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ORIGINAL ARTICLE

Pharmacist-Initiated Intervention Trial in Osteoarthritis: A Multidisciplinary Intervention for Knee Osteoarthritis

CARLO A. MARRA,[1] JOLANDA CIBERE,[2] MAJA GRUBISIC,[1] KELLY A. GRINDROD,[3] LOUISE GASTONGUAY,[4] JAMIE M. THOMAS,[4] PATRICK EMBLEY,[5] LINDSEY COLLEY,[1] ROSS T. TSUYUKI,[6] KARIM M. KHAN,[7] AND JOHN M. ESDAILE[8]

Objective. **Knee osteoarthritis (OA) is a commonly undiagnosed condition and care is often not provided. Pharmacists are uniquely placed for launching a multidisciplinary intervention for knee OA.**

Methods. **We performed a cluster randomized controlled trial with pharmacies providing either intervention care or usual care (14 and 18 pharmacies, respectively). The intervention included a validated knee OA screening questionnaire, education, pain medication management, physiotherapy-guided exercise, and communication with the primary care physician. Usual care consisted of an educational pamphlet. The primary outcome was the pass rate on the Arthritis Foundation's quality indicators for OA. Secondary outcomes included the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Lower Extremity Function Scale (LEFS), the Paper Adaptive Test-5D (PAT-5D), and the Health Utilities Index Mark 3 (HUI3).**

Results. **One hundred thirty-nine patients were assigned to the control (n = 66) and intervention (n = 73) groups. There were no differences between the groups in baseline measures. The overall quality indicator pass rate was significantly higher in the intervention arm compared to the control arm (difference of 45.2%; 95% confidence interval 34.5, 55.9). Significant improvements were observed for the intervention care group as compared to the usual care group in the WOMAC global, pain, and function scores at 3 and 6 months (all $P < 0.01$); the PAT-5D daily activity scores at 3 and 6 months (both $P < 0.05$); the PAT-5D pain scores at 6 months ($P = 0.05$); the HUI3 single-attribute pain scores at 3 and 6 months (all $P < 0.05$); and the LEFS scores at 6 months ($P < 0.05$).**

Conclusion. **Pharmacists can launch a multidisciplinary intervention to identify knee OA cases, improve the utilization of treatments, and improve function, pain, and quality of life.**

INTRODUCTION

Osteoarthritis (OA) is a degenerative joint disease characterized by a progressive and irreversible loss of articular cartilage accompanied by joint pain and dysfunction (1). OA is the most prevalent form of arthritis; symptomatic knee OA occurs in 10% of men and 13% of women ages >59 years (2). Musculoskeletal disease is highly debilitating and accounts for the largest disability costs of all disease categories. Musculoskeletal disease is also the second costliest illness category overall in Canada ($19.7 billion), second only to circulatory diseases ($24.8 billion) (3). With the aging of the population and the increase in

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[1]Carlo A. Marra, PharmD, PhD, Maja Grubisic, MSc, Lindsey Colley, MSc: University of British Columbia and Providence Health Care Research Institute, Vancouver, British Columbia, Canada; [2]Jolanda Cibere, MD, PhD: University of British Columbia and Arthritis Research Centre of Canada, Vancouver, British Columbia, Canada; [3]Kelly A. Grindrod, PharmD, MSc: University of Waterloo, Waterloo, Ontario, Canada; [4]Louise Gastonguay, RN, MHSA, Jamie M. Thomas, BSc: University of British Columbia, Vancouver, British Columbia, Canada; [5]Patrick Embley, BPT: Mary Pack Arthritis Centre, Vancouver, British Columbia, Canada; [6]Ross T. Tsuyuki, PharmD, MSc: University of Alberta, Edmonton, Alberta, Canada; [7]Karim M. Khan, MD, PhD: University of British Columbia and Centre for Hip Health and Mobility, Vancouver, British Columbia, Canada; [8]John M. Esdaile, MD, MPH: University of Calgary, Calgary, Alberta, and University of British Columbia and Arthritis Research Centre of Canada, Vancouver, British Columbia, Canada.

Address correspondence to Carlo A. Marra, PharmD, PhD, University of British Columbia, 2146 East Mall, Vancouver, British Columbia, V6T 1Z3, Canada. E-mail: carlo.marra@ubc.ca.

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Significance & Innovations

- Innovative approach for finding knee osteoarthritis (OA) cases using community pharmacists.
- Innovative mechanism to launch a multidisciplinary strategy for knee OA that includes pharmacists, physiotherapists, and primary care physicians.
- Improvement in quality of care in the intervention arm as compared to the control arm.
- Improvement in function, pain, and quality of life in the intervention arm as compared to the control arm.

obesity (4), the prevalence of OA is rising, with recent estimates projecting a 50% increase over the next 10–20 years (5).

