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Design and Implementation of a Home-Based Exercise Program Post-Hip Fracture: The Baltimore Hip Studies Experience

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Abstract

Objective—The objectives are to describe for the first time a home-based exercise intervention for frail elderly hip fracture patients and to describe the feasibility of this exercise program.

Design—A home-based exercise program was used in a randomized controlled trial in which the authors investigated exercise intervention versus no exercise intervention in patients after hip fracture.

Setting—This program was implemented at the patients' own home or place of residence after discharge.

Participants—Women 65 years of age or older were recruited within 15 days of hip fracture. Eligible patients were those with a nonpathologic fracture who were admitted within 72 hours of injury, had surgical repair of the hip fracture, and met medical inclusion criteria. Participants initially were randomized to exercise groups and then assigned to exercise trainers.

Intervention—The exercise contained strength training and aerobic components. Participants were expected to exercise 5 days per week by performing a combination of supervised and independently performed exercise sessions. Intensity and duration were increased gradually by trainers in a standardized way. The frequency of the supervised sessions decreased as participants became more independent. Treatment fidelity visits ensured that the intervention was being delivered as intended across trainers and across participants.

Main Outcome Measurement—This work describes the feasibility and challenges of administering an intensive home-based exercise program in this population of older adults.

Results—Of those patients randomized to exercise, 82% were followed by a trainer and almost all advanced to higher levels in both aerobic and strength programs. Overall, participants received an average of 44 (78.5%) of the prescribed visits by the trainer.

Conclusions—This study showed that it was possible to engage a frail older population of post-hip fracture patients in a program of aerobic and strength training exercise with a high rate of participation.

INTRODUCTION

By the year 2030, more than 650,000 hip fractures will occur annually in older adults, and 18–33% of these individuals will die within the first year of their fracture [1]. Many of those patients surviving the hip fracture will have reduced functional performance and consequently be unable to live independently in the community [2–4]. In the year after a hip fracture, there is a loss in bone mineral density ranging from 2% to 4.6%, and a loss in muscle mass of approximately 6.5% [5–7]. These changes place individuals at increased risk for falls and subsequent fracture, as does the commonly associated decline in function and physical activity after a hip fracture.

Losses in muscle mass are associated with declines in some specific muscle groups after hip fracture. A rapid decrease in muscle strength, especially of the knee extensors and flexors, is observed during the early post-fracture period [8,9]. Aniansson and Gustafsson [10] found that older male and female hip fracture patients had a decrease in fast-twitch muscle size in the quadriceps muscle compared with a similarly aged healthy population. Fast-twitch fibers are responsible for force development in high-speed contractions and are used in tasks such as regaining balance after a near fall.

Hip abductors also are weak after fracture, and there is a significantly positive correlation between abductor strength and independent ambulation in hip fracture patients [11]. Barnes and Dunovan [11] suggest that hip abductors may be weakened as the result of the insult of hip fracture surgery and that this weakness causes biomechanical changes in gait. Finally, a previous study by the authors' group found that during the first year of recovery, female hip fracture patients who lost ankle strength in the nonfractured leg had a worse recovery of mobility compared with those who gained strength [12]. Ankle dorsiflexion strength, as well as quadriceps strength, also was found to be lower in fallers compared with non- or one-time fallers when measured in an older nonfracture population [13].

Exercise training after hip fracture is an important strategy with the potential to improve recovery and prevent a decrease in function and subsequent falls in older adults. Regular exercise, even at low levels of intensity, can improve physical fitness in older adults [14,15]. For those who have sustained hip fractures, regular exercise (resistive and/or aerobic) has been reported to improve mobility [15,16], increase walking speed, and improve quadriceps strength [17]. Helping older adults to initiate and adhere to a regular exercise program after hip fracture may have an important impact on recovery and overall quality of life.

Therefore, this study has 2 objectives, which are to describe a home-based exercise intervention for frail elderly hip fracture patients and to describe the feasibility of this exercise program. In addition, the authors provide information comparing the amount of exercise during the year after fracture between the group that received the exercise intervention (exercisers) and a group receiving usual care (non-exercisers). Data are reported from one randomized controlled trial (Baltimore Hip Study [BHS] 4), in which 180 women

were enrolled. This work focuses on the feasibility of the exercise program and the comparison made between the exercisers ($n = 91$) and the nonexercisers ($n = 89$).

METHODS

The Baltimore Hip Studies

The current research is part of the BHS, an ongoing program of research conducted by the University of Maryland in Baltimore and dedicated to identifying strategies to enhance recovery from hip fracture. Investigators in the BHS have been conducting observational studies and single-center clinical trials since 1983. The program collaborates with a network of 22 hospitals serving 5 counties that surround and include the Baltimore Metropolitan area, Washington DC, and southern Pennsylvania.

STATOOLS software [18] was used to randomize participants of BHS 4 within blocks for each hospital to eliminate between-hospital biases. Those participants randomized to an exercise group were then assigned to an exercise trainer based on their geographic location and the trainer's work load at that time.

The BHS 4 study was a randomized, controlled trial of exercise versus usual care post-hip fracture. Usual care in this study is defined as the physician prescribed post-fracture standard of care for hip fracture patients in the greater Baltimore region at the time of the study. This included relatively short hospital stays and approximately 2 to 4 weeks of rehabilitation with follow-up by the orthopedist and primary care provider. The exercise program began at the end of the physician prescribed post-acute physical therapy. The exercise sessions occurred 5 days per week, and participants received 3 trainer-supervised exercise sessions per week in their homes during their first 2 months of the study. The frequency of supervised sessions decreased so that participants received a maximum of 56 supervised sessions by the end of the protocol, 12 months after the fracture. Participants were expected to exercise 5 times per week for 45 minutes. Two sessions per week focused on strength-training exercises performed with resistive bands and cuff weights, whereas 3 sessions per week (alternating days) involved aerobic activity using a specially designed stair step with handles. A total of 180 female hip fracture patients were enrolled in BHS 4 from 1998 to 2004.

