Genetic education for primary care providers

Improving attitudes, knowledge, and confidence

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ABSTRACT

OBJECTIVE To increase primary care providers' awareness and use of genetic services; increase their knowledge of genetic issues; increase their confidence in core genetic competencies; change their attitudes toward genetic testing for hereditary diseases; and increase their confidence as primary care genetic resources.

DESIGN Participants completed a workshop and 3 questionnaires: a baseline questionnaire, a survey that provided immediate feedback on the workshop itself, and a follow-up questionnaire 6 months later.

SETTING Ontario.

PARTICIPANTS Primary care providers suggested by deans of nursing, midwifery, family medicine, and obstetric programs, as well as coordinators of nurse practitioner programs, in Ontario and by the Ontario College of Family Physicians.

INTERVENTION A complex educational intervention was developed, including an interactive workshop and PowerPoint educational modules on genetic topics for participants' use (available at **www.mtsinai.on.ca/FamMedGen/**).

MAIN OUTCOME MEASURES Awareness and use of genetic services, knowledge of genetics, confidence in core clinical genetic skills, attitudes toward genetic testing, and teaching activities related to genetics.

RESULTS The workshop was attended by 29 participants; of those, 21 completed the baseline questionnaire and the 6-month follow-up questionnaire. There was no significant change found in awareness or reported use of genetic services. There was significant improvement in self-assessed knowledge of (P=.001) and confidence in (P=.005) skills related to adult-onset genetic disorders. There were significant increases in confidence in many core genetic competencies, including assessing risk of hereditary disorders (P=.033), deciding who should be offered referral for genetic counseling (P=.003), discussing prenatal testing options (P=.034), discussing benefits, risks, and limitations of genetic testing (P=.033), and describing what to expect at a genetic counseling session (P=.022). There was a significant increase in the number of primary care providers agreeing that genetic testing was beneficial in the management of adult-onset diseases (P=.031) and in their confidence in being primary care genetic resources for adult-onset genetic disorders (P=.006).

CONCLUSION Educational interventions that include interactive peer resource workshops and educational modules can increase knowledge of and confidence in the core competencies needed for the delivery of genetic services in primary care.

EDITOR'S KEY POINTS

- As genetic tests are marketed for common diseases, genetics will no longer be the domain of geneticists and genetic counselors; as such, primary care providers (PCPs) will need to play an increasingly important role in delivering genetic services.
- This study aimed to develop a complex educational intervention to increase PCPs' awareness and use of genetic services, their knowledge of genetics, and their confidence in carrying out core genetic competencies, as well as change their attitudes toward genetic testing for hereditary diseases.
- This intervention provided PCPs with relevant, case-based genetic information in an interactive, interdisciplinary environment. There was demonstrated improvement in PCPs' knowledge of, confidence in, and attitudes toward delivering genetic services.

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Formation en génétique pour les soignants de première ligne

Améliorer les attitudes, les connaissances et la confiance

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RÉSUMÉ

OBJECTIF Sensibiliser les soignants de première ligne aux services génétiques et à leur utilisation; accroître leurs connaissances sur les issues génétiques; augmenter leur confiance dans leurs compétences en génétique; modifier leur attitude envers les tests génétiques pour les maladies héréditaires; et accroître leur confiance en tant que ressources en génétique dans les soins de santé primaires.

TYPE D'ÉTUDE Les participants ont participé à un atelier de travail et répondu à 3 questionnaires: un questionnaire initial, un questionnaire fournissant des réactions immédiates sur l'atelier et un questionnaire de suivi 6 mois plus tard.

CONTEXTE Ontario.

PARTICIPANTS Soignants de première ligne suggérés par les doyens des programmes de sciences infirmières, des études de sage-femme, de médecine familiale et d'obstétrique, par les coordinateurs des programmes d'infirmières cliniciennes de l'Ontario et par le Collège des médecins de famille de l'Ontario

INTERVENTION On a développé une intervention de formation complexe, dont un atelier interactif et des modules d'enseignement PowerPoint sur des sujets de génétique à l'usage des participants (voir **www.mtsinai.on.ca/FamMedGen/**).

PRINCIPAUX PARAMÈTRES ÉTUDIÉS Sensibilisation et utilisation des services génétiques, connaissances en génétique, confiance dans les habiletés cliniques en génétique, attitudes envers les tests génétiques et activités d'enseignement liées à la génétique.

