Improved Functionality and Cost Savings Associated With Strength Training in High-Risk Frail Seniors –A Pilot Study

Abstract:

This pilot study compared 529 frail high-risk senior patients to 2,723 similar patients, not enrolled in the study because of capacity limitations or patient choice, to determine if strength training would have a quantifiable effect on their health care costs and functionality. The study consisted of a 12-week program utilizing two weekly 30-minute exercise sessions with eight specific resistance-training machines corresponding to the selected Rickli-Jones criteria for independent living. All patients, subjects and controls, were Medicare enrollees of a single medical group and all members participating in the study were referred to an affiliated facility solely dedicated to senior fitness.

The average percentage improvement of maximum usable strength over baseline for the enrolled patients was greater than 150% for each apparatus and in the corresponding Rickli-Jones tests of independent living. Annualized costs of the program plus hospital and SNF utilization costs averaged $784.38 for each of the 529 patients. The control group of 2,723 frail hi-risk seniors had no program costs but their annualized hospital and SNF utilization costs averaged $2,713.15 for each member. The annual cost savings from reduced hospital and SNF utilization averaged $1,928.77 per senior who participated in the strength-training program.

An additional positive aspect of this pilot study was the paucity of falls occuring in the study group compared to national data. During the training phase and an 18-month follow-up period there were only 3 falls and no fractures among this frail high-risk senior group even though it is estimated that more than one-third of people over 65 have a fall each year.

Further studies to confirm and refine these functionality and cost saving findings from strength training should be preformed on larger cohorts of patients, as should its effect on preventing falls in high-risk seniors.

Introduction

Various studies have demonstrated that senior patients involved in resistance training programs experience a rapid gain in strength[1], improvement in bone mineral density[2], improved glucose tolerance[3, 4], improved balance[5], a decreased number of falls[6] and improved depression scores.[7] In many instances, these programs have excluded patients that were classified as high-risk frail patients[8]; and in others, patients were excluded based on their use of specific pharmacological agents[9]. These exclusions seemed to emanate from concern, on the part of both patients and doctors, as to a possible injury or a worsening of the patient's primary disease process that might be associated with resistance training[10].

The fact that frail senior patients comprise fifteen percent of the senior population but utilize almost forty percent (40%) of all health care resources is becoming a crisis in health care delivery, for them and for society[11, 12]. A first step in addressing this emerging challenge is the acknowledgement that a reduction in muscle mass {sarcopenia} and partially reversible muscle weakness might be among the most important components of frailty[13].

The purpose of this study was to determine if strength training would have a significant and quantifiable effect in high-risk frail senior patients in regard to their quality of life and health care costs, as measured by (1) improved functionality and (2) hospital and/or skilled nursing facility [SNF] utilization. This pilot study was conducted using 529 patients of the CareMore Medical Group at their affiliated facility solely dedicated to senior fitness [Nifty after Fifty].

Selection of Patients

Irrespective of their primary disease process, patients that were observed as being extremely frail were consecutively culled from CareMore Medical Group's {CMG} Comprehensive Care Clinic {CCC}, an established clinic for senior patients meeting frail high-risk criteria as described below. Clinical evaluation alone, without the use of cardiac stress testing, was used to determine participation [14, 15]. Patients with active disease {angina, heart failure, arthritis etc}, if controlled by therapy and certified as stable by independent medical evaluation {other than by the referring physician}, were not excluded. Additionally all patients referred for strength training had to score a 1.5 or greater on the Washington Probability of Risk Utilization Scale[16], indicating a high

probability of risk {Table 1}. The only exclusionary criteria were patients with specific medical conditions, as recommended by the National Institute of Aging[17], that were thought to represent a special hazard to resistance training {Table 2} and patients whose primary disease process had exacerbated more than twice during the preceding four weeks or once during the preceding two weeks. Candidates for the study were required to be sixty-five years of age or older {average age was seventy-seven years} and have pronounced muscle weakness[18]. All patients were tested using selected Rickli-Jones criteria for frailty[19] {Table 3}. Those who demonstrated severe muscle weakness were designated as having sarcopenia and given a written prescription for strength enhancement therapy at Nifty after Fifty (a CareMore Fitness Center).

Due to facility capacity this study was limited to the first 676 consecutively referred patients from the CCC who fulfilled the inclusion criteria. From this cohort, a total of 529 patients {78%} completed the program and were followed for eighteen (18) months, 68 referred patients {10%} failed to present themselves for therapy, and 79 patients {12%} dropped before completing two weeks of the program or less than four workouts. There were no patients who dropped out if they had completed two weeks of training. The no-shows and the dropouts {147 patients-22%} had indicated they simply did not want to exercise and/or they did not believe it would help them.