Despite the demonstrable burden of OA, it is underdiagnosed and undertreated in North America. Because OA is a common, chronic, slowly progressing disease, patients with knee OA often fail to seek medical attention (6,7). Patients who do seek medical care are often incorrectly diagnosed or suboptimally managed (7,8). Evidence-based guidelines for OA also emphasize the utility of combined pharmacologic and nonpharmacologic treatment, such as nonprescription analgesics with exercise and weight loss, but many of the most effective interventions are not commonly implemented (9–13).

Many chronic diseases are being managed in partnership with pharmacists who help with the identification of patients not seeking physician attention and improvement of medication management (14). We hypothesized that knee OA could benefit from collaborative care as well. In the Pharmacist Identification of New, Diagnostically confirmed OA (PhIND-OA) study, pharmacists successfully identified people with previously undiagnosed knee OA (15). In another recent trial, enhanced pharmacist medication review was as effective as exercise in the short-term management of pain for patients with knee OA, while the combination of exercise and medication review was shown to be more effective overall than usual care (16). Combining the findings of these 2 studies, our intervention integrated both identification of knee OA and utilization of pharmacologic and nonpharmacologic treatment options: the Pharmacist-Initiated Intervention Trial in OA (PhIT-OA).

In the PhIT-OA, we evaluated whether pharmacists could address the gaps in OA patient care as measured using quality of care indicators and health-related quality of life markers (15). The strategy employed community pharmacists to identify patients with knee pain through passive recruitment strategies. Eligible patients were selected based on their responses to a screening questionnaire (15) and were randomly assigned to either usual care or intervention care. The intervention involved patient education, medication management, and collaborative care from a pharmacist, a physiotherapist, and the patient's primary care physician. The collaborative care model facilitated the correct diagnosis and initiation of pharmacologic and nonpharmacologic therapies.

MATERIALS AND METHODS

Study design. This study used a cluster randomized controlled clinical trial design (Figure 1).

Pharmacies. We recruited community pharmacies from our database based on geographic location (within the metropolitan area of Vancouver) to facilitate participant assessment and exercise sessions with the physiotherapists. At least 2 pharmacists from each pharmacy were committed to recruitment and medication management (depending on intervention status). Forty-three pharmacies were approached to participate in the trial. No financial incentives were given to the pharmacies.

Participants. Patients with knee pain were recruited at local community pharmacies across the greater Vancouver area during 2007/2008. Passive recruitment methods such as informational posters and shelf talkers were employed. Participants were included if they were ages ≥50 years; were experiencing pain, aching, or stiffness in or around the knee(s) on most days of the last month; were overweight, defined as a body mass index (BMI) ≥25 kg/m^2; had not been actively participating in a formal exercise program within the past 6 months; and had self-reported difficulty in activities attributed to knee pain. Participants were excluded if they had a previous physician-confirmed history of OA in any joint or one of the physician-confirmed conditions of gout, fibromyalgia, and other joint inflammations such as rheumatoid arthritis, psoriatic arthritis, or ankylosing spondylitis; a recent knee injury (within the previous 6 months) or recent knee surgery (within the past 4 months); or prior knee radiographs within the previous 2 years.

Randomization. To randomize the pharmacies, values from a uniform (0,1) distribution were generated by the study statistician (LC). Pharmacies were randomized to provide either the intervention (21 pharmacies) or usual care (21 pharmacies). The retention and dropout rates of the pharmacies are shown in Figure 1. Participants were informed whether they were to receive the intervention or usual care after they provided consent. Participants were not informed that randomization was done at the pharmacy level to prevent unblinding of the intervention status of the pharmacies.

Ethics approval for this study was obtained from the University of British Columbia Behavioural Research Ethics Board.

Treatment arms. *Usual care.* Participants from the pharmacies randomized to provide usual care received an educational pamphlet on knee OA created by the Arthritis Society (online at http://www.arthritis.ca/document.doc?id=328).

Intervention care. Participants from the pharmacies assigned to the intervention received one-on-one consulta-

