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Comparison of Clinic- and Home-Based Rehabilitation Programs After Total Knee Arthroplasty

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One hundred sixty patients (mean age, 68 ± 8 years) having primary total knee arthroplasty were assigned randomly to two rehabilitation programs: (1) clinic-based rehabilitation provided by outpatient physical therapists; or (2) home-based rehabilitation monitored by periodic telephone calls from a physical therapist. Both rehabilitation programs emphasized a common home exercise program. Before surgery, and at 12 and 52 weeks after surgery, no statistically significant differences were observed between the clinic- and the home-based groups on any of the following measures: (1) total score on the Knee Society clinical rating scale; (2) total score on the Western Ontario and McMaster Universities Osteoarthritis Index; (3) total score on the Medical Outcomes Study Short Form; (4) pain scale of the Knee Society clinical rating scale; (5) pain scale of the Western Ontario and McMaster Universities Osteoarthritis Index; (6) functional scale of the Western Ontario and McMaster Universities Osteoarthritis Index; (7) distance walked in 6 minutes; (8) number of stairs ascended and descended in 30 seconds; and (9) knee flexion range of motion, on either the per protocol or the intent-to-treat or the analyses. After primary total knee arthroplasty, patients who completed a home exercise program (home-based rehabilitation) performed similarly to patients who completed regular outpatient clinic sessions in addition to the home exercises (clinic-based rehabilitation). Additional studies need to determine which patients are likely to benefit most from clinic-based rehabilitation programs.

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Although there is general agreement that exercises completed after major surgery such as total knee arthroplasty promote walking and independence in activities of daily living, the relative advantages of clinic-based and home-based rehabilitation programs in this population have not been documented extensively.

This question is important because of time and cost differences between these service delivery settings. Clinic-based programs typically are provided by outpatient physical therapy clinics, and facilitate monitoring the patient's progress, modifying individual programs, and providing patient support and motivation. Home-based programs, however, typically do not require the patient to attend outpatient clinic sessions or require attendance at a minimum number of outpatient sessions, and provide fewer opportunities for monitoring or program modification. Although usually developed by and taught to patients by physical therapists, home-based exercises typically are completed independently by the patient at home.

No appreciable differences have been reported between clinic- and home-based rehabilitation programs after menisectomy,[5,7,10] and anterior cruciate ligament reconstruction.[1,3,4,11] The populations examined in those studies have tended to be younger individuals who otherwise were healthy, and with an interest in returning to work or sporting activities or both. Although, menisectomy and anterior cruciate ligament reconstruction are not as surgically intrusive as joint arthroplasty, similar outcomes have been suggested in a retrospective study after total hip and knee arthroplasty.[8]

The efficacy of clinic- and home-based rehabilitation programs is particularly important with respect to elderly patients. Owing to the older age of patients who have total knee arthroplasty, the likelihood of complicating medical conditions, the serious implications of postoperative complications in this population, and the medicolegal climate, surgeons may be hesitant to prescribe nonclinically-based rehabilitation programs after hospital discharge. An often used alternative to mandatory outpatient physical therapy has been having all patients complete a limited number of clinic visits.[1,3,4,11] Another alternative may be a home-based program, monitored via periodic telephone calls. Rene et al[9] reported that monthly phone calls by lay individuals were associated with increased function in patients with osteoarthritis. Although caution must be exercised in generalizing the findings of their study,[9] home exercise programs developed and monitored by physical therapists via periodic phone calls may provide an alternative to mandatory clinic-based programs and to requiring a defined number of clinic visits, and a means to provide some monitoring of patients during the early rehabilitation phase.

The purpose of the current study was to compare two rehabilitation programs after total knee arthroplasty: (1) clinic-based rehabilitation delivered in outpatient physical therapy clinics; and (2) home-based rehabilitation monitored by a physical therapist via periodic telephone calls, on disease-specific, joint-specific, and functional outcome measures.

MATERIALS AND METHODS

Inclusion and Exclusion Criteria

Patients were selected using the following criteria: patients having primary unilateral total knee arthroplasty as a result of osteoarthritis, having at least 90° active knee flexion range of motion (ROM) before surgery, having a functional hip on the operative side, able to follow the home exercise protocol independently, and able to give independent informed consent. Patients with rheumatoid arthritis or major neurologic conditions were excluded.

