CLINICAL INVESTIGATION

A Randomized Controlled Trial of Exercise to Improve Outcomes of Acute Hospitalization in Older Adults

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OBJECTIVE: Older adults hospitalized for nondisabling diagnoses can lose functional ability. Lack of exercise or physical activity during the acute illness and recovery may be contributory. This study evaluated whether increased exercise in hospital and afterward would shorten length of stay and improve physical function at 1 month.

DESIGN: A randomized controlled trial.

SETTING: A 700-bed community-based hospital with academic and teaching programs.

PARTICIPANTS: Three hundred patients (mean age 78.2 years ± 5.6) with nondisabling medical and surgical diagnoses who were admitted to an acute care hospital between December 1990 and April 1992. All patients had an expected length of stay 5 or more days, were ambulatory before admission, and were not expected to die within 12 months.

INTERVENTION: A hospital-based general exercise program was administered to intervention patients along with encouragement to continue the program, self-administered, at home.

MEASUREMENTS: The primary outcome was hospital length of stay. Secondary outcomes at 1 month postdischarge included measures of physical function and other general health indicators.

RESULTS: There was no significant difference in length of stay between treatment and control groups controlling for baseline characteristics and diagnoses. The intervention was associated with better function in instrumental activities of daily living (β = .433 (95% CI, 0.044–0.842)) at 1 month but no change in perceived general health status and other measures of physical function.

CONCLUSIONS: An exercise program started during hospitalization and continued for 1 month did not shorten length of stay but did improve functional outcome at 1 month. J Am Geriatr Soc 48:1545–1552, 2000.

Key words: deconditioning; exercise; rehabilitation; hospitalization, physical therapy

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Physical activity and exercise are now recognized as playing important roles in primary, secondary, and tertiary prevention of disease morbidity and mortality.[1–6] The preventive role of exercise may be especially important for older persons who are at high risk for developing the physiological changes of deconditioning with subsequent functional decline. Physicians, physical therapists, and exercise physiologists have been particularly concerned with the role exercise might play in treating the effects of acute illness and acute deconditioning on older medical and surgical patients during and after hospitalizations. These acute deconditioning effects are potentially reversible.

Deconditioning can be defined as "the multiple changes in organ system physiology that are induced by inactivity and reversed by activity."[7] From a clinical and physiological perspective, "acute" deconditioning refers to those changes that occur within days to a few weeks of sudden decrease in activity. "Chronic" deconditioning refers to those changes occurring over months and years. The majority of studies on the benefits of exercise in older persons have targeted the chronic deconditioning effects of a sedentary lifestyle in community-dwelling persons or those living in nursing facilities.[8–10,11]

The deconditioning effects of acute inactivity, i.e., total bedrest, have been studied extensively in younger healthy persons, mainly as part of the American space program.[7,12–16] Changes occur in mood, coordination, muscle strength, balance, and work tolerance. The multiple effects of disuse on muscles include muscle atrophy with loss of myofibrillar protein, inability of motor centers in the brain to recruit motor neurons, and increased fatigability of those motor units that remain functional.[17] The mechanism of this loss in strength may be decreased muscle protein synthesis. This decreased protein synthesis can be inhibited with resistance training in healthy younger persons.[18] Studies on the effects of acute bedrest on older healthy persons have not occurred. Similar results, of potentially greater clinical consequence, would be expected.

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Acute hospitalization in older persons is associated with functional decline that is not readily explained. Impairment in mobility has an incidence of 38 to 65% in cross-sectional studies of function in older hospitalized medical and surgical patients.[19–21] In one study, 80% of a group of hospitalized medical patients lost independence in mobility that had been

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present 2 weeks earlier.[22] Return to baseline independence had occurred by 1 week post-discharge in 66% of these cases. In a group of 187 medical, surgical, and psychiatric patients aged 75 years and older, 60% had functional impairments at the time of hospital admission, and 33% lost function before discharge.[23] Thirty-one percent of 1279 hospitalized medical patients 70 years of age and older experienced functional decline in Activities of Daily Living (ADL) at hospital discharge compared with 2 weeks before admission.[24] Forty percent of these patients had declined in one or more Instrumental Activities of Daily Living (IADLs) and remained disabled at 3 months after discharge.

