exercise for shoulder abduction and adduction	Kneeling to a half kneeling position and holding for 10 s; alternate both lower limbs
Using momentum to roll to affected and unaffected sides	Standing erect, flexion of both hips and knees (as if into squatting), hold for 10 s
Bridging with both lower limbs	Standing on 1 leg, hold for 10 s; alternate both lower limbs
Bridging with affected lower limb	Standing on 1 leg and raising other leg to a stair; alternate both lower limbs
Trunk rotations to affected and unaffected sides	Standing on 1 leg and tapping marked points on the ground with the other limb; alternate both lower limbs
Joint approximation exercises in sitting	Standing on 1 leg and kicking a ball with the other lower limb; alternate both lower limbs
Joint approximation exercises in standing	Standing with 2 feet on the ground and reaching for objects with upper limbs
Ball therapy for scapular movements by using a medium-size ball	Walking on 2 straight lines that are 10 cm apart
Ball therapy for trunk dissociation by using a big ball	
Hand activities	
Gait re-education in parallel bars or with an aid	

Instruments

The dependent variables of stability and balance were monitored by using the Postural Assessment Scale for Stroke Patients (PASS) and the Berg Balance Scale (BBS), respectively, pretest and posttest. The PASS and BBS have been widely used, validated, and tested for reliability [22] with several patient populations. To ensure the validity and reliability for the population under study, a pilot study was conducted. Participants' personal details and feelings about the program of exercises were captured on a questionnaire.

Procedure

Ethics clearance from the institutional research ethics committee and approval from the Department of Health, the hospital manager of the parent hospital, and the acting rehabilitation coordinator at the assessment and therapy center were requested and obtained before data collection. The institutional research ethics committee subscribes to the Declaration of Helsinki. Two treatment rooms in the physiotherapy department at the assessment and therapy center were allocated for the data collection. One room was assigned to the control group and the other to the experimental group to avoid participants conversing and tainting results. Both rooms were well ventilated and spacious, with nonslippery floors. During data collection, it was confirmed that the doors of both rooms were closed to ensure privacy and confidentiality of the participants. On the first visit, the demographic questionnaires, including qualitative responses about participants' perceptions about treatment effects, BBS, and PASS were administered. Physiotherapy for both the experimental and control groups continued for 12 sessions, once every 2 weeks, for 6 months. The posttest scores and verbalizations were recorded after the last therapy sessions.

Data Analysis

The internal consistency of the baseline scores was tested by using the Cronbach α. The normalized data for each participant for each of the control and experimental groups were pooled and subjected to analysis of covariance and the Fisher exact test to assess the effect of the intervention relative to the control. The level of significance was set at $P = .05$. In addition, the group effect size for each comparison was determined as the difference between the 2 means divided by the standard deviation of the group data. All qualitative data were described in themes, after being analyzed by using the grounded theory.

RESULTS

Fifty participants completed the study protocol, 25 in each, the control group and the experimental group. As shown in Table 2, the demographic profile of the participants in the groups was similar at baseline. The majority of participants in both groups were of Indian origin and in the age range of 50-74 years. Almost 50% of the participants in both groups were left dominant. Forty percent and 48% of the participants in the control and experimental groups, respectively, had a stroke 6-12 months earlier compared with 48% and 36%, respectively, from each group that reported having had the stroke 0-6 months earlier. No significant differences between the groups were noted.

Participants from both groups sought medical attention from either the private or public sector or from their local clinics or physicians at the time of their attacks. From the control and experimental groups, 11% and 9%, respectively, reported having no tests or investigations done. Reasons that were stated for having no investigations included "the machines were out of order," "tests were too expensive," and "medical funds had run out." When asked why the 8 participants from the control group and 6 from the experimental group had not attended a hospital after their attacks, 3 reported "having no finances," whereas 8 commented about the "long queues at the hospitals."

Table 2. *Demographic profile of participants who comprised the control and experimental groups*

	Control Group, no. (%)	Experimental Group, no. (%)
Side affected		
R hemiplegia, R dominant	3 (12)	1 (4)
R hemiplegia, L dominant	1 (4)	2 (8)
R hemiparesis, R dominant	5 (20)	6 (24)
R hemiparesis, L dominant	5 (20)	3 (12)
L hemiplegia, R dominant	2 (8)	2 (8)
L hemiplegia, L dominant	7 (28)	3 (12)
L hemiparesis, R dominant	2 (8)	5 (20)
L hemiparesis, L dominant	0 (0)	3 (12)
Total	25 (100)	25 (100)
Age		
0-34 y	0	1 (4)
35-49 y	2 (8)	6 (24)
50-74 y	22 (88)	16 (64)
>75 y	1 (4)	2 (8)
Total	25 (100)	25 (100)
Gender		
Men	11 (44)	15 (60)
Women	14 (56)	10 (40)
Total	25 (100)	25 (100)
Race		
Black	4 (16)	6 (24)
Indian	21 (84)	19 (76)
Total	25 (100)	25 (100)

R = right; L = left.

