

## ORIGINAL ARTICLE

# Physical Therapy versus Glucocorticoid Injection for Osteoarthritis of the Knee

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## ABSTRACT

**BACKGROUND**

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Both physical therapy and intraarticular injections of glucocorticoids have been shown to confer clinical benefit with respect to osteoarthritis of the knee. Whether the short-term and long-term effectiveness for relieving pain and improving physical function differ between these two therapies is uncertain.

**METHODS**

We conducted a randomized trial to compare physical therapy with glucocorticoid injection in the primary care setting in the U.S. Military Health System. Patients with osteoarthritis in one or both knees were randomly assigned in a 1:1 ratio to receive a glucocorticoid injection or to undergo physical therapy. The primary outcome was the total score on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) at 1 year (scores range from 0 to 240, with higher scores indicating worse pain, function, and stiffness). The secondary outcomes were the time needed to complete the Alternate Step Test, the time needed to complete the Timed Up and Go test, and the score on the Global Rating of Change scale, all assessed at 1 year.

**RESULTS**

We enrolled 156 patients with a mean age of 56 years; 78 patients were assigned to each group. Baseline characteristics, including severity of pain and level of disability, were similar in the two groups. The mean ( $\pm$ SD) baseline WOMAC scores were  $108.8 \pm 47.1$  in the glucocorticoid injection group and  $107.1 \pm 42.4$  in the physical therapy group. At 1 year, the mean scores were  $55.8 \pm 53.8$  and  $37.0 \pm 30.7$ , respectively (mean between-group difference, 18.8 points; 95% confidence interval, 5.0 to 32.6), a finding favoring physical therapy. Changes in secondary outcomes were in the same direction as those of the primary outcome. One patient fainted while receiving a glucocorticoid injection.

**CONCLUSIONS**

Patients with osteoarthritis of the knee who underwent physical therapy had less pain and functional disability at 1 year than patients who received an intraarticular glucocorticoid injection. (ClinicalTrials.gov number, NCT01427153.)

**O**STEOARTHRITIS OF THE KNEE IS A leading cause of disability.<sup>1</sup> Current management is typically limited to the treatment of symptoms until late stages of arthritis lead to knee replacement.<sup>2</sup> Intraarticular glucocorticoid injections are commonly used as a primary treatment for osteoarthritis of the knee,<sup>3</sup> but there are conflicting reports regarding the extent and duration of the relief of symptoms with this therapy.<sup>4-6</sup> Complications from these injections occur infrequently but include joint infection,<sup>7</sup> accelerated degradation of articular cartilage,<sup>8</sup> and subchondral insufficiency fractures.<sup>9</sup> Clinical practice guidelines vary regarding the use of glucocorticoid injections for osteoarthritis of the knee,<sup>10-12</sup> with a recent clinical practice guideline providing the highest level of endorsement (“strongly recommended”) for intraarticular glucocorticoid injections.<sup>13</sup> A study that used data from Humana on more than 1 million patients from 2007 through 2015 showed that 38% of the patients with osteoarthritis of the knee received a glucocorticoid injection.<sup>10</sup> In two other large population cohorts, 50%<sup>14</sup> and 43.5%<sup>3</sup> of patients received a glucocorticoid injection before total knee replacement.

Some clinical trials of treatments for osteoarthritis of the knee have suggested that physical therapy confers short-term and long-term relief of symptoms, functional improvement, and a decreased need for pain medications, including opioids.<sup>15-20</sup> However, despite some guideline recommendations for physical therapy and lifestyle changes as primary treatments, the use of physical therapy for osteoarthritis of the knee declined between 2007 and 2015.<sup>21</sup> In one large claims database analysis, four times as many patients with osteoarthritis of the knee received a glucocorticoid injection as received physical therapy before total knee replacement.<sup>3</sup> In the U.S. Military Health System, patients who were referred for therapy within 30 days after an initial diagnosis of osteoarthritis of the knee were more likely to be referred for glucocorticoid injection than for physical therapy (51% vs. 29%), and only 13% received both.<sup>22</sup> No clinical practice guidelines recommend using these two treatments together. One trial determined that glucocorticoid injection added to physical therapy provided no further benefit.<sup>23</sup> Strategies such as the use of manual physical therapy to

improve movement and reduce pain that occurs during exercise and daily activities may not be well understood. A recent clinical practice guideline conditionally recommended against manual physical therapy either with or without exercise.<sup>13</sup> We performed a trial to compare the effectiveness of glucocorticoid injection with that of physical therapy in patients with osteoarthritis of the knee.

