Systematic Home-Based Physical and Functional Therapy for Older Persons After Hip Fracture

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ABSTRACT. Tinetti ME, Baker DI, Gottschalk M, Garrett P, McGeary S, Pollack D, Charpentier P. Systematic home-based physical and functional therapy for older persons after hip fracture. Arch Phys Med Rehabil 1997;78:1237-47.

Objective: To describe the development, implementation, and results of a home-based rehabilitation protocol for older persons after hip fracture.

Design: Demonstration study.

Setting: Community.

Participants: One hundred forty-eight community-living, nondemented participants at least 65 years of age who underwent repair of a fractured hip at two local hospitals.

Intervention: A linked assessment-intervention, home-based rehabilitation strategy. The physical therapy (PT) component of the intervention was designed to identify and ameliorate impairments in balance, strength, transfers, gait, and stair climbing; the functional therapy (FT) component was designed to identify and improve unsafe and/or inefficient performance of specific activities of daily living (ADL).

Main Outcome Measures: The percentage of participants able to complete each component and the extent of progress noted in strength, balance, transfers, gait, and daily functioning.

Results: A total of 104 of the 148 participants (70%) completed the 6-month PT and FT program; 4 completed only PT and 6 refused both PT and FT. The remaining 32 participants (22%) received partial PT and FT that was terminated by death, hospitalization, or institutionalization. Seventy-seven percent of participants reported performing at least half of the recommended daily exercise sessions. Ninety-four percent and 96% of participants progressed in upper and lower extremity conditioning respectively; 33% progressed to the highest level in the graduated resisted exercise program. All participants progressed in the competency-based graded balance program, with 55% progressing to the fifth (most difficult) level. Similarly, the majority progressed in transfer maneuvers, stair climbing, and outdoor gait. One repetition maximum (RM) elbow extension increased from a mean of 5.8 (SD 4.6) pounds at baseline to 7.2 (SD 3.8) pounds at 6mo (t 2.22; $p < .02$). One RM knee extension increased from 5.8 (SD 5.8) pounds to 10.8 (SD 5.4) pounds ($t = 8.06$; $p < .0001$). The number of gait deviations decreased from 2.1 (SD 1.3) to 0.6 (SD 0.9) ($p < .0001$), while the mean modified Berg Balance Scale Score increased from 13.0 (SD 4.8) to 20.5 (SD 6.8) ($t = 16.6$; $p < .0001$). Finally, the Total ADL Score increased from a mean of 48.2 (SD 15.0) to 77.7 (SD 18.8) ($t = 17.03$; $p = .0001$).

Conclusions: This systematic assessment and intervention protocol, targeting impairments and ADL, was feasible, safe, and effective. Protocols such as the one presented should enhance the ability to implement rehabilitation programs for the increasing number of multiply impaired older persons receiving home-based therapy and to document the process and outcomes of this care.

ALMOST 300,000 PERSONS, the majority of whom are 65 years of age or older, suffer a hip fracture each year.[1] Most studies[2-6] have found that the majority of older persons do not recover their prefracture level of functioning. Older age and poorer prefracture physical and cognitive functioning have been associated with a poor prognosis for functional recovery.[2,5,6] Likely, the location and composition of rehabilitation also influence outcomes after hip fracture.[7-9] The location of posthospital rehabilitation for community-living persons who experience fractures varies among regions.[8-12] Nationwide, between 10% and 15% of participants are transferred to an acute rehabilitation facility.[9] Approximately half are transferred to a skilled nursing facility (SNF), either a traditional SNF or one of the increasing numbers of subacute or rehabilitation SNFs.[8,10] More than half of the number of persons discharged either to a traditional or subacute SNF and the majority of those discharged to an acute rehabilitation facility return home, where they receive additional rehabilitative services.[11,13] Much of the hip fracture rehabilitation among community-living older persons, therefore, occurs at home either immediately after acute hospital discharge or after an inpatient rehabilitative stay. Several studies[4,7-10,14-17] have reported on rehabilitation after hip fracture in the acute hospital, rehabilitation facility, and SNF setting. Little has been reported to date, however, on the process or outcome of home-based rehabilitation after hip fracture.[18]

The majority of patients who have had a hip fracture receive various combinations of conditioning, ambulation, transfer, and balance training by a home-based therapist. The specific components and intensity of these training programs are largely unstudied.[19] While help with self-care activities of daily living (ADL) often is provided by home care agencies,[9,10] there is little evidence that hip fracture participants receive retraining in self-care or home management ADL by occupational therapists or rehabilitation nurses.[9] Because many hip fracture participants have limitations in, and difficulty with, tasks of daily living, ADL assessment and intervention might be a beneficial complement to the usual postfracture physical therapy (PT).

Given the diversity and multiplicity of potential problems among older persons who have a hip fracture, a comprehensive

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assessment and treatment plan that addresses the full complement of modifiable impairments, ADL disabilities, and other impediments may best maximize functional recovery. Such a comprehensive strategy would be difficult to implement thoroughly yet efficiently without a systematic approach.

As part of an ongoing study of the effectiveness of a 6-month, home-based, multicomponent rehabilitation strategy for older participants with hip fracture, we developed an assessment and intervention protocol. Key features of this protocol include a systematic and thorough assessment of both impairments and functional tasks, direct linkage of assessment results to intervention recommendations, and periodic reassessments that document progress in, and adjustment of, interventions. This report describes the development, implementation, and results of this home-based protocol.

METHODS

Participants and Setting

Between May 1, 1993 and September 30, 1995, 321 of the 659 participants at least 65 years of age who had surgical repair of a hip fracture at two local hospitals and returned home within 100 days after hospital discharge met preliminary inclusion criteria for this study. The reasons for noninclusion included cognitive impairment (n = 127); life expectancy less than 1 year or death (n = 76); logistic reasons, most commonly that a study therapist was not available (n = 53) or lived too far (n = 47); and refusal (n = 52). One hundred forty-eight of the eligible 304 participants (49%) were randomly selected to receive our home-based rehabilitation program. Of these 148 participants, 50 went directly home after acute hospital discharge and 98 stayed less than 100 days at a subacute rehabilitation facility before returning home. All procedures were approved by the Human Investigation Committee.