The etiologies of these functional declines are unclear. Complications of hospitalization could be contributory.[25] Recent reviews suggest lack of physical activity and exercise during the hospitalization of older persons may contribute through the direct physiological effects of deconditioning.[26,27] Hospitals also do not have good systems for providing physical activity.[27a] In addition, older persons are the most sedentary age group in any population,[28,29] which lowers their threshold for onset of clinically significant muscle weakness and other metabolic effects from inactivity during an acute illness.

We designed this study to test whether a hospital-initiated exercise program could improve hospital outcomes in medical and surgical patients aged 70 years and older. The mechanism used would be the mitigation of the psychological and physical effects of physical inactivity associated with an illness episode. We tested the primary hypothesis that the hospital program would help patients recover more quickly and thereby reduce their length of hospital stay. We further expected that the additional prescribed home program would yield better functional and physical health outcomes at 1 month after discharge.

METHODS

The study design was a randomized controlled trial of an exercise program that included a hospital component and a self-administered 1-month home component. Multiple covariates were measured to assist in isolating the effect of exercise from the known effects of age, comorbidity, and gender on function in older persons. The study setting was Cedars-Sinai Medical Center, a 700-bed community-based hospital with academic and teaching programs. The study was approved through the Medical Center's Institutional Review Board.

Subjects

Subjects aged 70 years and older were recruited from medical and surgical admissions to Cedars-Sinai Medical Center, Los Angeles, from December 1990 through April 1992. Excluded from the study were patients who: (1) were nonambulatory or living in nursing homes before admission; (2) had hospital admission diagnoses (i.e., stroke, hip fracture) known to cause functional impairment; (3) were likely to die within 12 months according to their primary physician; (4) were admitted with primary cardiac diagnoses such as myocardial infarction because these patients already received cardiac rehabilitation programs (we included congestive heart failure patients, however, since they were not routinely referred for cardiac rehabilitation); (5) could not communicate clearly with staff secondary to non-English language or cognitive deficits; and (6) had an admission Diagnostic Related Group (DRG) average length of stay of less than 5 days. Additional criteria for exclusion included information from chart review that was a likely marker for one of the above six exclusion criteria (see Figure 1).

Covariates

General self-rated health was measured through the RAND General Health Scale.[30] To control for burden of

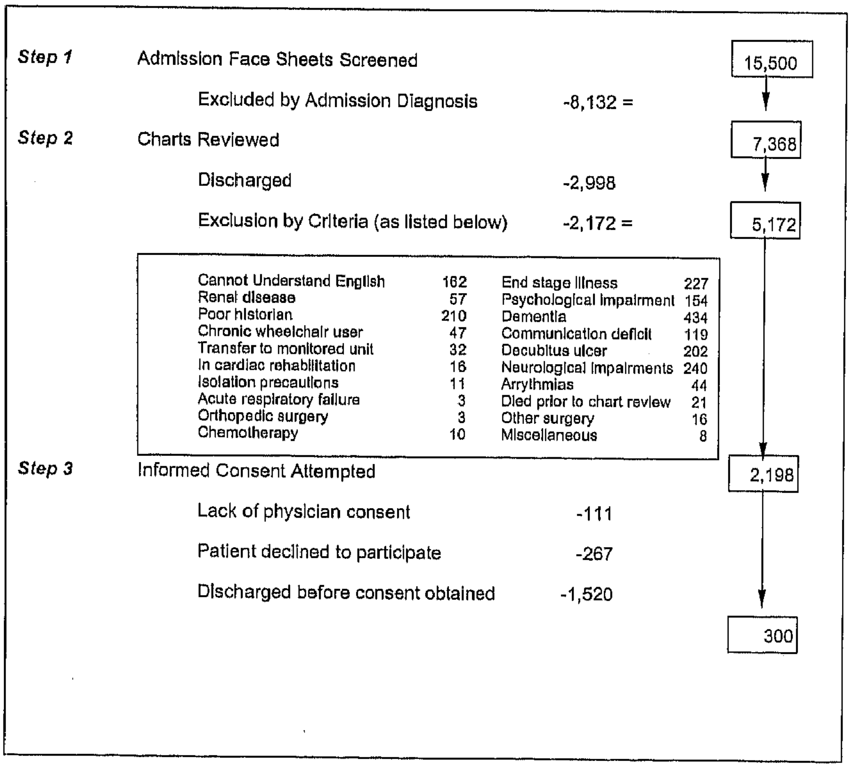

Figure 1. Derivation of the sample.