## METHODS

### PATIENTS

Patients were beneficiaries of the Military Health System and were active-duty or retired service members or their family members. Eligible patients were 38 years of age or older and presented to one of two large military hospitals from October 2012 through May 2017. Patients received treatment at a participating clinic at Madigan Army Medical Center, Tacoma, Washington (one physical therapy clinic and one orthopedic clinic) or Brooke Army Medical Center, San Antonio, Texas (one physical therapy clinic, one rheumatology clinic, and one orthopedic clinic).

Eligible patients met the criteria of the American College of Rheumatology clinical classification for osteoarthritis of the knee<sup>24</sup> and had radiographic evidence of osteoarthritis (weight-bearing views) assessed as Kellgren–Lawrence grade 1 (doubtful narrowing, possible osteophytic lipping) to grade 4 (highest Kellgren–Lawrence grade, indicating large osteophytes and marked narrowing of joint space).<sup>25</sup> We excluded patients who had received a glucocorticoid injection or had undergone physical therapy for knee pain in the previous 12 months or who had no radiographic evidence of osteoarthritis (Kellgren–Lawrence grade 0). Detailed inclusion and exclusion criteria are provided in the protocol<sup>26</sup> (available with the full text of this article at NEJM.org).

### TRIAL OVERSIGHT

The institutional review board at Madigan Army Medical Center approved the protocol. The authors vouch for the accuracy and completeness of the data, for the fidelity of the trial to the protocol, and for full reporting of adverse events.

**TRIAL PROCEDURES**

Patients were informed of the trial during an initial primary care or physical therapy visit. Research coordinators provided each patient with information about the trial, obtained written informed consent, and coordinated entry into the trial. Before randomization, we obtained demographic information and all baseline measures and provided education, based on current guidelines, that addressed the relationship between osteoarthritis of the knee and physical activity, nutrition, and obesity.<sup>27</sup>

Patients were assigned in a 1:1 ratio to undergo physical therapy or to receive a glucocorticoid injection in the joint (the trial design did not include a placebo injection). Assignment to treatment group was determined according to sequentially numbered labels prepared with the use of an electronic random number generator. These labels were placed inside corresponding numbered opaque envelopes and mailed to each site. Research assistants who were not investigators performed outcome assessments and were unaware of the trial-group assignments. Patients received guidance during each appointment-reminder telephone call and from the assistants at the beginning of each data-collection session about not revealing or discussing anything that would disclose their treatment to the assistants who performed the outcome assessments. At each time point during which data were collected, the assistants answered a yes-or-no question that determined whether blinding had been maintained; they also reminded patients to complete the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Global Rating of Change scale questionnaires regarding the knee that was identified as worse with respect to pain and physical function at baseline. Patients with symptoms in both knees received treatment in both knees, but trial outcomes were assessed only in the knee with worse symptoms at baseline.

**GLUCOCORTICOID INJECTIONS**

Orthopedists or rheumatologists performed the intraarticular injections according to local standards. One of the orthopedic providers who performed injections was a trial investigator. Patients received an injection in one or both knees of 1 ml of triamcinolone acetonide (40 mg per milliliter)<sup>28</sup> and 7 ml of 1% lidocaine with

the use of sterile technique. The same treating providers examined patients again at 4 months and 9 months to discuss the continued plan of care, including the appropriateness of additional glucocorticoid injections. Patients could receive up to three injections over the 1-year trial period, at the discretion of the clinician.