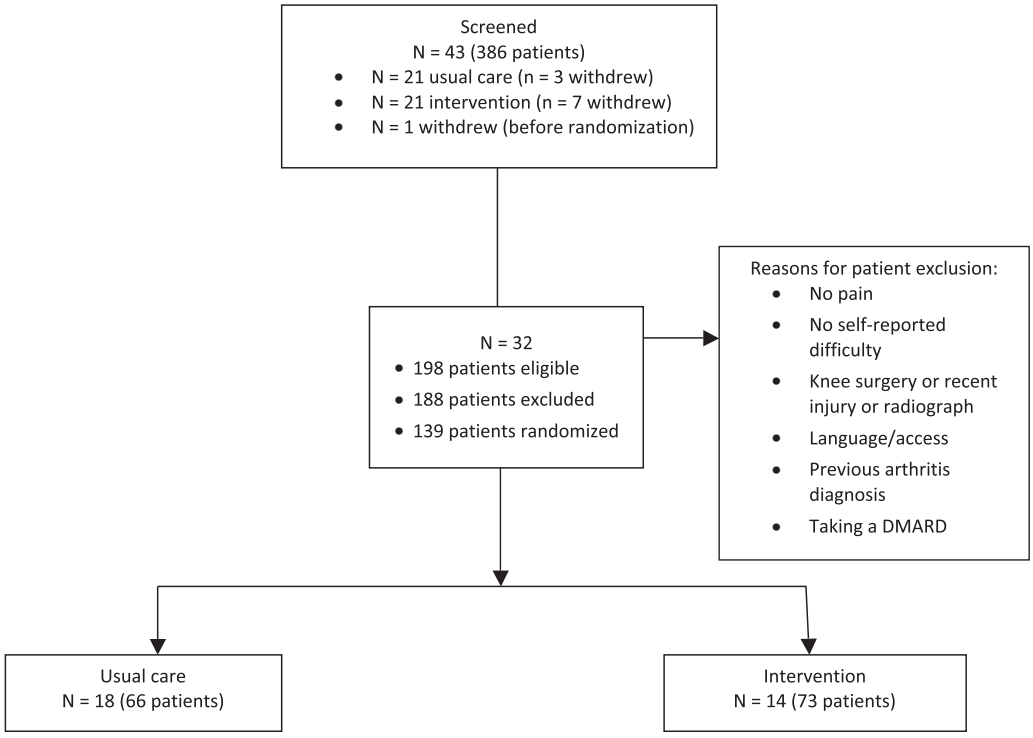

Figure 1. Randomization at the pharmacy level. N = number of pharmacies; DMARD = disease-modifying antirheumatic drug.

tion with a pharmacist. Pharmacists offered education, medication review, and referral to a physiotherapist-guided exercise program. Outcomes from the pharmacist-patient consultation were recorded and faxed to the patient's primary care physician.

We provided education regarding counseling on the symptoms and other aspects of knee OA. Patients were given the opportunity to participate in the Arthritis Self-Management Program (17).

For medication management, pharmacists conducted thorough reviews of the participants' prescription and over-the-counter analgesic use in concordance with the current OA guidelines and indicators pertaining to pharmacologic therapy and the criteria for acetaminophen, nonsteroidal antiinflammatory drug, and gastroprotective agent use and their contraindications (16). The participants were also counseled on the risks, benefits, and appropriate use of medications to achieve maximum therapeutic benefit and safety.

A letter was faxed to the participant's primary care physician identifying the participant as having a high likelihood of knee OA according to the pharmacist screening questionnaire and the elements of evidence-based quality indicators for the management of knee OA. The pharmacist also provided the participant's primary care physician with recommendations regarding medications. The physician was asked to approve inclusion into a physiotherapist-guided exercise program or provide a reason why this intervention would not be appropriate for the patient (for example, a history of unstable angina).

For the physiotherapist-guided exercise program, the physiotherapist determined an appropriate, individualized home exercise program based on the American College of Sports Medicine Physical Activity and Public Health guidelines (18).

Physiotherapist-guided exercise. Each patient in the intervention arm completed a 1-hour physiotherapy assessment in which appropriate exercise and mobility goals were identified. The physiotherapist determined an appropriate, individualized home exercise program based on the American College of Sports Medicine Physical Activity and Public Health guidelines (18). Each patient received personalized education from the physiotherapist for a personalized regimen, including education on how to perform exercises and the frequency of the exercises. Patients were told to avoid exercise during active symptom flares. Walking aids were recommended when necessary.

Five types of exercise were optimized for each patient's needs and abilities: strength, flexibility, range of motion, aerobic, and balance. Generally, 8–10 strength exercises were prescribed for each patient. Preventive exercises were instituted when appropriate.

The strength exercises were designed to attain the point of volitional fatigue of all major muscle groups targeted. Daily flexibility exercises were recommended for most patients. Patients were instructed to stretch to the end of their range but to stop short of pain. Static stretches were recommended for most major muscle groups, with some additional muscle groups targeted on a per patient basis. Range of motion exercises were also recommended on a per patient basis. Cardiorespiratory/aerobic exercises such as swimming and cycling were recommended at 30 minutes per day for 5 days per week at a moderate intensity for a total of 150 minutes per week. Moderate intensity was

calculated using the formula by Karvonen et al (40–60%) (19). All of the patients received balance exercises based on their abilities: either on a static surface or unidirectional wobble board with double leg support then single leg support, or on a multidirectional wobble board or Bosu ball.