Intervention

Development of protocol. A team of two physical therapists, one occupational therapist, one rehabilitation nurse, one home care nurse, and one physician was organized to develop a home-based assessment and intervention protocol for older persons recovering from hip fracture. The PT component was designed to identify and ameliorate impairments, while the functional therapy (FT) component was designed to identify and modify unsafe and/or inefficient performance of functional tasks performed daily. Since many persons had multiple impairments before their fracture, the rehabilitation strategy was geared toward identifying and modifying as many impairments and disabilities as possible. The intervention protocol involved instruction by the therapist followed by unsupervised (or family-supervised) exercises, as is typical in home care. The group developed algorithms and decision rules directly linking the assessment results with specific intervention plans. Details for each component of the assessment and intervention protocol were included in a procedure manual for the therapist and rehabilitation nurse (unpublished material, available from authors).

PT. Table 1 summarizes the assessments and interventions in the PT component.

Assessment. The physical therapist visited the patient within 48 hours of the participant's return home to complete and score the baseline assessment. The impairment areas assessed were: (1) joint range of motion (ROM); (2) generalized muscle strength conditioning; (3) balance; (4) basic and ADL transfers; (5) bed mobility; (6) indoor gait; (7) outdoor gait, ie, curbs and street crossing; (8) stair climbing; (9) sensation; and (10) tone. Impairments in the last two areas were included because their presence might lead to modifications of intervention recommendations for other impairments and disabilities. The criteria for intervention, based on the baseline assessment, are shown in table 1. In our previous study, interrater reliability for the assessment items proved high; the Kappa statistic for most of the items was >.6.[20,21] The assessment was readministered at 2 months and at termination of therapy.

Intervention. Interventions for gait, transfers, and bed mobility involved instruction in safer, more effective techniques, procurement and training in assistive devices, and environmental modifications. Progressive, competency-based exercises were developed for hip strength and ROM, balance (5 levels), and general conditioning (4 levels). Treatment programs for specific muscle and joint groups other than the hip were adapted from existing sources.[22] Deconditioning is a common problem both before and after fracture, so all participants underwent a progressive strengthening program using color-coded resistive bands (Theraband®) unless specifically contraindicated. Mechanisms for adjusting components of the program for specific health conditions (eg, cardiac or pulmonary disease) were incorporated into the protocols.

During the rehabilitation program, which lasted up to 6 months, PTs visited participants three times a week for the first 1 to 2 weeks, then twice a week for 2 weeks, then once a week for 2 weeks. Frequency of visits then decreased to one to three times a month. The therapists instructed the participants in the relevant exercises (eg, conditioning, balance), observed their performance to ensure safe and effective technique, and advanced the level of exercise if indicated. Exercises were supervised until the participants were able to perform them safely and effectively. They were then instructed to do the exercises daily throughout the 6-month intervention. Participants were advanced to a higher level of balance or greater resistance after they had consistently completed the previous level of exercise correctly and without significant effort. The resistive bands, which were set up by the therapist in the best location to facilitate each strengthening program, were left in place throughout the intervention. To monitor adherence to the program, participants completed an exercise check list each day.[23] After each home visit, the PT completed an intervention check list that recorded impairments addressed during the visit and the participant's level of balance and resistive exercises (table 1). Progress was thus documented by advancing levels of exercises.

FT. Tables 2 and 3 summarize the assessments and interventions in the FT component.

Assessment. The assessment by a rehabilitation nurse specialist, with consultation from an occupational therapist, began within 1 week after a participant returned home. The functional assessment was based on Occupational Therapy Functional Assessment Compilation (OTFACT), an automated system for integrating and reporting assessment information.[24] The activity areas chosen from OTFACT were personal care activities, home management, and communication. Each activity was separated into prespecified subtasks. Scoring categories for each subtask included 0 (total deficit), 1 (partial deficit), 2 (no deficit), 3 (maximum), 4 (deferred), 7 (refused), and 9 (not applicable). Concise criteria for scoring each activity and subtask were developed. Because persons may need to perform an activity in the future even if they do not at present (eg, cooking among older men), participants were encouraged to attempt activities even if they did not usually perform them. "Deferred" was used if the participant was not ready to attempt an activity for physical or psychological reasons or if the participant refused initial attempts at performance. Refusals were assigned only after several attempts to encourage the participant. Maximum (3) was used if after at least one re-evaluation and attempt at