The participants indicated that they were not aware of the stroke subtype (ischemic or hemorrhagic) that resulted in their cerebrovascular incidents. However, they did provide information about the resulting problems, which was explained to them by medical personnel attending to them at the time of seeking medical attention. None of the participants indicated falls or tragic circumstances (motor vehicle accidents) as the causes of their attacks. In both control and experimental groups, hypertension was reported as a significant cause of the attack (44% and 48%, respectively). Other comorbidities, for example, diabetes mellitus, hyperlipidemia, and blood clots, also were mentioned, but these comorbidities accounted for fewer than 20%. Approximately 4% of the participants in both groups reported having no known cause to their attacks. The majority of the participants from both groups were functional when using an assistive device, as reflected in Table 3. The most commonly used walking device was either a quadripod or an elbow crutch.

Assessment of Stability

The PASS was used to test stability. The means (standard deviations), and R^2 for overall PASS scores for the control and experimental groups are shown in Table 4. The internal consistency of the baseline PASS data was high (Cronbach $\alpha = .964$). Baseline control and experimental group means were not significantly different, but posttest scores for the experimental group improved significantly compared with pretest and control posttest values ($P = .004$). The low R^2 indicates a low predictability of the model. The strength of the association was modest ($R^2 = .221$) and the effect size was medium (effect size, .490).

Table 3. *Assistive devices used by the participants*

Assistive Devices Used	% Control Group	% Experimental Group
Quadripod	40	40
Elbow crutch	36	40
Wheelchair	12	8
Walking device	12	12
Total	100	100

Assessment of Balance

BBS was used to assess balance. The internal consistency of the baseline BBS data was high (Cronbach $\alpha = .974$). The means (standard deviations) and R^2 for overall BBS scores for the control and experimental groups are shown in Table 4. Baseline means were not significantly different between the groups, but posttest scores for the experimental group improved significantly compared with pretest and control posttest values ($P < .001$). The strength of the association was strong ($R^2 = .952$), and the effect size was medium (effect size, .532).

Qualitative Responses

By using the grounded theory, salient themes were identified from the patient responses. These are presented here.

Sitting Without Support. All the participants stated that they could sit without support; however, if the height of the seat from the floor varied, then 12% and 8% of the participants from the control and experimental group, respectively, reported they had difficulty getting into and out of the chair. These percentages did not change in the posttest interview.

Eating. Twelve percent of the control group and 8% of the experimental group needed assistance with their "food being

Table 4. *Summary PASS and BBS measurements by group*

	Control Group, mean (SD) (n = 25)	Experimental Group, mean (SD) (n = 25)	R^2	P
Before PASS	21.96 ± 21.41	21.52 ± 8.43		.924
After PASS	67.67 ± 28.42	80.16 ± 22.60	.221	.004
Before BBS	44.71 ± 22.24	43.43 ± 17.11		.821
After BBS	48.71 ± 23.18	59.71 ± 18.20	.952	<.001

PASS = Postural Assessment Scale for Stroke Patients; BBS = Berg Balance Scale; SD = standard deviation.

cut up" when eating. No changes were reported in the posttest interview. None of the participants had problems with chewing or swallowing food.

Dressing. Forty-four percent of the participants from the control group and 56% of the experimental group reported degrees of difficulty with dressing. Some needed total assistance, whereas others were unable to fasten "buttons," "zips," or "tie shoe laces." In the posttest interview, 4% and 45% of the control and experimental groups, respectively, verbalized that their dressing had become easier and more independent.

Perceptions of Stability and Balance. Eighty-eight percent and 80% of the control and experimental groups, respectively, stated that their balance when they walked and stood was poor, and verbalized that, since the stroke, "they are less confident when walking as they lose balance very often." In the posttest interview, 56% and 96% of the participants from the control and experimental groups, respectively, reported a "great improvement" in their standing balance. The participants reported "stumbling" and "forgetting about the stroke side" as their biggest hurdles when performing daily activities. Balancing during activities such as sitting down and standing up from a toilet and getting into and out of a bath or shower posed a problem for 76% of the participants from both groups in the pretest interview. However, after the physiotherapy or stability and balance intervention programs, 20% and 72% of the control and the experimental groups, respectively, reported an overall improvement in their balance regarding daily activities.