Randomization to Groups

At the time of primary total knee arthroplasty, 160 patients were assigned randomly to two rehabilitation programs (Table 1): (1) clinic-based rehabilitation provided by outpatient physical therapy clinics; or (2) home-based rehabilitation, monitored by a physical therapist via periodic telephone calls (Fig 1). Patients also were assigned randomly to receive one of two prostheses: (1) Genesis (Smith and Nephew Orthopaedics, Memphis, TN); and (2) AMK (DePuy, Warsaw, IN). Both surgeons in the current study used similar operative procedures and had extensive experience with the procedure.

Inpatient and Home Exercise Familiarization Period

All patients received standard inpatient physical therapy twice daily, for 20 minutes on each occasion. Inpatient physical therapy also included instruction

TABLE 1. Patient Baseline Characteristics for the Clinic- and Home-Based Groups

Variable	Clinic-Based (n = 80)	Home-Based (n = 80)
Continuous variables: mean (standard deviation)		
Age (years)	68.2 (6.9)*	68.6 (7.8)
Height (cm)	165.2 (9.6)	165.3 (11.1)
Mass (kg)	88.4 (15.6)	87.5 (15.9)
Disease duration (years)	7.8 (6.4)	8.2 (7.3)
Discrete variables: frequency and percent of group (percent)		
Gender—female	47 (59%)	44 (55%)
Prosthesis—AMK	37 (46%)	43 (54%)
Left replacement	41 (51%)	35 (44%)
Severe disease	53 (66%)	57 (71%)
Contralateral knee involvement	54 (68%)	56 (70%)
Contralateral hip involvement	2 (3%)	5 (6%)
Ipsilateral hip involvement	5 (6%)	7 (9%)

in a series of home exercises to be completed daily after discharge, regardless of the patient's group assignment. Continuous passive movement devices were not used in the current study. Ambulatory status on the surgical side was weightbearing as tolerated until 6 weeks after surgery, at which time the patient progressed to walking with a cane. Discharge criteria included the ability to transfer independently, ambulate more than 30 m using crutches, and ascend and descend at least five steps. Medication given at discharge was acetaminophen with codeine, or equivalent.

Common Home Exercises (All Patients)

The common home exercise program was that developed for routine total knee arthroplasty rehabilitation at the authors' institution, and consisted of basic (Stage 1) and more advanced (Stage 2) ROM and strengthening exercises. Each patient received Stages 1 and 2 booklets, which included written and pictorial descriptions of each exercise and educational information on using ice, controlling swelling, walking, and ROM. They were instructed to complete the common home exercises three times daily until their 12-week followup, at which time they were advised to continue the home exercises at least once daily, indefinitely.

Home-Based Group

A physical therapist familiar with the common home exercises telephoned each patient in the home-based group at least once during Weeks 2 to 6 and once during Weeks 7 to 12 after surgery to ask whether the patient was having any problems with the exercises, to remind them of the importance of completing the exercises, and to provide advice on wound care, scar treatment, and pain control. During each telephone call, which lasted approximately 5 to 15 minutes, the patient was asked when and how often he or she wished to be telephoned in the future. Patients also were provided with a contact telephone number to call if additional questions arose.

Clinic-Based Group

In addition to the common home exercises, patients in the clinic-based group were required to attend outpatient physical therapy between Weeks 2 to 12 after surgery, for as many as two sessions per week, for approximately 1 hour per session. After Week 12, patients were permitted to continue with clinic-based rehabilitation as previously described, on the advice of their surgeon. Outpatient physical therapists were provided with copies of the Stages 1 and 2 exercise booklets, and were asked to use these exercises as the basic component of their rehabilitation program. However, they were not advised that the patient was participating in a study comparing two rehabilitation programs. Therapists were permitted to modify or add exercises, use therapeutic modalities (such as ice, heat, and ultrasound), joint mobilizations, or other measures as they deemed appropriate. Patients in the clinic-based group were requested to complete the common home exercises at home only twice on days that they attended clinic sessions.