Table 1: PT Assessment and Intervention

Impairment	Criteria for Intervention	Intervention*
Joint Impairment		
Shoulder Elbow Wrist Knee Ankle	Joint impairment interventions are implemented when a specific ROM limitation requires specific one-on-one manual therapy in addition to general conditioning. Criteria for intervention based on insufficient active ROM for relevant ADL, balance, or gait *plus* absence of a neuromuscular, inflammatory, or musculoskeletal disorder that would make treatment either contraindicated or ineffective (eg, rotator cuff for shoulder, bony end feel, contracture from stroke).	Joint-specific exercise programs† • Performed only with PT, combination of passive ROM, active or assisted ROM, passive stretching, joint mobilization, and contract-relax.[3] • Program(s) continue until participant achieves active ROM better than criterion cutoff for the specific joint. • Bilateral intervention if meets criteria for either side. • Performs generalized conditioning exercises as well.
Hand	Unable to actively flex fingers to proximal palmar crease *or* grip strength by dynamometry ≤70% of age-gender norms.	• Begins with yellow (light resistance) Theraputty™, progresses to red (moderate resistance) when grip strength between 70% and 80% of normal. • Program ends when participant is able to flex fingers to proximal palmar crease and/or grip strength >80% of age-gender norm.
Muscle Conditioning		
Upper Extremity	All participants unless (1) or (2) (1) Neuromuscular or musculoskeletal disorder or amputation that would prohibit or limit the effectiveness of an upper extremity conditioning program. (2) Cardiovascular disorder that would contraindicate resisted upper extremity exercise.	Conditioning exercises using Theraband®‡ • Includes a diagonal shoulder abduction exercise and exercises to strengthen internal rotators, shoulder depressors, and elbow extensors. • Performed daily: 3 sets of 8 exercises (bilateral). • Begins with yellow (light resistance) and progresses when able to complete without significant effort → red → green → blue Theraband unless plateaus at earlier level *plus* • Chair push-ups—number of sets and repetitions based on endurance.
Lower Extremity	All participants unless a contraindication makes the strength training program ineffective	Conditioning exercises with Theraband®‡ • Includes resisted ankle dorsiflexion, knee extension, hip abduction and flexion exercises. • Begins, performs, and progresses as described for upper extremity. • Precautions observed for involved hip.
Balance	Unable to sit on edge of bed with hands on lap without deviation from the vertical for 30 seconds *or* Unable to unilaterally (unaffected leg) stand 5 seconds without arm support and without constant correction to the vertical position *or* Unable in any of the following hip impairment tests on either lower extremity: hip extension, supine hip flexion, gravity eliminated hip abduction, side lying hip abduction, or seated antigravity hip flexion.	Balance protocol • Progressive exercises incorporating isometrics, active ROM (gravity eliminated progressing to antigravity), closed and open chain maneuvers, and dynamic and static weight shifts. • Challenges balance by first ↓ing arm support, then by ↓ing base of support, and finally by ↑ing complexity of maneuvers. • Levels—Bed (I & II) and Standing (I–V). • Begins at Level I Bed and Standing, number of sets and repetitions based on tolerance, strength, ROM. • Performed once daily. • Progresses when previous level performed safely, correctly, without significant effort and as indicated by weight-bearing status, ROM, strength, endurance.
Basic Transfers Stand to sit Sit to lie (on bed) Lie to sit (on edge of bed) Sit to stand (from chair and/or bed)	Unable to independently transfer in one attempt: With controlled rate of descent, and appropriate use of arms and ambulatory device. Without using arms to assist lower extremities or poor trunk/pelvis alignment supine. Without using arms to assist lower extremities Appropriately using upper extremities, demonstrating regard for weight-bearing status and without extreme forward trunk flexion or lateral sway.	Balance protocol *plus* transfer training§ • Therapist demonstrates, assists, and/or provides verbal cues for proper technique. • Participant practices with therapist until demonstrates independence with good safety awareness. • Modify chair height with cushions to comply with limited hip flexion/adduction if hemiarthroplasty.
ADL Transfers		
Toilet or commode	Unable to independently transfer without adaptive equipment demonstrating appropriate technique (ie, no drop sitting; uses only safe objects for support; follows hip precautions)	• Check existing equipment for sturdiness and appropriate height. • Use adaptive equipment until safe/independent. • Instructions—approach toilet or commode, turn away from toilet, back up until legs touch toilet, follow stand to sit protocol (see procedure manual).
Tub	(1) Uses tub to bathe, *and* (2) Unable to independently lower self to a sitting position or stand smoothly and safely.	• Follow tub transfer instructions in procedure manual. • Check existing equipment for safety. • Use adaptive equipment until safe/independent.
Shower	(1) Uses shower to bathe *and* (2) Unable to independently transfer into the tub or shower and stand with good balance and stability.	• Follow shower transfer instructions in procedure manual. • Use adaptive equipment until safe/independent.
Car	Unable to independently transfer including opening the door and managing seat adjustment.	Follow car transfer instructions in procedure manual

(*continued*)

Table 1: PT Assessment and Intervention (*continued*)

Impairment	Criteria for Intervention	Intervention*
Bed Mobility	Unable to independently roll or move side to side without difficulty.	Follow bed mobility instructions in procedure manual.[§]
Gait		
Indoor gait	(1) Deviation from weight bearing order *or* (2) Uses assistive device incorrectly *or* (3) Unequal step length *or* (4) Unsteady or turns *or* (5) Unable to ambulate ≥20 feet *or* (6) Requires assistance/hands on guard *or* (7) Pain with ambulation.	Gait training program[§] Train with appropriate device: Bilateral hand support in NWB, TTWB, or PWB. Bilateral or unilateral hand support if WBAT. Bilateral unilateral, or no hand support if FWB. Work on the deviations noted in evaluation.
Stairs	Begin when independent in sit to stand transfers and ambulation.	Stair training per procedure manual with appropriate assistive device.
Outdoor gait	Begins when ambulates indoors independently or with supervision.	Outdoor ambulation training[§] • Begin 50-100ft (depends on endurance) on sidewalk. • Increases at own pace or about 2 min per week if not advancing on own. • Practices on grass when sidewalks mastered; add curbs and street crossing; and • Bus boarding if indicated.
Sensory/Tone		
Sensory	Exhibits either (1) Numbness/tingling or decreased light touch in hands or feet *or* (2) "Incorrect" response to upper or lower extremity proprioception test.	Modify intervention protocols as outlined in the procedure manual.
Tone	Demonstrates either hypertonus or hypotonus in either arms or legs.	Modify intervention protocols as outlined in the procedure manual.

* All interventions described in detail in the procedure manual.
† Adapted from definitions and techniques described by Kisner and Allen Colby.[22]
‡ Participants given illustrated instructions for all independent exercise programs.
§ Transfer and gait training performed during PT home visits. Details of training in procedure manual.

intervention, no further improvement was deemed likely. No deficit (2) was used only if the participant completed the subtask (assistive devices and adaptive equipment acceptable) in a manner that was deemed safe, effective, efficient, and independent. Definitions were provided for each of these terms. Partial deficit (1) was scored if the participant performed the subtask but did not meet criteria for either 0 or 2. Partial deficits, therefore, ranged from minimal problems with safety, effectiveness, efficiency, or independence to almost total dependence. A total deficit (0) was assigned if the participant was unable to perform the subtask at all, required total assistance, or attempted the task but performance was hazardous.

For each subtask scored 0 or 1, the rehabilitation nurse determined the impediments contributing to the deficit. Twelve potential impediments were identified (table 3). Subtasks requiring similar skills or movements were aggregated into 12 groups (eg, turning the water on for bathing and flushing the toilet). To ensure that "usual" function was observed, the rehabilitation nurse and participant agreed on the task to be performed, the subtasks to be observed, and the equipment to be used. When appropriate and feasible, the nurse arranged for the home visit to coincide with usual performance of an activity such as dressing, bathing, eating, or cooking. The assessment was set up, in the order shown in table 2, so that more basic and essential activities (eg, toileting, eating) were assessed earlier while more complicated activities such as laundry, housekeeping, and shopping were deferred until the participant had mastered earlier activities.