To master the prescribed exercise regimen, participants were asked to attend an exercise class twice per week for 6 weeks. During the class, participants rotated through various exercise stations doing the exercises prescribed by the physiotherapist. They were supervised by a rehabilitation assistant and the physiotherapist was available if needed. At the end of weeks 3 and 6, the patients were reassessed by the physiotherapist and the participant's exercise recommendations were adjusted as needed.

Quality of care measures. Our primary outcome measure was an assessment of the participants' overall quality of OA care based on the Arthritis Foundation quality indicators for the management of OA (12). Quality of care measures were administered by a trained research nurse as part of a larger questionnaire given to the participants during their regularly scheduled visits. Participants completed all health outcome measures at baseline and 3 and 6 months with the exception of the primary outcome measure, which was only completed at 6 months. The 9 criteria outlined by the Arthritis Foundation were assessed in terms of a patient's eligibility for a specified health care intervention and whether or not they actually received the intervention (see Supplementary Appendix A, available in the online version of this article at http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)2151-4658). This outcome was measured at the 6-month point, after patients had completed their course of either intervention care or usual care.

For example, patients satisfied the eligibility criteria for exercise if the answer to the following statement was yes: "The patient has no contraindications to exercise and is physically and mentally able to exercise." The patient satisfied the pass criteria if they answered yes to the question, "In the past 6 months, were you advised to do strength training or aerobic exercise at least once?"

Primary outcome. Specifically, consistent with other investigators, summary scores of quality of care for OA were calculated for each subject (20). This indicates the percentage of indicators passed for a particular patient, who may have been eligible for anywhere from 0 to 9 indicators. Summary scores were compared across the study groups.

Secondary outcomes. Secondary outcomes included function (measured by the Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC]) and the Lower Extremities Function Scale (LEFS). Generic quality of life was measured by the Paper Adaptive Test-5D (PAT-5D) and the Health Utilities Index Mark 3 (HUI3). Finally, pain was measured by the WOMAC pain scale, the HUI3, and the PAT-5D pain attributes (21–27). The WOMAC, LEFS, and PAT-5D were developed specifically for arthritis populations and the HUI3 was developed for use in the general population. The WOMAC was used to assess patients using 24 parameters over 3 domains assessing diverse aspects of health, including pain, joint stiffness, and physical function. Higher scores on the WOMAC indicate worse pain, stiffness, and functional limitations. The LEFS questionnaire was used to assess a patient's ability to perform everyday tasks, consisting of 20 questions relevant to arthritis on a scale that ranges from "extreme difficulty or unable to perform activity" to "no difficulty." A lower score on the LEFS questionnaire indicates greater disability. The PAT-5D is a newly developed questionnaire with conditional branching that was used to assess patients on 5 domains relevant to arthritis (daily activities, walking, handling objects, pain, and emotions) that are relevant to arthritis patients. Higher scores on the PAT-5D indicate better health. Finally, the HUI3 was used as a generic, preference-scored, comprehensive system for measuring health status and health-related quality of life and producing utility scores. Higher scores on the HUI3 scale indicate better health.

Sample size. Sample size calculations for this study were based on the methods of a cluster randomized controlled clinical trial. An intracluster correlation coefficient was calculated to be 0.003, based on our PhIND-OA study (28). A difference in the mean quality of care score of 20 between the 2 arms would be considered as clinically significant (8). Therefore, the sample size for a 2-tailed alpha level of 0.05 and 95% power would require a minimum of 13 pharmacies per group with the total of 65 patients per treatment arm, taking into consideration loss to followup.

Outcomes and statistical analyses. Although participants and their health care providers could not be blinded, the outcome assessors for this study were blinded to the intervention status of the subject.

All analyses were conducted using intent-to-treat principles. Pass rates of the primary outcome were calculated by finding the proportion of the total number of questions (for each patient) that satisfied the pass criteria and the total number of questions (for each patient) that satisfied the eligibility criteria (29). The pass rates were assessed at the end of the study (6 months after recruitment) and compared between the usual care and intervention care groups. These were then compared across the treatment groups for each quality indicator using the chi-square test or Fisher's exact test (where the number of expected counts was less than 5). The primary outcome, the difference in pass rate among eligible quality indicators in those who received the intervention versus control, was analyzed using the 2-level hierarchical linear model.