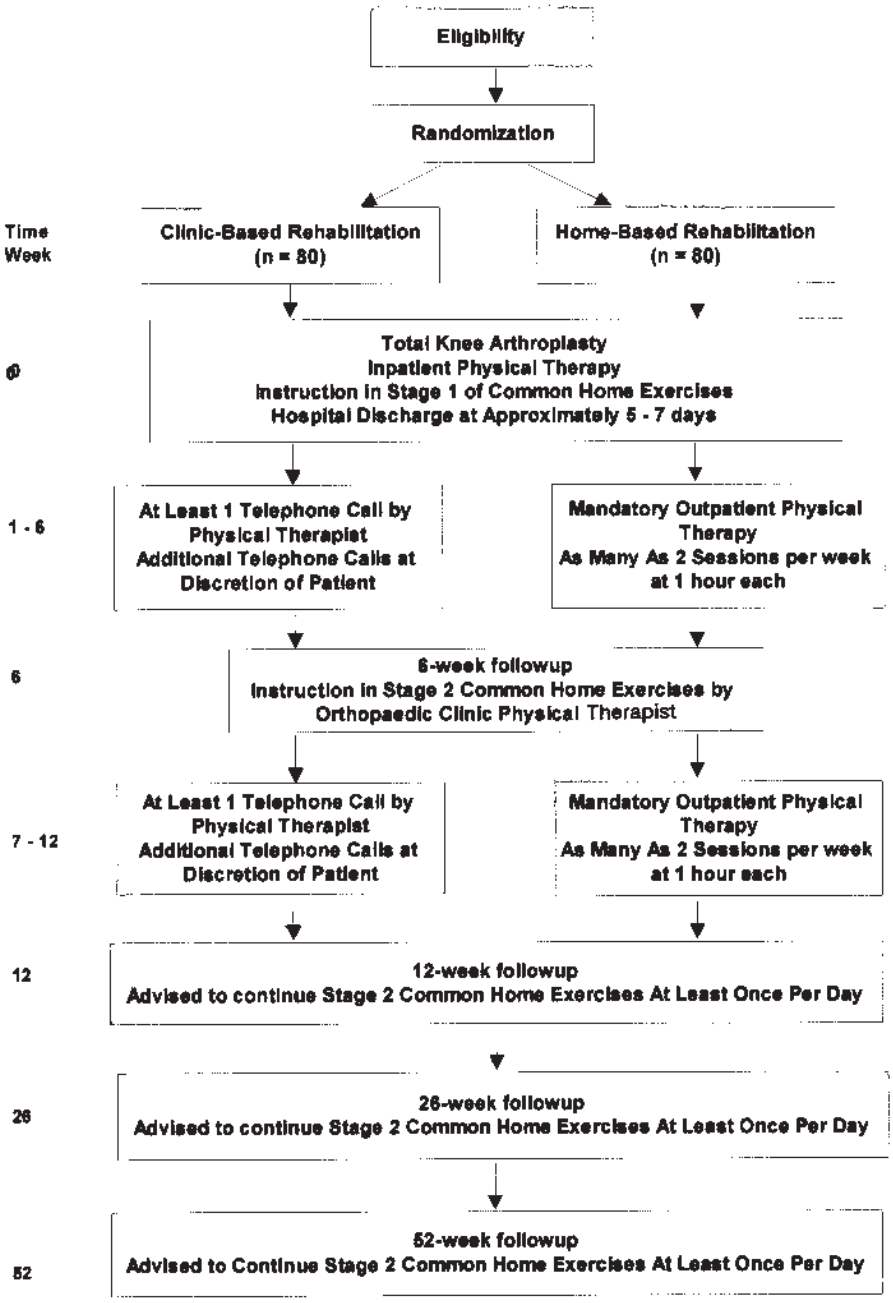

Fig 1. The study time-sequence flow chart is shown. Patients in both rehabilitation groups completed the common home exercises daily between Weeks 2 to 52.

Assessments and Measurements

In conjunction with routine orthopaedic clinic evaluations presurgically, and at 6, 12, 24, and 52 weeks after surgery, patients completed a series of questionnaires and functional tests that required approximately 1 hour. Throughout the study, these tests were conducted by two experienced testers who were blinded as to the patient's group assignment, and gave the test results directly to the study coordinator.

