Randomized controlled trial of Anticipatory and Preventive multidisciplinary Team Care

For complex patients in a community-based primary care setting

William Hogg MSc MCISc MD FCFP **Jacques Lemelin** MD CCFP FCFP **Simone Dahrouge** MSc PhDc **Clare Liddy** MSc MD
Catherine Deri Armstrong MA PhD **Frances Legault** RN Phd **Bill Dalziel** MD **Wei Zhang** MA

ABSTRACT

OBJECTIVE To examine whether quality of care (QOC) improves when nurse practitioners and pharmacists work with family physicians in community practice and focus their work on patients who are 50 years of age and older and considered to be at risk of experiencing adverse health outcomes.

DESIGN Randomized controlled trial.

SETTING A family health network with 8 family physicians, 5 nurses, and 11 administrative personnel serving 10 000 patients in a rural area near Ottawa, Ont.

PARTICIPANTS Patients 50 years of age and older at risk of experiencing adverse health outcomes (N=241).

INTERVENTIONS At-risk patients were randomly assigned to receive usual care from their family physicians or Anticipatory and Preventive Team Care (APTCare) from a collaborative team composed of their physicians, 1 of 3 nurse practitioners, and a pharmacist.

MAIN OUTCOME MEASURES Quality of care for chronic disease management (CDM) for diabetes, coronary artery disease, congestive heart failure, and chronic obstructive pulmonary disease.

RESULTS Controlling for baseline demographic characteristics, the APTCare approach improved CDM QOC by 9.2% ($P<.001$) compared with traditional care. The APTCare intervention also improved preventive care by 16.5% ($P<.001$). We did not observe significant differences in other secondary outcome measures (intermediate clinical outcomes, quality of life [Short-Form 36 and health-related quality of life scales], functional status [instrumental activities of daily living scale] and service usage).

CONCLUSION Additional resources in the form of collaborative multidisciplinary care teams with intensive interventions in primary care can improve QOC for CDM in a population of older at-risk patients. The appropriateness of this intervention will depend on its cost-effectiveness.

TRIAL REGISTRATION NUMBER NCT00238836 (CONSORT)

EDITOR'S KEY POINTS

- Reforming the delivery of primary care services has become a high priority in Canada and represents a substantial new investment in primary care. Information on how best to deploy these new resources is needed. This trial aimed to examine whether collaborative care improved quality of care for older, at-risk patients.
- The investigators observed an improvement in quality of care for chronic disease management but did not find improvements in the 2 clinical outcome measures studied (blood pressure and glycemic control) or in quality of life and functional status; they also did not find a reduction in service use. Caregiver burden scores were also not significantly different between groups at the end of the study.
- The findings of this study suggest that additional multidisciplinary care can increase adherence to evidence-based guidelines. However, these additional resources constitute a substantial additional cost. The appropriateness of such an intervention will ultimately depend on its associated costs and the value placed on its effect.

This article has been peer reviewed.
Can Fam Physician 2009;55:e76-85

Essai randomisé portant sur l'Anticipatory and Preventive multidisciplinary Team Care

Pour des patients risque élevé en contexte de soins primaires

William Hogg MSc MCISc MD FCFP **Jacques Lemelin** MD CCFP FCFP **Simone Dahrouge** MSc PhDc **Clare Liddy** MSc MD
Catherine Deri Armstrong MA PhD **Frances Legault** RN Phd **Bill Dalziel** MD **Wei Zhang** MA

RÉSUMÉ

OBJECTIF Déterminer si la qualité des soins (QDS) est meilleure quand les infirmières cliniciennes et les pharmaciens travaillent avec les médecins de famille et concentrent leurs efforts sur les patients de 50 ans et plus susceptibles de présenter des issues de santé défavorables.

TYPE D'ÉTUDE Essai clinique randomisé.

CONTEXTE Un réseau de santé familiale comprenant 8 médecins de famille, 5 infirmières et 11 membres du personnel administratif desservant 10000 patients d'une région rurale voisine d'Ottawa, Ontario.

PARTICIPANTS Patients de 50 ans et plus présentant des issues de santé défavorables (N=241).

INTERVENTIONS Les patients à risque élevé ont été choisis de façon aléatoire pour recevoir les soins habituels de leur médecin de famille ou ceux d'une Anticipatory and Preventive multidisciplinary Team Care (APTCare) prodigués en collaboration par une équipe comprenant leur médecin, une à trois infirmières cliniciennes et un pharmacien.

PRINCIPAUX PARAMÈTRES ÉTUDIÉS Qualité des soins dans la gestion des maladies chroniques (GMC): diabète, maladie coronarienne et maladie pulmonaire obstructive chronique.

RÉSULTATS Compte tenu des caractéristiques démographiques initiales, l'approche de l'APTCare a amélioré la QDS dans la GMC de 9,2% ($P<.001$) par rapport aux soins traditionnels. Elle a aussi amélioré les soins préventifs de 16,5% ($P<.001$). Nous n'avons pas observé de différence significative pour les autres issues secondaires étudiées (issues cliniques intermédiaires, qualité de vie [questionnaire généraliste sf-36 et échelles d'évaluation de la qualité de vie reliées à la santé], état fonctionnel [échelle des activités instrumentales de la vie quotidienne] et utilisation des services).

CONCLUSION L'addition de ressources sous forme d'équipes multidisciplinaires collaborant et intervenant de façon intensive au niveau des soins primaires peut améliorer la QDS dans la GMC chez une population de patients âgés à risque. L'opportunité d'une telle intervention dépendra de son rapport coût-bénéfice.