Subtask scores were developed for each activity and were the sum of the participants' scores (0, 1, 2) for each subtask as defined above. For scoring, all scores of 3, 4, and 7 were assigned a score of 0. The Total ADL Score was the aggregate of the subtask scores for the following activities: medication, eating, toileting, oral hygiene, bathing, grooming, dressing, meal preparation, laundry, housekeeping and shopping. The range of possible Total ADL Scores was 0 to 102.

The reassessment was used to document progress and to generate a new set of intervention menus reflecting the progress from baseline to 2 months. The final reassessment took place at 6 months.

Interventions. The specific interventions recommended depended on a combination of which subtasks were a problem, plus which impediments were believed to contribute to the problem. The FT interventions include the following categories: (1) task (subtask) modifications or behavioral adjustments; (2) adaptive equipment; (3) environmental modifications; (4) psychological interventions; (5) family or caregiver involvement; (6) referral to PT; and (7) referral to physician or other health care provider (table 3). Environmental modifications or adaptive equipment were implemented in conjunction with direct intervention on the task performance (eg, task modification).

The rehabilitation nurse visited each participant once or twice a week to work on task modification, use of adaptive equipment, environmental modifications, and family or caregiver education as indicated by the intervention menus. She also conferred with the physical therapist if physical impairments were determined to impede a participant's task performance. If a participant refused an intervention or continued to perform an activity in a hazardous manner, the nurse reintroduced recommended strategies over time. Thus, while the assessment and intervention protocol for functional therapy was standardized, the timing, and methods for task completion were flexible, based on the participant's capabilities and preferences.

Functional therapy assessment was repeated between months 2 and 3, at which time all activities except those that the participant had scored 2 (without deficit) at baseline were observed.

Descriptive and Outcome Data

A trained nurse assessor who was not part of the therapy team obtained self-report and physical performance data from participants before acute hospital discharge and 6 months after hip fracture. Demographic data and prefracture functioning were ascertained by self-report of participants before discharge from the

Table 2: Activities and Their Subtasks Included in FT*

Activity	Levels†	Subtasks‡
Manage Medications	—	(1) Opens and closes containers [4]. (2) Takes correct dose on correct schedule [7]. (3) Able to administer medications [6].
Eating	—	(1) Sets up food [4] and (2) manages utensils [4]. (3) Consumes solid foods [6] and (4) liquids [6].
Toileting	(1) Bedpan/urinal. (2) Commode. (3) Toilet and adaptive equipment. (4) Toilet without adaptive equipment.	(1) Obtains and uses supplies (eg, toilet paper) [4]. (2) Removes and replaces clothes [5]. (3) and (4) Achieves and leaves position [2]. (5) Cleans self [3]. (6) Flushes toilet [1].
Oral Hygiene	(1) Seated in chair or bed using basin. (2) Seated at sink. (3) Standing at sink.	(1) Obtains toothpaste, toothbrush, denture cleaner [4]. (2) Brushes teeth [4].
Bathing	(1) Bed bath. (2) Sponge bath at sink. (3) Shower, seated. (4) Stand in shower or sit in tub.	(1) Obtains and uses supplies (eg, towel, shampoo, soap) [4]. (2) Removes clothes [5]. (3) Turns water on/off and adjusts temperature [1]. (4) and (5) Gets into and out of bathing position [2]. (6) Cleans self [3]. (7) Dries self [3]. (8) Shampoos [3].
Grooming	(1) Seated in chair or bed using basin. (2) Seated at sink. (3) Standing at sink.	(1) Shaves face [4]. (2) Washes and dries face [4]. (3) Applies cosmetics [4]. (4) Cares for fingernails [4]. (5) Combs, brushes hair [4].
Dressing	(1) Bed clothes; robe. (2) Indoor clothes with slippers. (3) Indoor and outdoor clothes with street shoes.	(1) Obtains and puts away clothes [4]. (2) Obtains appliances (eg, glasses, hearing aids) [4]. (3) Dons and doffs clothes [5]. (4) Uses fasteners (eg, buttons, laces) [5].
Meal Preparation	(1) Meals served by other. (2) Retrieves fixed meals. (3) Prepares cold meals. (4) Prepares heated meals.	(1) and (2) Selects food and plans meals [7]. (3) Prepares meal (uses utensils and appliances, basic food preparation) [4,8]. (4) Clears table and puts food away [4].
Laundry	(1) Handwashes. (2) Uses washing machine at home. (3) Does laundry out of home.	(1) Launders clothes (washes, dries) [1,4,9]. (2) Stores clothes (hang in closet, put in drawers, etc) [4].
Housekeeping§	(1) Dust. (2) Pick-up. (3) Make bed. (4) Dry mop/sweep. (5) Vacuum. (6) Change bed. (7) Take out trash. (8) Others.	(1) Obtains and replaces supplies [4]. (2) Uses supplies [4]. (3) Completes the tasks [3].
Yardwork (Optional)§	(1) Mow. (2) Shovel or sweep. (3) Trim. (4) Garden. (5) Water lawn or garden. (6) Rake. (7) Others.	(1) Obtains and replaces supplies [4]. (2) Uses supplies [4]. (3) Completes the tasks [3].
Shopping		(1) Negotiates around store [10]. (2) Locates needed items [8]. (3) Carries and transports items [4]. (4) Handles money transaction [9].

* Intervention menus are generated based on evaluation of the combination of deficits in subtask performance (groups) and impediments identified. Ten menus were developed, based on similar movements and skills required to perform the subtask.
† Prefracture and postfracture levels are recorded. Levels are based on relative difficulty.
‡ Each subtask is scored 0 = total deficit (cannot do or needs total assistance or unsafe performing task), 1 = partial deficit (performs task but does not meet criteria for 0 or 2; minimal to moderate problems with safety, effectiveness, or independence; performs task independently but takes a long time or includes unnecessary steps), 2 = no deficit (performs task safely, effectively, efficiently, and independently; assistive devices and adaptive equipment allowed), 3 = plateaued at 0 or 1 and no further improvement likely (given only after at least one reevaluation), 4 = deferred (person not yet ready to attempt task or refuses initial requests), 7 = refused (person continues to refuse to perform tasks after several requests), and 9 = not applicable. Numbers in brackets after subtasks refer to one or more of the 10 intervention menus based on similar skills and movements required.
§ For these categories of activities, participant selects at least two from list or can select comparable ones not on list. These activities are not considered hierarchical levels.