DISCUSSION

Our study sought to compare the effects of a regular program of physiotherapy with one focused on stability and balance exercises in a resource-poor setting. The participation rate was 100%, which suggests that patients were willing to attend outpatient rehabilitation, despite obstacles imposed by poverty. The setting was a health district that was originally provided as a low-cost housing scheme for economically challenged people of Indian descent under the "apartheid era" of South Africa. Since South Africa's democracy in 1994, the district became populated by people of all races of low socioeconomic status but was still predominantly Indian. The majority of the district's population rely on health care provided by the state, age or disability pensions, and family members who go out to work to sustain the household. As such, support by family members toward functionality, attendance to rehabilitation visits, and compliance with home programs is minimal and/or scarce. As stated by Wasserman et al [14], some patients die within 3 months after discharge (30%), some are lost to follow-up (approximately 10%), and the remainder may seek rehabilitation if accessible.

The demographic profile of patients in our study was similar to that reported in other studies in terms of age [12,23,24]. The higher participation by Indian South Africans could be attributed to the location of the community-based therapy center, which was more accessible to the participating race group. The prevalence with increasing age in the other populations is similar to our finding. Connor [25] reported that stroke incidence is higher in the 35-54 years old age group based on hospital data of black South Africans. It must be noted that stroke is also a manifestation of human immunodeficiency virus and/or acquired immunodeficiency syndrome in this age group in South Africa. Our study, which was conducted with outpatients, noted that the majority of stroke patients who reported for therapy in the study period were between 55 and 80 years of age. In the United States, approximately three-fourths of strokes occur in patients older than 65 years of age, with the risk of a stroke doubling after the age of 55 years. A similar trend has been observed in Canada and the United Kingdom. Seventy-two percent of strokes occurred in persons older than the age of 50 years [23]. Lifestyle has been suggested as a major risk factor.

Our findings concur in some respects with other studies conducted in South Africa. de Villiers et al [26] studied survivors of acute stroke in an urban community in Cape Town with limited rehabilitative resources. The median age was 60 years; the majority were women and black; and two-thirds of the patients presented with a disability at 6 months, which was associated with shack housing [26]. Wasserman et al [14] in a study of stroke patients in a rural community in South Africa also found that 70% of stroke survivors were either bed or chair bound at discharge. Analysis of the pretest PASS and BBS scores also suggests significant disability in our study cohort. Verbalizations by patients in our study suggest difficulties in eating, restrictions of function imposed by the height of chairs. Neither the PASS nor the BBS considered height of the chair or the simple aspects of stumbling and neglect as stated by the participants in this study. In the study by Wasserman et al [14], the patients were discharged to the care of families because no stroke rehabilitation facilities were available to communities. In this study, which consisted of 30 patients, approximately 50% of the 20 survivors were receiving home-based care by a caregiver and/or a physiotherapist, and were mobilizing independently despite the significant disability. The traditional physiotherapy program in our study is provided by the provincial department of health as outreach rehabilitation care in community-based facilities at least once every 2 weeks. However, only patients who are mobile with assistive devices could attend the outreach program, as seen in the profile of participants in our study. The life expectancy of South Africans, which is 59.6 years, is contaminated by the prevalence of human immunodeficiency virus, which caused 31.9% of all deaths, as revealed in the 2013 mid year population review [27]. The study by Wasserman et al [14] showed that, of a follow-up of 30 patients in a rural hospital,

by 3 months, one-third had died. It must also be noted that, in a setting such as the one in which this study was conducted, stroke survivors receive very little assistance from family members or caregivers, simply because they have to go out to work to earn a living.

Many of the South African studies on stroke were conducted in predominantly rural areas populated by blacks [1,14,25,26]. Our study was conducted in an area previously designated to South Africans of Indian origin, and, therefore, the majority of participants were Indian. The fact that 50% of participants in both groups were left dominant may be due to chance because it is estimated that only 10% of the general population is left dominant. This finding requires further investigation and follow-up.