NUMÉRO D'ENREGISTREMENT DE L'ÉTUDE NCT00238836 (CONSORT)

POINTS DE REPÈRE DU RÉDACTEUR

- La réforme des services de dispensation des soins primaire est devenue une priorité majeure au Canada, représentant un nouvel investissement considérable dans ce domaine. Il importe de préciser comment utiliser au mieux ces nouvelles ressources. Cette étude voulait déterminer si des soins en collaboration améliorent la qualité des soins aux patients âgés à risque.
- Les auteurs ont observé une amélioration de la qualité des soins dans la gestion des maladies chroniques mais n'ont pas trouvé d'amélioration pour les 2 issues cliniques étudiées (contrôle de la tension artérielle et de la glycémie) ni pour la qualité de vie ou l'état fonctionnel; de plus, ils n'ont pas observé de diminution de l'utilisation des services. Les scores évaluant la charge de travail du personnel soignant ne différaient pas significativement entre les groupes à la fin de l'étude.
- Les résultats de cette étude suggèrent que l'addition de soins multidisciplinaires peut augmenter l'adhésion aux directives fondées sur des preuves. Toutefois, ces ressources supplémentaires représentent un coût additionnel considérable. La pertinence de ce genre d'intervention dépendra finalement des coûts qu'elle entraîne et de la valeur attribuée à ses effets.

Cet article a fait l'objet d'une révision par des pairs.
Can Fam Physician 2009;55:e76-85

Reforming the delivery of primary care services has become a high priority in Canada as a result of problems with access to care, reports of care gaps, and concerns about the aging population.[1] The reforms represent a substantial new investment in primary care and require information on how best to deploy these new resources. In 2002, the Primary Health Care Transition Fund was established to help inform and enable this change, a key element of which was the introduction of multidisciplinary team care in family practices.[2]

In response to this, in 2004 we initiated a $1.2 million study evaluating the effect of multidisciplinary team care focused on the most vulnerable patients in a family practice. At that time, there was some evidence suggesting that intensifying management of patients with chronic illnesses by channeling multidisciplinary resources toward their care was effective. In these studies team composition varied, but the intervention usually involved care planning and management of elderly patients, sometimes with emphasis on self-care. For example, in one study, timely evaluation and management of high-risk elderly patients by a team composed of a social worker, nurse practitioner (NP), geriatrician, and nurse was associated with reduced functional decline.[3] Similarly, a geriatric assessment and provision of team care involving a physician, NP, social worker, and clinical psychologist was found to improve health perception, general sense of well-being, and functional status in veterans, and was associated with fewer clinic visits compared with usual care.[4] In another study, which was focused on elderly patients with chronic illnesses, team care involving the family physician, a nurse, and a social worker reduced hospitalizations and office visits while enhancing patients' participation in social activities.[5] Other multidisciplinary teams were also successful in improving outcomes in specifically targeted conditions.[6,7] There was also some evidence that bringing multidisciplinary team care to patients' homes was effective. One study, in which care was provided by family physicians, nurses, and social workers to elderly patients in their homes, demonstrated improved patient and caregiver quality of life, reduced emergency service use, and high satisfaction with care.[8]

We evaluated the benefits of home-based multidisciplinary team management involving an NP, a pharmacist, and a general practitioner working collaboratively within a family practice and focusing on providing care to community-dwelling patients who were considered to be at risk of poor health outcomes. This paper reports on the outcomes of this randomized controlled study.

METHODS

Design

This is a randomized controlled trial of Anticipatory and Preventive Team Care (APTCare) with new additional allied health providers compared with usual care (1:1). The random treatment allocation list was generated electronically by TrialStat Corporation and was concealed from all study personnel. Patients were randomized during a home visit by a research associate through an automated central telephone system. All care providers and patients were blind to the primary outcome measure of the study. Where more than 1 individual in a household was enrolled, all were randomized together to the same arm.

Setting

The study was conducted in a family health network with 8 family physicians, 5 nurses, and 11 administrative personnel serving 10 000 patients in a rural area near Ottawa, Ont. Physicians in the practice were remunerated by the publicly funded Medicare system through a blended payment formula of capitation (principally), fee-for-service, and incentives.

Selection of participants

Details of the study methodology are provided in a companion article.[9] Briefly, patients were eligible if they were 50 years of age or older, rostered in the practice, and considered by their family physicians to be good candidates to benefit from additional medical resources and at risk of functional decline, physical deterioration, or experiencing an event requiring emergency services. There were no restrictions on diagnoses. Exclusion criteria included substantial cognitive impairment, language or cultural barriers, life expectancy less than 6 months, and plans to move or to be away for more than 6 weeks during the study period.

Sample size calculation

The trial was originally designed to detect a difference in emergency department visits between the APTCare and the usual care groups. Based on our original postulation, we required 120 patients in each arm. However, 5 months after the trial was initiated and before any outcome data were available, the primary outcome was deemed inappropriate owing to the low observed baseline rate of emergency department visits. Instead the objective was altered to examine differences in the quality of care (QOC) for chronic disease management (CDM) in 4 conditions (ie, diabetes, coronary artery disease [CAD], congestive heart failure [CHF], and chronic obstructive pulmonary disease [COPD]). To estimate the power of the study given a sample of 240 patients, several Monte Carlo simulations were repeated, each with 10 000 iterations of 3400 observations, yielding similar results. For these simulations, at random, 10% of the patients were assumed to be eligible for each of the maneuvers based on probabilities estimated by clinical experts. A Kruskal-Wallis test (a nonparametric test for estimating equality of medians)[10] was then performed

to test the difference between the 2 arms. It was determined that a sample size of 200 (allowing for dropouts) would provide 99% power to detect an absolute average difference of 25% between the 2 arms.

