Effect of nurse practitioner and pharmacist counseling on inappropriate medication use in family practice

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Abstract

Objective To measure the effect of nurse practitioner and pharmacist consultations on the appropriate use of medications by patients.

Design We studied patients in the intervention arm of a randomized controlled trial. The main trial intervention was provision of multidisciplinary team care and the main outcome was quality and processes of care for chronic disease management.

Setting Patients were recruited from a single publicly funded family health network practice of 8 family physicians and associated staff serving 10 000 patients in a rural area near Ottawa, Ont.

Participants A total of 120 patients 50 years of age or older who were on the practice roster and who were considered by their family physicians to be at risk of experiencing adverse health outcomes.

Intervention A pharmacist and 1 of 3 nurse practitioners visited each patient at his or her home, conducted a comprehensive medication review, and developed a tailored plan to optimize medication use. The plan was developed in consultation with the patient and the patient's doctor. We assessed medication appropriateness at the study baseline and again 12 to 18 months later.

Main outcome measures We used the medication appropriateness index to assess medication use. We examined associations between personal characteristics and inappropriate use at baseline and with improvements in medication use at the follow-up assessment. We recorded all drug problems encountered during the trial.

Results At baseline, 27.2% of medications were inappropriate in some way and 77.7% of patients were receiving at least 1 medication that was inappropriate in some way. At the follow-up assessments these percentages had dropped to 8.9% and 38.6%, respectively ($P<.001$). Patient characteristics that were associated with receiving inappropriate medication at baseline were being older than 80 years of age (odds ratio [OR]=5.00, 95% CI 1.19 to 20.50), receiving more than 4 medications (OR=6.64, 95% CI 2.54 to 17.4), and not having a university-level education (OR=4.55, 95% CI 1.69 to 12.50).

Conclusion We observed large improvements in the appropriate use of medications during this trial. This might provide a mechanism to explain some of the reductions in mortality and morbidity observed in other trials of counseling and advice provided by pharmacists and nurses.

Trial registration number NCT00238836 (ClinicalTrials.gov).

EDITOR'S KEY POINTS

- Primary care reform in Canada has emphasized team-based care. Studies have shown that pharmacists can improve prescribing, reduce health care resource use and medication costs, and contribute to clinical improvements in many chronic medical conditions. This study aimed to explore the effect of nurse practitioner and pharmacist consultations on the appropriate use of medications in primary care.
- At the beginning of this study a large proportion of patients were using medications inappropriately, but this had dropped considerably by the end of the study. Those more at risk were the elderly, those taking many medications, and those who were less well educated.
- The most common problem was the presence of a condition for which the patient was either not prescribed medication or, more commonly, not taking the prescribed medication. Most problems required a single action to resolve; in 10 cases, 2 actions were required.

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Effet des conseils donnés par des infirmières praticiennes et des pharmaciens sur l'usage inapproprié des médicaments en pratique familiale

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Résumé

Objectif Déterminer l'effet des conseils donnés par des infirmières praticiennes et des pharmaciens sur l'utilisation appropriée des médicaments par les patients.

Type d'étude Nous avons étudié les patients du groupe d'intervention d'un essai randomisé. La principale intervention de l'essai était la prestation de soins par une équipe interdisciplinaire, et l'issue principale était la qualité et les processus de soins pour le traitement des maladies chroniques.

Contexte On a recruté les patients à partir d'un seul établissement en réseau de médecine familiale financé par des fonds publics comprenant 8 médecins de famille et le personnel associé, et desservant 10 000 patients d'une région rurale voisine d'Ottawa, Ont.

Participants Un total de 120 patients de 50 ans et plus faisant partie de la liste de pratique et qui étaient considérés à risque de connaître des problèmes de santé par leur médecin de famille.

Intervention Un pharmacien et une des 3 infirmières praticiennes ont rendu visite à chaque patient à son domicile, ont fait une revue complète de la médication et ont élaboré un plan taillé sur mesure pour optimiser l'utilisation de la médication. Ce plan a été élaboré en concertation avec le patient et son médecin. La justesse de la médication utilisée a été mesurée au début de l'étude et de nouveau, 12 à 18 mois plus tard.