To account for longitudinal correlations between outcomes assessed over time within the patients, the data were analyzed using 3-level hierarchical linear growth models with an unstructured correlation matrix. We used this method to model the 4 subscales of the WOMAC (global, pain, function, and stiffness), as well as the 2 domains of the PAT-5D (daily activities and pain), LEFS,

Table 1. Baseline characteristics of usual care and intervention care participants*

	Usual care (n = 66)	Intervention care (n = 73)	*P*
Age, mean ± SD years	60.8 ± 7.2	62.7 ± 9.2	0.242
Sex			0.883
Male	29 (44)	31 (42)	
Female	37 (56)	42 (58)	
BMI, kg/m^2†			0.876
<18.5	2 (3)	0 (0)	
18.5–24.9	22 (33)	28 (38)	
25.0–29.9	27 (41)	24 (33)	
≥30.0	15 (23)	21 (29)	
Income, Canadian dollars/year			0.151
<20,000	6 (9)	7 (10)	
20,000–50,000	21 (32)	14 (19)	
>50,000	39 (59)	52 (71)	
Education			0.301
Less than high school	2 (3)	1 (1)	
High school	12 (18)	9 (12)	
More than high school	52 (79)	63 (86)	
Ethnicity‡			0.840
Aboriginal	0 (0)	1 (1)	
Asian	6 (9)	15 (21)	
White	52 (79)	53 (73)	
South Asian	5 (8)	4 (5)	
Other	2 (3)	0 (0)	
HUI3, mean ± SD (no. missing)			
Total	0.679 ± 0.253 (9)	0.750 ± 0.170 (16)	0.133
Pain	0.845 ± 0.127 (3)	0.895 ± 0.080 (8)	0.025
Ambulation	0.986 ± 0.051 (3)	0.994 ± 0.024 (8)	0.355
Pain (single-attribute utility)	0.651 ± 0.285 (3)	0.764 ± 0.182 (8)	0.023
LEFS, mean ± SD (no. missing)	53.39 ± 15.91 (4)	54.58 ± 12.48 (8)	0.714
PAT-5D, mean ± SD (no. missing)			
Daily activities	41.41 ± 9.19 (7)	44.30 ± 7.31 (13)	0.148
Pain domain	44.12 ± 8.26 (7)	46.20 ± 6.41 (13)	0.289
WOMAC, mean ± SD (no. missing)			
Global	8.62 ± 4.43 (4)	6.97 ± 3.47 (8)	0.056
Pain subscale	3.01 ± 1.69 (4)	2.38 ± 1.34 (8)	0.098
Function subscale	2.19 ± 1.87 (4)	1.76 ± 1.18 (8)	0.205
Stiffness subscale	3.43 ± 1.95 (4)	2.83 ± 1.84 (8)	0.149

* Values are the number (percentage) unless otherwise indicated. BMI = body mass index; HUI3 = Health Utilities Index Mark 3; LEFS = Lower Extremity Function Scale; PAT-5D = Paper Adaptive Test-5D; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index.
† Based on self-reported weight.
‡ 1 missing (usual care).

and HUI3 (including the single attributes of ambulation and pain) outcomes. The treatment effect was added to the third level of the model (the pharmacy level). The model intercept and slope were treated as random effects. Differences in means were computed for each group at baseline and 3 and 6 months. Statistical significance was set at 0.05 (2-tailed). All analyses were performed using SAS statistical software, version 9.2.

RESULTS

In a consecutive manner over a period of 6 months, 386 patients were approached to participate in the study. Pharmacists administered the screening questionnaire to 198 eligible participants and 139 consented to participate in the study. Nine patients, 5 from the intervention pharmacies and 4 from the control pharmacies, withdrew from the study prior to completing the questionnaires, and 2 patients were lost to followup (1 from each arm). A total of 32 pharmacies participated in the trial (14 intervention and 18 control), with 73 and 66 participants in the intervention and control arms, respectively (Figure 1).

Table 1 shows the sociodemographic characteristics of patients from the usual care and intervention care pharmacies. The intervention arm was characterized by a slightly higher economic status (71% reported income >$50,000 per year) and education level (86% reported more than a high school education) than the usual care arm (59% reported income >$50,000 per year and 79% reported more than a high school education). Additionally, the intervention arm had a higher Asian population (21%) compared to the usual care arm (9%). The baseline

Table 2. Comparison of pass rates across treatment groups for each quality indicator*

Quality indicators	Usual care (n = 66)		Intervention care (n = 73)		*P*‡
	Eligible, no.	Passing, no. (%)†	Eligible, no.	Passing, no. (%)†	
Physical examination	21	10 (47.6)	18	10 (55.6)	0.62
Pain and functional assessment	23	6 (26.1)	17	13 (76.5)	0.002
Exercise	56	6 (10.7)	59	56 (94.9)	< 0.0001
Education	40	5 (12.5)	49	36 (73.5)	< 0.0001
Weight loss	30	4 (13.3)	22	11 (50.0)	0.004
Assistive devices	4	2 (50.0)	5	1 (20.0)	0.36
Pharmacologic therapy	5	1 (20.0)	8	1 (12.5)	0.51§
Surgery	2	0 (0.0)	1	1 (100.0)	0.33§
Radiographs	66	8 (12.1)	73	38 (52.1)	< 0.0001

* Pass rates of the primary outcome were calculated by finding the proportion between the total number of questions (for each patient) that satisfied the pass criteria and the total number of questions (for each patient) that satisfied the eligibility criteria (12,28). The overall difference between the usual and intervention care arms is 45.2% (95% confidence interval 34.5, 55.9; $P < 0.0001$).
† Percentage is based on the passing/eligible ratio.
‡ Chi-square test was used to obtain the *P* values.
§ For the cases where the number of expected counts is <5, Fisher's exact test was used.

quality of life and function scores (HUI3, LEFS, PAT-5D, and WOMAC) were not significantly different between participants from the usual care and intervention care pharmacies.