RÉSULTATS Sur les 29 participants de l'atelier, 21 ont complété les questionnaires initial et du suivi de 6 mois. Il n'y avait pas de changement significatif de la sensibilisation ni de l'utilisation déclarée des services génétiques. D'après les sujets, il y avait une amélioration significative des connaissances ($P=,001$) et de la confiance ($P=,005$) dans les habilités relatives aux maladies héréditaires débutant à l'âge l'adulte. Il y avait une augmentation significative de la confiance relative aux compétences de base en génétique, incluant l'évaluation des risques de maladies héréditaires ($P=,033$), ceux qu'on devrait orienter vers la consultation génétique ($P=,003$), les tests génétiques prénatals ($P=,034$) et les avantages, risques et limitations des tests génétiques ($P=,0,033$), et les attentes à l'égard de la consultation génétique ($P=,022$). On observait une augmentation significative du nombre de soignants de première ligne qui reconnaissaient que les tests génétiques étaient avantageux pour le traitement des maladies débutant à l'âge adulte ($P=,031$) et de leur confiance en tant que ressources des soins primaires pour les affections héréditaires débutant à l'âge adulte en génétique ($P=,006$).

CONCLUSION Des interventions de formation dont des ateliers interactifs avec pairs et des modules d'enseignement peuvent accroître les connaissances et la confiance dans les compétences de base requises pour dispenser des services de génétique dans les soins primaires.

POINTS DE REPÈRE DU RÉDACTEUR

- Avec la mise en marché de tests génétiques pour des maladies courantes, la génétique ne sera plus le domaine exclusif des généticiens et des conseillers en génétique; les soignants de première ligne (SPL) devront donc jouer un rôle de plus en plus important à cet égard.
- Cette étude visait le développement d'une intervention de formation complexe pour sensibiliser les SPL aux services génétiques et à leur utilisation, augmenter leurs connaissances et leur confiance dans l'utilisation de leurs compétences en ce domaine, en plus de modifier leur attitudes à l'égard des tests génétiques pour les maladies héréditaires.
- Cette intervention a fourni des informations pertinentes sur la génétique à partir de cas réels dans un environnement interdisciplinaire interactif. On a observé une amélioration des connaissances, de la confiance et des attitudes des SPL à l'égard de la dispensation des services génétiques.

Cet article a fait l'objet d'une révision par des pairs.
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The Human Genome Project led to a rapid increase in the number of genetic diseases for which genetic testing is available. Patients are likely to hear about genetic advances through the media and will turn to their primary care providers (PCPs) for information and advice as they make decisions about genetic services. As genetic tests are marketed for common diseases, genetics will no longer be the sole domain of geneticists and genetic counselors. Primary care providers will need to play an increasingly important role.[1,2]

Primary care providers lack the knowledge and skills required to effectively deliver genetic services.[3-14] Knowledge is not the only challenge, as family physicians and other professionals are willing to offer genetic testing only if there will be benefits for their patients.[2,15] The challenge is how to deliver genetic education to PCPs in ways that respect the beliefs, expectations, and culture of primary care. Many groups have developed guidelines for genetic education[16,17] and defined core competencies in genetics for health care providers.[16,18] Published evaluations of genetic educational interventions, although few, have shown an increase in cancer genetic knowledge[19-21] and reported improvement in referral decisions regarding patients with a family history of breast and ovarian cancer.[22] In general, it is known that educational interventions, especially interactive sessions, can change physicians' behaviour.[23,24]

The Genetics Education Project was created to help PCPs in Ontario obtain the knowledge needed to help their patients make informed decisions regarding genetic services. Genetic educational materials for PCPs were developed and evaluated, and a dissemination strategy was created. In accordance with research showing that "the use of local opinion leaders can successfully promote evidence-based practice,"[25] an interactive workshop that involved individuals perceived to be leaders in their communities and who would likely serve as informal peer resources following the workshop, was organized.

A multidisciplinary team consisting of professionals in family medicine, medical genetics, nursing, laboratory medicine, and health services research was formed. Based on a qualitative needs assessment[2] and core competencies published by the National Coalition for Health Professional Education in Genetics,[18] the team developed PowerPoint educational modules, with referenced speaker notes, on common adult-onset genetic disorders: hereditary breast and ovarian cancer, hereditary colorectal cancer, Alzheimer disease, hemochromatosis, and prenatal genetic screening. These modules are available at **www.mtsinai.on.ca/FamMedGen/** and can be used for educational purposes.