**PHYSICAL THERAPY**

The physical therapy intervention, which is described in the protocol,<sup>26</sup> included instructions and images for exercises, joint mobilizations, and the clinical reasoning underlying the priorities, dosing, and progression of treatment. During a typical clinical session, the physical therapist would implement hands-on, manual techniques immediately before the patient performed reinforcing exercises to help the patient perform the movements with little or no pain. For example, if a patient could not fully extend or flex the knee, or those movements were painful, the physical therapist would use a hands-on, passive mobilizing technique to repeatedly move the knee to reduce stiffness while altering the mechanics of the technique to avoid pain. The patient would then perform repeated active knee movements in the same direction. Similarly, if muscles around the knee were tight, the physical therapist would perform manual muscle stretching before the patient would perform the same stretches. A strategy of hands-on, passive movement followed by reinforcing exercise in a single session has been shown to improve knee extension in patients with osteoarthritis.<sup>29</sup> Patients underwent up to eight treatment sessions over the initial 4-to-6-week period; the patient could attend an additional one to three sessions at the time of the 4-month and 9-month reassessments if that plan of care was agreed on by the physical therapist and the patient. The five treating physical therapists, who were investigators in this trial, were board certified in orthopedic physical therapy and fellowship-trained in orthopedic manual physical therapy.

**ASSESSMENTS AND OUTCOMES**

We assessed outcome measures for pain, physical function, and global assessment according to the recommendations for clinical trials of the Outcome Measures in Rheumatology–Osteoarthritis Research Society International.<sup>30</sup> The primary outcome was the total WOMAC score at

1 year. We used WOMAC, version 3.1, which contains 24 items and is composed of three subscales: pain (5 questions), physical function (17 questions), and stiffness (2 questions). Each item is rated on a scale of 0 to 10 (with higher scores indicating worse pain, function, and stiffness), and total scores range from 0 to 240. Secondary outcomes were the score on the 15-point Global Rating of Change scale (scores range from  $-7$  to  $+7$ , with higher positive values indicating more improvement and lower negative values indicating worsening symptoms), the 1-year cost of knee-related health care utilization, and the results of two functional tasks (the Timed Up and Go test<sup>31</sup> and the Alternate Step Test,<sup>32</sup> both measured in seconds to complete the task, with a mean of three trials for each functional measure).

The minimal clinically important difference for the total WOMAC score has been reported to be a 12% or 16% improvement from baseline.<sup>33,34</sup> The Global Rating of Change scale measures perceived improvement, and a score of  $+3$  (“somewhat better”) or higher is considered to be clinically meaningful.<sup>35</sup> There is no published minimal clinically important difference for the Alternate Step Test. Estimates of clinically important improvement for the Timed Up and Go test range from 0.8 to 1.2 seconds.<sup>36</sup>

Data regarding health care utilization were obtained from the Military Health System Data Repository, which captures person-level data for all outpatient and inpatient medical visits to military and civilian hospitals. We identified all medical visits and associated costs for care with a code for a knee diagnosis or a knee procedure in the entire 1-year trial period, starting from the day of enrollment and including all trial-related care. No formal cost-effectiveness analysis was conducted, but descriptive cost values for each group are provided in the Supplementary Appendix, available at NEJM.org.