Intervention

The intervention consisted of care provided by a multidisciplinary team. One pharmacist and 3 NPs were added to the family practice. The pharmacist worked full-time for the first 9 months and 1 NP worked full-time for 5.4 months, after which all worked half-time. Patients allocated to the intervention group were assigned to 1 of 3 NPs. The NPs provided coverage for one anothers' patients when an NP was absent. The pharmacist and NPs delivered their care almost exclusively in the patients' homes or by telephone. Both performed comprehensive chart reviews and home visits for each patient at the start of the study. The pharmacist then conducted a medication management review, identifying potential drug-related problems and actions required to address such issues. She then worked directly with the patients and in collaboration with the NPs and family physicians to address these and new drug-related problems as they arose. Each patient's NP developed an individualized care plan in collaboration with the patient and in consultation with the pharmacist and the patient's family physician. The care plan identified the patient's active health issues and outlined the management goals that the patient and the team of providers would work toward over the course of the intervention.

Recruitment of patients took place between October 2004 and March 2005 and all patients were followed until March 31, 2006, for total intervention durations of 12 to 18 months (mean of 14.9 months in each arm). The study received approval from the Ottawa Hospital Research Ethics Board and is registered with CONSORT as NCT00238836.

Data collection

Chart audits were performed to review the quality of CDM, using 12 indicator chronic disease maneuvers and 6 indicator prevention maneuvers, and to evaluate the use of emergency services and hospitalization. Chart reviews for baseline and end-of-study QOC measures were performed by a foreign-trained physician. Instances in both arms in which a QOC maneuver was coded as not having been performed were reviewed by a nurse, and consensus was obtained between the 2 coders.

Outcome questionnaires were administered by a research associate in each patient's home at baseline before randomization and again at the end of the study before withdrawing the services. Questionnaires captured quality of life (Short-Form 36 [SF-36] and health-related quality-of-life scales, both of which indicate better status with higher scores), instrumental activities of daily living evaluations (with higher scores showing more limitations in activity), and self-reported emergency department visits and hospitalization. The latter 2 items were also assessed at the midpoint to reduce recall bias, and a research associate, blinded to the treatment arm, integrated the information with that derived from the chart to obtain a final measure of service utilization. A caregiver burden questionnaire was left with each patient's identified informal caregiver at the home visit following randomization and was mailed to the same individuals at the end of the study (higher scores indicated greater burden). Data entry of questionnaire results was performed by a research associate. Baseline data entry was validated using double data entry methods (error rate < 1%).

Analysis

Intention-to-treat analysis was performed. Patients who withdrew during the study were not contacted for surveys but were included in the QOC measures.

Primary outcome measure

Chronic disease management score. A CDM QOC composite score based on 12 indicator maneuvers for 4 chronic diseases (CAD,[11,12] diabetes,[13,14] CHF,[15,16] and COPD[17]) was developed to measure adherence to guidelines at study start and study end. Indicators were based on the guideline recommendations shown in **Table 1.**[1-7] This could only be evaluated in the subset of patients with at least 1 of these chronic conditions. Normalized scores were computed by dividing the number of appropriately performed maneuvers by the number of maneuvers for which that patient was eligible. Quality-of-care scores were calculated for individual diseases, then combined to create an overall score for CDM in which each chronic disease had equal weight. The differences in the end-of-study and baseline normalized scores for individual patients were computed and compared between the treatment and control arms using independent *t* tests. All patients having at least 1 of the 4 indicator diagnoses, including those who withdrew and those who died during the study, were included in this analysis.

Secondary outcome measures

Intermediate clinical outcomes. We evaluated mean hemoglobin A_{1c} and blood pressure in the 2 study groups and compared the changes from baseline to end-of-study measurements in each individual using independent *t* tests.

Quality of preventive care. We evaluated adherence to the Canadian Task Force on Preventive Health Care recommendations for 6 preventive indicator maneuvers over the previous 24 months at baseline and again at the end of the study (**Table 2**[8-13]). Normalized scores

for individual maneuvers and overall prevention were analyzed using the same approach as for CDM.

Additional secondary outcomes. Independent *t* tests and χ^2 tests were used where appropriate to evaluate SF-36 scores, health-related quality of life, activities of daily living, hospitalization, and emergency use. Deceased patients were assumed to have each had 1 emergency department visit. For quality-of-life and functional status evaluation, sensitivity analyses were performed in which deceased patients and those who withdrew were assigned the lowest score on the scale. The calculation of the mental and physical component summary scores of the SF-36 was performed using SF Health Outcomes Scoring software (Basic Version), which follows the computation methodology presented by Ware et al.[18]

Multivariate analyses

Multivariate linear regression models were performed for each continuous outcome measure, adjusted for age; sex; baseline measures of self-assessed health, estimated risk level, polypharmacy, frequent visits to the office in the previous year, multiple health conditions,

Table 1. Maneuvers evaluated for measuring performance in chronic disease management: *1 point was awarded for each maneuver performed (0.5 points were awarded if HbA_{1c} was measured only once in the past y).*