The goals of the full-day interactive workshop (held in November 2005) were the following:

- increase awareness of the role of genetics in primary care;
- increase participants' knowledge of and confidence in …
  - taking a family history,
  - assessing risk of hereditary disorders,
  - referring to genetic services,
  - discussing the basic advantages and disadvantages of genetic tests, and
  - obtaining additional resources; and
- increase participants' confidence in being primary care genetic resources in their communities.

The workshop opened with a presentation on the future of genetics in primary care, followed by a session on hereditary breast and ovarian cancer as an exemplar of the content of educational modules and as a model of how they can be used for learning and teaching about genetic disorders. These key presentations were made by PCPs, not genetic specialists, in order to emphasize both the importance of peer education and the usability of the educational modules. There were brief presentations on gathering and interpreting family history and ethical, legal, and social issues in genetics. All presentations were case-based and interactive. Participants were grouped at lunch with their local geneticists. In the afternoon, following presentations on risk communication and psychosocial issues in genetics, participants broke into working groups to apply their newly learned skills to actual genetic cases (prenatal screening, colorectal cancer, or Alzheimer disease). The workshop closed with a general discussion of strategies on how to serve as informal peer educators and to disseminate the educational modules.

The objective of this research project was to determine if the complex educational intervention described above, including the interactive workshop and the PowerPoint modules, could increase PCPs' awareness and use of genetic services; increase their knowledge of genetics and confidence in genetic competencies; change their attitudes toward genetic testing for hereditary diseases; and increase their confidence as primary care genetic resources. Our goal was to determine if this kind of learning experience was worth evaluating more definitively as a useful approach to the provision of education and to build capacity in primary care genetics.

METHODS

Subjects and setting

Participants were recruited in several ways. Invitations were sent to the 5 Ontario medical schools. Deans of nursing, midwifery, family medicine, and obstetric programs, as well as coordinators of nurse practitioner programs, were contacted and asked to recommend 1 or 2 local opinion leaders in their communities. Invitation letters were also sent to individuals on a list of "educational influentials" assembled by the Ontario College of Family Physicians using Hiss methodology.[26]

(A questionnaire was sent out to a sample of family physicians asking them questions regarding who they contact informally when they have questions. Those family physicians who were named more than 3 times were selected as potential "educational influentials." A committee reviewed the potential group to determine suitability and potential conflicts of interest.) An invitation was sent out on the listserv of academic family physicians in the Department of Family and Community Medicine at the University of Toronto in Ontario.

Evaluation

Participants completed a baseline questionnaire (Q1) before the workshop. This contained questions on demographics, awareness and use of genetic services, knowledge of genetics, confidence in core clinical genetic skills, attitudes toward genetic testing, and teaching activities related to genetics. Many of the items on this questionnaire were derived from several of the authors' previous surveys on physicians' and nurses' awareness and knowledge of, confidence in, and attitudes toward the delivery of genetic services.[27,28] Six months following the workshop (June 2006), participants were mailed a similar questionnaire (Q3). Participants were sent a reminder letter 4 weeks following the initial mailing of Q3, and a full package 4 weeks later. Immediate feedback on the workshop itself was obtained by a separate survey (Q2). Ethics approval was obtained from the Ethics Review Office at the University of Toronto.

Table 1. Characteristics of respondents and nonrespondents: *Mean age of respondents was 46 (SD 6, range 37 to 56); mean age of nonrespondents was 50 (SD 10, range 37 to 64).*

CHARACTERISTICS	RESPONDENTS N = 21 N (%)	NONRESPONDENTS* N = 8 N (%)
Profession		
• Nurse	5 (24)	1 (12)
• Nurse practitioner	1 (5)	2 (25)
• Midwife	0	2 (25)
• Family physician	14 (67)	2 (25)
• Obstetrician or gynecologist	0	1 (12)
• Other	1 (5)	0
Sex		
• Male	4 (19)	2 (25)
• Female	17 (81)	6 (75)
Geographic location		
• Urban or suburban†	18 (86)	6 (75)
• Small town or rural†	3 (14)	2 (25)
Setting		
• Hospital	2 (10)	1 (12)
• Community	11 (52)	3 (38)
• Academic teaching unit	8 (38)	1 (12)
• Other	0	3 (38)
Years in practice		
• Less than 5 y	1 (5)	0
• 5 to 9 y	1 (5)	2 (25)
• 10 to 19 y	13 (62)	2 (25)
• 20 y or more	6 (29)	4 (50)

*Of the 29 participants, 21 completed the baseline questionnaire (Q1) and the follow-up questionnaire (Q3); 8 completed only Q1.
†As defined by participant; no definition provided.