#### ADVERSE EVENTS

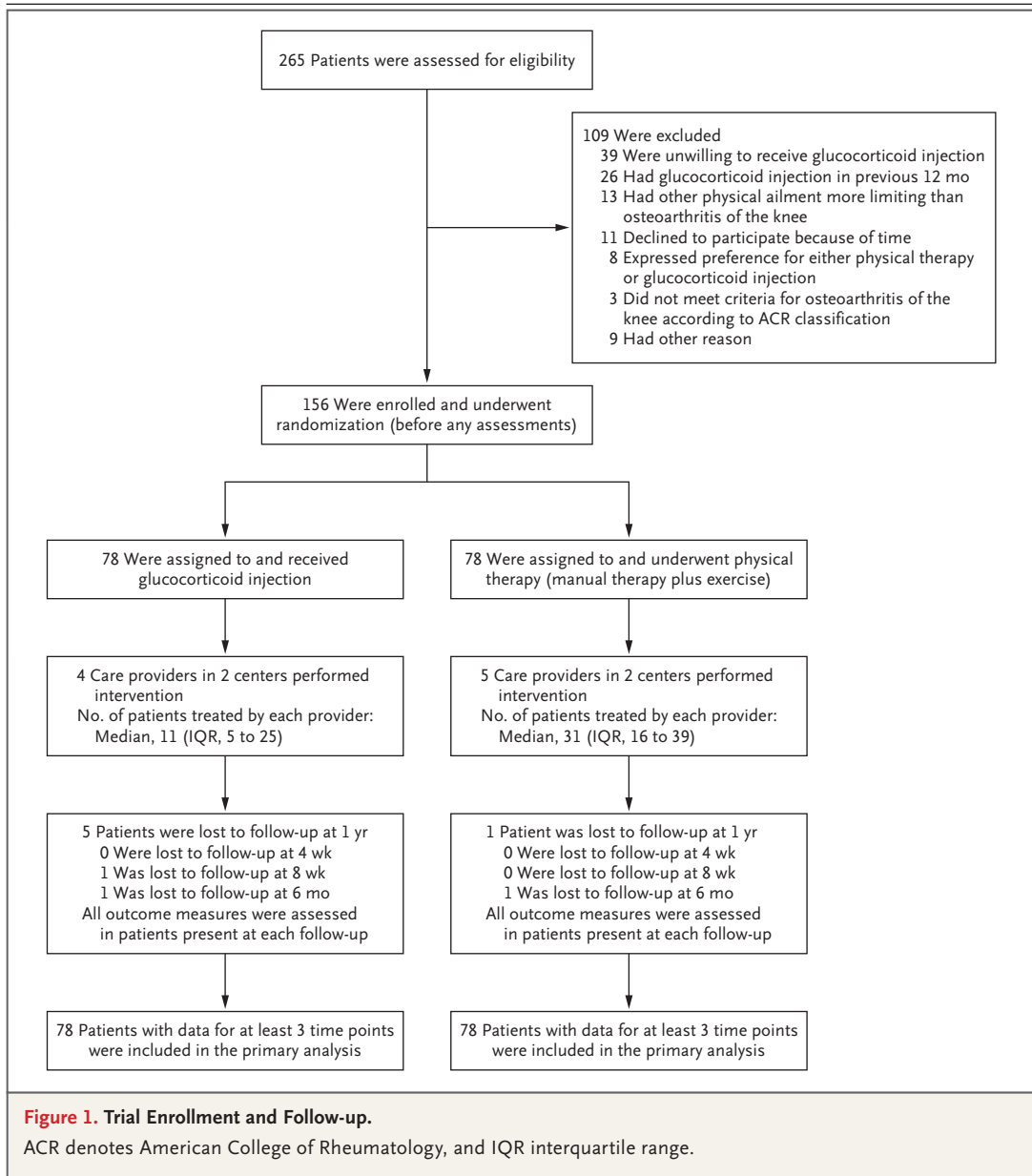
In addition to serious adverse events of death, infection, and fracture, we defined an adverse event as a persistent worsening of symptoms resulting in additional treatment outside the trial.<sup>26</sup> We asked patients at every follow-up to report any complications, signs, or symptoms they perceived as an adverse outcome related to their treatment. We also recorded any additional care and examined claims data in the Military

Health System Data Repository to identify and validate reported additional care, including emergency department visits.

#### STATISTICAL ANALYSIS

We calculated that a sample size of 138 patients would provide the trial with 80% power, at a two-sided alpha level of 0.05, to detect an interaction of time with treatment group, assuming that group means would be equal at baseline, that there would be a difference between groups of 12 percentage points in mean WOMAC scores at the first post-treatment assessment, and that this difference would be unchanged at each subsequent assessment.<sup>34</sup> The calculation of the group mean WOMAC score was based on five repeated measurements, a common standard deviation of 46.8, a mean correlation between repeated measures of 0.681, and a nonsphericity correction factor of 0.890 — values consistent with data from previous trials.<sup>16,17</sup> The sample-size calculation was performed with the use of G\*Power software, version 3.1.2.<sup>37</sup> We added approximately 10% more participants to account for potential loss to follow-up, resulting in a final enrollment goal of 156 participants (78 per group).