comorbid illness, patients were classified as either low or high comorbidity, based on a questionnaire protocol obtained through interview. The questionnaire was adapted from the comorbidity assessment tool used in the Medical Outcomes Study. A scoring algorithm for this study was developed in collaboration with Dr. Sheldon Greenfield.[31,32] The severity of the illness for hospitalization was dichotomized based on the admission DRG as "short" (expected length of stay less than 7 days) or "long" (expected length of stay 7 days or more). Patients' preadmission aerobic physical activity or exercise habit was obtained using the physical activity scale from the Center for Disease Control Health Risk Appraisal (frequency of exercise or work lasting at least 20 minutes with degree of breathlessness, faster heart rate).[33]

Primary and Secondary Outcome Measures

The primary outcome measure was hospital length of stay. Functional measures at 1 month after discharge, obtained through telephone interview, included the Functional Independence Measure (FIM) Locomotion Scale (ambulation), frequency of leaving the neighborhood (community mobility), IADLs (telephone use, shopping for groceries, transportation, meal preparation, housework, taking medications, finances), and the National Health Interview Survey Physical Activity Scale (walking ¼ mile, walking up 10 steps, standing or being on ones feet for 2 hours, stooping/crouching/kneeling, lifting/carrying 10 lbs).[34–37] Physical health outcome measures at 1 month included the RAND General Health Scale. Prehospital levels of these secondary outcome variables were measured through a structured interview that asked patients within 2 to 3 days of admission about their status 2 weeks before admission. One-month follow-up data were obtained through structured telephone interviews. All interviews were fully scripted with fixed choice responses to maximize reliability of responses. Only one admission interview was completed by a proxy respondent; however, at the 1-month follow-up, 14 interviews were conducted with proxy respondents (5.0%).

Randomization and Stratification

Individuals were randomized after initial chart review and interview. This data placed the patient into one of four groups: (1) short DRG, low comorbidity, (2) short DRG, high comorbidity, (3) long DRG, low comorbidity, and (4) long DRG, high comorbidity. The research assistant chose a randomly preassigned envelope from the one of the four categories that described the subject. The randomization scheme was developed by Cedars-Sinai Medical Center's Information Systems Service using a SAS computer program system.

Given the nature of the intervention, patients could not be blinded to the intervention. In the follow-up data collection over the telephone at 1 month, the interviewer was blinded as to whether the patient was in the treatment or control group. At times, however, subjects made comments that indicated the group they had been in, precluding a totally blinded follow-up.

Intervention

Control patients received usual hospital care. Intervention patients were screened within 2 to 3 days of admission by a physical therapist (Z.G.) for appropriate exercise exclusions (e.g., no abdominal strengthening after abdominal surgery, etc.). The physical therapist supervised trained aides (college graduates trained by us) in administration of the daily exercise program. Training the staff included emphasis on program content, adult teaching techniques, and communication skills with older adults. The training was developed through the assistance of a professional teacher (D.E.) who ran a large community-based exercise program for older adults. The exercise program consisted of a hospital program and a home program.

The exercise program included 12 exercises for flexibility and strengthening and a walking program. Both parts were to be performed twice daily in hospital, once with the physical therapy aide and once independently by the patient, and three times a week at home. The subjects were instructed to perform each strengthening exercise five times, increasing to 10 repetitions as they felt they could. The exercises included (subjects seated) a shoulder blade pinch, arm press, biceps curl, arm circles, tummy strengthener, leg lifts, and (subjects standing) toe/heel raises and leg swings. The flexibility exercises (subjects seated) included reaching overhead, side bends, and thigh pushes held initially for about six counts. The walking program was based on 60 to 80% of age-adjusted maximum heart rate levels. However, patients were instructed to walk so that their rate of breathing increased and still permitted them to talk while walking. Each patient began walking for 5 minutes, or less if that was all they could do, with instruction to progress up to 30 minutes as tolerated. Upon discharge, the patient was encouraged to continue unsupervised with the home program.