Analysis

The analysis focuses on before-after changes between Q1 and Q3. Data from the questionnaires were coded and double entered in Excel. Descriptive analyses were generated using SPSS, version 15.0. Change in responses among variables of interest, from baseline (Q1) to follow-up (Q3), were determined using the McNemar test for matched categorical variables and Wilcoxon signed rank tests for paired data ($P < .05$).

RESULTS

The workshop was attended by 29 participants. Results and analysis are reported for the 21 (72%) participants who completed both Q1 and Q3. Demographics are presented in **Table 1**. Most participants were women, family physicians, and practising in urban locations. There were no significant differences between respondents and nonrespondents with respect to age and sex.

Table 2 describes current practices regarding genetic services. Preworkshop awareness of the availability of genetic testing was much higher for hereditary breast and ovarian cancer than for colorectal cancer, with no significant change following the workshop. In this small group of providers, there was no significant change in participants' reported awareness or use of genetic services.

Participants' self-rated knowledge of prenatal genetic issues (rated on a 5-point Likert scale from 1 [poor] to 5 [excellent]) did not change (median 3 [range 1 to 5] on Q1; median 3 [range 2 to 5] on Q3) but significantly improved for adult-onset genetic disorders (median 2 [range 1 to 5] on Q1; median 3 [range 1 to 4] on Q3; $P = .001$), such as cancer, hemochromatosis, or Alzheimer disease.

Table 3 shows that 6 months following the workshop there was an increase in participants' self-rated confidence (rated on a 5-point Likert scale from 1 [low confidence] to 5 [high confidence]) in their ability to carry out various core competencies in the delivery of genetic services across several domains: assessing risk for hereditary disorders, deciding who should be

Table 2. Participants' self-reported awareness and use of genetic services, preworkshop (baseline questionnaire [Q1]) and 6 months postworkshop (follow-up questionnaire [Q3]): *N = 21.*

YES OR NO QUESTIONS	PARTICIPANTS WHO RESPONDED YES	
	PREWORKSHOP Q1 N (%)	POSTWORKSHOP Q3 N (%)
"Based on your current knowledge, is genetic testing for hereditary breast or ovarian cancer available as a clinical service in Ontario?"	18 (86)	19 (90)
"Based on your current knowledge, is genetic testing for hereditary colorectal cancer available as a clinical service in Ontario?"	10 (48)	15 (71)
"Do you know where to refer your patients for genetics services?"	18 (86)	19 (90)
"Have you referred patients to genetics services in the past 6 months for prenatal issues?"	13 (62)	11 (52)
"Have you referred patients to genetics services in the past 6 months for other genetic issues (eg, family history of cancer or other disorders)?"	8 (38)	11 (52)
"In the past 6 months, have you contacted your local genetic counseling clinic for information about a prenatal genetics issue?"	9 (43)	8 (38)
"In the past 6 months, have you contacted your local genetic counseling clinic for information about any genetics issue (not related to prenatal care)?"	4 (19)	5 (24)

Table 3. Participants' (N = 21) self-reported confidence in their ability to carry out core clinical genetics competencies in clinical practice, baseline questionnaire [Q1] versus follow-up questionnaire [Q3]: *Confidence was rated on a 5-point Likert scale (1 = low confidence; 5 = high confidence).*