The following tests were completed: (1) Knee Society clinical rating scale[6]; (2) the Western Ontario and McMaster Universities Osteoarthritis Index[2]; (3) Medical Outcomes Study Short Form[12]; (4) 6-minute walk, which was completed by walking back and forth along a 30-m long, low-traffic, carpeted hallway. The patient was asked to walk as far as possible during 6 minutes, with or without a walking aid; (5) 30-second stair test, which was completed in a low-traffic stairway with 20-cm high steps and eight steps between platforms. The patient was asked to ascend the eight steps, turn around and descend the same steps, then turn around and repeat this sequence, completing as many steps as possible during the 30-second period, with or without using the handrail; and (6) knee flexion ROM was determined using an active test, with the patient supine. From a position of maximum extension, the patient slid the heel of the test leg toward the buttocks to a position of maximum knee flexion. The knee angle was measured using a goniometer and scored as the average of three repetitions.

Nondirectional, t tests, and tests of the significance of the difference between two percentages were used to compare the clinic- and home-based groups on presurgical descriptive measures, and to compare the patients who were lost to, or dropped out of the study with those who remained in the study, on baseline measures. Four-way analysis of variance (ANOVA) tests (two treatments $\times$ two surgeons $\times$ two prostheses $\times$ three times of measurement) were used to examine the following nine criterion variables: (1) total score on the Knee Society clinical rating scale; (2) total score on the Western Ontario and McMaster Universities Osteoarthritis Index; (3) total score on the Medical Outcomes Study Short Form; (4) pain scale of the Knee Society clinical rating scale; (5) pain scale of the Western Ontario and McMaster Universities Osteoarthritis Index; (6) functional scale of the Western Ontario and McMaster Universities Osteoarthritis Index; (7) distance walked in 6 minutes; (8) the number of stairs ascended and descended in 30-seconds; and (9) knee flexion ROM. After a significant F-ratio, the Newman-Keuls technique was used to compare selected means.

Any patients who were removed from their assigned group by the surgeons for reasons related to the surgically treated knee or medical conditions not related to the surgically treated knee, or who withdrew consent to participate, were encouraged to continue with the home exercises and any other therapies prescribed, and to continue coming for regular followups and testing. To take into account that some patients were removed or otherwise lost from their group, but did continue to be tested at their regular followups, two types of analyses were completed: (1) a per protocol analysis, which included all patients who completed the study in their assigned group; and (2) an intent to treat analysis, in which all patients were analyzed as having remained in their assigned group, regardless of whether they had completed the study in that group. Analysis of variance tests were confined to patients who had full data sets for the three times of measurement (before surgery, and 12 and 52 weeks after surgery). In view of the number of statistical tests computed and to minimize the likelihood of Type 1 or alpha error, the 0.01 level was used to denote statistical significance throughout analyses.

RESULTS

Before surgery, no significant differences were observed between the clinic- and the home-based groups on the demographic variables shown in Table 1, or on any of the nine criterion measures ($p > 0.01$). No statistically significant differences were observed between the patients lost and those who remained in the study (Table 2), or between the patients lost to the two groups on the baseline scores for any of the nine criterion measures, or for age, height, and weight ($p > 0.01$). Length of stay in the hospital for the patients who completed the study in their assigned group was 5.1 ± 1.5 and 5.2 ± 1.7 days for the home- and clinic-based groups, respectively.

On ANOVA tests, the per protocol and the intent to treat analyses produced identical results for all nine criterion measures; no treatment, surgeon, or prosthesis-related effects

TABLE 2. Number of Patients Lost From Each Group and Reason for Loss

Patient Losses	Clinic-Based (n = 80)	Home-Based (n = 80)
Patients lost during the inpatient period (before hospital discharge)		
Medical issues related to the surgically treated knee	3*	3
Withdrawal of consent by the patient	0	3
Other medical issues	1	1
Totals	4	7
Patients lost after hospital discharge (Weeks 2–52 after surgery)		
Medical issues related to the surgically treated knee	2*	6*
Withdrawal of consent by the patient	5	3
Other medical issues	4	6
Total losses	11	15

*Two patients required manipulation of the surgically treated knee.

were observed ($p > 0.01$), and only the main effect for time (averaged over treatment, surgeon, and prosthesis) was significant ($p < 0.01$) (Figs 2, 3). Subsequent analysis of the main effect for time indicated that the scores before surgery, 12 weeks after surgery, and 52 weeks after surgery differed significantly from one another ($p < 0.01$); with one minor exception. Pain before surgery, measured via the Knee Society clinical rating scale, was significantly greater than that at 12 and 52 weeks after surgery ($p < 0.01$), whereas there was no statistically significant difference ($p > 0.01$) between the pain scores at 12 and 52 weeks, on the per protocol and the intent to treat analyses.