Principaux paramètres à l'étude Nous avons utilisé l'indice de justesse de la médication pour évaluer l'utilisation de la médication. Nous avons examiné les associations entre les caractéristiques personnelles et l'usage inapproprié des médicaments au début de l'étude et à la suite des améliorations au moment de l'évaluation du suivi. Durant l'étude, tous les problèmes liés aux médicaments ont été enregistrés.

Résultats Au début de l'étude, 27,2 % des médicaments étaient inappropriés d'une façon ou d'une autre et 77,7 % des patients prenaient au moins un médicament qui était plus ou moins inapproprié. À l'évaluation du suivi, ces pourcentages avaient diminué à 8,9 % et 38,6 % respectivement ($P<,001$). Les caractéristiques des patients associées au fait de recevoir des médicaments inappropriés au début de l'étude étaient le fait d'avoir plus de 80 ans (rapport de cote [RC] = 5,00, intervalle de confiance [IC] à 95 % 1,19 à 20,5), le fait de recevoir plus de 4 médicaments (RC = 6,64, IC à 95 % 2,54 à 17,4) et le fait de n'avoir pas une formation de niveau universitaire (RC = 4,55, IC à 95 % 1,69 à 12,50).

Conclusion Nous avons observé de grandes améliorations dans l'utilisation appropriée de la médication durant cette étude. Cela pourrait être un mécanisme permettant d'expliquer les réductions de mortalité et de morbidité observées dans d'autres études où des infirmières et des pharmaciens ont prodigué des conseils et des avis.

POINTS DE REPÈRE DU RÉDACTEUR

- La réforme des soins primaires au Canada a mis l'emphase sur les soins en équipe. Certaines études ont montré que les pharmaciens peuvent améliorer la prescription, réduire l'utilisation des ressources dans les soins de santé et le coût des médicaments, et contribuer à des améliorations cliniques dans plusieurs conditions médicales. Cette étude voulait explorer l'effet de conseils donnés par les infirmières praticiennes et des pharmaciens sur l'usage approprié des médicaments en contexte de soins primaires.
- Au début de l'étude, une forte proportion des patients faisaient une utilisation inappropriée des médicaments, mais cette proportion avait diminué considérablement à la fin de l'étude. Les plus à risque étaient les personnes âgées, celles qui prenaient beaucoup de médicaments et les moins instruites.
- Le problème le plus fréquent était la présence d'une condition pour laquelle le patient n'avait pas eu de prescription de médicament ou, plus souvent, ne prenait pas la médication prescrite. La plupart des problèmes ont été résolus après une seule intervention; 10 cas ont nécessité 2 interventions.

Cet article a fait l'objet d'une révision par des pairs.
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Reforms in the delivery of primary care in Canada have involved an emphasis on team functioning, both among physicians and through increasing the involvement of other health professionals in the delivery of care. The reforms represent a substantial new investment in primary care, and information on how best to deploy these new resources is needed.

It has been demonstrated that pharmacists can improve prescribing, reduce health care resource use and medication costs, and contribute to clinical improvements in many chronic medical conditions, such as cardiovascular disease, diabetes, and psychiatric illness.[1-3] We recently reported the results of a randomized controlled trial of the addition of a collaborative team of a physician, a nurse, and a pharmacist to usual care in a family health network of 8 family physicians serving 10 000 patients in rural Ontario.[4] The results of this trial included important improvements in the quality of care, particularly for people with diabetes, with the largest differences being observed in preventive health care such as foot examination and vaccine uptake. While there were small increases in prescription of aspirin and inhalers, the prescription rates of most drugs used to treat common chronic conditions were not appreciably different between intervention and control groups.

This paper further explores the effects of this multidisciplinary care intervention on medication use. If the differences in actual medication use were modest, was there any improvement in the quality of prescribing or the instructions given to patients?