Several interventions were used to encourage learning of and adherence to the exercise program. They were based on two adult education approaches. First, adults need encouragement to successfully learn new behaviors. Second, adults learn in different ways i.e., through live demonstrations, through reading, and through printed illustrations. Components of the interventions included: (1) provision of clearly printed educational materials about the exercise prescription including a basic instructional text and one page with an illustration and directions for each exercise; (2) a certificate of completion of the program on leaving the hospital; (3) weekly adherence calendar cards, which patients were to mail to research staff; (4) two friendly, encouraging "calls of concern" from the physician principal investigator (H.S.), 1 week post-discharge, and from the research staff that were teaching the exercises, 3 weeks post-discharge; (5) a post card of encouragement at 4 weeks after discharge.

Measurement of Dose of Exercise

The number of repetitions of each exercise and whether patients walked were recorded by the staff during hospitalization. After discharge, these data were obtained from weekly calendar cards patients mailed to the research staff. Follow-up phone calls by research staff at 2 and 5 weeks after discharge clarified exercise adherence of those patients who did not send in cards. A dose of exercise, calculated for each patient in the treatment group, was the proportion of total possible exercise opportunities in the program that the patient actually documented exercising. Six dose levels were established based on the percentage of exercise sessions performed, with a maximum of 24 possible home sessions (12 flexibility/strengthening sessions and 12 walking sessions): (1) no exercise; (2) less than 50% of possible hospital exercise and no home exercise; (3) more than 50% of hospital exercise and no home exercise; (4) any hospital dose, low dose at home (less than or equal to 33% of the sessions prescribed); (5) any hospital dose, moderate dose at home (34–66% of home sessions); and (6) any hospital dose and high dose at home (67–100% of prescribed sessions).

Predictors of self-administered dose of exercise were assessed through a full model linear regression. Predictor variables included age, gender, education, DRG, medical/surgical status, comorbidity, and prior exercise habit.

Analysis

A sample size of 320 patients was determined to be required to show a difference in length of stay. This was based on the distribution of length of stay in a 1988 study sample (n = 1016) of patients whose DRGs were similar to those in our study. Sample size was calculated based on the power to detect a 1- to 2-day shortening of length of stay for "short" DRG diagnoses and 2 to 3 days for "long" DRG diagnoses. Forty subjects would be required in each of eight stratified groups: short DRG, low comorbidity; short DRG, high comorbidity; long DRG, low comorbidity; long DRG, high comorbidity. This would yield 80% power to detect the desired difference at a 0.05 significance level.

All outcome comparisons were based on intention to treat. The initial plan was to use an analysis of variance model with patients stratified by comorbidity and severity of DRG. However, 1-month follow-up data revealed differential drop out of subjects. More data were missing from sicker control subjects and from the healthier intervention subjects. Therefore, outcomes were assessed through multiple regression models controlling for baseline covariates.

A multiple regression analysis was performed for each functional outcome variable at 1 month after discharge. The full set of covariates (including demographics, DRG group, comorbidity level, medical/surgical status, and the admission status of the outcome measure) was entered with the treatment variable into each model. The number of subjects included in each analysis of 1-month outcomes varied slightly because of uncodable responses in some interviews.

RESULTS

Participant Flow and Follow-up

Three hundred subjects were recruited within the study period through a four-step process that began with screening face sheets of 15,500 patients admitted at age 70 or older (Figure 1). There were no significant differences between the control group (n = 151) and intervention group (n = 149) in basic demographics, general health status, and baseline functional status (Tables 1 and 2). Twenty-four percent of the patients in both groups self- reported being hospitalized in the prior 3 months, and 18% reported one or more falls in the prior 3 months (data not shown). Distribution of diagnoses based on Medical Diagnostic Categories included diseases and disorders of: the digestive system (n = 88 or 29.3%), the respiratory system (n = 60 or 20.0%), the circulatory system (n = 22 or 7.3%), the hepatobiliary system and pancreas (n = 19 or 6.3%), male reproductive system (n = 16 or 5.3%), skin, subcutaneous tissue or breast (n = 14 or 4.7%), kidney and urinary tract (n = 14 or 4.7%), female reproductive system (n = 14 or 4.7%), and other (n = 53 or 17.6%).

Random assignment, based on comorbidity and severity of DRG, was by strata: (1) short DRG, low comorbidity: 26 in the Control group, 25 in the Intervention group; (2) short DRG, high comorbidity: Control 36, Intervention 35; (3) long DRG, low comorbidity: Control 53, Intervention 54; (4) long DRG, high comorbidity: Control 36, Intervention 35.