CONDITION	MANEUVER*	EVIDENCE GRADE LEVEL
CAD[1,2]	Recommended aspirin†	A
	Recommended β-blockers‡	A
	Recommended statins§	Ungraded
Diabetes[3,4]	Recommended ACE inhibitor‖ or ARB¶	A, A
	HbA_{1c} measured at least twice in past y	D
	Feet examined in the previous 2 y	B
	Eyes examined in the previous 2 y	B
CHF[5,6]	Recommended ACE inhibitor or ARB	A, B
	Recommended β-blockers	A
COPD[7]	Influenza immunization in the previous 15 mo	A
	Pneumococcal vaccine in the previous 10 y	C
	Recommended bronchodilators	A

ACE—angiotensin-converting enzyme, ARB—angiotensin receptor blocker, CAD—coronary artery disease, CHF—congestive heart failure, COPD—chronic obstructive pulmonary disease, HbA_{1c}—hemoglobin A_{1c}.
*For all medications a minimum of 5 y from the date of evaluation were reviewed for any evidence of recommendation of medication.
†Aspirin, acetylsalicylic acid, Entrophen, Novasen, enteric-coated acetylsalicylic acid.
‡Sectral, Monitan, Tenormin, Novo-Atenol, Apo-Atenol, Kerlone, Zebeta, Monocor, Cartrol, Coreg, Trandate, Normodyne, Lopresor, Novo-Metoprol, Betaloc, Apo-Metoprolol, Toprol-XL, Corgard, Trasicor, Levatol, Visken, Novo-Pindol, Inderal, Inderal-LA, Apo-Propranolol, Sotacor, Blocadren, Novo-Timol, Apo-Timol.
§Lovastatin, pravastatin sodium, lovastatin and niacin, simvastatin, fluvastatin sodium, atorvastatin calcium, rosuvastatin, cerivastatin.
‖Benazepril, captopril, enalapril, fosinopril, lisinopril, trandolapril, quinapril, quinapril and hydrochlorothiazide, moexipril, cilazapril, ramipril, perindopril.
¶Losartan, losartan and hydrochlorothiazide, irbesartan, irbesartan and hydrochlorothiazide, valsartan, valsartan and hydrochlorothiazide, candesartan cilexetil, cilexetil and hydrochlorothiazide, eprosartan, eprosartan and hydrochlorothiazide, telmisartan, telmisartan and hydrochlorothiazide, olmesartan.

Table 2. Maneuvers evaluated for measuring performance in preventive care

MANEUVER	PREVENTION	ELIGIBILITY	GRADE LEVEL	SCORE ATTRIBUTED
Influenza vaccination[8]	Influenza prevention	Higher risk of influenza*	A	1
FOBT or FS[9]	CRC screening	≥ 50 y	A (FOBT) B (FS)	1
Mammography and clinical breast examination[10]	Breast cancer screening	Women 50-59 y	A	0.5 each
Papanicolaou smear[11]	Cervical cancer screening	Women 17-69 y	B	1
Eye examination[12]	Visual impairment screening	≥ 65 y	B	1
Hearing examination[13]	Auditory impairment screening	≥ 65 y	B	1

CRC—colorectal cancer, FOBT—fecal occult blood testing, FS—flexible sigmoidoscopy.
*Adults with serious chronic conditions (eg, chronic cardiac or pulmonary disorders, diabetes, lupus, colitis, Crohn disease), those in an immunocompromised state, those with active hepatic disease, those ≥ 65 years of age, and residents of nursing homes or chronic care facilities.

emergency department visits in the previous year, education level, living accommodations, household income, main activities, having someone to confide in, and registration as a client of home care services; the presence of diabetes, CAD, COPD, or CHD; and baseline QOC scores.

RESULTS

Of the 316 patients contacted, 241 participated (response rate of 76%); 8 of these had been deemed low risk but were enrolled with their at-risk partners. Patients who declined participation were dealing with personal or health issues (n = 16), were too busy or active (n = 10), thought they were receiving enough care or did not want additional individuals involved in their care (n = 8), or did not provide reasons for refusing to participate (n = 41). In the intervention arm, 5 participants withdrew and 3 died. In the control arm, 4 withdrew and 1 moved. **Table 3** depicts the baseline patient profile. Patients in the APTCare arm were younger by 3.2 years ($P = .018$). The 2 groups were otherwise similar.

Table 3. Patient characteristics

CHARACTERISTIC	APTCARE (N = 120)	USUAL CARE (N = 121)
Demographic information		
• Mean age, y	69.6	72.8
• Male sex, %	48	37
• First language is English, %	92	93
• Has someone to confide in, %	87	88
• High school or more education, %	57	65
• Working for pay or profit, %	18	14
• Household income ≥ $40 000, %	41	40
• Lives alone, %	28	29
• Owns home, %	76	79
Health profile		
• Fair or poor self-assessed health, %	27	37
• Home care services client, %	9	12
• Mean no. of chronic conditions*	2.7	2.4
• CAD, %	26	33
• Diabetes, %	33	32
• CHF, %	8	9
• COPD, %	18	17
Risk level		
• Mean no. of ED visit in previous year, %	19	24
• No. of visits to doctor in the previous y	9	8
• Identified as high risk by family physician, %	33	36
• Mean no. of medications	4.0	3.7

CAD—coronary artery disease, CHF—congestive heart failure, COPD—chronic obstructive pulmonary disease, ED—emergency department.
*Including diabetes; CHF; chronic anxiety, depression, or other mental illnesses; COPD; CAD; neurologic conditions; hypertension; anemia; arthritis or back problems; cancer; asthma; cerebrovascular disease; and ischemic heart disease, atrial fibrillation, or peripheral vascular disease.