Our results show significant improvements in both PASS and BBS items, and overall in the experimental group posttest and compared with the control group, which suggests that focused rehabilitation is important in improving critical components of neuromuscular control. Lin et al [28] indicated that postural control is the best predictor of achieving independent living, which is similar to specificity of training in sports training regimens. and is supported by our findings of significant mean percentage score improvements in the intervention group compared with the control. Although learning effects is an avoidable contaminator that affects research rigor, it is necessary to promote the physiological neuroplastic changes to improve functional components of neuromuscular control. Januario et al [6] showed that a balance training program by using feedback on a force platform improved bilateral postural stability in stroke patients. These investigators used the Biodex Stability System (Biodex Medical Systems, Inc, New York, NY) to measure balance. Chen et al [8] noted the effects of visual feedback training when using a SMART Balance Master (Neurocom, Clackamas, OR) on static and dynamic balance function and activities of daily living in stroke patients. They concluded that balance training was beneficial based on significant outcomes in the trained group. Geiger et al [7] applied a balance training intervention by using a NeuroCom Balance Master (Neurocom) for 4 weeks and did not find any significant difference in the improvements between the control and experimental groups.

To support the motor learning basis of our study, Mulder [11] believes that the motor learning theories of adequate feedback, variability of practice, and visual feedback effected significant improvements in the experimental group of stroke patients at 6 months of follow-up. The value of practice in motor learning was validated by Hocherman and Dickstein [4] who noted the importance of regular training on stability of stance in patients who were hemiplegic. Our intervention program focused on repeated practice of functionally oriented stability and balance exercises, which was reinforced by the request to perform the exercises at home.

Improvements were noted in the experimental and control groups. The participation rate in our study, together with compliance with their home programs (not quantified) and the fact that the majority of the participants in our study were mobile by using either a quadripod or an elbow crutch may suggest that, in a resource-poor setting, patients are willing to access any assistance that is available to improve their functional status in addition to spontaneous recovery. Other investigators [12] also found improvements in the control groups that were attributed to spontaneous recovery. The minimal improvement in the control group was disappointing because this is the minimal standard of care afforded to patients in rural and community settings in this country. The findings of this study will be shared with the Provincial Department of Health to ensure modifications in the minimal standard of care afforded to patients in communities. Analysis of the findings of Leroux [15] and Bayouk et al [13] suggests that balance senses have to be specifically targeted when designing balance-retraining programs for subjects who are hemiparetic. Bayouk et al [13] compared the effects of a task-oriented exercise program with and without altered sensory input on postural stability in stroke. They found that the standing balance of stroke patients in the experimental group improved more than that in the control group.

The quantitative data were supported by qualitative responses by the participants about the impact of the program on other aspects of their function, such as eating, dressing, and so forth. In both groups, the participants noted improvements. However, some activities, for example, transfers, were difficult to perform. On the basis of qualitative responses and critical review of the exercise programs in this study, it seems important to introduce variability in the practice of functional exercises and adapt them to particular home settings. This is especially important where family support is minimal.

Limitations

The strength of this study could have been improved by a larger sample size. In addition, the dependant variables could have included quality of life, socioeconomic status, and family support. Compliance with the home program could have been monitored more stringently, even though, in a setting such as this, caregivers or family members are themselves limited by the resources they could provide.

CONCLUSION

An exercise program that focused on stability and balance exercises improved balance, stability, and subjective feelings of outcome compared with the regular physiotherapy program for stroke patients in this study. This finding has implications for functional improvements, including participation and quality of life of people living with a stroke. This finding could also be useful in the design of programs of

therapy in resource-poor settings and home programs in an effort to improve quality of life in this sector of patients.