Six patients were removed from their assigned groups to have manipulation of the surgically treated knee and intensive physical therapy, and were lost to the per protocol analyses. Of these patients, two who had been assigned to the clinic-based group had manipulation during the inpatient period, whereas two patients in each group had manipulation between Weeks 2 and 7 after surgery (Table 2).

DISCUSSION

After primary total knee arthroplasty, patients who completed home-based rehabilitation performed similarly to patients who completed clinic-based rehabilitation during the first 52 weeks after surgery. That all nine criterion measures in the current study produced similar results for the per protocol and the intent-to-treat analyses suggests that these findings apply across a spectrum of disease-specific, joint-specific, and functional variables. Overall, the additional patient monitoring, adjustment of program, and motivational support available through clinic-based rehabilitation was not advantageous for the population studied. These findings were not confounded by any interactions with surgeon, type of prosthesis, or time since surgery. The current results extend those of previous studies of meniscectomy[5,7,10] and anterior cruciate ligament reconstruction[1,3,4,11] populations, and corroborate a previous retrospective study using a total knee arthroplasty sample.[8]

Patients who were lost to their assigned group were not included in the per protocol analysis, but did raise concerns that the group comparisons may have been affected (Table 2). Comparisons within and between groups indicated no differences between patients lost and those remaining. In addition, when patients who had been lost to their assigned group, but continued being tested at their normal followups and had complete data sets, were returned to their assigned group for the intent to treat analysis, results were the same as for the per protocol analysis. For these reasons, patient losses were not considered to have significantly affected the overall results of the current study.