For the intervention arm, it is important to note the overall amount of physiotherapy prescribed for each patient compared to the actual amount of physiotherapy the patient completed. Patients in the intervention group were recommended to attend at least 2 physiotherapist-guided exercise sessions per month for a total of 12 sessions of the intervention period. On average, patients attended 6 physiotherapy sessions (mean ± SD 5.95 ± 4.73); however, the range of physiotherapy sessions attended per patient was between 0 (n = 14) and 14 sessions (n = 1).

The primary outcome, the overall quality indicator pass rate (Table 2), was significantly higher for those in the intervention arm compared to the control arm (difference of 45.2% [95% confidence interval 34.5, 55.9]; $P < 0.0001$). Additionally, the following individual quality indicator pass rates were significantly higher in those from intervention pharmacies compared to the usual care group: pain and functional assessment, exercise, education, weight loss, and knee radiographs. Only 2 quality indicators were higher in the control group than the intervention group (assistive devices and reliance on pharmacologic therapy).

Significant improvements were observed for the intervention care group as compared to the usual care group in the WOMAC global, pain, and function scores at 3 and 6 months (all $P < 0.01$). The PAT-5D daily activity scores at 3 and 6 months (both $P < 0.05$) and pain scores at 6 months ($P = 0.05$) also showed significant improvements, as did the HUI3 single-attribute pain score at baseline, 3 months, and 6 months (all $P < 0.05$) and the LEFS scores at 6 months ($P < 0.05$) (Table 3). The expected longitudinal changes in LEFS scores between usual care and intervention care at baseline and 3 and 6 months are shown in Figure 2.

Participants were asked to report their reasons for visiting the pharmacy on the day they learned about the study, and 60% (74% usual care and 50% intervention) indicated they were picking up a prescription medication, of which 15% (14% usual care and 16% intervention) specified the prescription was for pain relief medication. Another 16% (12% usual care and 19% intervention) reported they were in the pharmacy to pick up over-the-counter (nonprescription) medication, of which 78% (83% usual care and 75% intervention) specified over-the-counter pain relief medication. Participants were also asked to report how they came to learn about the study, and ~52% (52% usual care and 52% intervention) reported that they saw a display card on the pharmacy counter. Another 38% (43% usual care and 34% intervention) learned about the study through informational posters or shelf talkers posted around the pharmacy, and 15% (13% usual care and 16% intervention) were advised about the study by a pharmacist, pharmacist assistant, or technician.

Additionally, pharmacists followed up with patients in the intervention arm each month and were asked to report any pertinent information regarding pain, exercise, and medication to the patients' physicians (Table 4). Over the 6-month followup period, a total of 355 documented comments involving pain, medication, and exercise were made to patients' physicians as a result of the monthly pharmacist–patient followups.

DISCUSSION

This study is the first to assess community-based pharmacists in their ability to implement a multidisciplinary intervention to improve health outcomes for patients with undiagnosed knee OA. The results show that patients experience measurable gains when health care professionals from community pharmacies and physiotherapy clinics are partnered with primary care physicians for OA management. The most important outcome of this trial was the marked improvement in participants' overall quality of OA care for the intervention arm compared to the usual care arm. Specifically, compared to the usual care group, significantly more individuals in the intervention group described their care as meeting the quality indicators for

Table 3. Differences in health-related quality of life scores across treatment groups at each time point of followup (baseline, 3 months, and 6 months)*