All analyses were performed with the use of the intention-to-treat approach. We had planned to use a linear mixed-effects model for analyses, but after the discovery of significant positive skewness in the distributions of scores on the continuous scales, we used a log-linear mixed-effects model<sup>38</sup> to analyze the measurements on those scales. The model included treatment, time, and the interaction of treatment with time as fixed effects and patient-specific random intercepts. Outcome analyses are reported as least-squares means and 95% confidence intervals, including the mean differences between groups. There were no prespecified adjustments for multiple comparisons, but P values and their corresponding 95% confidence intervals for post hoc pairwise comparisons for all outcomes are reported with Bonferroni adjustment. We prespecified the use of our statistical model as the primary plan for handling missing data, and we imputed missing values post hoc with the use of the Markov chain Monte Carlo method with 20 imputations in sensitivity analyses.<sup>39</sup> Categorical outcomes for dichotomized variables at 1 year were analyzed with two-by-two contingency tables to determine relative risk, absolute and relative



risk reductions, and the numbers needed to treat, with failure to have a clinically meaningful benefit as the event of interest. We planned for two large military hospitals to participate but were able to enroll only four participants at one of the hospitals. For this reason, we did not adjust our model for trial site. We compared the mean costs between groups with the use of a gener-

alized linear model with a log link. We used SPSS software, version 24.0 (IBM), for all analyses. Data were missing for 1.4% of all values and for 7% of data on primary and secondary outcomes. Every participant had primary outcome data available for at least three time points. The statistical analysis plan is available with the protocol.

**Table 1. Baseline Characteristics of the Patients.\***

Characteristic	Total Cohort (N=156)	Glucocorticoid Injection (N=78)	Physical Therapy (N=78)
Age — yr	56.1±8.7	56.0±8.2	56.3±9.2
Female sex — no. (%)	75 (48.1)	38 (48.7)	37 (47.4)
Body-mass index	31.5±5.6	31.6±6.1	31.4±5.1
Beneficiary category — no. (%)			
Active duty	36 (23.1)	19 (24.4)	17 (21.8)
Army Reserve or National Guard	5 (3.2)	1 (1.3)	4 (5.1)
Retired service member	54 (34.6)	26 (33.3)	28 (35.9)
Family member	61 (39.1)	32 (41.0)	29 (37.2)
Smoker — no. (%)	8 (5.1)	3 (3.8)	5 (6.4)
Duration of symptoms — mo†	92.5±107.2	85.0±89.2	100.0±122.7
Baseline symptoms — no./total no. (%)			
Knee swelling	98/149 (65.8)	46/76 (60.5)	52/73 (71.2)
Knee giving way	80/149 (53.7)	39/76 (51.3)	41/73 (56.2)
Knee locking	44/149 (29.5)	21/76 (27.6)	23/73 (31.5)
More symptomatic knee — no. (%)			
Right knee	72 (46.2)	32 (41.0)	40 (51.3)
Left knee	70 (44.9)	39 (50.0)	31 (39.7)
Equal	14 (9.0)	7 (9.0)	7 (9.0)
Right-hand dominant — no./total no. (%)	137/154 (89.0)	69/76 (90.8)	68/78 (87.2)
Symptoms in both knees — no./total no. (%)	98/154 (63.6)	49/76 (64.5)	49/78 (62.8)
Kellgren–Lawrence grade — no. (%)‡			
1	6 (3.8)	1 (1.3)	5 (6.4)
2	68 (43.6)	42 (53.8)	26 (33.3)
3	59 (37.8)	25 (32.1)	34 (43.6)
4	23 (14.7)	10 (12.8)	13 (16.7)
Knee pain affects sleep — no./total no. (%)			
No	38/155 (24.5)	19/77 (24.7)	19/78 (24.4)
A little, but can sleep through the night	113/155 (72.9)	56/77 (72.7)	57/78 (73.1)
Cannot sleep because of pain	4/155 (2.6)	2/77 (2.6)	2/78 (2.6)
Baseline measures			
WOMAC total score§	108.0±44.7	108.8±47.1	107.1±42.4
Time to complete Alternate Step Test — sec	11.3±2.8	11.7±3.0	10.9±2.5
Time to complete Timed Up and Go test — sec	9.7±2.8	9.9±3.0	9.4±2.5

\* Plus–minus values are means ±SD. Percentages may not total 100 because of rounding.