Study Participants

The participants in these studies were women 65 years of age and older. They were community-dwelling at the time of fracture and were enrolled in the studies within 15 days of their hip fracture. Eligibility was determined through a medical chart review, a medical assessment, and a cognitive screen. Eligible patients were those with a nonpathologic fracture who were admitted to a hospital within 72 hours of injury and had surgical repair of the hip fracture. Medical exclusions included the presence of cardiovascular disease, neuromuscular conditions limiting exercise (for example, Parkinson disease, amyotrophic lateral sclerosis, multiple sclerosis), respiratory conditions, diseases of the bone (such as Paget disease, osteomalacia), metastatic cancer, cirrhosis, and end-stage renal disease. Other miscellaneous exclusions were considered that would increase the risk of falling while a patient was exercising independently (such as a history of seizures, alcohol abuse, or narcotic or benzodiazepine use) or increase the risk of injury if a fall occurred (such as recent gastrointestinal bleeding or the use of Coumadin). Participants also had to be walking without human assistance (independent ambulation with or without an assistive device) before the fracture and achieve a score of ≥ 20 on the Folstein Mini-Mental State examination [19]. Institutional review board approvals were obtained from the University of Maryland and study hospitals. All enrolled participants provided their own informed

consent. A Data and Safety Monitoring Board met quarterly and reviewed all adverse events and safety reports.

Design of Exercise Program

One of the challenges of the investigative team while designing the intervention was to determine whether the exercise program would be facility-based or home-based. After reviewing the literature and considering the authors' experience with previous hip fracture patient populations, it was decided that a home-based exercise program would be most successful for this population. The advantages of such a program included increased adherence to the exercise program, because travel would not be necessary to participate, and a greater ability to individualize the program based on physical conditions and abilities.

In addition, it was thought that exercise could be initiated earlier in the post-fracture period and that placing equipment in the patient's home improved the likelihood of independent exercise between the trainer's visits and after completion of the study. An in-home program also would afford the opportunity to build a one-on-one relationship between the trainer and the patient. Finally, it would allow the trainer to advance exercise more rigorously over a longer period of time and to optimize motivation, thereby changing the exercise behavior in these individuals beyond the 12-month intervention.

The authors believed the disadvantages of a home-based program would include an initial reluctance on the part of some participants to let the trainers into their homes, cost related to trainer time and travel, and limited space for placement of the exercise equipment in their homes. An institution-based program would offer the camaraderie of group exercise and availability of institutional medical services. Research has shown, however, that home-based and group exercise programs in patients with orthopedic problems are equally effective [20]. Moreover, it was thought that the increased potential for adherence in the home-based program and ability to individualize treatment were most important and that the disadvantages could be overcome with our trained staff and the use of our self-efficacy based motivational component.

The exercise program was designed based on previous investigations of hip fracture patients, previous work with cardiac rehabilitation in a slightly younger population, and knowledge of postsurgical restrictions after various surgical procedures to repair hip fractures. The type, frequency, and intensity of exercise were designed with consideration of the American College of Sports Medicine [21] and the National Osteoporosis Foundation [22,23] guidelines for exercise in older adults. Initially, the program focused on weight-bearing, aerobic-type exercises because previous studies with older adults [24] indicated a slowing or halting of the rate of loss of bone mineral density. However, evidence for the benefits of a strength training program in facilitating ambulation and improving the ability to recover from a near fall was so compelling that a strengthening component was also added [25–31].

The exercise program was designed and carefully reviewed by 2 orthopedic surgeon consultants and a group of physical therapists who work with hip fracture patients after their surgeries. The program was then piloted in the homes of several female residents in a retirement community who were of similar age as our population and had previous history of hip fractures. Final exercise programs with descriptions and pictures for all exercises, including warm-up, cool down, and aerobic and strengthening exercises, were printed on sturdy paper and put into flip books and/or posters. The Yale physical activity questionnaire [32] was administered to all subjects at 2, 6, and 12 months after fracture.

Standardization Versus Individualization—One of the greatest challenges of the program was to balance standardization of the exercise protocol with the need to tailor

exercises to the individual patient's medical status and level of conditioning. Although each participant started at her own individual level, all participants were advanced to a higher level according to a standard protocol. Each participant was assessed during her initial visit to identify an appropriate exercise prescription. Exercise trainers documented the level, intensity, and frequency of each exercise during supervised sessions. Participants received a calendar page each month on which they were asked to record all independent exercise. Individual exercises were modified in a standard way, for consistency according to participant limitations such as physical restriction, and were documented. All participants were advanced to a higher level of exercise in a standardized manner using the same equipment.

Exercise Program

Warm-Up and Cool-Down Exercises—All sessions began and ended with a warm-up that included a set of flexibility and range of motion exercises for the upper and lower extremities. These exercises, listed in Table 1, took approximately 10 minutes to complete. Participants were given a flipbook or poster that had explanations and pictures of each exercise for use during unsupervised exercise sessions.