Follow-up data at 1 month were available for 274 of 278 surviving subjects. The four missing subjects excluded from follow-up analyses were all control subjects: three refused the interviews and one was lost to follow up.

Table 1. Description of the Sample—Demographics

	Control (n = 151)		Intervention (n = 149)	
Average Age (Standard Deviation)	78.2	(5.6)	78.5	(5.6)
	n	%	n	%
Gender				
Female	94	62.2	88	59.1
Male	57	37.8	61	40.9
Race				
White	134	88.7	133	89.3
Other	17	11.2	16	10.7
Marital status				
Married	62	41.1	76	51.0
Widowed	64	42.4	50	33.6
Sep/Div/Single	25	16.6	23	15.4
Residence				
Private home	143	94.7	137	91.9
Assisted living	8	5.3	12	8.0
Education				
Less than high school	31	20.5	33	22.1
High school graduate	37	24.5	51	34.2
Beyond high school	83	55.0	65	43.6

Table 2. Baseline and 1-Month Post-Discharge Health and Functional Status

	Baseline				1-Month			
	Control		Intervention		Control		Intervention	
	n	%	n	%	n	%	n	%
General Health	(151)		(149)		(130)		(133)	
Excellent	17	11.3	20	13.4	8	6.2	4	3.0
Very good	26	17.2	20	13.4	18	13.8	19	14.3
Good	36	23.8	33	22.1	46	35.4	46	34.6
Fair	33	21.9	40	26.8	40	30.8	41	30.8
Poor	39	25.8	36	24.2	18	13.8	23	17.3
Ambulation (FIM)	(151)		(149)		(137)		(134)	
Requires assistance	26	17.2	23	15.4	32	23.4	30	22.4
Uses cane or walker	49	32.5	37	24.8	29	21.2	18	13.4
Independent	76	50.3	89	59.7	76	55.5	86	64.2
Community mobility frequency of leaving neighborhood	(151)		(149)		(137)		(134)	
≤1 time/week	39	25.8	43	28.9	43	31.9	36	26.9
2–4 times/week	47	31.1	43	28.9	32	23.7	30	22.4
5+ times/week	65	43.0	63	42.3	60	44.4	68	50.7
	mean	(SD)	mean	(SD)	mean	(SD)	mean	(SD)
Average number of independent IADLs	5.3	(1.8)	5.3	(1.9)	4.6	(2.2)	5.1	(2.0)
Average NHIS Physical Activity Scale score	14.2	(5.1)	14.6	(5.5)	13.5	(5.4)	14.2	(5.3)

Primary Outcome – Length of Stay

The average length of stay for the control group was 10.5(±7.1) days, and for the intervention group it was 12.0 (±8.2) days (t test = 1.725, df = 298, P = .09). Using a log-transformation of length of stay and controlling for DRG, comorbidity, and medical versus surgical status in a multiple regression analysis, there was no statistically significant difference in length of stay between treatment and control groups (see Table 3). There was a nonstatistically significant trend for the intervention to be associated with longer length of stay.

Table 3. Log-Transformed Length of Stay Differences by Treatment Group Controlling for DRG severity, Comorbidity, and Medical versus Surgical Status (N = 300)

Model	Beta	95% Confidence Interval	
DRG severity	0.049	−0.008	0.105
Comorbidity (low vs high)	0.084**	0.033	0.136
Medical vs Surgical status	0.131***	0.076	0.187
Treatment (0 vs. 1)	**0.049**	**−0.002**	**0.100**
Adjusted r^2	0.122***		

(*) = $P < .05$
(**) = $P < .01$
(***) = $P < .001$

Mortality

Two deaths occurred during hospitalization, both intervention patients. Chart review showed no relationship to the exercise program. At 1 month there were no significant differences between deaths in the control and intervention groups (n = 10 in each group).

Secondary Outcomes – Functional Effects

The intervention was associated with better functional health outcomes as measured in average number of independent IADLs at 1 month (Table 4). There were no differences in outcomes in general health perception, basic ambulation, community mobility measure (frequency of leaving the neighborhood), and in the NHIS Physical Activity Scale. Nonsignificant trends for association of the intervention with 1-month outcomes were all in the hypothesized direction.