† Duration of symptoms was reported by the patient.

‡ Grades on the Kellgren–Lawrence scale range from 0 (no radiographic evidence of osteoarthritis) to 4 (large osteophytes, marked narrowing of joint space).

§ The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total scores range from 0 to 240, with higher scores indicating worse pain, function, and stiffness.

**Table 2. Primary and Secondary Outcomes at 1 Year.\***

Outcome	Glucocorticoid Injection	Physical Therapy	Mean Between-Group Difference (95% CI)
Primary outcome: total WOMAC score — least-squares mean (95% CI)	55.8 (45.0–69.1)	37.0 (30.8–44.5)	18.8 (5.0–32.6)†
Secondary outcomes			
Median Global Rating of Change score (IQR)‡	+4 (0.5–6.0)	+5 (3.3–6.0)	
Least-squares mean time to complete Alternate Step Test — sec (95% CI)	9.0 (8.5–9.5)	8.0 (7.6–8.4)	1.0 (0.3–1.6)§
Least-squares mean time to complete Timed Up and Go test — sec (95% CI)	8.1 (7.7–8.6)	7.3 (6.8–7.7)	0.9 (0.3–1.5)¶

\* All 156 patients were included in the analyses. The 95% confidence intervals and reported P values were adjusted with the use of Bonferroni correction for multiple comparisons.

† The between-group difference is the difference in points (P=0.008).

‡ Scores on the Global Rating of Change scale range from –7 to +7, with higher positive values indicating more improvement and lower negative values indicating worsening symptoms; a score of +4 indicates “moderately better,” and a score of +5 “quite a bit better.” A total of 50 patients in the glucocorticoid injection group and 67 in the physical therapy group had a score of at least +3.

§ The between-group difference is the difference in seconds (P=0.003).

¶ The between-group difference is the difference in seconds (P=0.005).