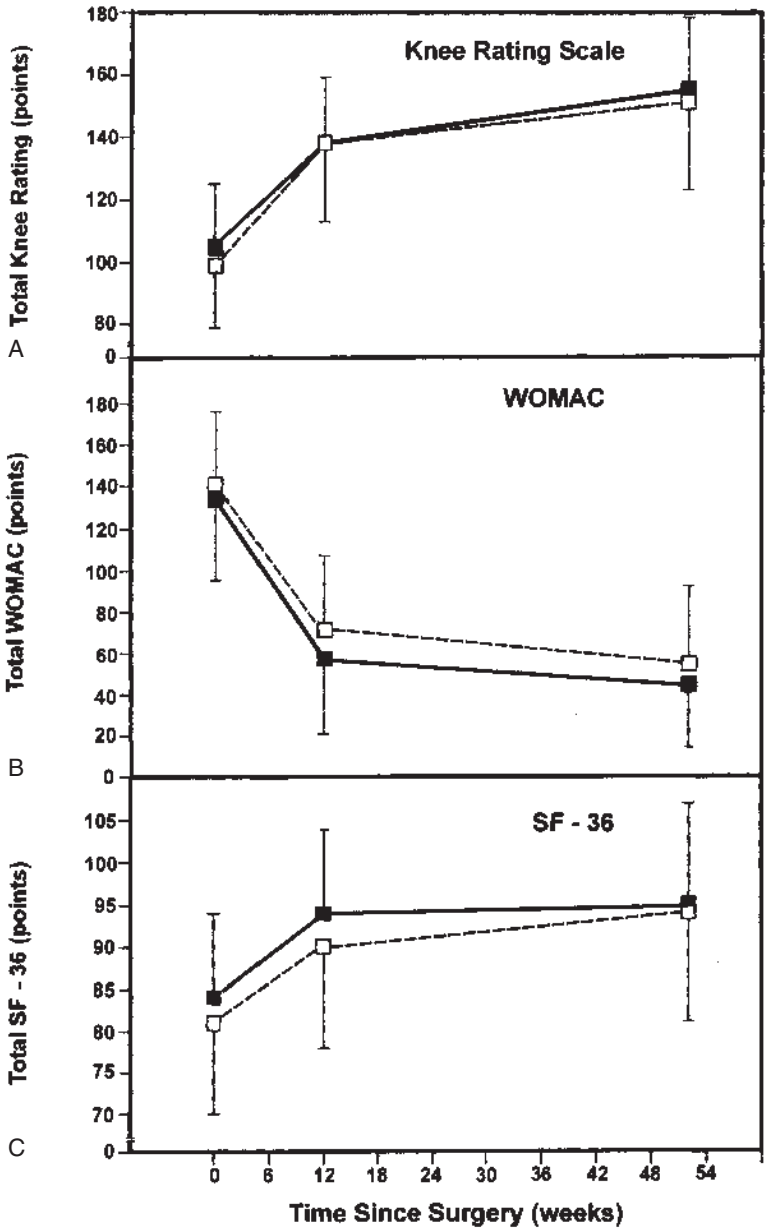

Fig 2A–C. Total scores for the (A) Knee Society clinical rating scale, (B) the Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index, and (C) the Medical Outcomes Study Short Form – 36 (SF-36), for the clinic-based (□) and the home-based (■) rehabilitation groups are shown (vertical bars show sample standard deviations).

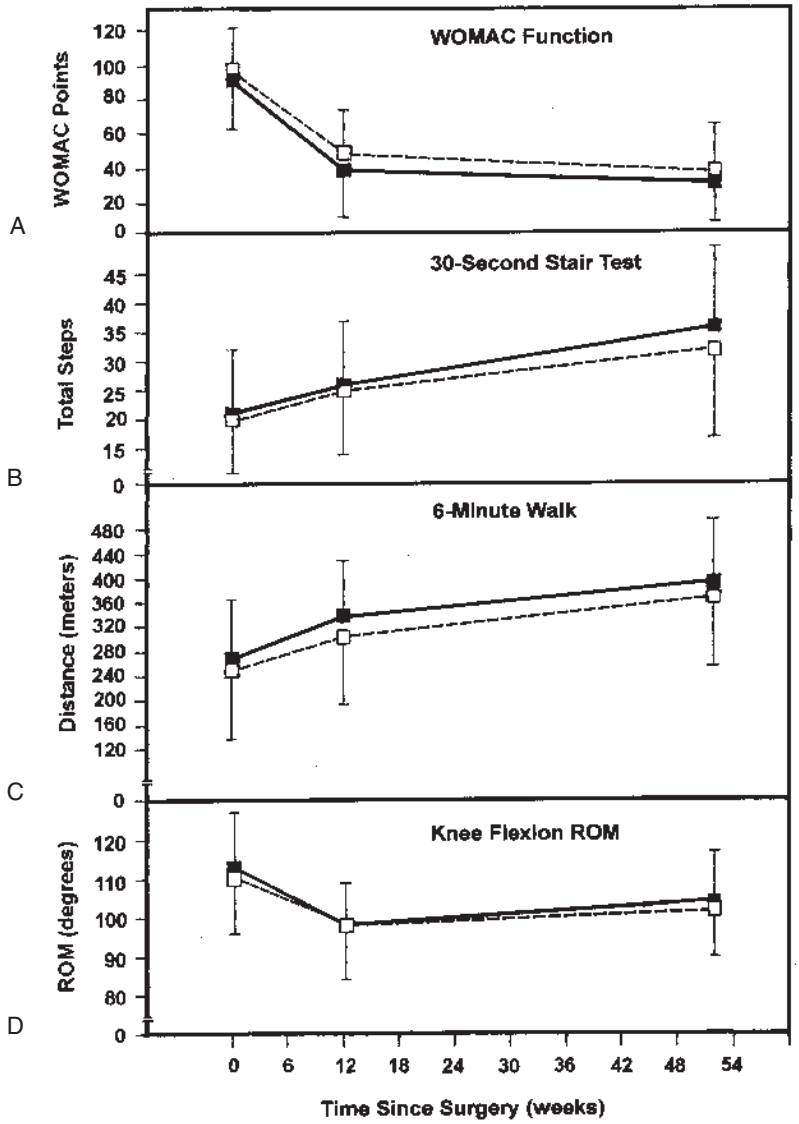

Fig 3A–D. Total scores for the (A) Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index function scale, (B) the 30-second stair, (C) the 6-minute walk, and (D) knee flexion ROM for the clinic-based (□) and the home-based (■) rehabilitation groups are shown (vertical bars show sample standard deviations).