METHODS

Design

The randomized controlled trial is described in detail elsewhere,[4] and this paper reports on only the intervention arm of that trial. We describe the trial briefly below, with added detail covering the intervention to improve appropriate use of medications and its assessment. For the trial, patients were individually randomized to receive usual care in the control arm, or to receive usual care plus home visits and telephone support from a nurse practitioner and a pharmacist in the intervention arm. Assessing medication appropriateness, the main outcome here, involved a patient interview with a pharmacist and an audit of medication use. This made it impractical to implement in the control group, as it is an intervention in itself and would involve a pharmacist knowingly allowing bad practice and keeping this knowledge from patients.

Setting

The study was conducted in a family health network of 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

Patients were eligible if they were 50 years of age or older, rostered in the practice, and considered by their family physicians to be at risk of functional decline, physical deterioration, or experiencing events requiring emergency services, and to be good candidates to benefit from additional medical resources. There were no restrictions based on diagnoses. Exclusion criteria included substantial cognitive impairment, language or cultural barriers, life expectancy less than 6 months, and patient plans to move or to be away for 6 or more weeks during the study period. 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 ClinicalTrials.gov as NCT00238836.

Intervention

The intervention consisted of care provision by a multidisciplinary team composed of 1 pharmacist and 3 nurse practitioners added to the family practice. The pharmacist worked full time for the first 9 months and 1 nurse practitioner 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 nurse practitioners and received care coverage for urgent issues in her absence from the other nurse practitioners. The pharmacist and nurse practitioners delivered their care almost exclusively in the patients' homes or by telephone contact. Both the pharmacist and a nurse practitioner performed a comprehensive chart review and home visit for each patient at the study onset. The pharmacist then conducted a medication management review, identifying potential drug-related problems and actions required to address the issues. Initial medication assessments were reviewed and discussed with a pharmacist mentor who had experience in care of the elderly. The pharmacist then worked directly, with the patients and in collaboration with the nurse practitioners and family physicians, on addressing these and new drug-related problems as they arose. The nurse practitioner 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.

Instrument and assessment

Medication use was assessed by chart audit in 4 chronic conditions: diabetes, coronary artery disease, chronic obstructive pulmonary disease, and congestive heart failure. Chart review for baseline and end-of-study measures were performed by 1 researcher. Where an indicated drug was coded as not having been prescribed, the chart was reviewed by another researcher and consensus was obtained between the 2 coders.

The medication appropriateness index (MAI) was used to evaluate prescription medications. It has been proven to be a reliable, valid measure of the appropriateness of medication prescribing.[5-9] Medication appropriateness is evaluated using 10 criteria, each rated as *appropriate, neutral, inappropriate,* or *unknown,* and assigned a relative weight for calculating the total score for each medication (**Table 1**). Higher scores indicate increasing inappropriateness.

At the study onset, the study pharmacist used the MAI to complete an evaluation of all active prescribed medications for each patient. At the end of the study, the same pharmacist interviewed each patient again and reevaluated the MAI for each medication. We have not included the cost component of the MAI, as we were interested primarily in clinical appropriateness.

Analysis

We dichotomized each MAI rating into *inappropriate* versus all others. Criteria rated as inappropriate were weighted according to **Table 1** to produce the MAI score for each medication (based on the first 9 criteria). The MAI score per medication could therefore range from 0 to 17, with higher scores reflecting more inappropriateness.

We evaluated the effects of the intervention in several ways. For each drug we calculated the MAI score based on 9 items and we compared the mean score for all drugs at baseline with the mean score at study completion. For each patient we calculated the sum of the MAI score for each medication they received and compared the mean for all patients at baseline with the mean for all patients at completion. Because changes in MAI score are not easy to interpret, we also report dichotomized measures—that is, the proportion of drugs that were assessed by any single criterion to be inappropriate and the proportion of patients with any drug assessed to be inappropriate. Finally, we determined whether there were patient characteristics that were associated with inappropriate medication use at baseline or improvement in medication use over the study period. We compared means using the appropriate *t* tests, unadjusted odds ratios (ORs) using the Fisher exact method, and adjusted ORs using logistic regression. Because our aim in the regression analysis was to assess the independence of the observed associations, we included all the variables under examination.