	Estimate of differences at baseline (95% CI)	Estimate of differences at 3 months (95% CI)	Estimate of differences at 6 months (95% CI)
WOMAC score (normalized)			
Global (range 0–30)	−1.59 (−3.25, 0.075)	−1.99 (−3.45, −0.54)†	−2.40 (−4.10, −0.71)†
Pain subscale (range 0–10)	−0.63 (−1.37, 0.13)	−0.78 (−1.40, −0.16)†	−0.93 (−1.59, −0.28)†
Function subscale (range 0–10)	−0.46 (−1.14, 0.22)	−0.65 (−1.20, −0.10)†	−0.84 (−1.45, −0.24)†
Stiffness subscale (range 0–10)	−0.48 (−1.19, 0.24)	−0.54 (−1.12, 0.047)	−0.59 (−1.30, 0.11)
LEFS total score (range 0–80)	1.69 (−4.02, 7.41)	4.14 (−1.06, 9.35)	6.59 (1.24, 11.94)†
HUI3 score			
Total (range −0.36 to 1.0)	0.0728 (−0.02, 0.16)	0.0459 (−0.03, 0.12)	0.0189 (−0.06, 0.10)
Pain score (range −0.36 to 1.0)‡	0.0993 (0.01, 0.19)†	0.0873 (0.02, 0.15)†	0.0753 (0.002, 0.15)†
Ambulation score (range −0.36 to 1.0)	0.02458 (−0.03, 0.08)	0.0210 (−0.03, 0.07)	0.0174 (−0.04, 0.07)
PAT-5D score			
Daily activities domain	2.48 (−1.28, 6.23)	3.28 (0.38, 6.19)†	4.09 (0.95, 7.23)†
Pain domain	2.10 (−1.58, 5.78)	2.88 (−0.26, 6.02)	3.65 (0.40, 6.91)†

* 95% CI = 95% confidence interval; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; LEFS = Lower Extremity Function Scale; HUI3 = Health Utilities Index Mark 3; PAT-5D = Paper Adaptive Test-5D.
† $P < 0.05$.
‡ There were significant differences between the usual care and intervention groups at baseline ($P = 0.03$), 3 months ($P = 0.01$), and 6 months ($P = 0.04$) for the pain single-attribute utility HUI3 index.

pain and functional assessment, exercise, education, weight loss, and radiographs (Table 2). Specifically, the results show that the intervention group experienced a measurable increase in more than half of the Arthritis Foundation quality indicators (see Supplementary Appendix A, available in the online version of this article at http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)2151-4658).

Pharmacists enrolled 139 patients for this study from community pharmacies across the greater Vancouver area.

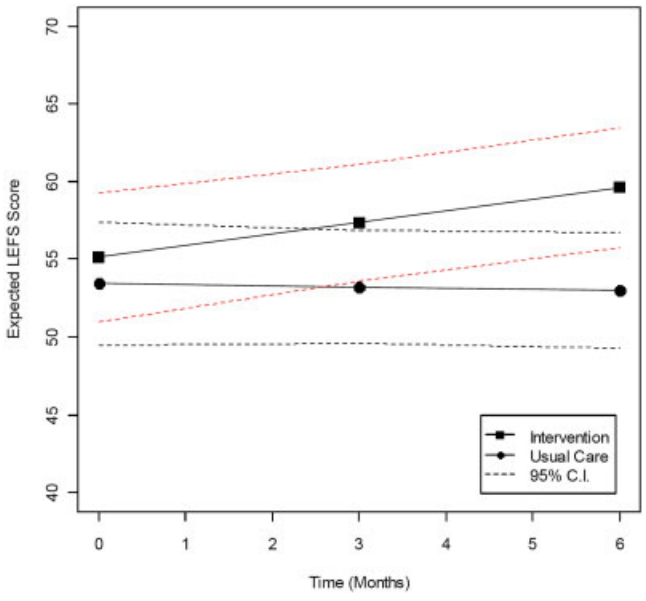

Figure 2. Longitudinal changes in Lower Extremity Function Scale (LEFS) scores between the usual care and intervention care groups showing significant differences across the treatment groups at 6 months ($P = 0.02$). The expected LEFS scores based on the results of the 3-level hierarchical linear model are shown. 95% C.I. = 95% confidence interval.

Many factors affect the epidemiology of OA, including age, sex, genetics, obesity, and injury (4); however, the baseline demographics were distributed evenly and normally in the populations of the 2 arms (Table 1). There were no explanatory differences between the intervention and usual care arms in terms of age or sex, and while some variation occurred across BMI, education, income, and ethnicity, baseline health-related quality of life showed little variation across the 2 arms. As such, the differences in baseline characteristics between the arms likely contributed to the differences in the outcomes observed.

A set of health-related quality of life markers was monitored during this study. The WOMAC, using 24 parameters in 3 domains, was used to assess diverse aspects of health, including pain, joint stiffness, and physical function, of participants with OA (21). The results showed no significant difference between the intervention and usual care groups at baseline, and significant improvements were observed for the intervention arm in the global, pain, and function subscales at both the 3- and 6-month measurements (Table 3). Consistent with the WOMAC, the LEFS questionnaire, assessing patients' ability to perform everyday tasks (22), showed no difference at the baseline or 3-month measurements, but a significant improvement for the intervention group was observed at the 6-month measurement.

Consistent with the WOMAC and LEFS, the PAT-5D (25,26) is a newly developed, preference-based questionnaire based on item response theory assessing 5 domains (daily activities, walking, handling objects, pain, and emotions) that are relevant to patients with arthritis. By the 6-month measurement, a significant improvement was observed for the intervention group compared with the usual care group.