Outcome measures

Unadjusted analysis. Chronic disease could be evaluated in 152 patients, 45 of whom had multiple chronic conditions. **Table 4** represents comparisons of the unadjusted CDM QOC scores between the 2 arms. For both arms, baseline estimates and differences between end points and baseline values are reported. The last section represents the difference between the 2 arms and their corresponding confidence intervals (CIs) and *P* values. Patients in the intervention arm had a significant increase in the quality of CDM (absolute difference of 9.1%, 95% CI 3.7% to 14.4%). Improvement in CDM appears to be driven by enhanced adherence to guidelines, primarily for diabetes management. We did not observe significant differences in intermediate clinical outcome measures ($P \geq .071$). An 18.1% (95% CI 10.8% to 25.5%) absolute difference in prevention (**Table 5**) was observed between the 2 arms. Improvement was detected for all indicator maneuvers except 2 for which performance was relatively high (> 85%) before the intervention.

Adjusted analysis. The duration of the intervention was not significantly associated with the QOC score (data not shown). However, improvements in CDM and prevention scores were greater for individuals with lower baseline CDM scores. For CDM, the β value for baseline scores was -28.8% (95% CI -39.3% to -18.2%); for prevention it was -57.5% (95% CI -69.0% to 46.0%). After adjusting for potential confounders, including baseline scores, the intervention arm remained associated with a significant improvement in CDM QOC (β coefficient 9.2%; 95% CI 4.1% to 14.4%) and disease prevention (β coefficient 16.5%; 95% CI 10.1% to 22.9%).

At baseline, the caregiver burden score in the control arm was significantly higher than that in the intervention arm (scores of 18.0 vs 12.6 out of a possible 88). This was consistent for most questions throughout the 22-item survey. At the end of the study, the scores in the 2 arms were 14.6 and 14.2, respectively, reflecting a significant drop in the control arm burden assessment ($P = .0070$). We did not observe any differences between the 2 arms in quality of life or functional status. Sensitivity analyses in which nonrespondents were assigned the lowest score were consistent with these results. Use of emergency department services or hospitalization did not differ between the 2 arms.

DISCUSSION

To our knowledge, this is the first report of a randomized controlled trial evaluating the effects of a multidisciplinary team in which a pharmacist and NPs are added to a family practice. We found significant enhancements in the CDM QOC processes, especially for diabetes care. There is evidence supporting the notion that it is beneficial to add pharmacists[6,19-22] or NPs[22] who focus on the management of a special population to a traditional family practice. There is additional evidence that interdisciplinary primary care teams that include NPs and other health workers are associated with improved outcomes in the elderly.[3,4] Of these studies, only 2 measured QOC processes, some of which could be related to our study. One trial that compared pharmacist-led case management with standard care reported an intervention effect similar to ours on 3 common indicators for quality of diabetes care (eg, foot care, eye care, hemoglobin A_{1c} assessment).[21] The second trial evaluated an NP–family physician team in the care of patients with diabetes and hypertension and found improvement in the likelihood of the patients receiving foot care (51% absolute difference) but not eye care (9% absolute difference).[23]

Table 4. Chronic disease management quality of care and intermediate outcomes: *Differences (D1 and D2) were calculated for individual patients with data available at baseline and at the end of the study; the difference between D1 and D2 represents the effect of the intervention.* P *values were calculated using student* t *tests.*

	APTCARE			CONTROL			OUTCOME	
MEASURE	N	BASELINE	DIFFERENCE (D1)	N	BASELINE	DIFFERENCE (D2)	D1 - D2 (95% CI)	*P* VALUE
Quality of care—chronic disease, proportion of patients	74	0.741	0.098	78	0.764	0.008	0.091 (0.037 to 0.144)	.0013
Diabetes, proportion of patients	40	0.722	0.144	39	0.708	0.013	0.131 (0.036 to 0.226)	.0074
• ACE inhibitor or ARB		0.875	0.050		0.718	0.077	-0.027	
• HbA_{1c} measured ≥2 in past y		0.600	0.225		0.539	0.102	0.123	
• Feet examination		0.750	0.200		0.923	-0.077	0.277	
• Eye examination		0.525	0.200		0.513	-0.051	0.251	
CAD, proportion of patients	31	0.796	0.075	40	0.817	0.025	0.050 (-0.008 to 0.109)	.090
• Aspirin		0.742	0.193		0.900	0.000	0.193	
• β-blocker		0.710	0.032		0.750	0.025	0.007	
• Statin		0.935	0.000		0.800	0.050	-0.050	
COPD, proportion of patients	22	0.731	0.080	20	0.725	0.017	0.063 (-0.058 to 0.183)	.30
• Influenza immunization		0.909	-0.091		0.850	0.000	-0.091	
• Pneumococcal vaccine		0.636	0.182		0.750	0.100	0.082	
• Bronchodilators		0.636	0.136		0.550	0.000	0.136	
CHF, proportion of patients	9	0.667	0.000	11	0.727	0.000	0.000	-
• ACE inhibitor or ARB		0.889	0.000		0.818	0.000	0.000	
• β-blocker		0.444	0.000		0.636	0.000	0.000	
Intermediate outcomes								
Diabetes								
• Mean HbA_{1c}, %	36	7.16	-0.15	36	6.74	0.04	-0.04 (-0.09 to 0.02)	.19
Hypertension								
• Mean systolic BP, mm Hg	87	127	-2.74	80	126	-1.81	-0.93 (-5.79 to 3.92)	.70
• Mean diastolic BP, mm Hg	87	72	-3.67	79	72	-0.37	-3.30 (-6.88 to 0.28)	.071

ACE—angiotensin-converting enzyme; ARB—angiotensin receptor blocker, BP—blood pressure, CAD—coronary artery disease, CHF—congestive heart failure, CI—confidence interval, COPD—chronic obstructive pulmonary disease.