Strength Training—Strength training consisted of a series of 11 exercises for the upper and lower extremities with the use of exercise bands, ankle and wrist cuff weights, and a specially designed 4-inch stair step with handles on either side for support and balance (Figure 1). Participants performed these exercises at various levels (easy, moderate, advanced, and challenging). These exercises are described in detail in Table 2. Generally, the duration of each exercise was increased until the participant could do 3 sets of 10 repetitions on the right and left sides. Intensity was then augmented by increasing the resistance of exercise bands or tubes and/or adding ankle and wrist cuff weights. Specific criteria for progression of exercises are described in Table 3. Padded handles were attached to the bands for comfort for some strength exercises. Participants received either a flipbook or poster illustrating and explaining each exercise.

Aerobic Exercise—Aerobic exercise was performed on a specially designed 4-inch step with handles on either side for support and balance (Figure 1). There was non-skid material on the stepping surface and extra ballast boards along the bottom edges to prevent tipping. Duration of stepping was increased gradually with the goal of completing 30 minutes of continued stepping during each aerobic session. Once participants could perform the step exercise for 20 minutes, light ankle weights were added to increase exercise intensity. Before full weight-bearing activity, some participants did a seated march, or walking with walkers. Alternative aerobic exercise included stepping on a traditional staircase and marching in place.

Safety Assessment—Before initiation of exercise during the supervised sessions, the trainers conducted a brief medical screen including blood pressure, heart rate, observation of clammy skin, cyanosis, and documentation of any new confusion, and hip or chest pain. Criteria were established and taught to participants to indicate when it was not safe for them to exercise (Table 4). Ensuring safety and proper technique were the focus of the early post-fracture visits. After exercise, recovery heart rate and perceived exertion were measured.

The Plus or Motivational Component

In addition to the exercises, there was a self-efficacy-based motivational component. This component addressed patient education and encouragement, physiologic feedback, and cuing and self-modeling. The theoretical basis of the motivational intervention has been published previously [33].

Education and Encouragement—To educate patients post-hip fracture, a simple “Exercise After your Hip Fracture” booklet was used (available from authors upon request). The booklet reviewed the benefits of exercise for older adults who have had a hip fracture and acknowledged and addressed the barriers to exercise (such as pain, time constraints) and how to overcome them. In addition, the exercise program was taught to the participant one-on-one by the trainer. Verbal encouragement was provided through identification of individualized goals and reinforcement of progress made towards attaining them. Short-term goals focused on which exercises the individual could do, and long-term goals were individualized based on activities and goals appropriate for the participant. Examples of these were walking without an assistive device, being able to go out with family or on a trip, lifting a grandchild, or carrying a bag of groceries. Goals were written on a special Goal Identification Form and reviewed periodically with the trainer so that reinforcement could be provided and/or goals revised as appropriate. Rewards for goals achieved were given on a weekly basis (such as a pen, refrigerator magnet, pill box, magnifier, or night light).

Physiologic Feedback—The physiologic feedback intervention involved the trainer asking the participants at each supervised exercise session about any pain, fear, or fatigue that they associated with exercise. Standard interventions were implemented to decrease these unpleasant sensations and thereby facilitate increased physical activity and willingness to engage in an exercise program. Table 5 provides an overview of the techniques utilized to address these problems.

Cueing and Self-modeling—The cueing with self-modeling component of the intervention involved the use of written material in the form of a poster, a booklet, and/or large print typed pages that described exactly what exercises the participant should do. During the first trainer visit, a picture of the participant exercising (self-modeling) was taken to serve as a reminder to the participant that they were capable of doing these exercises. Follow-up pictures were taken at 6 and 12 months post-fracture to reflect progress.

An exercise calendar also was given to participants to serve as a reminder to exercise, provide cues for what exercise to do, and help the individual review their own progress and adherence to exercise. The calendar also was useful for friends, family, and other health care providers to see what types of exercise the individual was doing and to provide additional social support and encouragement.

Trainers

After the participants were randomized to the exercise group, a single trainer was assigned to a participant for the duration of the study. The subjects were assigned to a particular trainer based on their geographic location and the trainer’s work load at that time. Trainers had previous experience as physical therapy assistants or were certified exercise trainers and had experience working with older adults. All trainers were taught the Exercise Plus Program, which had been fully articulated in a protocol manual. Trainers demonstrated their ability to correctly implement the entire Exercise Plus Program in a pilot/practice situation before working individually with a participant. All trainers were CPR certified and trained in study emergency procedures.

Trainers met monthly as a group with the exercise physiologist to review all of the participants’ records and discuss any problems. Records were checked for consistency and safety in advancing a participant through different stages of the exercise protocol. In addition, changes in medical status that affected the participants’ ability to exercise were assessed, as well as changes in environmental issues, scheduling difficulties, motivational

issues, and other concerns. Finally, the trainers' workloads were reviewed and modified as needed.

The close monitoring of the intervention done by the trainers and exercise physiologist was part of a larger treatment fidelity plan implemented in these studies [34] that comprehensively evaluated study design, training providers, delivery of treatment, receipt of treatment, and enactment of treatment skills [34]. The delivery of the treatment (ie, the Exercise Plus Program) was based on 70 randomly selected home observations by 2 observers during the entire study intervention period. Checklists related to delivery of the Exercise Plus Program were used to guide the observers, one of which was a nurse researcher and one an exercise physiologist. In addition, during the monthly meeting of the interventionists with the exercise physiologist, each current participant's exercise log books were monitored to assure that the intervention was being delivered as intended.

The observations were used as an indication of adherence to delivery of the intervention across all of the treatment groups. As appropriate, after the observations, feedback to the interventionist was provided and ranged from specific exercise intervention techniques to reminders to use the exercise calendars, review the exercise booklets, or incorporate verbal encouragement. In so doing deviations from the proposed intervention were addressed and corrected immediately.