Table 3: Impediments to Performance of Specific Subtasks* With Recommended Interventions

Impediment	Categories of Interventions Recommended
Memory	Task modification (eg, simplify steps; perform repetitively) Caregiver involvement (eg, supervision, cueing)
Problem-solving	Task modification (eg, segment tasks, perform repetitively) Caregiver involvement (eg, supervision, cueing; provide written instructions) Environmental (eg, provide environmental cues; simplify environment; reduce background stimuli)
Decreased motivation	Psychological If depressed, referral to MD If low confidence, follow confidence protocol If neither, follow adherence protocol
Low confidence (fear)	Task modification (eg, start with easy task to ensure "success"; perform repetitively; advance slowly but steadily) Caregiver involvement (eg, positive encouragement, avoid negative persuasion) Psychological, follow self-efficacy protocol
Pain†	Task modification (to avoid or reduce painful movements) Psychological (eg, relaxation techniques; "distraction" techniques) Referral to PT (eg, heat, cold, exercises) Referral to MD for medication management; encourage use of prescribed or over-the-counter medications on a short-term regular basis rather than PRN
Activity tolerance	Task modification (to conserve energy, eg, segment task; perform tasks seated rather than standing; frequent rests) Adaptive equipment (eg, reduce carrying, use lightweight objects) Environmental (eg, avoid overheated rooms; reduce distances needed to travel)
Vision	Task modification (eg, simplify tasks) Caregiver involvement (eg, constant placement of objects) Environment (eg, color coding; large visual indicators; remove obstacles; keep supplies in easy reach; increase lighting; talking clock; preprogrammed telephone, velcro indicators, etc)
Hearing	Task modification (eg, stay in kitchen when cooking) Environment (eg, visual indicators for tasks usually requiring hearing-phone, faucet, smoke detectors)
Coordination (fine motor)	Task modification (eg, simplify tasks; allow more time) Adaptive equipment appropriate to task Environment (eg, modify handles on faucets, stoves, door knobs etc)
Strength	Task modification (eg, lead with stronger side; segment and simplify tasks) Environmental (eg, modify handles on faucets, stoves, etc.) Caregiver instructions (assistance with tasks as needed) Adaptive equipment appropriate to task. Referral to PT for exercises
ROM	Similar to strength recommendations
Balance	Task modification (eg, perform tasks seated rather than standing; avoid hazardous tasks (eg, stairs, tub bathing; simplify tasks) Environmental (eg, grab bars; organize supplies in easy reach) Adaptive equipment (eg, reachers, shoe horns, sock donners, etc)

* Subtasks from multiple activities were aggregated into 10 groups based on requirement for similar skills and movements.
† Based on Agency for Health Care Policy Guidelines.

acute hospital. Fracture-related data, including type of fracture and repair and weight-bearing status, were ascertained from medical chart review. The nurse assessor, blinded to progress with PT or FT, also ascertained participants' self-reported performance of the following self-care ADL and instrumental ADL (IADL) 6 months after hip fracture: eating, grooming, toileting, bathing, dressing, getting from bed to chair, walking across a small room, using the telephone, preparing simple meals, doing housework, doing laundry, shopping, using transportation, and handling medication.[25,26] Each ADL and IADL was scored 0 (does not do), 1 (does with some human help), or 2 (does without human help). Composite self-reported ADL-IADL score, the aggregate of the score on each of these activities, ranged from 0 to 28. The nurse assessor performed strength, balance, and gait tests at baseline (in the hospital, nursing home, or home) and at 6 months (at home). A modified Berg Balance Scale, a reliable and valid measure that includes tests of maintenance of position and postural adjustment, was used to assess balance.[27] Because several items in the Berg Balance Scale are unsafe or contraindicated after hip fracture or in persons who have had hemiarthroplasty, only sitting unsupported, transferring sit to stand, standing unsupported with feet together, standing with eyes closed, transferring stand to sit, standing on one leg, transferring chair to chair, and turning 360° were tested to show change from baseline to 6 months. Each item was scored 0 to 4. Total score on the modified Berg Balance Scale ranged from 0 to 32. Qualitative assessment of gait, using five items from the gait component of the Performance Oriented Mobility Assessment (POMA), included step length and symmetry, path deviation, turning, and stepping over an object.[28] Possible scores ranged from 0 to 8. One repetition maximum (1 RM) of the triceps and knee extensors, using lead-shot pouches, was used to measure upper and lower extremity strength, respectively. The nondominant arm and nonfractured leg were tested. To accommodate modifications required because of the fracture, all strength testing was performed in a supine position with a flexion (quad) board used for lower extremity testing. One RM was defined as the amount of weight in pounds a participant could lift through a full range of motion.

Statistics

Descriptive statistics, means, medians, and standard deviations were calculated for all assessment measures. The proportion of participants progressing in the various physical therapy

regimens was determined. Differences among the measures assessed at baseline, 2 months, and 6 months were determined with the paired t test. The correlation between self-reported ADL-IADL at 6 months and the Total ADL Score (defined above) was determined using the Spearman correlation coefficient.

RESULTS

Eighty-three percent of the 148 participants were women with a mean age of 80.5 (±7.0) years. While 89% of participants had been independent in all their self-care ADL, 80% had required help with one or more IADL before the fracture. The majority of fractures (57%) were of the femoral neck; 40% were intertrochanteric and 3% were subtrochanteric. Surgical repair involved a pin, nail, or screw in 105 participants; the remaining 43 participants underwent hemiarthroplasty. Among the 148 participants, weight-bearing status at hospital discharge was non–weight-bearing for 2, toe touch for 23, partial for 38, as tolerated for 59, and full for 26. The median acute hospital length of stay was 9 days. Among the 98 participants (66%) who experienced a subacute rehabilitation stay before returning home, average length of stay in the subacute facility was 40.8 ± 22.3 days (range 1 to 92). A total of 104 participants (70%) completed the PT and FT program. An additional four completed PT but refused all FT and six refused both PT and FT. Two participants were admitted to a nursing home before therapy could begin. For 32 of the 148 participants (22%), PT and FT was terminated or interrupted by death (n = 5) or by hospitalization for an acute medical or surgical problem (n = 17) or an orthopedic problem (n = 9; [failed repair = 4; fracture other hip = 2; and one each of wrist fracture, knee replacement; and dislocation of other hip]).