Between Weeks 2 and 52, four more patients were removed from the home-based group than from the clinic-based group for reasons related to failure of the surgically treated knee to progress (Table 2). These patients then had more intensive outpatient physical therapy than that provided by the clinic-based program. Four patients in the clinic-based group were advised by their surgeon to continue clinic-based rehabilitation after Week 12. Although both groups of patients tended to have poorer baseline scores on the majority of objective measures, their scores were not consistently low across the same measures and tended to be within 1

standard deviation of the group mean. The combination of poorer scores plus subjective factors such as the patients' attitudes, motivation, pain tolerance, and home environment were considered in making the decision to remove these patients from their assigned group or to continue clinic-based rehabilitation. Additional studies are needed to document psychosocial and demographic variables to help identify patients who might derive greatest benefit from clinic-based rehabilitation programs.

The telephone calls to patients in the home-based group were completed by an experienced physical therapist who had been introduced to all of the patients during their inpatient period. The telephone calls focused on the home exercises and did not introduce any new exercises or provide unique treatment guidance beyond that available from similarly experienced therapists. Six patients with potential major problems, such as unresolved swelling, infection, and deep vein thrombosis, were identified via the telephone calls and were referred to the patient's physician or surgeon for treatment. Whether delayed treatment of these conditions would have resulted in major complications is unclear. All of these patients completed the 52-week study in their assigned group. As a result, the telephone calls received by the home-based group provided a form of minimally supervised rehabilitation, which also enabled some monitoring of the patient's medical status.

The major component of the current study was the common home exercise program, taught to all patients during their hospitalization after surgery and at their 6-week followup. Outpatient clinicians used this program as the basis for their treatments, and determined the number and frequency of treatments, which averaged 15 ± 7 sessions; whereas the home-based group was monitored by periodic telephone calls from a physical therapist, which averaged 5 ± 4 calls during the first 11 weeks after hospital discharge. At hospital discharge, patients in the home-based group indicated when they wished to be telephoned, and again did so during each telephone call. Pilot study had indicated that virtually all patients having primary total knee arthroplasty had previous experience with home exercise programs and that the majority preferred to determine the contact schedule themselves. In addition to the phone calls, the followups at 6 and 12 weeks after surgery included review of the home exercises. That no patients in the home-based group requested additional telephone calls after 12 weeks and only three patients in the clinic-based group phoned to ask questions about the home exercises, suggests all patients felt competent in doing their home exercises.

The current study was limited to patients having their first total knee arthroplasty on the study knee and to those with at least 90° active knee flexion ROM before surgery (sample mean before surgery, 113° ± 12°. Although passive ROM was examined by the surgeons at each followup, active ROM was used to compare groups, to minimize the extent to which pain tolerance and motivation may have affected ROM. Compliance with the home exercises was considered high, with only two patients in the home-based group and one patient in the clinic-based group considered to have been noncompliant between Weeks 2 and 12 after surgery (where compliance was defined as completion of the home exercises at least 90% of the time, as per exercise log booklets). Exercise compliance was discussed with the patients before surgery and at each followup thereafter. The sample studied was limited to elderly patients who agreed to be assigned randomly to one of the two rehabilitation programs. Approximately 10% of eligible patients refused to participate for this reason. The extent to which a home exercise program would be effective for patients with a more complicated history, more limited ROM, or less motivation, needs to be determined.

The current study compared two rehabilitation programs, where the basic component of each program was a series of common exercises to be completed independently by all patients at home. Because these exercises were developed by and taught to the patients by physical therapists, the current study might be viewed as having compared two means of

providing physical therapy services; that is, physical therapy monitored by telephone calls (home-based) and physical therapy monitored in person by outpatient physical therapists (clinic-based). The current study did not compare physical therapy versus no physical therapy. Caution should be exercised not to generalize the results of the current study to a situation in which the home-based group received no form of treatment after hospital discharge.

After primary total knee arthroplasty, patients who completed a standardized home exercise program performed similarly during the first 52 weeks after surgery, regardless of whether they participated in a clinic-based or a home-based rehabilitation program. These results suggest that when the major component of a rehabilitation program is a series of uncomplicated home exercises, the majority of patients having primary total knee arthroplasty can be treated effectively via periodic telephone calls by a physical therapist. The relative advantages of postoperative rehabilitation via minimal clinic visits and telephone calls, and identification of patients most likely to benefit from clinic-based rehabilitation need to be explored.

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