Table 1. Criteria and relative weights for the MAI

MAI CRITERION	WEIGHT*	PROPORTION UNKNOWN†
1. Is there an indication for the drug?	3	3.0
2. Is the medication effective for the condition?	3	1.7
3. Is the dosage correct?	2	2.0
4. Are the directions correct?	2	0.7
5. Are the directions practical?	1	0.3
6. Are there clinically significant drug-drug interactions?	2	0.7
7. Are there clinically significant drug-disease interactions?	2	0.4
8. Is there unnecessary duplication with other drugs?	1	0.9
9. Is the duration of therapy acceptable?	1	4.7
10. Is this drug the least expensive alternative compared with others of equal utility?	1	46.5

MAI—medication appropriateness index.
*Relative weight applied to inappropriate ratings in the calculation of the total MAI score. The maximum potential MAI score is 18; however, the cost component was not considered in this study, so the highest potential score was 17.
†Proportion of medications coded as *unknown* at baseline.

Process evaluation

The pharmacist used a separate tool to monitor drug-related problems for her clinical management of patients. That tool consisted of an electronic database in which problems were attributed a code from a list of 8 standard drug-related problems (plus an *other* code) and 17 associated corrective measures. The tool allowed the pharmacist to track individual patient progress by entering that information and retrieving those problems that had not been resolved in order that they might be addressed.

RESULTS

A total of 120 patients were randomized to the intervention arm of the study. The MAI evaluations were performed for 117 of these patients: 112 at baseline (4 patients took no medication, 1 withdrew, 1 died early on, 1 refused the pharmacist visit, and 1 assessment could not be completed for other reasons) and 114 at the end of the study (1 patient had no medication, 3 had died during the study, and 2 died shortly after the study ended and before the final MAI evaluation could be performed). Patient characteristics are outlined in **Table 2**. Patients were on average 69.6 (95% CI 67.7 to 71.5) years old and had 2.8 (95% CI 2.5 to 3.1) of the 13 chronic conditions under study. The total number of prescription medications at baseline and end point was 764 and 774, respectively, for an average of 6.8 medications per patient at both times.

Table 2. Characteristics of the 120 patients at the start of the trial

CHARACTERISTIC	N (%)
Age, y	
• 50-59	24 (20)
• 60-69	33 (28)
• 70-79	39 (32)
• ≥ 80	24 (20)
Female	63 (52)
Highest level of education high school or lower	78 (65)
Annual income < $40 000	71 (59)
Chronic conditions	
• Hypertension	66 (55)
• Arthritis or back problems	62 (52)
• Chronic anxiety, depression, or other mental illness	50 (42)
• Neurologic condition	36 (30)
• Diabetes	35 (29)
• Chronic obstructive pulmonary disease	17 (14)
• Cancer	16 (13)
• Ischemic heart disease or atrial fibrillation	15 (12)
• Asthma	12 (10)
• Congestive heart failure	8 (7)
• Peripheral vascular disease	8 (7)
• Anemia	7 (6)
• Cerebrovascular disease	4 (3)
Visit to emergency department in past year	23 (19)
More than 10 visits to practice in previous year	33 (28)
No. of drugs	
• 0-4	36 (30)
• 5-7	39 (32)
• 8-10	31 (26)
• ≥ 11	14 (12)

The MAI ratings

The proportion of medications and patients for whom each of the MAI criteria was found inappropriate is shown in **Table 3**. For example, at baseline the duration of therapy was found to be inappropriate in 7.3% of medications reviewed and in at least 1 medication for 33.9% of patients, while at the end of the study 2.5% of medications and 13.2% of patients had an inappropriate duration of therapy. Overall, before the intervention 27.2% of medications and 77.7% of patients met at least 1 criterion of inappropriateness, while after the intervention only 8.9% of medications and 38.6% of patients showed at least 1 criterion of inappropriateness. Average MAI score per drug decreased from 0.69 at baseline to 0.18 at the end of study (**Table 4**). The average total MAI score per patient decreased from 4.58 to 1.28.