Table 5. Quality of preventive care, quality of life, and other secondary outcomes: *The difference between D1 and D2 represents the effect of the intervention; in all cases, except HRQoL, caregiver burden, ED visits, and hospital admissions, a positive difference between D1 and D2 represents a better outcome in the APTCare arm. P values were calculated using student t tests.*

	APTCARE			CONTROL			OUTCOME	
MEASURE	N	BASELINE	DIFFERENCE (D1)*	N	BASELINE	DIFFERENCE (D2)*	D1 - D2 (95% CI)	*P* VALUE
Quality of care—prevention, proportion of patients	120	0.760	0.126	121	0.760	-0.056	0.181 (0.108 to 0.255)	<.001
• Influenza vaccination	115	0.896	0.078	117	0.932	-0.009	0.087 (0.012 to 0.162)	.023
• Screening for CRC	120	0.625	0.175	121	0.612	0.008	0.167 (0.046 to 0.288)	.0070
• Screening for breast cancer	29	0.897	0.052	19	0.868	0.000	0.052 (-0.077 to 0.181)	.42
• Screening for cervical cancer	20	0.900	-0.050	15	0.933	0.000	-0.050 (-0.319 to 0.219)	.71
• Hearing examination	64	0.766	0.062	76	0.724	-0.211	0.273 (0.106 to 0.44)	.0016
• Eye examination	84	0.762	0.119	99	0.747	-0.101	0.220 (0.076 to 0.364)	.0029
SF-36								
• Physical component, score out of 100	109†	41.6	2.7	114‡	40.4	1.1	1.6 (-0.8 to 4.1)	.18
• Mental component, score out of 100	109	53.6	-1.2	114	52.3	-0.1	-1.1 (-3.7 to 1.6)	.44
HRQoL								
• Self-assessed poor or fair health, %	112§	26.8	3.6	116‖	36.2	3.5	0.1 (-12.8 to 13.1)	.98
• No. of unhealthy days in last 30 days	112	8.6	-1.0	116	9.5	0.4	-1.4 (-4.5 to 1.8)	.39
IADL, score out of 31	112¶	10.3	0.3	116#	10.3	0.6	-0.3 (-1.1 to 0.5)	.50
Caregiver burden, score out of 88	61	12.6	1.7	68	18.0	-3.3	5.0 (1.4 to 8.6)	.0070
Any ED visit, % of patients**	120	NA	38	121	NA	42	-4 (-16.4 to 8.4)	.46
Average no. of ED visits††	120	0	0.63	121	0	0.73	-0.10 (-0.38 to 0.18)	.48
Any hospital admission, % of patients**	120	NA	26	121	NA	26	0 (-11.1 to 11.1)	.97
Average no. of hospital admissions††	120	0	0.40	121	0	0.46	-0.06 (-0.31 to 0.2)	.67

CI—confidence interval, CRC—colorectal cancer, ED—emergency department, HRQoL—health-related quality of life, IADL—instrumental activities of daily living, NA—not applicable, SF-36—Short-Form 36.

*D1 and D2 were calculated as differences between end-of-study and baseline measures for individual patients with data available for both baseline and the end of the study only. For outcomes that were dichotomous, D1 and D2 have values of -1, 0, or 1.

†5 withdrew, 3 died, and 3 answered the question incompletely.

‡4 withdrew, 1 moved and could not be reached at the end of the study, and 2 answered the question incompletely.

§5 withdrew, 3 died.

‖4 withdrew, 1 moved and could not be reached at the end of the study.

¶5 withdrew, 3 died.

#4 withdrew, 1 moved and could not be reached at the end of the study.

**Compared by χ^2 test.

††D1 and D2 represent the encounters during the intervention (ie, 0 assigned as the baseline value).

We did not detect improvements in the 2 clinical outcome measures: glycemic control and hypertension. In contrast most studies have demonstrated that the addition of pharmacists[7,20-22] or NPs[23] to the primary care team was associated with better clinical outcomes, including improved glucose control, blood pressure, and cholesterol levels in patients with diabetes, hypertension, or both. In all of these studies, the clinical team was specifically focused on the management of these 2 conditions and their indicators. In contrast, in our study the clinicians were blinded to the indicator diseases and maneuvers. Their mandate was more general: improve the management of the chronic diseases of individuals in their care. The heterogeneity of the population also meant that fewer individuals with each disease were available for each analysis, limiting the study power to detect a difference.