Physical Therapy

Table 4 shows the number and percentage of participants who received each component of the PT intervention and the progression in each component over the 6 months. Only a small percentage of participants required a specific intervention for joint impairments, while almost 20% of participants received a hand strengthening exercise program. The majority of participants met criteria and received interventions for each of upper and lower extremity muscle conditioning, balance, transfers, and gait. From one third to half of participants required intervention in each basic transfer, while a higher percentage required ADL transfer training (eg, 91% for toilet and 68% for shower transfers). The number of PT visits during which impairment areas were addressed ranged from 3 for ADL transfers to 16 for balance training. The length of the PT intervention ranged from 1 to 27 weeks with a median of 12 weeks. More than half of the 148 participants (56%) reported performing at least 70% of the recommended conditioning and balance exercise sessions; 77% completed more than half the recommended sessions. No serious injuries or falls were reported during any sessions.

The majority of participants progressed to higher level resistive bands and balance exercises and to better categories of transfer performance from pretreatment to 6 months (table 4). Improvements in muscle and balance were confirmed by independent assessment of 1 RM elbow and knee extension and modified Berg Balance Scale, respectively. There was excellent progression among participants in each parameter of gait including number of deviations, type of assistive device used, weight-bearing status, and competency on stairs, curbs, and street crossings.

Functional Therapy

Table 5 shows the number and percentage of participants receiving interventions for self-care ADL and IADL, the impediments most frequently identified for each activity, and the performance scores at baseline, 2 months, and 6 months. Among self-care ADL, as expected, the percentage needing intervention was higher for more complicated tasks such as dressing and bathing than for simpler activities such as feeding and grooming. Thirty-two percent of participants required intervention for toileting after PT had worked on the transfer component. The low percentage of participants receiving intervention for some of the IADL, such as laundry, was partially because many participants had experienced recovery by the time the activity was observed. Many other participants however, had already developed alternate strategies, eg, family participation, hired help or store delivery, that they did not wish to change. In addition, because of serious coexisting health problems such as end-stage obstructive lung disease, blindness, hemiparesis, and cognitive impairment, or serious environmental obstacles, the rehabilitation nurse deemed as unsafe laundry chores for 18 participants, heavy housekeeping for 17, and shopping for 19 participants. There was no intervention related to shopping for an additional 25 persons because transportation could not be coordinated.

The most frequently identified impediments for participants receiving FT varied among the activities (table 5). For most activities there was a combination of physical (eg, strength, balance, activity tolerance), psychological (eg, motivation), and cognitive (eg, problem-solving)) impediments cited. The number of visits by the rehabilitation nurse per participant ranged from 1 to 22 (median = 5; mean = 7). Each visit averaged 1 hour.

For some tasks, including toileting and oral hygiene, most of the improvement occurred between baseline and 2 months; for other tasks such as housekeeping and shopping, the improvement occurred between 2 and 6 months. For most activities, however, improvement as identified by increasing activity scores continued throughout the period from baseline (pretherapy) to 2 months to 6 months. Total ADL Scores, defined in the Methods section, increased from a mean of 48.2 (±15.1) from baseline to 67.1 (±16.1) at 2 months to 77.5 (±18.8) at 6 months. Self-reported composite ADL-IADL scores ascertained by an independent assessor were 24.64 before fracture and 22.37 6 months after fracture. The correlation at 6 months between the rehabilitation nurse score and self-reported score reported to a blinded assessor was .73.

DISCUSSION

We found that this structured assessment and intervention protocol, targeting impairments and ADL disabilities, was feasible, safe, and effective for use in home-based rehabilitation of older persons after hip fracture. Documentation was deemed easier and less time-consuming than for home care participants therapists had cared for under "usual care." The physical therapists noted that they identified and intervened on a broader range of impairments than in their previous practice with hip fracture participants. Importantly, participants were able to carry out the progressive conditioning and balance exercise program independently after instructions from the therapists. Adherence to the exercise sessions was excellent. The effectiveness of the conditioning exercise program was suggested both by the increasing proportion of participants using bands with greater resistance over time and by the significant increase in 1 RM testing of elbow and knee extension from baseline to 6 months as assessed by a nurse not involved with the participant's therapy. Similar to conditioning, participants adhered to, and appeared to benefit from, the progressive balance exercises, with

Table 4: Progress in Impairment-Based PT

Impairment	No. Receiving Intervention for Impairments	Measure of Progress	Baseline (n = 142)*	2mo (n = 133)*	6mo (n = 123)*
		Color Theraband			
Upper extremity conditioning†	108	Yellow	100%	16%	6%
		Red		54%	24%
		Green		28%	36%
		Blue		2%	33%
		1 RM elbow (pounds)§	5.8 (4.6)	—	7.2 (3.8)¶
Hand strength	27	Dynamometry	11.4 (3.2)	—	13.7 (4.6)††
Lower extremity conditioning‡	124	Yellow	100%	21%	4%
		Red		55%	17%
		Green		21%	46%
		Blue		2%	33%
		1 RM knee (pounds)§	5.8 (5.8)	—	10.8 (5.4)‡‡
Balance	139	Level§			
		I	94%	8%	0
		II	3%	17%	3%
		III	2%	45%	6%
		IV	<1%	27%	35%
		V	0	3%	55%
		Modified Berg Scale§	13.0 (4.8)	—	20.5 (6.8)‡‡
		Category‖			
Transfers					
Sit to stand	77	1	14%	0	3%
		2	74%	20%	12%
		3	11%	80%	85%
Bed mobility	84	1	32%	0	1%
		2	52%	24%	13%
		3	16%	75%	85%
Toilet	124	1	8%	0	1%
		2	83%	57%	28%
		3	5%	42%	69%
Shower	100	1	20%	2%	1%
		2	76%	74%	55%
		3	3%	24%	44%
Tub	26	1	—	10%	6%
		2	—	80%	71%
		3	—	10%	20%
Car	120	1	—	—	—
		2	—	66%	31%
		3	—	31%	69%
Stairs	124	1	—	4%	1%
		2	—	49%	14%
		3	—	47%	84%
Outdoor gait—curbs and street	130	1	—	9%	3%
		2	—	49%	24%
		3	—	42%	74%
Gait	139	No. impairments§	2.1 (1.3)		0.6 (0.9)††
		Modified POMA Scale§	4.1 (1.3)		5.9 (1.7)‡‡