RESULTS

Data from the BHS 4 are presented in this section to provide a description of the patient population as well as to demonstrate the willingness of these patients to participate in this type of exercise program. Of the BHS 4 female hip fracture admissions (1276) to the study hospitals, 243 (19%) were eligible for the study, and 180 (74%) of those eligible consented to participate. Ninety-one subjects were randomized to the exercise group and 89 to the nonexercise group. The mean age of the participants was 82 years (range, 66 to 100 years). Among the participants, 94% were white, and 93% had at least an 8th-grade education. The majority of the participants were admitted with intertrochanteric (43.3%) and femoral neck (36.7%) fractures with the remainder of the fractures located in the subcapital (11.7%), subtrochanteric (3.9%), intracapsular (2.8%), and femoral neck base (1.7%) regions of the hip. Table 6 shows the types of surgery received.

At the time of discharge from the acute care site, patients went home, or to skilled nursing homes, rehabilitation hospitals (transitional care units), or assisted living facilities (Table 6). Of the intervention participants, 41 started exercising before 60 days and 51 subjects started exercising before their actual 2-month measurement. Participants were followed at their discharge location and the average time to initiate exercise was 67.8 days (range, 25 to 203 days) after fracture.

Of the 91 subjects randomized to the exercise program, 75 (82%) were actively followed by a trainer and 16 (18%) refused the first visit by the trainer or any further participation in the study. Only 1% refused further participation in the program once they received visits by the trainer. The average number of visits for all those randomized to receive exercise was 36.2 (65%); however, if the participant received at least one trainer visit, the average number of visits the participants received was 44 visits (78.5%) of the possible 56 trainer visits over the post-fracture year. Missed visits were mostly the result of acute illnesses, traveling, schedule conflicts, and rehospitalizations. No serious exercise associated events occurred while the participants were engaged in the exercise program during the course of the 12-month study intervention.

Treatment fidelity visits were performed by 2 investigators on 5 different exercise trainers. Trainers were observed a total of 70 times. Adherence to the delivery of the intervention was 91%, and 92% of participants demonstrated evidence that they received the intended intervention during these observations.

At baseline, exercisers were similar to nonexercisers in all of the demographic variables measured (Table 6). As measured by the Yale physical activity questionnaire, exercise participants tended to report that they spent more time exercising at 2, 6, and 12 months post fracture than non-exercisers, but this trend did not reach significance ($P = .08$). However, the number of kilocalories expended while exercising as reported on the Yale, was significantly higher than non-exercisers at all time-points measured ($P = .03$).

DISCUSSION

Hip fractures in older adults have a substantial impact on morbidity, mortality, and cost to the individual and society [35]. Unfortunately, it is anticipated that the numbers of individuals who sustain hip fractures will increase given the current demographics. For older adults who are provided with traditional treatment post-hip fracture, there is on average a 25% reduction in life expectancy, a high likelihood of remaining in nursing facilities, and an average cost of \$26,900.00 in the first 6 months after fracture [35]. In addition, the hip fracture is perceived by many individuals as a stressful life event [36] and has a substantial impact on quality of life [37]. The authors believe that interventions such as the Exercise Plus Program not only improve recovery from hip fracture but could help older women post-hip fracture to use this event to change health behaviors focused on optimizing bone and muscle such as exercise.

This exercise intervention was designed in an effort to maximize participation by older hip fracture patients. Design elements such as the one-to-one trainer to subject ratio, selection of a home-based program to eliminate the burden of traveling to a facility, the variety and multiple benefits of including both aerobic and resistance exercises, and the focus on strengthening self-efficacy and outcome expectations related to exercise were all anticipated to help these individuals not only initiate exercise immediately after hip fracture but to adhere to a regular exercise program for the remaining year and beyond.

The one-on-one relationship of the trainer to the subject provided maximum opportunity for trainers to individualize exercise programs, learn the personalities and physical abilities of subjects, and provide motivation and encouragement to not only continue but to increase intensity and amount of exercise. However, the administration and oversight of a one-on-one exercise program compared with exercise in a bigger group setting may be more labor and time intensive. During monthly meetings with the trainers and an investigator exercise physiologist, a month's worth of exercise logs for all subjects were reviewed and discussed to assure that patients' exercise programs were being progressed in a standard fashion. Quarterly treatment fidelity visits for each trainer assured that exercises were being administered in a safe and technically correct manner by all trainers.

BHS 4 showed that those subjects receiving the exercise intervention exhibited an increase in the amount of exercise compared with those in the nonexercise group. To determine whether the exercise program alone caused this improvement or whether it could be attributed, at least in part, to the motivation subjects received from their trainer visits, we conducted another study (BHS 5). The 2 studies, BHS 4 and BHS 5, occurred concurrently.

The BHS 5 study also was a randomized, controlled trial and had a 2-by-2 factorial design. The factors were the presence or absence of an exercise trainer, and whether or not the Plus component, a self-efficacy-based motivation intervention, was used. In contrast to BHS 4,

participants of BHS 5 received a maximum of 38 supervised sessions by 12 months after hip fracture. The content, timing, and frequency of exercise activities were the same as in BHS 4. A total of 208 female hip fracture patients were enrolled in the BHS 5 trial from 2000 to 2004 [38]. The BHS 5 investigators found no differences in any of the indices of recovery as a function of the exercise intervention and/or the motivation intervention [39].

On the basis of knowledge gained from the authors' previous 15 years of experience in studying the hip fracture patient, the research team designed a home-based program consisting of a combination of supervised and unsupervised exercise. Only a small number of studies have been conducted that examine the effect of both facility- and home-based exercise after hip fracture [17,29,40–45]. A wide range of rates of adherence to and drop out from these programs has been reported. Differences in the type and duration of the exercise programs, the time in which they were administered in relation to the time of fracture, and differences in patient populations studied are all possible reasons for the reported variety of adherence and dropout rates.