On the other hand, the HUI3 failed to measure differences in health-related quality of life between the inter-

Table 4. Monthly pharmacist followup with intervention care participants: documented comments and recommendations made to participants' primary care physicians*

Month	Comments and recommendations†				Patient followup§	Total recommendations¶
	Pain	Medication	Exercise	Other‡		
Baseline	13 (19)	6 (9)	2 (3)	0 (0)	69 (95)	21 (30)
1	33 (61)	12 (22)	21 (39)	2 (4)	54 (74)	68 (126)
2	29 (73)	7 (18)	17 (43)	3 (8)	40 (55)	56 (140)
3	22 (66)	7 (21)	15 (45)	1 (3)	33 (45)	62 (188)
4	19 (63)	6 (20)	12 (40)	1 (3)	30 (41)	38 (127)
5	21 (68)	3 (10)	15 (48)	0 (0)	31 (42)	39 (126)
6	34 (85)	8 (20)	27 (68)	2 (5)	40 (55)	71 (178)
Total no.	171	49	109	9	297	355

* Values are the number (percentage) unless otherwise indicated.
† Number of recommendations per month as a percentage of the number of followups performed in that month.
‡ Includes braces, hot/cold therapy, weight loss, etc.
§ Total number of followups performed each month as a percentage of the total number of patients enrolled in the intervention arm (n = 73).
¶ Number of recommendations per month as a percentage of the number of followups performed in that month. Where the percentage of total recommendations exceeds 100, on average, more than 1 recommendation was made to each physician per patient followup.

vention and usual care groups. The HUI3 is a generic, preference-scored, comprehensive system for measuring health status and health-related quality of life and for producing utility scores (23,24,27,30–32). The results of the HUI3 showed significant differences only between the intervention and usual care groups on the pain subscale; however, even this subscale improvement should be interpreted with caution, as modest differences were also present at the baseline measurement. Although the results of the HUI3 differ substantially compared to the other 3 health-related quality of life measures, this is likely attributable to the disease-specific nature of the WOMAC, LEFS, and PAT5-D, as well as the decreased sensitivity of the HUI3 due to the range of nonspecific measures included.

Pharmacists were integral in the initial identification of the OA patients that were undiagnosed or had not sought physician attention regarding their knee pain, which lends support to earlier findings (28). Additionally, the monthly pharmacist followups clearly demonstrated the value of pharmacists' expanded roles in this collaborative care intervention. Patients were contacted monthly for information regarding pain, medication, and exercise, and 355 documented and categorized comments were directly communicated to physicians with any recommendations the pharmacist could offer. For poorly managed chronic conditions such as knee OA, this regular contact between pharmacists and patients presents an opportunity to narrow the care gap in a cost-effective manner. Of note, quite a few pharmacies dropped out of participation, and this number was greater in the intervention arm as compared to usual care. The reasons for this are likely multifactorial and complex and are likely not limited to lack of time (33).

There are a few limitations to this study that have been described previously (15). First, although comprehensive data were collected from participants who were initially included by the pharmacists but then were subsequently excluded (false-positives), nothing is known about how many of those that were excluded by the pharmacists actually had knee OA (false-negatives). As such, no calculation of sensitivity, specificity, positive predictive value, or negative predictive value for the diagnosis of knee OA is possible. Second, we relied on patient self-report to exclude a previous OA diagnosis by their primary care physician. The impact of this factor is small but not negligible, as followup with family practitioner offices revealed that only 26% of patients had OA mentioned in their charts in the 24 months prior to enrollment in the study. We utilized experienced physiotherapists employed at an arthritis referral facility to perform the physical examinations and to recommend appropriate exercise programs. It is possible that generalist physiotherapists might not have the time or expertise to provide a comparable service. Finally, the patients were not blinded to the intervention, and as such, may have been biased when answering the quality of life questionnaires. We attempted to ameliorate this limitation by using blinded assessors to administer the questionnaires.

Taken together, these results suggest that community pharmacists can effectively launch a multidisciplinary intervention to address the gaps in OA patient care, including identification and utilization of pharmacologic and nonpharmacologic treatment options. Considering the rising prevalence of OA and the associated personal and societal costs, these findings have important implications for efficient referral to prevention and intervention programs. This study represents the first step toward collaborative care in the management of knee OA.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr. Marra had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design. Marra, Cibere, Gastonguay, Tsuyuki, Khan, Esdaile.

Acquisition of data. Marra, Gastonguay, Embley, Tsuyuki, Khan.

Analysis and interpretation of data. Marra, Grubisic, Grindrod, Gastonguay, Thomas, Colley, Tsuyuki, Khan, Esdaile.

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