REFERENCES

1. Bryer A, Connor M, Haug P, et al. South African guideline for the management of ischaemic stroke and transient ischaemic attack: 2010. A guideline from the South African Stroke Society (SASS) and the SASS Writing Committee. S Afr Med J 2010;100:750-788.
2. Bradshaw D, Schneider M, Norman R, Bourne D. Mortality patterns of chronic diseases of lifestyle in South Africa. In: Steyn K, Fourie J, Temple N, eds. Chronic diseases of lifestyle in South Africa 1995-2005. Tygerberg, South Africa: MRC; 2006, 15.
3. Yavuzer G, Eser F, Karakus D, Karaoglan B, Stam IJ. The effects of balance training on gait late after stroke: A randomized clinical trial. Clin Rehabil 2006;20:960-969.
4. Hocherman S, Dickstein R. Platform training and postural stability in hemiplegia. Arch Phys Med Rehabil 1984;65:588-592.
5. De Haart M, Geurts AC, Huidekoper SC, Fasotti L, van Limbeek J. Recovery of standing balance in post-acute stroke patients: A rehabilitation cohort study. Arch Phys Med Rehabil 2004;85:886-895.
6. Januario F, Campos I, Amaral C. Rehabilitation of postural stability in ataxic/hemiplegic patients after stroke. Disabil Rehabil 2010;32:1775-1779.
7. Geiger RA, Allen JB, O'Keefe J, Hicks RR. Balance and mobility following stroke: Effects of physical therapy interventions with and without feedback/forceplate training. Phys Ther 2001;81:995-1005.
8. Chen IC, Chen PT, Chen CL, Chen SC, Chung CY, Yeh TH. The effects of balance training on hemiplegic stroke patients. Chang Chung Med J 2002;25:583-590.
9. Bonan IV, Colle FM, Guichard JP, Viacut E, Eisenfisz M, Tran Ba Huy P, et al. Reliance on visual information after stroke. Part I: Balance on dynamic posturography. Arch Phys Med Rehabil 2004;85:268-273.
10. Tyson SF, Hanley M, Chillala J, Selley A, Tallis RC. Balance disability after stroke. Phys Ther 2006;86:30.
11. Mulder TA. Process oriented model of human motor behaviour: Towards a theory based rehabilitation approach. Phys Ther 1991;71:157-164.
12. Geurts AC, de Haart M, van Nes IJ, Duysens J. A review of standing balance recovery from stroke. Gait Posture 2005;22:267-281.
13. Bayouk JF, Boucher JP, Leroux A. Balance training following stroke: Effects of task oriented exercises with and without sensory input. Int J Rehabil Res 2006;29:51-59.
14. Wasserman S, de Villiers L, Bryer A. Community-based care of stroke patients in a rural African setting. S Afr Med J 2009;99:579-583.
15. Leroux A. Improvements in balance and mobility after exercise training in elderly individuals with stroke. Arch Phys Med Rehabil 2002;83:1492.
16. Garland SJ, Willems DA, Ivanova TD, Miller KJ. Recovery of standing balance and functional mobility after stroke. Arch Phys Med Rehabil 2003;84:1753-1759.
17. Lloyd-Sherlock P. Stroke in Developing Countries: Epidemiology, Impact and Policy Implications. School of International Development, University of East Anglia; 2009. Available at https://www.uea.ac.uk/polopoly_fs/1.133457!Stroke%20in%20developing%20countries.pdf. Accessed July 24, 2014.
18. Kuipers P, Doig E. Community-based rehabilitation. In: Stone JH, Blouin M, eds. International Encyclopedia of Rehabilitation. Available at http://cirrie.buffalo.edu/enclopedia/en/article/362/. Accessed July 24, 2014.
19. Rhoda A, Mpofu R, De Weerdt W. The rehabilitation of stroke patients at community health centers in the Western Cape. S Afr J Physiother 2009;65:1-6.
20. Bateman C. "One size fits all" health policies crippling rural rehab-therapists. S Afr Med J 2012;102:200-206.
21. Steyn K, Fourie J, Temple N, eds. Chronic diseases of lifestyle in South Africa 1995-2005. Tygerberg, South Africa: MRC; 2006.
22. Mao H, Hsueh I, Tang P, Sheu C, Hsieh C. Analysis and comparison of the psychometric properties of three balance measures for stroke patients. Stroke 2003;34:1741-1745.
23. Maron BJ, Olivotto I, Bellone P, Conte MR, Cecchi F, Flygenring BP, et al. Clinical profile of stroke in 900 patients with hypertrophic cardiomyopathy. J Am Coll Cardiol 2002;39:301-307.
24. Alan S, Go AS, Mozaffarian D, Roger VL, et al. on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics — 2013 update: A report from the American Heart Association. Circulation 2013;127:143-152.
25. Connor MD. A Racial and Urban-Rural Comparison of the Nature of Stroke in South Africa [doctoral thesis]. Johannesburg, South Africa: University of the Witwatersrand; 2007. Available at wiredspace.wits.ac.za/bitstream/handle/10539/5030/M%20D%20C. Accessed January 14, 2013.
26. de Villiers L, Badri M, Ferreira M, Bryer A. Stroke outcomes in a socioeconomically disadvantaged urban community. S Afr Med J 2011;101:345-348.
27. Statistics South Africa. Mid-year population estimates. 2013. Available at http://www.statssa.gov.za/publications/P0302/P03022013.pdf. Accessed July 10, 2013.
28. Lin JH, Hsieh CL, Hsiao SF, Huang MH. Predicting long-term care institution utilization among post rehabilitation stroke patients in Taiwan: A medical center based study. Disabil Rehabil 2001;23:722-730.

CME Question

Which of the following exercise programs was offered to the experimental group?

a. ball therapy with the use of a large ball for scapular movements
b. gait training with the use of robotic assisted devices
c. balance training while standing on one leg and raising the other to a stair
d. standing exercises while throwing a ball with both arms

Answer online at me.aapmr.org