QUESTIONS*	Q1		Q3		*P* VALUE (WILCOXON SIGNED RANK TEST)
	MEAN (SD)	MEDIAN (RANGE)	MEAN (SD)	MEDIAN (RANGE)	
Indicate how confident you are in your ability to carry out each of the following:					
• Elicit genetic information as part of a family or medical history	3.6 (1.1)	4 (2-5)	3.8 (0.7)	4 (3-5)	.248
• Assess risk of hereditary disorders	2.9 (1.0)	3 (1-5)	3.5 (0.8)	3.5 (2-5)	.033†
• Decide who should be offered referral for genetic counseling or testing based on family history	2.7 (0.7)	3 (2-4)	3.5 (0.6)	3 (3-5)	.033†
• Order genetic testing for hereditary cancer or adult-onset disease	1.8 (0.8)	2 (1-4)	2.3 (0.9)	2 (1-4)	.102
• Discuss a variety of prenatal testing options with your patients	3.7 (1.3)	4 (1-5)	4.0 (1.1)	4 (2-5)	.034†
• Evaluate the clinical usefulness of a genetic test	3.0 (0.8)	3 (2-4)	3.3 (0.8)	3 (2-4)	.130
• Discuss the benefits, risks, and limitations of genetic testing	3.0 (0.8)	3 (2-4)	3.4 (0.9)	4 (2-5)	.033†
• Provide counseling to patients making decisions about whether or not to have genetic testing	3.1 (0.9)	3 (2-4)	3.4 (1.1)	4 (1-5)	.237
• Provide psychosocial support to patients coping with a genetic test result	3.6 (1.0)	4 (2-5)	3.7 (0.9)	3 (2-5)	.637
• Provide counseling related to screening, lifestyle changes, or surveillance strategies indicated by a genetic test result	3.0 (1.2)	3 (1-5)	3.3 (1.3)	3 (1-5)	.484
• Describe what to expect at a genetic counseling session	2.9 (1.1)	3 (1-5)	3.5 (1.1)	3 (1-5)	.022
Overall, rate your current level of confidence in the following:					
• Prenatal genetics	3.4 (1.1)	4 (2-5)	3.6 (1.1)	3.5 (2-5)	.655
• Genetics of adult-onset disorders	2.3 (0.7)	2 (1-4)	3.0 (0.9)	3 (1-4)	.005†

*Some questions might have missing data.
†Significant difference between Q1 and Q3.

offered referral for genetic counseling, discussing prenatal testing as well as the benefits, risks, and limitations of genetic testing, and describing what to expect at a genetic counseling session. Most significant was the increase in participants' confidence in adult-onset genetic disorders ($P = .005$).

Participants' attitudes toward genetic testing (rated on a 5-point Likert scale from 1 [strongly disagree] to 5 [strongly agree]) are shown in **Table 4**. Six months following the workshop, there was a significant increase in the number of participants who strongly agreed and agreed that genetic testing was beneficial in the management of adult-onset genetic disorders ($P = .031$).

Table 4. Participants' attitudes toward genetic testing for hereditary diseases, baseline questionnaire (Q1) versus follow-up questionnaire (Q3): *N = 21.*

STATEMENTS	PARTICIPANTS WHO RESPONDED STRONGLY AGREE AND AGREE* Q1 N (%)	Q3 N (%)	*P* VALUE (MCNEMAR TEST)
It is important for me to learn about new advances in genetics	20 (95)	20 (95)	> .99
There are insufficient benefits to warrant genetic testing for adult-onset diseases	3 (14)	1 (5)	.625
I have sufficient time in my practice to counsel patients about genetic risk	6 (29)	7 (33)	> .99
In general, the concept of risk is too difficult for patients to understand	3 (14)	2 (10)	> .99
Genetic testing is beneficial in the management of adult-onset genetic diseases	8 (38)	14 (67)	.031†

*Choices 4 and 5 on Likert scale (ie, strongly agree and agree) combined.
†Significant difference between Q1 and Q3.

Six months following the workshop, there was also a significant increase in participants' confidence (rated on a 5-point Likert scale from 1 [not very confident] to 5 [very confident]) in serving as informal resources to other health care providers in the community regarding adult-onset genetic disorders (median 1 [range 1 to 4] on Q1; median 3 [range 1 to 4] on Q3; $P = .006$). There was no significant increase in confidence in serving as a resource for prenatal genetic issues (median 2 [range 1 to 5] on Q1; median 3 [range 1 to 5] on Q2). There was also no significant difference in the number of times they reported serving as educational resources for genetic issues in the 6 months before and after the workshop.

Table 5 shows the answers to 3 knowledge questions, taken from the Wideroff et al[29] study. The baseline data indicate fairly high levels of knowledge for the questions relating to hereditary breast cancer but lower levels relating to hereditary colorectal cancer. A significant increase in correct answers was found for only the colorectal cancer question ($P = .031$).