Five studies of facility-based, supervised exercise programs for hip fracture patients have been reported [17,40,41,43,44]. They all involve some type of resistance exercise and vary in duration from 2 weeks [44] to 18 months [43]. Subjects in both Nicholson's and Sherrington's studies also lived in the facility in which the exercise was conducted. Drop-out rates from these programs ranged from 4% [44] to 19% [40] and adherence from 87% [40] to 96% [17,44].

Home-based exercise programs for hip fracture patients vary in the amount of supervision and instruction that patients receive. Sherrington and Lord's population [29] received initial testing and exercise prescription then performed self administered exercise with periodic follow-up visits. Hip fracture patients in studies by Mangione et al [42] and Tinetti et al [45] received up to 2 to 3 weekly home exercise sessions administered by physical therapists. Home-based exercise programs varied in length from 12 weeks [42] to 6 months [40,45] and comprised flexibility exercises [40], physical and functional therapy [45], weight-bearing activity [29], and 2 groups performing either aerobic or resistance exercise [42]. Drop-out rates in these studies ranged from 5% [29] to 21% [42] and adherence was 77% [45] to 131% in the study by Binder et al [40], in which her patients exceeded the amount of exercise prescribed.

In comparison, the program described here was home-based with patients doing a combination of supervised and unsupervised exercise. The duration of the program, approximately 10 months, was longer than any of the other home-based programs. The number of home visits per week was comparable to that in the studies of Mangione et al [42] and Tinetti et al [45], although the total number of visits was substantially greater in the current study, a maximum of 56, compared with 20 in Mangione's study and up to 24 in Tinetti's study. Unlike any of the programs undertaken previously, the program discussed in this article included flexibility, resistance, and aerobic types of exercises performed by all of the exercise subjects. In the current study, the drop-out rate of 18% (the percentage of people who were randomized to the exercise program but refused to participate after enrollment) and adherence rate of 78% (completion of 44.5 of the maximum 56 exercise visits) compared favorably with other home-based or community-based exercise programs for hip fracture patients.

There were special challenges to motivation for older adults who sustained a hip fracture. Addressing pain post-fracture and fear of future falls and trauma were particularly important. A major emphasis of the Plus program was to teach these individuals about the importance of exercise and to help them overcome the challenges they faced related to

participation in a regular exercise program [46,47]. Qualitative findings supported the benefit of the Plus program as participants appreciated the written instructions, identification and articulation of goals, and the rewards and recognition of goal achievements, in addition to the support and encouragement they received from the trainers [48].

CONCLUSION

During the design phase of this study, some experts in the field doubted that it would be possible to get such a frail older population to participate in any form of exercise, especially after a hip fracture. The results shown here indicate that it is possible to develop and implement a home-based exercise program for frail older adults after hip fracture. The rate of participation in and enjoyment of the program was high, and patients often complained when it was time for the exercise trainer to decrease the frequency of his or her exercise visits. As the study progressed, the authors of this study continued to learn about the program's usefulness in a frail older population and about the potential future usefulness of similar programs in other populations.

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Figure 1.
Four-inch stair step with handles on either side for support and balance.

Table 1

Exercise Plus Program: Flexibility exercise for warm-up and cool-down exercises

Type of Exercise	Description
Deep breathing	Raise your arms slowly above your head while taking a deep breath. Lower your arms slowly while exhaling [repeat 3 times].
Shoulder rolls	Roll your shoulders forward 5 times and backward 5 times.
Arm swings	Swing your right arm forward in small circles 5 times and then backward 5 times. Do this with your right and then left arm.
Body side stretch	Place your left hand on your hip and extend your right arm over your head with your palm down (or palm up for a challenge) and bend toward the left [repeat 3 times]. Repeat this on the opposite side by placing your right hand on your hip and extending your left arm over your head with your palm down and bending to the right.
Stomach crunch	Sit up in a chair and tighten your stomach muscles while pushing your lower back into the chair. Hold this for 3 seconds [repeat 3 times].
Ankle pumps and circles	While seated, lift your right leg straight in front of you about 2 inches off the floor. Point your toes to the ceiling and then to the floor [repeat 5 times]. Now rotate your foot clockwise 10 times and counter-clockwise 10 times. Repeat the same exercise using your left leg.
Shoulder shrugs	While seated, lift your shoulders up and down slowly 10 times.
Back and chest stretch	Stretch your arms out in front of you and cross them giving yourself a big hug. With each hand, reach for your shoulder blades and hold this for 3 seconds. You should feel the stretch between your shoulder blades. Now uncross your arms and stretch those elbows out to the sides trying to jab someone with your elbows! Again, hold for 3 seconds. You should feel this stretch across your chest [repeat this 5 times].
Knee extension	Sit in a chair with both feet on the floor. Raise your right leg 45° (not quite as high as straight out in front of you). Keep your toes pointed to the ceiling. Repeat this 10 times alternating the right and left leg.
Calf stretch	Place your hands on the grab bar of the stair step or against the wall, and put your right heel on the floor about 4 inches in front of your left foot and lean forward slightly so you feel a stretch in your left calf. You must keep your left heel on the floor. Hold this for 3 seconds and repeat it 3 times. Now switch legs and lean forward on your left leg stretching your right calf. Again, hold for 3 seconds and repeat 3 times.
Leg stretch	Standing up, hold onto the grab bar of your stair step and bow forward slowly at the waist to no more than 90°. Keep your knees straight and stomach muscles tight. You should feel the stretch in the back of your thighs. Hold for 3 seconds and repeat 3 times.