Values for 1 RM elbow, dynamometry, 1 RM knee, Modified Berg Scale, impairments, and Modified POMA Scale given as mean (standard deviation).
* Numbers vary because of missing assessments.
† Four of 12 participants who received shoulder specific interventions gained near full range of motion by 6 months; 3 of 4 participants who received specific wrist intervention gained near full ROM.
‡ Seven of 11 participants who received knee specific intervention gained near full ROM at 6 months; 6 of 7 participants who received ankle specific exercises gained near full ROM at 6 months.
§ See Methods for definitions. These measures were assessed by a nurse researcher blinded to the progress reported by the PT.
‖ Categories: 1 = severe/moderate deficit; 2 = mild deficit; 3 = no deficit.
¶ $p < .05$, †† $p < .001$, ‡‡ $p < .0001$, baseline versus 6mo, paired t test.

the majority progressing to more difficult exercises over the intervention period. Again, the improvement in balance was validated by concomitant improvements in the Berg Balance Scale.

The nurse found most of the FT assessment and intervention feasible, safe, and effective in the majority of participants. She identified a common set of subtasks for each of the targeted basic ADL and IADL that were independent of individual "style." She observed and rated the safety, effectiveness, and efficiency with which individual participants carried out the various subtasks involved in ADL and IADL. Based on these observations and ratings, she was then able to recommend, and instruct in, various combinations of task modifications and environmental adaptations, as well as implement strategies for enhancing motivation or confidence when indicated.

Implementing the FT assessment and intervention protocols was more difficult than implementing the PT component. As the specific tasks, methods, and personal preference for completing basic ADL and IADL vary widely, designing an assessment and intervention protocol that was "standardly tailored" was a challenge. However, strategies such as assuring participants that we wanted to help them perform tasks more safely and effectively within their own "style" or preference, scheduling the visits to coincide with usual performance (eg, while preparing breakfast or lunch), discussing the tasks ahead of time, and allowing participants to select which tasks would be addressed when, increased their willingness to participate in functional therapy.

The two main barriers to assessing and intervening on self-care ADL were the concerns of some participants that they would lose their home health aide (covered by Medicare) if

Table 5: Implementation of FT After Hip Fracture

Activity	Received Intervention, *n* (%)	Most Frequent Impediments*	Activity Score,† mean (SD) and median (range)		
			Baseline (*n* = 136)‡	2mo (*n* = 127)‡	6mo (*n* = 112)‡
Manage medication	43 (32)	Memory	5.4 (1.2)	5.6 (0.9)	5.6 (0.9)
		Motivation	6.0 (0-6)	6.0 (0-6)	6.0 (0-6)
		Problem solving			
Eating	10 (7)	Fine motor	7.2(2.2)	7.7 (1.1)	7.9 (0.5)
		Strength	8.0 (0-8)	8.0 (0-8)	8.0 (4-8)
Toileting	43 (32)	ROM	10.3 (3.1)	11.3 (2.3)	11.2 (2.5)
		Problem solving	12.0 (0-12)	12.0 (0-12)	12.0 (0-12)
		Balance			
Oral hygiene	10 (7)	Balance	3.5 (1.2)	3.9 (0.4)	3.9 (0.3)
		ROM	4.0 (0-4)	4.0 (0-4)	4.0 (2-4)
		Strength			
Bathing	107 (79)	ROM	8.6 (4.5)	10.5 (5.2)	11.8 (5.5)
		Problem solving	10.0 (0-16)	11.5 (0-16)	14.0 (0-16)
		Balance			
Grooming	19 (14)	ROM	3.5 (2.2)	6.5 (1.9)	7.3 (2.1)
		Strength	3.3 (0-10)	6.7 (0-10)	7.5 (0-10)
		Fine motor			
Dressing	94 (69)	ROM	5.2 (2.3)	6.9 (1.8)	7.3 (1.9)
		Problem solving	5.6 (0-8)	8.0 (0-8)	8.0 (0-8)
		Strength			
Meal Preparation	94 (69)	Motivation	2.8 (3.0)	5.1 (3.1)	6.3 (2.6)
		Problem solving	1.0 (0-8)	7.0 (0-8)	7.0 (0-8)
		Memory			
Laundry	21 (15)	Activity Tolerance	0.2 (0.7)	1.6 (1.7)	2.5 (1.7)
		Environment	0 (0-4)	1.5 (0-4)	4.0 (0-4)
		Motivation			
Housekeeping	20 (15)	Activity tolerance	1.9 (3.4)	8.2 (6.1)	12.3 (6.6)
		Motivation	0 (0-18)	10 (0-18)	17 (0-18)
		Balance			
Shopping	8 (6)	Activity tolerance	0.07 (0.7)	0.5 (1.8)	2.2 (3.4)
		Motivation	0 (0-8)	0 (0-8)	0 (0-8)
		Strength			
Total ADL Score			48.2 (15.0)	67.1 (16.1)	77.5 (18.8)
			49.6 (3-86)	69 (11-110)	83.5 (18-102)

* The impediments listed most frequently by the rehabilitation nurse during initial observation of the activity.
† Activity score = sum of scores (0, 1, or 2) for each subtask for an activity. Subtasks are listed in table 2. Criteria for scoring described in Methods.
‡ Numbers vary because of missing assessments.
§ Total ADL Score = sum of scores for each activity.

they became independent too soon, and embarrassment in performing personal tasks (eg, toileting and bathing) with the nurse. Determining the optimal time to intervene on ADL is crucial to implementing an effective yet efficient home-based strategy. Waiting might either enhance a participant's willingness or ability to work on specific ADL or, alternatively, the participant might recover sufficiently not to require a specific intervention. By waiting "too long," however, the participant may become "too dependent" and more resistant to change. Timing of observation seemed appropriate for IADL such as housekeeping and laundry. By the time the nurse assessed these activities (usually after month 2), many participants who had performed these activities before the fracture were again able to perform them safely and effectively without specific FT intervention. Among those who were not able to do so, however, many refused intervention because family members or hired help had taken over these tasks.