Table 1

Washington Probability of Utilization Risk	
Hospitalized two or more times in last year	0.9
Hospitalized one time in last year	0.7
Age 80 and older	0.8
Age 75-79	0.4
Five or more medications	0.5
Three to four medications	0.4
Impaired ability to shop, cook or feed	0.4
Self reported poor health	0.4
Self reported good health	0.2
Weight change of more than 10 lbs. in 2months	0.2
Assigned Risk Category: low < 0.6; moderate 0.6-1.5; high > 1.5	

Table 2
Exclusionary Criteria from the Pilot Study
[National Institute of Aging]

- Any new undiagnosed symptom
- Chest pain
- Irregular, rapid heart beat-fibrillation or flutter
- Severe shortness of breath
- Significant, ongoing weight loss that has not been diagnosed
- Infections, such as pneumonia
- Fever
- Acute deep vein thrombosis
- A symptomatic hernia
- Aortic aneurysm
- Foot or ankle sores that won't heal
- Persistent pain or a disturbance in walking after a fall
- Certain eye conditions, such as, bleeding in the retina or detached retina
- Six weeks after cataract surgery or a lens implant, or after laser treatment or other eye surgery

Table 3
Rickli-Jones Tests
Independent Living Criteria for Frailty

1. **30-Second Chair Stand:** Selected to reflect lower body strength, involves counting the number of times in thirty seconds that an individual can rise to a full stand from a seated position with arms crossed over chest.
2. **Arm Curl:** Selected to reflect upper body strength. Counting the number of times a hand weight can be curled from a seated position with their dominant arm. (5 lbs. For woman, 8 lbs. For men)
3. **2-Minute Step Test**: Selected to correlate with aerobic endurance. Counting the number of times an individual can step in place. The knees must be raised to a height halfway between the iliac crest and the middle of the patella.
4. **Chair-Sit-and-Reach:** Selected to measure lower body flexibility. Patient sits on the edge of a chair with one leg straight out in front of the hip, with foot flexed and heel resting on the floor. Patient reaches forward as far as possible and the distance (inches) from the tip of the middle finger to the dorsiflexed great toe is measured.
5. **Back Scratch**: To evaluate overall shoulder range of motion. Measurement of distance or overlap between middle fingers, with one hand reaching over shoulder and one hand up middle of back.
6. **8 Foot-Up-and-Go: Selected** to evaluate power, speed agility and dynamic balance. Number of seconds required to rise from a seated position, walk 8 feet, turn and return to a seated position in the shortest amount of time.

Training Program

Training sessions of twenty to thirty minutes each were initially scheduled three times weekly {Monday, Wednesday and Friday} under direct physician supervision. During the initial three weeks of the program, several patients complained of fatigue. To alleviate this condition, the training regime were changed to twice weekly {Tuesdays and Fridays} for twelve weeks. This allowed for rest periods of forty-eight hours and seventy-two hours between workouts[20].