## RESULTS

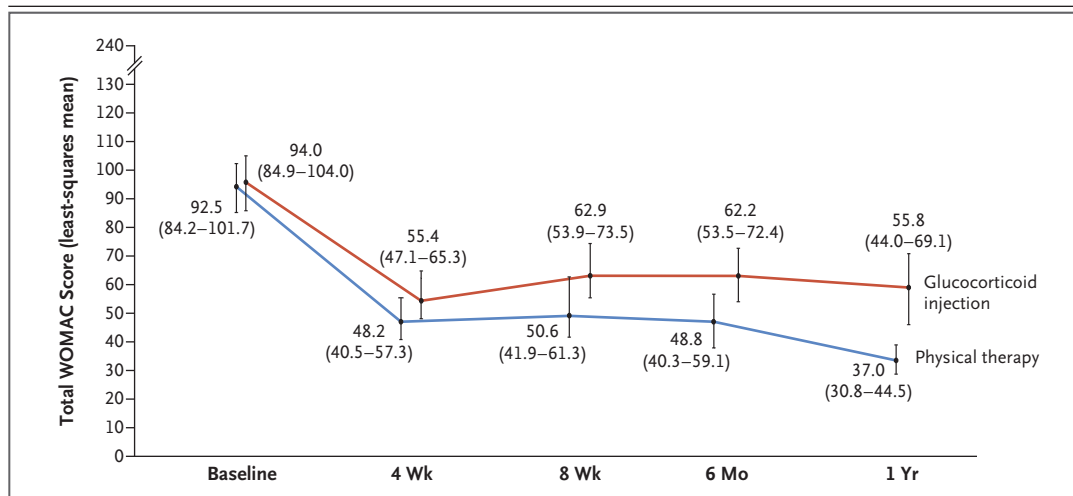
### PATIENTS

From October 2012 through May 2017, we screened 265 patients who met diagnostic criteria for osteoarthritis of the knee and enrolled 156 patients; the mean age of the patients was 56.1 years, 48% were women, and the mean body-mass index (the weight in kilograms divided by the square of the height in meters) of the entire cohort was 31.5. The primary reasons for exclusion were unwillingness to receive a glucocorticoid injection and receipt of a glucocorticoid injection in the previous 12 months (Fig. 1). A total of 78 patients were randomly assigned to each group. Patients in the glucocorticoid injection group received a mean of 2.6 injections (range, 1 to 4). Patients in the physical therapy group attended a mean of 11.8 treatment visits (range, 4 to 22) (Table S9 in the Supplementary Appendix). Baseline demographic and clinical characteristics were similar in the two groups, except for radiographic severity of osteoarthritis measured according to the Kellgren–Lawrence scale<sup>25</sup> — more patients in the physical therapy group than in the glucocorticoid injection group had a Kellgren–Lawrence grade of 3 or 4 (Table 1). Seven patients (9%) in the physical therapy group also received a glucocorticoid injection; 14 patients (18%) in the glucocorticoid injection group also received physical therapy.

Assessors became aware of the trial-group assignment during 11 of 616 postbaseline data-gathering sessions (for 6 patients in the physical therapy group and 5 in the glucocorticoid injection group) (Table S6). The mean cost for all knee-related medical care during the 1-year trial period was similar in the two groups (\$2,113 in the glucocorticoid injection group and \$2,131 in the physical therapy group) (Table S5). Some patients in each group sought additional care outside the trial. Four patients in the glucocorticoid group had surgery (3 underwent total knee replacements and 1 underwent arthroscopy) (Table S8).

### PRIMARY OUTCOME

The mean ( $\pm$ SD) WOMAC scores at 1 year were 55.8 $\pm$ 53.8 in the glucocorticoid injection group and 37.0 $\pm$ 30.7 in the physical therapy group (mean between-group difference, 18.8 points; 95% confidence interval [CI], 5.0 to 32.6; P=0.008) (Table 2 and Fig. 2). (The least-squares mean WOMAC scores at all trial time points are provided in Table S1 and Fig. S1.) In a prespecified analysis, 8 patients (10.3%) in the physical therapy group, as compared with 20 (25.6%) in the glucocorticoid injection group, did not have an improvement from baseline of at least 12% (the minimal clinically important difference<sup>34</sup>) in the WOMAC score at 1 year (Table S3). The overall direction of results for the primary outcome remained unchanged in five post hoc



**Figure 2.** Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Total Scores over the 12-Month Follow-up Period.

WOMAC total scores range from 0 to 240, with higher scores indicating worse pain, function, and stiffness. The values in parentheses are 95% confidence intervals (also indicated by the I bars). All 156 participants (78 per group) were included in the analysis.

sensitivity analyses — those performed with imputation for missing data, with exclusion of 6 participants without WOMAC data at 1 year, with adjustment for differences in radiographic severity and duration of symptoms at baseline, with exclusion of 7 patients in the physical therapy group who received a glucocorticoid injection, and with exclusion of 14 patients in the injection group who received physical therapy (Table S4).

#### SECONDARY OUTCOMES

At 1 year, the median score on the Global Rating of Change scale was +5 (“quite a bit better”) in the physical therapy group and +4 (“moderately better”) in the glucocorticoid injection group (Table 2). A total of 11 patients (14.1%) in the physical therapy group, as compared with 26 (33.3%) in the glucocorticoid injection group, did not have a score on the Global Rating of Change scale of +3 or higher at 1 year (relative risk, 0.42; 95% CI, 0.23 to 0.80) (Table S2 and Fig. S2). Data were imputed for 6 patients who had missing data. The mean difference between groups at 1 year for the Alternate Step Test was 1.0 second (95% CI, 0.3 to 1.6) and for the Timed Up and Go test, 0.9 seconds (95% CI, 0.3 to 1.5); patients in the physical therapy group performed better (had lower mean times) on both tests than patients in the glucocorticoid injection

group (Bonferroni adjustment of 95% confidence intervals are provided in Table 2, and no definite inferences can be made because this was not the prespecified method of analysis). One patient in the glucocorticoid group fainted while receiving an injection; there were no other adverse events.