Table 5. Knowledge of hereditary breast, ovarian, and colorectal cancers: *Respondents' answers to multiple-choice questions, baseline questionnaire (Q1) versus follow-up questionnaire (Q3).*

QUESTIONS*	Q1 N = 21 N (%)	Q3 N = 20† N (%)	*P* VALUE (MCNEMAR TEST)
"Suppose you had a patient whose aunt or grandmother on her father's side carries the *BRCA1* gene mutation for breast/ovarian cancer syndrome. In your opinion, could your patient also be a carrier of this mutation?"			
• Yes‡	15 (71)	18 (90)	.219
• No	2 (10)	1 (5)	
• Not sure	4 (19)	1 (5)	
"In your opinion, what percentage of female breast cancer patients has a *BRCA1* or *BRCA2* gene mutation?"			
• < 10%‡	19 (90)	18 (90)	> .99
• > 10%-100%	0	1 (5)	
• Not sure	2 (10)	1 (5)	
"In your opinion, what percentage of patients who carry a gene for hereditary non-polyposis colorectal cancer will actually go on to develop colorectal cancer?"			
• < 50%	9 (43)	7 (35)	.031§
• ≥ 50%‡	5 (24)	10 (50)	
• Not sure	7 (33)	3 (15)	

*Questions are from Wideroff et al.[29]
†One participant did not answer this question.
‡Correct answer.
§Significant difference between correct and incorrect answers.

Overall, 19 of the 21 participants (90%) reported they were more confident in dealing with genetic issues 6 months after the workshop compared with their baseline levels of confidence.

When asked how they would change their practices, 15 of 21 (71%) participants indicated they would improve their family history taking, 10 (48%) said they would increase teaching genetics, and 10 (48%) reported increased knowledge of genetics.

The workshop was evaluated (Q2) by 28 participants (97%); 24 of the 28 (86%) agreed the information presented was relevant to their practices, and 26 (93%) found it very effective to learn about genetics alongside other PCPs.

DISCUSSION

This was a complex intervention to assist PCPs in playing a key role in the provision of genetic health care. It is one component of efforts to develop a national educational initiative for PCPs, providing tools to help navigate the new genetics. This intervention involved an interactive workshop for PCPs who were identified as interested in genetics or perceived to be opinion leaders in their communities to foster learning about genetic issues and empower participants to use a set of purpose-designed educational modules for informal peer-to-peer learning. The results were consistent with this approach being effective in achieving at least some of its goals. Although this was designed as a formative evaluation and the analysis had inadequate statistical power for formal hypothesis testing, a larger number of statistically significant results were obtained than would be expected by chance. The findings at 6 months after the intervention are consistent with improvements in participants' self-rated knowledge of adult-onset genetic disorders, their attitudes toward the benefits of genetic testing, and, to some extent, their confidence in core competencies in genetics. The most significant changes were seen in relation to adult-onset genetic disorders and increased confidence in the role of informal resources for other health care providers in their communities (P=.006). Despite these findings, many areas of knowledge, confidence, and attitudes demonstrated no change—for example, in contacting local genetic clinics for information or advice. This suggests that further interventions are required if these clinics are to be resources for their primary care referral base.

Our results were similar to those of other studies that have shown increased knowledge of genetics[19-22] and reported confidence in management of individuals with a family history of hereditary cancer[22] following educational interventions. Our results also provide guidance for future work. In our study, participants rated the interaction and interdisciplinary learning provided in the educational session quite highly. It would be interesting to see if merely providing the PowerPoint resources alone would have resulted in the changes seen in knowledge and confidence, as has been seen in some other work.[22] Further, most participants (90%) said they found it very effective to learn about genetics alongside other PCPs. This was also found by Blazer et al in their evaluation of a genetic cancer risk counseling course for clinicians.[20] New genetic discoveries are likely to change the practice of medicine for all health care providers, offering a wonderful opportunity for interprofessional learning and practice. Finally, an increase in number and appropriateness of cancer genetic referrals has been noted in communities following an educational intervention.[19] Although our participants did not report increased use of genetic services in the 6 months following the workshop, it would be of value to track actual referrals to genetics and appropriateness of these referrals in future studies of genetic educational interventions.