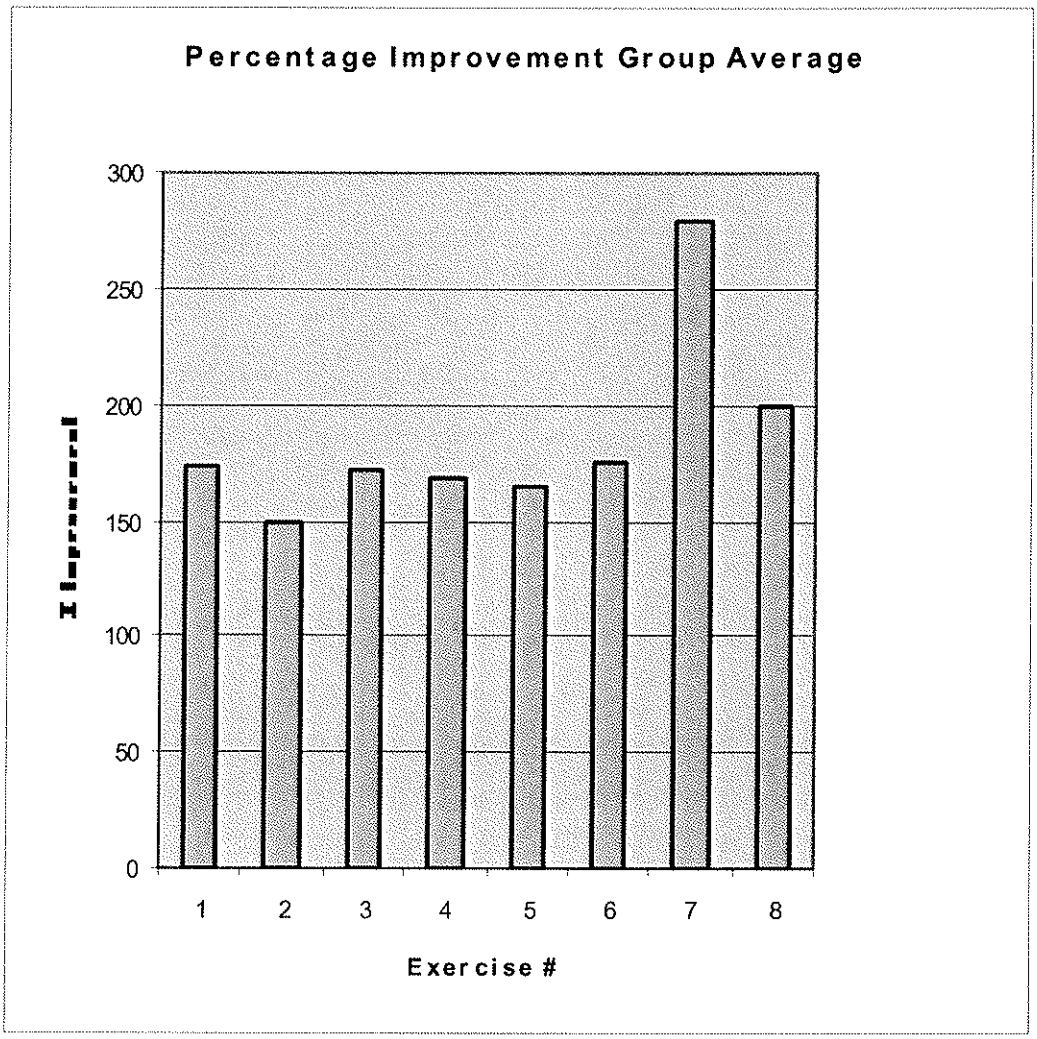
Each patient had their baseline Maximum Usable Strength [MUS], (defined by the authors as the maximum amount of resistance weight the patient was capable of utilizing per apparatus), tested on eight assorted resistance-training machines at the start of the study and every four weeks thereafter {Table 4}. Patients were trained to perform two sets of eight repetitions with seventy five percent [75%] of their MUS. Each repetition was performed to a count of three or four for the concentric and the eccentric phase of muscle activity. The number of repetitions in each set was progressively increased from eight to twelve. When the larger number of repetitions became more easily managed and as improvement in strength permitted, the resistance was gradually increased. The patients were given instructions in resistance training exercises to be utilized at home after completing the 12-week program. They were also given the opportunity to enroll in a physician supervised maintenance program that required a health club membership to be purchased at their own expense. No organized effort was made to improve aerobic exercise ability, balance, flexibility, or the nutritional habits of the patients.

Maximum Usable Strength

Average Percentage Improvement for Group over Baseline

1. Leg Extensions 173%
2. Upper Back Row 150%
3. Biceps Curl 171%
4. Triceps Push Down 168%
5. Shoulder Press 164%
6. Chest Press 175%
7. Leg Press 280%
8. Leg Curl 200%