Table 3. Proportion of inappropriate medications and proportion of patients receiving inappropriate medications according to MAI criteria

	MEDICATIONS, %		PATIENTS, %	
MAI CRITERIA	BASELINE (N = 764)	END POINT (N = 774)	BASELINE (N = 112)	END POINT (N = 114)
Indication	3.0	0.6*	17.9	3.5*
Effectiveness	1.0	0.4*	6.3	2.6
Dosage	5.5	1.0*	32.1	6.1*
Correct directions	3.8	1.7*	21.4	9.6†
Practical directions	7.1	3.5*	33.0	20.2†
Drug-drug interactions	6.7	0.8*	24.1	1.8*
Drug-disease interactions	3.9	0.8*	23.2	5.3*
Duplication	2.4	0.9*	10.7	5.3
*Statistically significant change at $P<.001$.	7.3	2.5*	33.9	13.2*
†Statistically significant change at $P<.05$.	27.2	8.9*	77.7	38.6*

MAI – medication appropriateness index.
*Statistically significant change at $P<.001$.
†Statistically significant change at $P<.05$.

There was more inappropriate medication use at baseline in the older age groups, with those older than 80 years being 5.00 times more likely than those younger than 60 years to be prescribed inappropriate medication (**Table 5**). Those taking more than 4 drugs were also more likely to have inappropriate medications at baseline (OR = 6.64). Those without a university-level education were much more likely to have inappropriate medications at baseline (OR = 4.55). These associations were statistically significant and remained so when adjusted for other factors measured in this study. The only characteristic independently associated with improvement in medication appropriateness was inappropriate medication at baseline (**Table 5**).

Table 4. Change in MAI scores from baseline to end of study

	MEAN (95% CI) SCORE		
SCORES	BASELINE	END POINT	DIFFERENCE
MAI score per drug	0.69 (0.58-0.79)	0.18 (0.13-0.24)	0.50 (0.39-0.62)
Total of drug MAI scores per patient	4.58 (3.66-5.49)	1.28 (0.82-1.75)	3.29 (2.34-4.24)
Individual drug MAI score per patient	0.64 (0.53-0.76)	0.17 (0.11-0.22)	0.48 (0.36-0.60)

MAI—medication appropriateness index.

During the study period, 782 drug-related problems were identified, each one affecting between 29 and 82 patients (**Table 6**). Drug-related problems were usually associated with a single action required (in 10 cases, 2 different actions were performed). The most common problem was the presence of a condition for which the patient was either not prescribed medication or, more commonly, not taking the prescribed medication. There were also several instances of patients not taking or receiving the prescribed drugs appropriately.

DISCUSSION

At the beginning of this study a large proportion of patients were using medications inappropriately, but this had dropped considerably by the end of the study. Those more at risk were the elderly, those taking many medications, and those who were less well educated.

The prevalence and dangers of suboptimal prescribing of medications are well documented,[10,11] as is inappropriate medication use in the elderly.[12,13] Other researchers have demonstrated that medication reviews can reduce both polypharmacy and the use of inappropriate medications in the elderly.[14] Our findings support these previous findings and highlight the added likelihood of inappropriate prescribing in the elderly and those with lower educational attainment.

Advice from a community pharmacist has been shown to reduce mortality,[15] although after publication of the trial that showed this, scepticism was expressed that such a seemingly simple thing as counseling or advice could have such an effect.[16] Our trial was not designed to detect a difference in deaths. However, our results show that many of the problems addressed by pharmacists in this trial were not trivial, as many patients were taking drugs that appeared not to be indicated and some were not receiving drugs they needed. Reducing the number of these inappropriate situations might provide a mechanism by which medication assessment by a pharmacist could have an important effect on health outcomes.

Limitations

The main limitation of our study is that we only explored changes in appropriateness in the intervention arm of this trial. We cannot be sure that the pharmacist intervention was responsible for the improvements in medication appropriateness. Our expectation, when

Table 5. Associations with inappropriate drug use at baseline and at end of study