We did not observe improvements in quality-of-life or functional status measures. Studies of multidisciplinary teams focusing on elderly or at-risk populations have focused primarily on the more general measures of patient well-being, such as activities of daily living and quality of life. For example, 2 trials of geriatric management involving the primary care physician, a social worker, and an NP found improvements in quality of life[4] and functional status,[3,4] while results from trials of multidisciplinary teams in the management of diabetes are conflicting.[8,22,23] A meta-analysis of trials evaluating home visits in preventing functional deterioration concluded that this strategy could be useful in maintaining functional levels, but that such programs were only effective when targeting patients who were relatively young and at lower risk of death.[24] Our population had been identified by their physicians to be at substantial risk of functional decline. The potential increased risk of irreversible functional decline associated with complex older patients[25] might have been a limitation of this study.

We did not observe a significant reduction in service use. Approaches used to measure emergency department visits and hospitalization have limitations, such as recall bias for surveys and incomplete information for chart reviews. However, we complemented the information we obtained from the survey and chart reviews with data from the Ministry of Health and Long-Term Care health care service utilization database for all emergency department encounters and hospital admissions. Despite this, our study found no significant difference between the 2 arms. Previous studies of multidisciplinary care showing a reduction in emergency department visits focused on patients with high use of these services before the studies.[6,26] Also, our study might not have had sufficient power to detect meaningful changes in this service utilization, or longer follow-up might have been required to observe the effect on this parameter.

Caregiver burden scores were markedly different between groups at baseline. The caregiver burden survey was the only survey administered after patients were informed of their randomization status. This might have influenced the perceptions of caregivers at that time. When surveys were readministered at the end of the intervention, the level of burden in both arms was similar, reflecting a significant drop in the control arm ($P = .0070$). This change might, therefore, represent a correction of the potential bias introduced at baseline.

The main strength of this study is that it was a randomized controlled trial with a good response rate (76%). The effect of the intervention might have been hampered by the limited intervention period and time-intensive initial care planning, as well as contamination of the control arm by enhanced practice by family physicians working in the multidisciplinary team. However, the fact that the QOC level did not rise in the control arm during the duration of the study intervention does not support the latter. Our study was powered to detect differences in the composite score for CDM QOC but not to draw inferences for individual chronic conditions, although the results suggest that the approach yielded considerable changes in diabetes care. Further investigation is required to ascertain which patients would benefit most from this type of intervention and evaluate the generalizability of our findings. The findings of this study suggest that additional care in the form of multidisciplinary teams for complex community-dwelling patients can increase adherence to evidence-based guidelines. However, these additional resources are provided at a substantial additional cost. The appropriateness of the intervention will ultimately depend on its associated costs and the value that society places on its effect.

Conclusion

We found that a multidisciplinary care management with NPs, a pharmacist, and the general practitioner improved the quality of chronic care delivered to older, complex patients. While the quality of preventive care also improved, patients did not experience changes in their quality of life, functional status, or in their use of emergency department or hospital services. The intervention was delivered exclusively in the patients' home with some telephone contacts. We recommend that further research be conducted to evaluate whether the same intervention could be delivered in the practice setting without compromising effectiveness to improve efficiency. The intervention also needs to be evaluated at multiple practice sites to enhance generalizability.

Dr Hogg is a Professor in the Department of Family Medicine at the University of Ottawa and Director of Research at the C.T. Lamont Primary Health Care Research Centre of the Elisabeth Bruyère Research Institute in Ottawa, Ont. **Dr Lemelin** is Professor and Chair of the Department of Family Medicine at the University of Ottawa. **Dr Dahrouge** is the Manager of Research Operations at the C.T. Lamont Primary Health Care Research Centre. **Dr Liddy** is an Assistant Professor in the Department of Family Medicine at the University of Ottawa and a Clinical Investigator at the C.T. Lamont Primary Health Care Research Centre. **Dr Deri Armstrong** is an Assistant Professor in the Department of Economics at the University of Ottawa. **Dr Legault** is an Assistant Professor in the School of

Nursing at the University of Ottawa. **Dr Dalziel** is Chief of the Regional Geriatrics Program at the Ottawa Hospital and an Associate Professor at the University of Ottawa. **Ms Zhang** is a research assistant at the Centre for Health Evaluation and Outcome Sciences at St Paul's Hospital in Vancouver, BC.

Acknowledgment

We thank **Drs Stephanie Amos** and **David Gray** for their input in the preparation of the manuscript and **Jennifer Englert** for her assistance in editing the manuscript. Funding for this research was provided by the Ontario Ministry of Health and Long-Term Care Primary Health Care Transition Fund. The views expressed in this report are the views of the authors and do not necessarily reflect those of the Ontario Ministry of Health and Long-Term Care.

Contributors

Drs Hogg and **Lemelin** were involved in the conception of the study, oversaw its conduct, and contributed to writing the paper. **Drs Legault, Dalziel,** and **Deri Armstrong** helped with the conception of the study, oversaw its conduct, and contributed to writing the paper. **Dr Dahrouge** helped manage the study and the data analysis and participated in writing the paper. **Ms Zhang** and **Dr Liddy** were involved in the data analysis and contributed to writing the paper. All authors reviewed and accepted the final version for submission.