In addition to the problems described above for FT, there were occasional instances in which the PT and rehabilitation nurse did not follow the decision rules for interventions completely or accurately. We are now developing a method to computerize the assessment and the decision rules for intervention to facilitate accurate and consistent implementation of the protocols and further reduce the burden of documentation.

There appeared to be three patterns of functional recovery among ADL. For some activities (eg, toileting), persons showed early improvement as suggested by the increase in score from baseline to 2 months without change from 2 to 6 months. Activities represented by bathing and dressing showed steady improvement from baseline to 2 months to 6 months. Finally, the more complicated IADL such as shopping and housekeeping showed little improvement from baseline to 2 months, but marked improvement from 2 to 6 months. These patterns of improvement likely reflect a combination of physical and psychological recovery after the hip fracture and acute hospitalization, plus improvement in strength, balance, gait, and other impediments through the structured PT, plus the effect of FT for specific activities.

The FT component was carried out by a rehabilitation nurse who had more than 20 years of experience in inpatient and home rehabilitation settings. The study's occupational therapist was integrally involved in developing the assessment and treatment components of functional therapy and was available as a consultant through most of the project. We cannot comment on whether results would have been similar to those obtained if implemented by an occupational therapist.

As expected, intervening illnesses and hospitalizations interrupted PT and FT for many participants. Of note, however, 70% of these frail older persons were able to complete, to show progress in, and to benefit from, the home-based rehabilitation program after a hip fracture. Objective evidence of the benefits of rehabilitation in this group remains scant and is essential to ensuring continued support from third-party payers.

Although direct comparison is needed to determine whether a structured, comprehensive PT and FT assessment and intervention protocol such as the one used in this study results in greater improvement than present usual home care, several findings support the effectiveness of our approach. First, a high proportion of participants improved in each PT parameter (level

of resistive and balance training, number of gait impairments, safety and effectiveness of transfers and stair climbing) and in self-care ADL and IADL. Independent assessments of upper and lower extremity strength, balance, and gait verified these improvements. Further, the proportion of participants reporting complete independence in self-care ADL (68%) at 6 months is much higher than the 25% to 50% figures reported in several previous observational studies in community-living older persons 6 months after a hip fracture.[2-6] There have been few previous studies of rehabilitation after hip fracture. Most investigations to date have been of inpatient rehabilitation; results have been inconsistent.[4,7,8,14-16] In one of the few home-based studies, Pryor[18] found no increase in functional independence 6 months after fracture with enhanced home service. The rehabilitation program did not appear to have been as intense or multifaceted as ours.

We realize that this 6-month rehabilitation program does not represent "standard practice" for Medicare-covered home care participants after hip fracture. Although 6 months was the maximum amount of time that participants were seen, intervention was discontinued earlier if participants stopped progressing or showed full recovery earlier. The median length of intervention was 12 weeks. The progress shown in every area of PT and FT between 2 months (the usual termination of home-based rehabilitation after hip fracture) and 6 months suggests that the longer period of intervention for those who were still improving resulted in greater eventual recovery. Although the ability to implement longer programs in actual practice will obviously depend on reimbursement from fee-for-service Medicare, managed Medicare organizations, or other sources, findings such as ours should influence decisions concerning coverage of rehabilitation programs. Effective and efficient home-based rehabilitation programs for participants after hip fracture are increasingly important as acute hospital and subacute stays have shortened and fewer participants with hip fracture are eligible for acute rehabilitation. Certainly, if the greater recovery resulting from more prolonged and broader therapy results in less subsequent health care utilization (from hospitalization, home care, or nursing home placement), the cost-effectiveness of a program such as ours could well argue in its favor. Although we did not do formal cost comparisons, we can estimate the average cost of our program. Participants received an average of 24 PT visits. Assuming $100 per visit, the PT component cost averaged $2,400 per participant. The mean number of visits from the rehabilitation nurse was 7 for an average cost of $700. The mean cost for our home-based program was thus $3,100, which compares favorably with 1-year postfracture acute rehabilitation, subacute, home care, and nursing home costs that have recently been estimated at between $9,000 and $14,000.[17]

CONCLUSION

In summary, a competency-based, systematic assessment and individually tailored intervention protocol could be beneficial to home-based therapists and rehabilitation nurses for several reasons. First and foremost, the standardized assessment protocol with criteria for intervention would help remind therapists to look for, and treat, modifiable impairments and disabilities. Given the diversity and multiplicity of potential problems among older persons experiencing hip fracture, a comprehensive assessment and treatment plan would be difficult to implement without a systematic approach. Second, communication among care providers concerning treatment plans could be improved, reducing the likelihood of either duplication or neglect of beneficial care and services. Third, as shown in this study, a systematic assessment and intervention protocol could decrease the time spent on documentation while enhancing accuracy and thoroughness. If coupled with periodic reevaluations, documentation of both process and outcome of care—increasingly required by reimbursers—could be relatively straightforward. A systematic assessment and intervention protocol should not constrain therapists' clinical judgement by forcing conformity. Indeed, a successful system requires sufficient flexibility and individuality to allow the therapist to handle unanticipated problems and to tailor any treatment plan to the combination of comorbidities, contraindications, preferences, and circumstances unique to individual participants and households. We found that these systematic, structured, linked assessment and intervention PT and FT protocols were feasible, safe, and effective in home-based rehabilitation for older persons after hip fracture. For the most part, participants were willing and able to do the prescribed exercise programs and to implement recommended task modifications and environmental adaptations for various ADL. We were able to implement unsupervised progressive resistive and balance exercises—after careful instruction—without injuries. We were able to enhance participant's independence in, and safe performance of, a spectrum of ADL, although a subset of participants showed resistance to, or were deemed unsafe in, performing some higher level IADL such as housekeeping and shopping. Protocols such as the one presented here should enhance the capability of rehabilitation therapists to design and implement rehabilitation programs for the ever-increasing number of multiply impaired older persons receiving home-based therapy and to document the process and outcomes of this care.

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