Patient instructions: Do these exercises before and after your strengthening and aerobic exercise. They will increase your flexibility and may help to prevent future falls. Try to do these standing if you can, otherwise you may sit.

Table 2**Strengthening exercises**

Exercise	Description
Stair step	<p>[EASY] Sit in a chair and march in place for 1 minute.</p> <p>[MODERATE] Hold onto the grab bar of your stair step and step up and down for 1 minute.</p> <p>[CHALLENGING] Do the same exercise as the [MODERATE] exercise but put ankle weights on.</p> <p>[ADVANCED] Standing with your back to the wall, press your lower back into the wall. Bend your knees and hold yourself in a sitting position counting to 10. Now straighten your legs slowly.</p>
Leg lifts	<p>[EASY] Sit in a chair with your feet flat on the floor, then lift the toes of your right foot toward the ceiling until your knee is at about a 45° angle. [Perform a total of 10 leg lifts]. Work up to 30 lifts with each leg.</p> <p>[MODERATE] Sit with your feet flat on the floor and lift your right toes to the ceiling so your knee is straight. Repeat this 10 times. Now lift your left leg so your knee is straight and repeat this 10 times. Work up to 30 lifts with each leg.</p> <p>[CHALLENGING] Do the same exercise as the [MODERATE] exercise but put ankle weights on.</p>
Knee bends	<p>[EASY] Hold on to the grab bar of your stair step and reach your right leg behind you and touch your toe on the floor. Repeat this 10 times with your right leg and 10 times with your left leg touching your toe to the floor each time. Work up to 30 with each leg.</p> <p>[MODERATE] Hold on to the grab bar of your stair step and bend your right knee 45°, or so your heel is moving toward your bottom but only a quarter of the way there. Hold this and lower it slowly. Repeat this 10 times with the right leg and then 10 times with the left. Work up to 30 with each leg.</p> <p>[CHALLENGING] Do the same exercise as the [MODERATE] exercise adding ankle weights.</p>
Hip muscle exercises	<p>[EASY] Hold onto the grab bar of your stair step with your left hand, stretch your right leg out to the side and point your toe on the floor. Do this 10 times with the right leg, and then switch sides and stretch your left leg out to the side 10 times. Work up to 30 with each leg.</p> <p>[MODERATE] Hold on to the grab bar of your stair step with your left hand. Raise your right leg to the side 45° and hold it, and then lower it slowly. Make sure you keep your trunk straight and do not lean your body over the stair step. Repeat this 10 times with the right leg, rest and then 10 times again with the right leg. Repeat this with the left leg. Work up to 20 with each leg.</p> <p>[CHALLENGING] Do the same exercise as the [MODERATE] using ankle weights.</p>
Stair dips	<p>[EASY] Lie on your back and put the small exertube (exercise tubing) loop around your feet and try and push your legs out feeling the resistance of the tubing. Hold this for 10 seconds.</p> <p>[MODERATE] Stand on the stair step and imagine that you are going down a flight of stairs while holding onto railings on both sides. Hold onto the grab bars with both hands and lower your “bad” leg down to the floor so that your foot is flat on the ground while your other leg is still on the top step above it, and then bring your foot back up to the step. Repeat this 10 times with the “bad” leg and then switch and do it 10 times with the other leg. Work up to 20 on each leg.</p>
Ankle flexion exercises	<p>[EASY] While seated with your right knee extended, point the toes of your right foot to the floor and then to the ceiling. Repeat 10 times with the right foot, and then 10 times with the left foot. Work up to 20 times with each leg.</p> <p>[MODERATE] While seated put a cuff weight around your foot and do the EASY ankle flexion exercise.</p> <p>[CHALLENGING] Loop a 24-inch exercise band around a sturdy chair or table leg. Sit on the floor with your legs straight in front of you and the loop of the exercise band around the top instep of your foot. Now flex your foot by pulling the band toward your body. Repeat this 10 times on each leg, and then repeat again flexing 10 times on each leg.</p>
Standing toe raises	<p>[EASY] While standing on the floor and holding the grab bars of your stair step with both hands, roll up onto the balls of your feet, lifting your heels off the ground and keeping your knees and your back straight, and then roll down slowly. Repeat this 10 times, take a rest and repeat it 10 times.</p> <p>[MODERATE] Same exercise as EASY adding ankle cuff weights progressively. Start with a half-pound weight on each ankle. Once this exercise can be done for 3 sets of 10 repetitions each, for 2 consecutive weeks, add another half pound to each side.</p>
Biceps exercises	<p>[EASY] While sitting, hold your right arm down by your side with your palm up and grab a hand weight (1, 1.5, or 2 lb). Bending your elbow, bring the weight up to your shoulder. Do 3 sets of 10 elbow bends. Now repeat this exercise with your left arm.</p> <p>[MODERATE] While sitting, hold on to the handle of your yellow exercise band in your left hand with your palm up, and place the knot of the band under your right foot. Stretch the band by pulling the handle upward toward your shoulder, bending your elbow. Do this exercise 10 times with your left arm and then 10 times with your right arm,</p>