Table 4



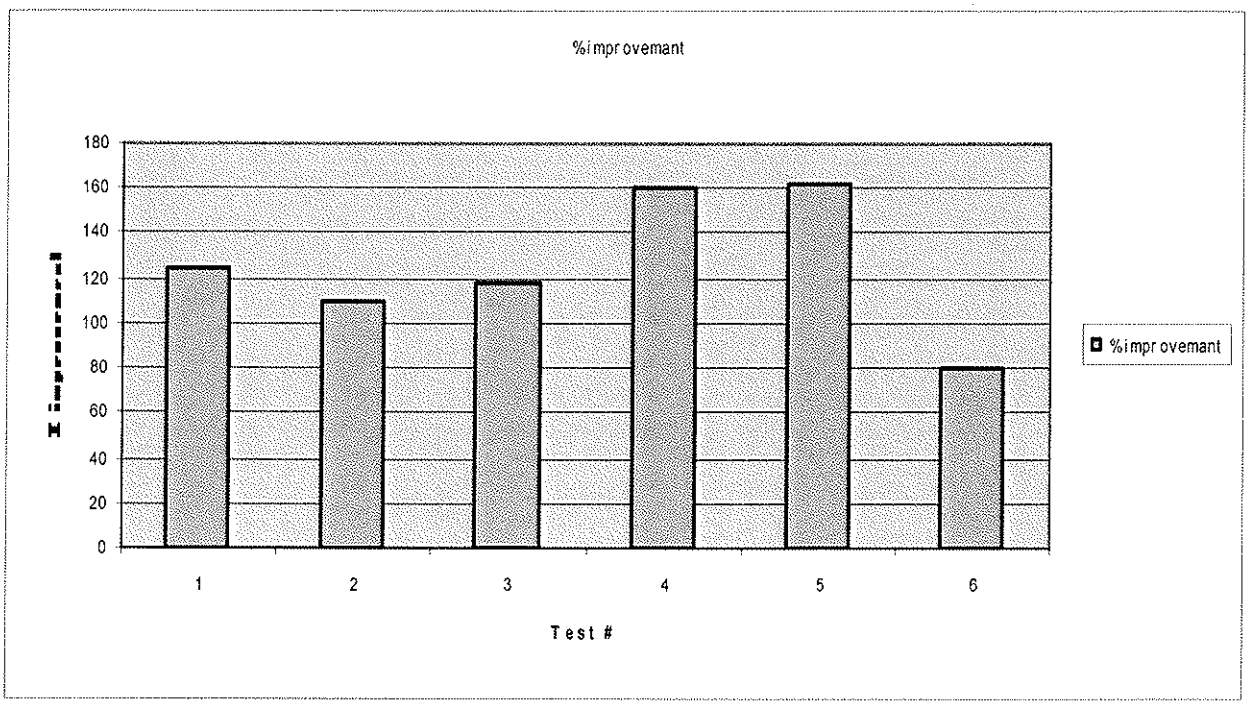
Functionality testing, using Rickli-Jones evaluations {Table 5}, was calculated at the start of the program and again at six weeks and eight weeks.

RICKLI-JONES TEST

Average percentage improvement for group over baseline.

1. Chair Stands 125%
2. Arm Curl 110%
3. 1 Minute Step in Place 118%
4. Chair Sit and Reach 160%
5. Back Scratch 162%
6. 8 Foot up and go 80%

TABLE 5



Hospital and SNF utilization by the participants was measured for a twelve month period following their having completed the program. During the same timeframe the number of hospital and SNF days was measured in 2,723 (including the no-shows and dropouts) high-risk frail senior patients, under the care of CMG, not enrolled in the pilot study and who also qualified for the program. All necessary hospital utilization data was extracted from internal claims records available from the patient-specific UB92.

Results

Changes in MUS and Functionality

As shown in Tables 4 and 5, all the patients that completed the program demonstrated a significant increase in MUS and in the corresponding Rickli-Jones tests of independent living. Most patients increased both their upper and lower body MUS and the related Rickli-Jones tests of independent living and functionality by greater than one hundred percent {Tables 4, 5}.

Program Costs and Institutional Utilization Costs

The annualized cost of conducting the program for 529 patients for twelve weeks was $332,690 [$610.00 per senior per year]. This cost included physician supervision, culling the cohort of participants, and membership fees to the fitness center. During the twelve-month follow-up period, the average cost per hospital day was $1,800.00 and the average cost per SNF day was $450.00 per day. In this period, the 529 patients who completed the program used 43 hospital days or 0.081 days per patient per year and 33 SNF days or 0.062 days per patient per year. The annualized average hospital and SNF costs were $146.31 per patient and $28.07 per patient respectively. The total annualized hospital and SNF costs plus the program cost of $610.00 per patient averaged $784.38 per patient {Chart 1}. No additional hospital or SNF days were used in a subsequent six-month follow-up period by these patients.

The 2,723 eligible high-risk patients not enrolled in the program experienced a hospital utilization of 3,113 days or 1.14 days per patient per year at a cost of $2,052.00 per patient. The SNF utilization in this cohort was 4,009 days or 1.47 days per patient per year at an annualized cost of $661.15 per patient. The total cost for these patients averaged $2,713.15 per year. [See chart 1]. The annual cost savings in the group of patients who participated in the program, as compared to those who did not, averaged $1,928.77 per patient.