	BASELINE		IMPROVEMENT AT END POINT	
CHARACTERISTIC	CRUDE OR	ADJUSTED OR	CRUDE OR	ADJUSTED OR
Age, y				
• 50-59	Reference	Reference	Reference	Reference
• 60-69	2.06 (0.65-6.60)	2.89 (0.68-12.3)	0.72 (0.28-1.90)	1.81 (0.38-8.60)
• 70-79	4.95 (1.43-17.10)	4.01 (0.94-17.1)	2.44 (0.86-6.87)	2.59 (0.53-12.53)
• ≥ 80	5.00 (1.19-20.50)	8.18 (1.35-49.4)	2.19 (0.63-7.51)	2.91 (0.46-18.55)
Sex (reference = male)	0.84 (0.35-2.03)	0.66 (0.22-1.98)	0.84 (0.35-2.03)	0.85 (0.26-2.77)
University-level education	0.22 (0.08-0.59)	0.11 (0.03-0.50)	0.37 (0.14-1.02)	0.77 (0.15-3.98)
Household income ≥ $80 000	0.37 (0.12-1.11)	1.35 (0.27-6.80)	0.52 (0.17-1.62)	1.55 (0.23-10.52)
≥ 2 chronic conditions	2.68 (0.98-7.34)	0.84 (0.18-3.94)	2.68 (0.98-7.34)	1.84 (0.38-8.81)
Polypharmacy (> 4 medications)	6.64 (2.54-17.4)	8.38 (2.55-27.5)	4.10 (1.60-10.5)	1.40 (0.35-5.56)
Any inappropriate medication at baseline	NA	NA	21.0 (7.02-62.8)	14.62 (4.03-53.04)

NA—not applicable, OR—odds ratio.

Table 6. Drug-related problems addressed throughout the study period

PROBLEMS	NO. OF PROBLEMS (N = 782)	NO. OF PATIENTS (N = 112)
Patient is taking or receiving a drug for which there is no valid indication	91	57
Patient requires drug therapy for an indication and is not receiving or taking this therapy	157	82
Patient is not taking or receiving the appropriate drug or drug product	48	38
Patient is taking or receiving too little drug	83	57
Patient is taking or receiving too much drug	69	43
Patient is not taking or receiving the prescribed drugs appropriately	128	66
Patient is experiencing an adverse drug reaction (not related to dose)	36	29
Patient is experiencing a drug-drug, drug-food, or drug-laboratory interaction	56	44
Other	114	60

carrying out the trial, was that we would see some change in the rate of prescription drug use, and we only assessed appropriateness as part of an exploration of processes. However, the observed changes in the intervention arm were ones that were intended to be brought about by the trial intervention and were large in magnitude. It seems reasonable to attribute some of this effect to the role of the pharmacist and correspondingly unlikely that the intervention was no better than placebo. A second limitation of our study is that family physicians were not blinded to which patients were participating in the trial nor to which group patients had been allocated to. Physicians might have paid more attention to their prescribing irrespective of the input of the pharmacist. However, all care providers and patients were blind to the primary outcome measure of the study, and we believe a Hawthorne effect is likely to have been only a small component of the improvements seen. A third limitation is that the small sample size leaves some lack of precision around our main findings and might have prevented us from detecting some less-important associations with inappropriate medications and improvements during the trial. The small sample size also precluded measurement of effects on mortality and serious medical events such as hospital admission, and we are unable to comment on the cost-effectiveness of this intervention for these outcomes.

Limitations of the MAI tool itself include its inability to address underuse of medications, drug allergy, adverse reactions, as-needed medications, and compliance.[17] Thus, the high number of "patient requires drug therapy" drug-related problems recorded in **Table 6** is not reflected in the MAI scores, although presumably the pharmacist, along with the health care team, addressed these issues.

The main strength of our study is that we have explored an intermediate step that goes beyond simply measuring prescribing rates to assess the effect of pharmacist advice on the appropriateness of medication use.

Conclusion

Although there was little change in measured drug use in this trial, there was a large improvement in the appropriate use of drugs, and this provides a likely explanation for some of the large improvements in health outcomes and reductions in mortality observed in some trials of counseling or advice by pharmacists.

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Contributors

Dr Fletcher drafted the paper and coordinated editing, conducted the analyses, and approved the final version. **Drs Hogg, Farrell, Woodend, Lemelin, Dahrouge,** and **Dalziel** contributed to the study design and acquisition of data. All authors revised the article for important intellectual content and all authors gave final approval for the version submitted for publication.

Competing interests

None declared

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