Exercise	Description
	resting in between. Now repeat this whole series 2 more times taking a rest in between. Work up to a total of 30 with each arm.
	[CHALLENGING] Do the same as the moderate exercise but use a different color (red) exercise band.
Shoulder raises	[EASY] While sitting, hold the tan exercise band handle in your left hand with your palm facing down and the knot still under your right foot, keep your elbow straight and bring your arm as far up toward the ceiling as you can. Hold this for 5 seconds. Repeat this exercise 10 times with your left arm and then 10 times with your right arm. Repeat this whole series 2 more times. Work up to a total of 30 with each arm.
	[MODERATE] Do the same exercise as the [EASY] exercise, only use a yellow exercise band.
	[CHALLENGING] Do the same exercise as the [EASY] exercise, only use a red exercise band.
Triceps exercises	[EASY] Sit with your feet shoulder width apart and flat on the floor. With your arms raised up to shoulder height, bend your elbows, make fists and place your fists on your chest. Now stretch your arms out to the sides as far as you can by straightening your elbows. Repeat this exercise 10 times going hands apart, hands together.
	[MODERATE] Do the same exercise as the [EASY] one, only hold a yellow exercise band. Holding the band raise your arms to shoulder height, bend your elbows, and place your fists (holding the band) on your chest. Now stretch your arms out to the sides as far as you can by straightening your elbows and stretching the exercise band between your hands. Go hands apart and hands together 10 times. Repeat this 2 more times. Work up to 30 times.
	[CHALLENGING] Do the same exercise as the [MODERATE] exercise with a red exercise band.
Rowing exercises	[EASY] Sit in your chair with your feet on the floor. Put both arms out in front of you with your palms facing the ceiling. Bend both elbows, bringing your hands toward your chest, and then straighten your elbows. Straighten and bend your elbows 10 times. Take a rest, and repeat this 2 more times, resting in between sets of 10. Work up to 30 times.
	[MODERATE] Sit in your chair with your feet on the floor. Use the exercise band that has no handle. Put the knot under both feet and hold the other side of the loop in both hands with your palms facing the ceiling. Beginning with your arms straight, bends both elbows, bringing your hands toward your chest, and then straighten your elbows. Straighten and bend your elbows 10 times. Take a rest, and repeat this 2 more times, resting in between sets of 10. Work up to 30 times.
	[CHALLENGING] Do the same exercise as the [MODERATE] exercise with a different color exercise band.

Table 3**Criteria for progressing the level of exercise for strength training**

Exercise	Guidelines for advancing the exercise
Stair step	If the participant can do this exercise unweighted for 10 repetitions, have her rest and then try to repeat it with the 1-lb ankle weight. If she can do 5 to 10 repetitions with the 1-lb ankle weight on the second set of this exercise, have her rest and repeat with the 1.5- or 2-lb ankle weight. If she can do 5 to 10 repetitions with this weight, use the 2-lb weight at the moderate level for the first 2 weeks of exercise. Next, move to the advanced level of this exercise. The advanced exercise involves standing with your back to the wall and pressing your lower back into the wall. Knees should be bent slowly to a sitting position and held for a count of 10 then straightened. Participants should work up to 1 set of 10 repetitions.
Leg lift	<p>The participant should be able to complete 1 set of 10 repetitions in order to do this exercise at the moderate level. If she cannot, she should be moved back to the easy level. If the participant can do 1 set of 10 repetitions easily at the moderate level, then the 1-lb weight should be put on for the second set. If the participant can easily do up to 5 repetitions of the exercise with this weight on, then she would do this exercise at the moderate level with the 1-lb weight. If she can do a full second set of 10 exercises with that ankle weight, then the next level of ankle weight can be tried for the third set. The participant should probably not do this exercise with more than 1.5-lb weights for the first 2 weeks of exercise.</p> <p>When a participant can do 3 sets of 10 repetitions of this exercise with the 3-lb weight, then she can be moved to the advanced level. For the advanced level, the participant should be started with the yellow exercise band and for the first 2 weeks. The participant should be able to do 3 full sets of the exercise at a specific exercise band color before being moved up to the next level. If the participant can do exercise with exercise band at the highest resistance, then she can be transferred to a moderate resistance exercube.</p>
Knee bends	During the first session, this exercise should be done on all participants at the easy level. Once a participant can do all 3 sets of repetitions on both sides at the easy level, the moderate level should be attempted. Once the participant is able to do 3 sets of repetitions of this exercise at the moderate level, 1-lb ankle weight should be added. If the participant can easily do 1 set of 10 repetitions with the 1-lb ankle weight, then she can be moved up to the 1.5-lb ankle weight for the second set and onward.
Hip muscle exercises	When a participant is able to do 3 sets of this exercise on the easy level, then the moderate level should be introduced gradually. When the participant can do 3 sets of 10 on each leg at the moderate level, then a 1-lb weight can be added. If she can do a full set of lifts using the 1-lb weight, try a 1.5-lb weight for the second repetition. If she can do 10 repetitions of this exercise with a 1.5-lb weight, then add a 2-lb weight. At 2-week intervals weights can be added by half-pound increments.
Stair dips	Except for participants with known balance problems, all participants should begin doing the stair dips exercise at the moderate level. If a person is partial weight-bearing, then this initial exercise can only be done on the non-affected leg. Add weights as indicated.
Ankle flexion exercises	If the participant can easily do 10 repetitions with no weights, then a 1-lb weight should be added for the second set of 10. If 10 repetitions can be done for this set, then following a rest, a 1.5-lb weight should replace the 1-lb weight. If a participant can do 10 sets of repetitions with the 1.5-lb weight, then this would be her weight level for the next 2 weeks. Weight should be increased by a half pound or a pound in subsequent 2-week intervals.
Standing toe raises	The participant should be asked to do 1 set of 10 repetitions of this exercise with a rest and then a second set of 10. If she can do this successfully, then this will be her level for the next 2 weeks. If a participant cannot do 2 sets of 10 repetitions of this exercise, then the number of repetitions should be increased by 2 every 2 weeks up to where she can do 2 sets of 10 repetitions each.
Biceps exercises	<p>The participant should begin with the yellow exercise band on the moderate level and see if she can do a single set of 10 repetitions on each arm. If she can do 1 set of 10 repetitions on each arm, then she will be at the moderate level. If she can successfully do 3 sets of 10 repetitions for an entire 2-week period, then she can be progressed up to the next resistance level of exercise band.</p> <p>If she cannot do 1 set of 10 repetitions on the moderate level, then she should be moved down to the easy level. Try this with a set of 5 repetitions with the 1-lb weight. If she can do 5 or more repetitions with the 1-lb weight, that will be her level for 2 weeks and then after 2 weeks, she will be progressed up to the 1.5-lb weights. In 2 more weeks, progress to the 2-lb weights and then, test her again on the moderate level of exercise using the exercise band.</p>
Shoulder raises	All participants should be started with the yellow exercise band on the easy level. If the participant can do 1 set of 10 repetitions on each arm, then she should use the yellow exercise band. If she cannot, then she should be moved down to the tan exercise band. Once the participant has demonstrated that she can do 3 sets of 10 repetitions of this exercise using the yellow exercise band, then she can be progressed to the next color.
Triceps exercises	All participants should begin with the yellow exercise band. After the exercise is demonstrated, the participant should try to perform 1 set of 10 exercises. If she can perform 5 repetitions with the yellow band, then this would be the color band she would use on the moderate level. If she cannot do 5 repetitions, then a loop of the tan exercise band can be used. Once a participant demonstrates that she can do 3 sets of 10 repetitions at a specific exercise band level, she can be graduated to a higher resistance band.