CHART 1
Hospital and SNF Costs per Patient

	Hospital Days (PSPY)[1]	**Hospital Cost (PSPY)**	**Hospital Days per 1,000**	**SNF Days (PSPY)**	**SNF Cost (PSPY)**	**SNF Days per 1,000**	**Costs of Program (PSPY)**	**Total Cost (PSPY)**
Completed training-529 patients	0.081	146.31	81 per 1,000	0.062	28.07	62 per 1,000	610.00	784.38
Never enrolled-2,723 patients	1.14	2,052.00	1,140 per 1,000	1.47	661.15	1,472 per 1,000	NA	2,713.15

[1]PSPY – Per Senior Per Year

Discussion

The National Institute on Aging estimates that typically men and women lose 1% of their muscle strength each year between the ages of forty-five and sixty and that this loss increases to 1.5% a year after the age of sixty. Between the ages of fifty and seventy years, this loss will increase to 30% or more of their physical strength; and by age seventy-five, a loss of more than fifty percent would not be uncommon.

This pilot study, performed over 2 ½ years, evaluated functionality and cost savings in high-risk frail senior members of CMG after undergoing supervised strength training. CMG physicians referred all patients into the study from the frail-high-risk CCC after being further assessed as high-risk to utilize hospital resources. These seniors were then referred to a single CMG affiliated facility for resistance training and medical supervision. Only CMG patients, referred by a formal written prescription were entered into this study. Other frail senior patients from CMG, who were not entered into the study, due to facility capacity limitations, served as a control group.

The components of most wellness programs include aerobic exercise, stretching exercises, resistance training, balance training, and nutritional guidance. While all of these are meritorious, resistance training has traditionally received the least emphasis. The sole focus of this study was to evaluate the effect of strength training therapy on frail senior patients. No intervention was employed to affect any other aspects of wellness.

It is apparent that certain people either choose or physically can not exercise and frequently refuse to voluntarily participate in exercise programs. It is believed that such reluctance was, in large part, overcome by how the program was packaged: [1] a definitive diagnosis of a specific pathological entity [sarcopenia]; and [2] linking the diagnosis to the "power" of a written prescription for corrective therapy. A careful explanation of sarcopenia with a discussion of how the remedial measure of strength training therapy would be productive of an improved quality of life, irrespective of their primary disease process, seemed to be highly persuasive in achieving compliance. Additionally, it is further believed that compliance in completing the program was

related to clinical supervision, social interaction, and the non-intimidating atmosphere associated with group exercise with people of similar age.

The issue of fatigue that some patients experienced while performing three workouts sessions per week, was quickly resolved by changing the program to two workout sessions per week. This change permitted a forty-eight hour and seventy-two hour rest period between workouts. Patients reported the longer rest periods imposed by the biweekly schedule seemed to enhance their performance. In the final analysis, every patient's usable strength and functionality were improved. Notably, no complications or injuries were incurred during the program, a result that might be attributed to careful clinical supervision. Moreover, it has been published that more than one-third of adults older than 65 each year have a fall and it is the leading cause of injury deaths among older adults and the most common cause of hospital admissions for trauma[21]. Of those who have a fall 20-30% will suffer moderate to severe injuries such as hip fractures and head traumas and greater than 400,000 hospitalizations will occur from fall-related injurues[21]. In 1991, Medicare costs for hip fractures alone were estimated to be $2.9 billion[21]. However, of the 529 participants in this program, only three (3) patients reported falls during their 18 months of follow-up (as many as 176 falls could have been expected) and there were no fall-related fractures.

At eighteen months, most of the patients who completed the program have continued to engage in a higher level of physical activity than they did prior to starting the program.

SUMMARY

Partially reversible sarcopenia and muscle weakness should be considered one of the most important determinants of frailty. While strength training is one of the constituents of most wellness programs, its value and importance is extremely under-represented. A therapeutic resistance-training program requires little in terms of technology and expense; and when properly supervised, marked improvement can be anticipated with few or no complications. This study suggests that rapid results can be obtained as measured in terms of cost savings accompanied by an improved state of functionality. Furthermore, endurance training, balance

training, stretching exercises and other beneficial aspects of a wellness program are likely to be more effective when usable strength has been improved.

The annual cost savings from reduced hospital and SNF utilization by the frail senior patients who participated in the strength training program averaged $1,928.77 per patient per year when compared to the cost of utilization of those who dropped out or who were not enrolled in the program. These calculations are believed to be conservative considering the additional cost savings that might have been determined by measuring the frequency of physician office visits, professional fees and the consumption of pharmaceuticals and ancillary services [i.e., imaging, laboratory tests, etc.].We recognize that the results of this pilot study are astounding and far better than we anticipated and therefore further investigation including determining all additional outpatient costs, should be pursued on larger cohorts of patients to confirm and refine the findings of this pilot study. Additionally, an expanded evaluation on the effect of strength training in reducing falls and fractures in frail hi-risk seniors seems appropriate in light of the remarkably small number of falls with no fractures in the pilot study group.

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This study was funded by the CareMore Foundation

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