Limitations

Confidence in these findings is clearly limited by the low statistical power and generalizability of the study; however, a larger workshop would have compromised our goals of interaction and dialogue. This study might not be generalizable to all PCPs, as participants were not chosen to be representative of PCPs in Ontario, rather to have an interest in genetics or clinical leadership qualities. A further limitation was the loss of 8 of the 29 workshop participants to follow-up. This formative evaluation will assist us in developing further primary care genetic educational programs. Even though the participants were likely to be more interested in, and better informed about, genetics than the average PCP, we were still able to show worthwhile changes in their knowledge, attitudes, and confidence, lasting 6 months following the workshop. It could be argued that although statistically significant, the effect size found in our study was small. The literature shows that most educational interventions achieve only modest to moderate improvements in care.[30] In a review by Grimshaw et al,[30] dissemination of educational materials showed an 8.1% improvement in process of care and the combination of educational materials and meetings achieved between 1.9% and 10% improvement in process of care. Our findings were at or above this level.

The challenge remains regarding how this educational intervention might be delivered to large numbers of PCPs. If this program were to be more broadly adopted as a primary care genetic educational strategy, attention would need to be given to the costs associated with workshop organization and development of educational materials, both financial and time, and the challenge of motivating health care professionals to devote a full day to genetic education. Shorter sessions should be evaluated. We recommend that PCPs who have an interest and expertise in the area of genetics use the PowerPoint educational materials for teaching sessions as either informal individual or group study aids or as learner teaching aids. Members of the project team will continue to update the Web-based educational resources at **www.mtsinai.on.ca/FamMedGen/**.

Conclusion

There is a clear need for genetic education for PCPs. By providing relevant, case-based genetic information in an interactive, interdisciplinary learning environment, we were able to demonstrate improvement in knowledge and confidence and foster peer-to-peer learning. Complex educational interventions, such as the one described here, can play an important role in much-needed educational programs for primary care genetics.

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Contributors

Drs Carrol and **Prakash** and **Ms Rideout** contributed to the concept and design of the study; data gathering, analysis, and interpretation; and preparing the manuscript for submission. **Dr Wilson** contributed to the concept and design of the study, data analysis and interpretation, and preparing the manuscript for submission. **Drs Allanson, Graham, Blaine, Esplen, Farrell, MacKenzie, Taylor, Meschino,** and **Summers** and **Ms Shuman** contributed to the concept and design of the study, data interpretation, and preparing the manuscript for submission. **Dr Miller** contributed to data analysis and interpretation and preparing the manuscript for submission. **Dr Carroll** takes responsibility for the integrity of the work as a whole, from inception to published article.