Exercise	Guidelines for advancing the exercise
Rowing exercises	<p>If initially the participant cannot do 5 repetitions of this exercise using the tan exercise band, she should be moved down to the easy level. The participant should be able to do 2 sets of this exercise on the easy level for 2 weeks before she is once again tried with the tan band.</p> <p>All participants should try starting this exercise using the yellow exercise band on the moderate level. If the participant can do 1 set of 10 repetitions using the yellow band, then this will be her level. She will be asked to do 2 more sets of 10 repetitions. Once she can do 3 sets of 10 repetitions of a particular exercise using the yellow band, then she can progress to the next highest resistance color. If she cannot do 10 repetitions of this exercise using the yellow band, she should be given a loop of the tan band. If she can do 5 repetitions of this exercise using a piece of tan band, then she will be asked to do this exercise on the moderate level. Increase the number of repetitions by 1–2 repetitions every week using the tan band and eventually progress to where she can do 3 sets of 10 using the tan band. If she cannot do 5 repetitions of this exercise using the tan band, then she will be moved down to the easy level.</p>

Table 4

Contraindications to exercise

Reasons not to initiate exercise	Reasons to terminate exercise
A systolic blood pressure >200 or <85 mm Hg, or a diastolic blood pressure >100 or <50 mm Hg A resting heart rate <50 or >120 beats/min Clammy skin Cyanosis of lips, fingers, or extremities Evidence of a change in cognitive status or behavior (agitation) Acute hip pain that increases with weight-bearing activity or joint pain that is associated with redness, warmth, and swelling Chest pain at rest or with exercise	Chest pain Shortness of breath that does not resolve after 30 minutes of rest Dizziness Acute hip pain that increases with weight-bearing activity

Table 5**Interventions to decrease unpleasant sensations associated with exercise**

Problem	Intervention
Pain	1 Have participant take pain medication one half hour before exercise. If not effective, then in conjunction with the primary care provider, alter current medication regimen (as appropriate).
	2 Implement use of ice for 10 minutes before exercise.
	3 Educate/encourage that exercise will help reduce pain and that exercises given will not aggravate pain.
	4 Implement relaxation techniques, guided imagery, acupuncture, massage, or other complementary treatment options.
Fear	1 Educate/encourage that exercise will prevent future falls.
	2 Educate/assure participants that they will not be asked to do exercise they are not capable of performing safely.
	3 Encourage verbalization of fears and progress from easy to more difficult exercises to build confidence.
	4 Implement relaxation techniques as appropriate.
	5 Implement guided imagery as appropriate.
	6 Implement distraction techniques.
Fatigue	1 Stress the importance of exercise to combat fatigue and improve sleep.
	2 Encourage one half hour rest period before exercise activity.
	3 In conjunction with the primary care provider evaluate for other causes of fatigue including anemia, electrolyte imbalance, drug side effects, infection, dehydration, or altered nutritional status.
	4 Educate regarding sleep patterns for older adults and ways to naturally facilitate sleep.

Table 6

Demographic variables of BHS 4 exercisers and nonexercisers at baseline

Variable	Non-Exercisers				Exercisers				Overall			
	n	Mean, %	SD	Range	n	Mean, %	SD	Range	n	Mean, %	SD	Range
Age, years	89	82.18	6.91	66.4–95.3	91	82.47	7.11	66.7–100	180	82.32	6.99	66.4–100
Race												
White	84	94.38			86	94.51			170	94.44		
Non-white	5	5.62			5	5.49			10	5.56		
Education (years)	87	12.16	3.4	1–20	90	12.53	3.72	1–20	177	12.35	3.56	1–20
Type of surgery												
Internal fixation	50	56.18			57	62.64			107	59.44		
Arthroplasty	39	43.82			34	37.36			73	40.56		
Residence at discharge												
Own home	3	3.37			2	2.2			5	2.78		
Other's home	0	0			1	1.1			1	0.56		
Nursing home skilled	28	31.46			31	34.07			59	32.78		
Hospital skilled	57	64.04			57	62.64			114	63.33		
Nursing home no rehab	0	0			0	0			0	0		
Assisted living	1	1.12			0	0			1	0.56		