#### DISCUSSION

This trial comparing physical therapy with glucocorticoid injection in symptomatic patients with clinical<sup>40</sup> and radiographic<sup>25</sup> evidence of osteoarthritis in one or both knees showed that physical therapy was more effective than glucocorticoid injections in leading to improved outcomes at 1 year, as assessed by the total WOMAC score. Secondary outcomes that measured functional tasks and patient assessment of improvement also favored physical therapy. The median score on the Global Rating of Change scale in both groups was above the clinically meaningful threshold of perceived improvement; however, 18 patients (23%) in the glucocorticoid group and 7 (9%) in the physical therapy group reported no perceived improvement or reported worsening symptoms at 1 year. Health care costs over the 1-year trial period were similar in the two groups, but no formal comparisons were made between groups.

Previous studies of physical therapy for osteo-



arthritis of the knee, with treatment limited to 4 weeks, showed large short-term benefits exceeding minimal clinically important difference thresholds for the change from baseline in WOMAC score, and the benefits persisted to 1 year.<sup>16,17</sup> However, by 1 year, mean WOMAC scores in these studies were regressing toward baseline values. In our trial, we found a similar effect size for short-term improvement with physical therapy but an even greater reduction from baseline in the mean WOMAC score at 1 year. This difference seen in our trial at 1 year may have been the result of the educational sessions, additional provider contact at 4 months and 9 months, and the use of interim treatment visits as needed.<sup>41,42</sup>

The within-group effect size for glucocorticoid injection in this trial was greater than effect sizes reported in other clinical trials.<sup>4,5</sup> This finding is potentially explained by the educational sessions, the follow-up visits with clinicians, which provided the opportunity for additional injections throughout the 1-year trial period, and the additional care sought by some patients outside the trial protocol.

The results of our trial are consistent with those of previous trials,<sup>16,17</sup> which suggests that the short-term improvement expected with glucocorticoid injection can also be seen with physical therapy; however, treatment effects of physical therapy persist for a year. Glucocorticoid injections are used in clinical practice more frequently than physical therapy.<sup>3,10,14</sup>

There are limitations to this trial. First, patients assigned to physical therapy had more visits with a health care provider than patients in the glucocorticoid group, which resulted in more provider contact time. Second, 18% of patients assigned to glucocorticoid injections also received physical therapy treatment, four patients had surgery, and four had more than three injections

(the protocol allowed for up to three injections); in addition, 9% of patients assigned to physical therapy also received a glucocorticoid injection. These additional interventions may have contributed to the observed benefit within and between groups. Third, there was a higher proportion of patients with severe arthritis (Kellgren–Lawrence grades 3 and 4)<sup>25</sup> in the physical therapy group than in the glucocorticoid injection group. Fourth, this trial compared the two treatments as independent interventions and cannot be generalized to cases in which both interventions are used concurrently. Fifth, it was not possible to conceal trial-group assignment from patients or providers. Finally, most patients in this trial were referred directly by primary care physicians; however, approximately one third were identified during an initial physical therapy visit. This method of recruitment may have biased the trial sample toward patients more likely to benefit from physical therapy and may have influenced patients' perception of the interventions; however, patient expectations regarding the benefit of the assigned treatment were similar in the two groups, and all screened patients who wanted only physical therapy were excluded (Table S7).

In conclusion, physical therapy for osteoarthritis of the knee resulted in better absolute scores on scales of pain and physical function than glucocorticoid injection at 1 year.

The views expressed here are those of the authors and do not reflect the official policy or position of Madigan Army Medical Center, Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Air Force, the Department of the Army, the Department of Defense, or the U.S. government.

A data sharing statement provided by the authors is available with the full text of this article at NEJM.org.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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