Level of Adherence to Exercise

We examined the amount of the intervention (the dose of exercise) individuals actually received. In this study the subject was an active participant in determining how much intervention she or he received. As shown in Table 5, 21 intervention subjects (14% of the intervention sample) received no intervention (13 because of medical deterioration or administrative reasons; 6 refused exercise intervention after having given consent originally; 2 of the treatment patients died in hospital). Eighty-two percent of subjects (n = 123) received some proportion of the in-hospital program. The second hurdle of participation was negotiating the self-administered dose of home program. When added to the 21

Table 4. Treatment Effects on Patient Outcomes at One-Month Post-Discharge

Regression Model	General Health (N = 263)		Ambulation (N = 271)		Community Mobility (N = 269)		IADLs (N = 269)		NHIS Physical Activity (N = 271)	
	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI
Baseline assessment	.321***	.230,.412	.541***	.418,.665	.414***	.297,.531	.653***	.553,.773	.584***	.481,.686
Age	−.017	−.037,.003	−.001	−.026,.004	−.021*	−.037,−.005	−.050**	−.086,−.013	−.008	−.094,.079
Gender	.160	−.067,.386	−.191*	−.360,−.021	−.432***	−.608,−.256	−.535*	−.945,−.125	−1.296*	−2.277,−.315
Education	−.090	−.236,.055	.038	−.070,.146	.058	−.054,.169	.082	−.179,.343	.658*	.040,1.276
DRG severity	−.045	−.297,.207	.237*	.052,.423	.087	−.107,.281	.587*	.136,1.039	1.487**	.425,2.548
Comorbidity (low vs high)	.372**	.132,.613	−.085	−.261,.091	−.182*	−.358,−.005	−.062	−.490,.367	−.840	−1.862,.182
Medical vs surgical status	−.044	−.293,.206	−.116	−.300,.067	−.242*	−.435,−.050	−.330	−.778,.119	−1.043	−2.093,.006
Treatment	.130	−.091,.352	.040	−.125,.205	.141	−.030,.311	.443*	.044,.842	.491	−.450,1.431
Adjusted r^2	.260***		.330***		.327***		.406***		.472***	

$^*P < .050$
$^{**}P < .010$
$^{***}P < .001$

Table 5. Dose of Exercise Intervention Received by Patients in the Intervention Group (N = 149)

Dose	Adherence Level	N	%
No Hospital or Home Program		21	14.1
≤50% in Hospital, No Home Program	Low	26	17.2
>50% in Hospital, No Home Program	Low	39	26.2
Any in Hospital, Low Dose at Home	Moderate	21	14.1
Any in Hospital, Moderate Dose at Home	Moderate	13	8.7
Any in Hospital, High Dose at Home	High	29	19.5

subjects who received no intervention at all, a total of 76 (57.7%) of the 149 intervention subjects had no home exercise as prescribed by the study. However, 29 subjects (19.5%) in the intervention group elected to perform a substantial dose of hospital and home exercises.

Predictors of Adherence

In the linear regression, no variable predicted self-administered dose. However, in a cross-tabulation of education and dose of exercise, less educated patients were more likely to have a low dose of exercise and more educated patients a high dose of exercise (Table 6). It is important to note, however, that 28% of the treatment group (n = 42) received a potentially beneficial dose of exercise despite their illness burden (level of comorbidity, admission DRG severity, or preadmission functional status). There was no significant difference in the mean dose frequency between the medical and surgical patients.

DISCUSSION

This randomized controlled trial of an exercise program found no significant effect on decreasing hospital length of stay. The dose of exercise actually received during hospitalization may have been too low, or in-hospital exercise may not be able to change patient function sufficiently, during the brief period of hospitalization, to impact a length of stay frequently predetermined by scheduling of diagnostic and therapeutic procedures and by payor constraints. In addition, changes in many physiological variables may require weeks of training.