Competing interests

None declared

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References

1. Greendale K, Pyeritz RE. Empowering primary care health professionals in medical genetics: how soon? How fast? How far? *Am J Med Genet* 2001;106(3):223-32.
2. Carroll JC, Brown JB, Blaine S, Glendon G, Pugh P, Medved W. Genetic susceptibility to cancer. Family physicians' experience. *Can Fam Physician* 2003;49:45-52.
3. Aalfs CM, Smets EM, de Haes HC, Leschot NJ. Referral for genetic counselling during pregnancy: limited alertness and awareness about genetic risk factors among GPs. *Fam Pract* 2003;20(2):135-41.
4. Watson EK, Shickle D, Qureshi N, Emery J, Austoker J. The 'new genetics' and primary care: GPs' views on their role and their educational needs. *Fam Pract* 1999;16(4):420-5.
5. Acton RT, Burst NM, Casebeer L, Ferguson SM, Greene P, Laird BL, et al. Knowledge, attitudes, and behaviors of Alabama's primary care physicians regarding cancer genetics. *Acad Med* 2000;75(8):850-2.
6. Baars MJ, Henneman L, Ten Kate LP. Deficiency of knowledge of genetics and genetic tests among general practitioners, gynecologists, and pediatricians: a global problem. *Genet Med* 2005;7(9):605-10.
7. Emery J, Watson E, Rose P, Andermann A. A systematic review of the literature exploring the role of primary care in genetic services. *Fam Pract* 1999;16(4):426-45.
8. Freedman AN, Wideroff L, Olson L, Davis W, Klabunde C, Srinath KP, et al. US physicians' attitudes toward genetic testing for cancer susceptibility. *Am J Med Genet A* 2003;120A(1):63-71.
9. Hunter A, Wright P, Cappelli M, Kasaboski A, Surh L. Physician knowledge and attitudes towards molecular genetic (DNA) testing of their patients. *Clin Genet* 1998;53(6):447-55.
10. Metcalfe S, Hurworth R, Newstead J, Robins R. Needs assessment study of genetics education for general practitioners in Australia. *Genet Med* 2002;4(2):71-7.
11. Mouchawar J, Klein CE, Mullineaux L. Colorado family physicians' knowledge of hereditary breast cancer and related practice. *J Cancer Educ* 2001;16(1):33-7.
12. Pichert G, Dietrich D, Moosmann P, Zwahlen M, Stahel RA, Sappino AP. Swiss primary care physicians' knowledge, attitudes and perception towards genetic testing for hereditary breast cancer. *Fam Cancer* 2003;2(3-4):153-8.
13. Lapham EV, Kozma C, Weiss JO, Benkendorf JL, Wilson MA. The gap between practice and genetics education of health professionals: HuGEM survey results. *Genet Med* 2000;2(4):226-31.
14. Qureshi N, Armstrong S, Modell B. GPs' opinions of their role in prenatal genetic services: a cross-sectional survey. *Fam Pract* 2006;23(1):106-10. Epub 2005 Aug 22.
15. Robins R, Metcalfe S. Integrating genetics as practices of primary care. *Soc Sci Med* 2004;59(2):223-33.
16. Burke W, Emery J. Genetics education for primary-care providers. *Nat Rev Genet* 2002;3(7):561-6.
17. Burke W, Acheson L, Botkin J, Bridges K, Davis A, Evans J, et al. Genetics in primary care: a USA faculty development initiative. *Community Genet* 2002;5(2):138-46.
18. National Coalition for Health Professional Education in Genetics [website]. Lutherville, MD: National Coalition for Health Professional Education in Genetics; 2008. Available from: **www.nchpeg.org.** Accessed 2009 Oct 13.
19. Blazer KR, Grant M, Sand SR, MacDonald DJ, Uman GC, Weitzel JN. Effects of a cancer genetics education programme on clinician knowledge and practice. *J Med Genet* 2004;41(7):518-22.
20. Blazer KR, MacDonald DJ, Ricker C, Sand S, Uman GC, Weitzel JN. Outcomes from intensive training in genetic cancer risk counseling for clinicians. *Genet Med* 2005;7(1):40-7.
21. Schroy PC 3rd, Glick JT, Geller AC, Jackson A, Heeren T, Prout M. A novel educational strategy to enhance internal medicine residents' familial colorectal cancer knowledge and risk assessment skills. *Am J Gastroenterol* 2005;100(3):677-84.
22. Watson E, Clements A, Yudkin P, Rose P, Bukach C, Mackay J, et al. Evaluation of the impact of two educational interventions on GP management of familial breast/ovarian cancer cases: a cluster randomised controlled trial. *Br J Gen Pract* 2001;51(471):817-21.
23. Davis D, O'Brien MA, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education: do conferences, workshops, rounds, and other traditional continuing education activities change physician behavior or health care outcomes? *JAMA* 1999;282(9):867-74.
24. Grimshaw JM, Eccles MP, Walker AE, Thomas RE. Changing physicians' behavior: what works and thoughts on getting more things to work. *J Contin Educ Health Prof* 2002;22(4):237-43.
25. Doumit G, Gattellari M, Grimshaw J, O'Brien M. Local opinion leaders: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2007;(1):CD000125.
26. Hiss RG, MacDonald R, David WR. Identification of physician educational influentials in small community hospitals. *Res Med Educ* 1978;17:283-8.
27. Bottorff JL, Blaine S, Carroll JC, Esplen MJ, Evans J, Nicolson Klimek ML, et al. The educational needs and professional roles of Canadian physicians and nurses regarding genetic testing and adult onset hereditary disease. *Community Genet* 2005;8(2):80-7.
28. Carroll JC, Cappelli M, Miller F, Wilson BJ, Grunfeld E, Peeters C, et al. Genetic services for hereditary breast/ovarian and colorectal cancers—physicians' awareness, use and satisfaction. *Community Genet* 2008;11(1):43-51. Epub 2008 Jan 15.
29. Wideroff L, Vadaparampil ST, Greene MH, Taplin S, Olson L, Freedman AN. Hereditary breast/ovarian and colorectal cancer genetics knowledge in a national sample of US physicians. *J Med Genet* 2005;42(10):749-55. Epub 2005 Mar 22.
30. Grimshaw JM, Thomas RE, MacLennan G, Fraser C, Ramsay CR, Vale L, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technol Assess* 2004;8(6):iii-iv, 1-72.