Competing interests

None declared

Correspondence

Dr W. Hogg, University of Ottawa, Department of Family Medicine, 43 Bruyère St, Ottawa, ON K1N 5C8; telephone 613 562-4262, extension 1354; e-mail **whogg@uottawa.ca**

References

1. Romanow RJ. *Building on values: the future of health care in Canada—final report.* Commission on the Future of Health Care in Canada. Ottawa, ON: Government of Canada; 2002.
2. Health Canada. Primary Health Care Transition Fund [website]. Ottawa, ON: Health Canada; 2006. Available from: **www.hc-sc.gc.ca/hcs-sss/prim/phctf-fassp/index-eng.php**. Accessed 2009 Oct 10.
3. Boult C, Boult LB, Morishita L, Dowd B, Kane RL, Urdangarin CF. A randomized clinical trial of outpatient geriatric evaluation and management. *J Am Geriatr Soc* 2001;49(4):351-9.
4. Burns R, Nichols LO, Martindale-Adams J, Graney MJ. Interdisciplinary geriatric primary care evaluation and management: two-year outcomes. *J Am Geriatr Soc* 2000;48(1):8-13.
5. Sommers LS, Marton KI, Barbaccia JC, Randolph J. Physician, nurse, and social worker collaboration in primary care for chronically ill seniors. *Arch Intern Med* 2000;160(12):1825-33.
6. Welsh HG. Number 15 [comment]. *Eff Clin Pract* 2001;4(2):80-1. Comment on: Coleman EA, Eilertsen TB, Kramer AM, Magid DJ, Beck A, Conner D. Reducing emergency visits in older adults with chronic illness. A randomized, controlled trial of group visits. *Eff Clin Pract* 2001;4(2):49-57.
7. Borenstein JE, Graber G, Saltiel E, Wallace J, Ryu S, Archi J, et al. Physician-pharmacist comanagement of hypertension: a randomized, comparative trial. *Pharmacotherapy* 2003;23(2):209-16.
8. Hughes SL, Weaver FM, Giobbie-Hurder A, Manheim L, Henderson W, Kubal JD, et al. Effectiveness of team-managed home-based primary care: a randomized multicenter trial. *JAMA* 2000;284(22):2877-85.
9. Dahrouge S, Hogg W, Lemelin J, Liddy C, Legault F. Anticipatory and Preventive Team Care. Methods for a study of multidisciplinary team care in a family practice. *Can Fam Physician.* In Press.
10. Pett MA. *Nonparametric statistics for health care research: statistics for small samples and unusual distributions.* Newbury Park, CA: Sage Publications; 1997.
11. Canadian Cardiovascular Society 1997 Consensus Conference on the Evaluation and Management of Chronic Ischemic Heart Disease. *Can J Cardiol* 1998;14(Suppl C):1C-23C.
12. Wilt TJ, Bloomfield HE, MacDonald R, Nelson D, Rutks I, Ho M, et al. Effectiveness of statin therapy in adults with coronary heart disease. *Arch Intern Med* 2004;164(13):1427-36.
13. Canadian Diabetes Association. *Canadian Diabetes Association 2003 clinical practice guidelines for the prevention and management of diabetes in Canada.* Toronto, ON: Canadian Diabetes Association; 2003.
14. Haley L. Regular eye care essential for diabetic patients. *Med Post* 2002;38(41):11-2.
15. Liu P, Arnold JM, Belenkie I, Demers C, Dorian P, Gianetti N, et al. The 2002/3 Canadian Cardiovascular Society consensus guideline update for the diagnosis and management of heart failure. *Can J Cardiol* 2003;19(4 [Print]):347-56.
16. Ontario Program for Optimal Therapeutics. *Ontario drug therapy guidelines for chronic heart failure in primary care.* Toronto, ON: Queen's Printer of Ontario; 2000.
17. O'Donnell DE, Aaron S, Bourbeau J, Hernandez P, Marciniuk D, Balter M, et al. Canadian Thoracic Society recommendations for management of chronic obstructive pulmonary disease—2003. *Can Respir J* 2003;10(Suppl A):11A-65A.
18. Ware J, Kosinski M, Dewey J. *How to score version 2 of the SF-36® health survey.* Lincoln, RI: QualityMetric Incorporated; 2000.
19. Borenstein JE, Graber G, Saltiel E, Wallace J, Ryu S, Archi J, et al. Physician-pharmacist comanagement of hypertension: a randomized, comparative trial. *Pharmacotherapy* 2003;23(2):209-16.
20. Sookaneknun P, Richards RM, Sanguansermsri J, Teerasut C. Pharmacist involvement in primary care improves hypertensive patient clinical outcomes. *Ann Pharmacother* 2004;38(12):2023-8. Epub 2004 Nov 2.
21. Choe HM, Mitrovich S, Dubay D, Hayward RA, Krein SL, Vijan S. Proactive case management of high-risk patients with type 2 diabetes mellitus by a clinical pharmacist: a randomized controlled trial. *Am J Manag Care* 2005;11(4):253-60.
22. Scott DM, Boyd ST, Stephan M, Augustine SC, Reardon TP. Outcomes of pharmacist-managed diabetes care services in a community health center. *Am J Health Syst Pharm* 2006;63(21):2116-22.
23. Litaker D, Mion L, Planavsky L, Kippes C, Mehta N, Frolkis J. Physician–nurse practitioner teams in chronic disease management: the impact on costs, clinical effectiveness, and patients' perception of care. *J Interprof Care* 2003;17(3):223-37.
24. Stuck AE, Egger M, Hammer A, Minder CE, Beck JC. Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. *JAMA* 2002;287(8):1022.
25. Hébert R. Functional decline in old age. *CMAJ* 1997;157(8):1037.
26. Caplan GA, Williams AJ, Daly B, Abraham K. A randomized, controlled trial of comprehensive geriatric assessment and multidisciplinary intervention after discharge of elderly from the emergency department—the DEED II study. *J Am Geriatr Soc* 2004;52(9):1417-23.