The improvement in IADLs at 1 month is an encouraging finding. This suggests that the intervention was sufficiently effective to improve some patients' functional status at the IADL level. The intervention did not change other functional measures, but the direction of effect shows a trend in favor of the treatment group. Basic ambulation skills as measured by the FIM didn't change, suggesting that for these more impaired patients, the exercise intervention was insufficient to make a difference. The home dose of exercise may have been too small — both in frequency of adherence and in intensity of the exercise program itself — to have greatly influenced outcomes of more impaired patients 1-month after discharge. Given our concern for the potential risks of exercising older

Table 6. Level of Adherence to the Exercise Program by Level of Education (N = 128)

Level of Education	Low	Moderate	High	Total
Less than high school	21	5	2	28
Percent	75.0%	17.9%	7.1%	100%
High school graduate	21	16	7	44
Percent	47.7%	36.4%	15.9%	100%
Beyond high school	23	13	20	56
Percent	41.1%	23.3%	35.7%	100%
Total	65	34	29	128
Percent	50.8%	26.6%	22.7%	100%

Kendall's Tau-b = .259; $P = .001$

hospitalized patients, we chose for this initial study a mild and minimally challenging program. These same explanations may account for the lack of effect on frequency of leaving the neighborhood and the measures of physical activity as measured by the NHIS Physical Activity Scale. The sample size calculation was not based on what might be needed to show a difference in these functional measures since the primary outcome measure was hospital length of stay. Perhaps a larger sample size would show benefits in these other functional variables.

Another explanation for nonsignificant results in ambulation, community mobility, and the NHIS Physical Activity scale might be measurement insensitivity. The measures have reliability and validity in large epidemiological studies of older persons, but the amount of change in the intervention subjects may have been insufficient to be detected by these other functional measures. It may be that exercise benefits were occurring but were not apparent by broad categories of self-report functional performance. For example, one intervention subject who returned to her high school teaching position after a 20-day hospitalization for pneumonia reported, with real pleasure, that erasing at her chalk board was much easier than before her illness. We had no method for measuring these types of clinically important improvements.

In regard to the observed adherence to the exercise program, there are no baseline data on exercise behaviors of older persons after hospitalization. We had no sensitive method to measure this behavior in the control group. Possibly, the level of adherence achieved in this study can be viewed as quite good if, without any exercise prescription, the usual pattern after hospitalization in this patient population is even less exercising than we observed.

One study design feature that may have contributed to the observed adherence rate was our choice not to use the subjects' own physicians to educate and motivate them to perform the exercise program. We were concerned these physicians might begin encouraging all their patients (including the control group) to increase exercising. Anecdotally, the physical therapy aides noted that the physicians were uniformly pleased and encouraging to their patients if they rounded while the patient was receiving an exercise session with the aide. Using patients' own physicians as motivators for exercise adherence in future studies may improve both adherence rates and clinical outcomes.[38–41]

An additional factor that may have limited adherence is that, for financial reasons, we could offer only a home exercise program rather than a group class. However, one study demonstrated better adherence to home programs than to group classes.[42]

Another factor that might have minimized the treatment effect was the unanticipated increase in in-hospital physical therapy in the control group compared with the intervention group. However, on review of all records, we found no difference in this service in either group. Thirty control subjects received a total of 9245 minutes of physical therapy, and 31 intervention subjects received 8561 minutes.

We identified several promising findings in this study. There was a statistically and clinically relevant improvement in the number of IADLs that patients could perform at 1 month after discharge. Another promising finding is that 28% of these patients did choose to exercise, using a home program, as part of their acute illness recovery despite severe acute illness and significant comorbidity. Some of these patients expressed great appreciation for having been given the program and for receiving phone calls. Comments included, "It shows you care." and "I could do the program in my hotel room during business trips." We also achieved some lifestyle changes. Part of our home-based program included suggestions to walk in the neighborhood instead of driving. One patient told us that he was now walking to his local store rather than driving. Such changes in lifestye activity can have health benefits.[43,44]

Another promising finding is that according to in-hospital tracking and follow-up questionnaires, no injuries occurred. When we designed our intervention, we were extremely concerned about the risks of musculoskeletal injury, especially in the home program. We received no calls from patients, families, or physicians about any problems with the program. Thus, we have demonstrated that a general exercise program can be safely administered to a group of older persons recovering from serious acute illness.

We recommend that continued efforts be made at investigating the potentials of prescribing appropriate, general exercise programs (a few simple exercises, encouragement to walk) as a routine component of hospitalization recovery in older adults. Patients' primary care physicians or their specialist physicians can be directly involved in encouraging adherence to these exercise prescriptions right after hospitalizations. Targeting interventions based on the construct of self-efficacy may yield better results.[45] These programs may improve short-term recovery as well as decrease the prevalence of chronically sedentary lifestyles in older adults.

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