Advances in genetic knowledge and technology over the last decade have made genetics increasingly relevant for preventive health care and clinical management. There are currently fewer than 3,300 genetics professionals in the United States who are certified by the American Board of Medical Genetics and the American Board of Genetic Counseling. By the early 1990s, it was anticipated that primary care physicians would have to address genetics issues in their practice but that their training was inadequate. As genetic medicine now becomes integrated into clinical practice, it becomes even more urgent for primary care physicians to have the ability to address genetic issues by providing appropriate services, counseling, and referrals.

Primary care physicians identify many barriers to the provision of genetic services in primary care settings, including inadequate knowledge of basic genetics, lack of adequate family histories, lack of confidence, and lack of referral guidelines. Genetic education in medical school is still deficient. In response to the need for more genetics education for family physicians, the American Academy of Family Physicians issued Core Educational Guidelines for medical genetics for family medicine residents in 1999.

Most of the research on genetics education for primary care physicians that has been published to date consists of surveys of their educational needs, attitudes, or current practice regarding genetic issues or discussions of challenges and potential solutions for the provision of genetic services in clinical practice. There is limited evidence about the outcomes of educational interventions designed to improve the genetic knowledge of primary care physicians.

The Genetics in Primary Care Project

The Genetics in Primary Care (GPC) project, a national faculty development initiative, was designed to improve the ability of primary care faculty to incorporate genetic information into training programs for medical students and residents, thereby preparing...
primary care physicians to address genetic issues in practice. It was meant to address the poor knowledge of genetics of practicing primary care physicians and the limited genetics content of medical school curricula. Participants were recruited as teams from 20 different academic centers across the United States. These centers were selected from more than 40 applications.

On average, each team consisted of four primary care physicians with teaching duties and one genetics expert (clinical geneticist or genetic counselor). Program activities were comprised of two components: (1) participation in two national "train the trainer" workshops and (2) local implementation of newly acquired skills and knowledge during informal teaching encounters and in the medical school/residency curricula.

Educational materials were developed specifically for this project and were designed to incorporate the perspectives of both primary care physicians and genetics experts. They consisted of eight case-based modules on conditions likely to be seen in primary care settings. As noted, the project used a train-the-trainer strategy, in which participating faculty were introduced to the teaching modules and were expected to adapt them for use at their own institutions. The curriculum and program are described in detail elsewhere.

We present an evaluation of the long-term effects of the GPC on participants' teaching and clinical practices. We also present feedback from GPC participants about their overall impression of the GPC project, including what they perceived as its strengths and weaknesses.

Methods
Seventy-nine primary care physicians (PCPs) and 21 genetics experts from 20 teaching medical universities across the United States participated in the GPC program between October 2000 and April 2001. In 2004–2005, we performed a follow-up evaluation of the GPC program. Site visits were done at nine institutions. Because of limited time and resources, individual phone interviews were conducted instead of site visits for the remaining 11 institutions. Study procedures qualified for an exemption from the University of Washington Institutional Review Board/Human Subjects Review Committee.

Site Visits
Site visits were conducted by four interviewers, all authors of this paper. Two individuals made four visits each, while two other individuals made one site visit together. Interviewers met with team members at each institution as a group or individually, using the interview guide found in Table 1. Site visitors took detailed notes, which were later typed and made available for content analysis. Site visit data is reported in aggregate by site because of the team nature of the interviews conducted in those settings.

Phone Interviews
The names and e-mail addresses of all GPC participants from the 11 remaining institutions were obtained from the GPC files. When no e-mail address was available, we sought them on the institution's Web site or other publicly accessible Web sites. GPC participants were contacted individually by e-mail. If they did not respond, a maximum of two e-mail reminders were sent, at least a week apart. We arranged telephone interviews with those who responded.

All phone interviews were conducted by the same individual. A short explanation of the purpose of the interview was read to the interviewee, followed by the same questionnaire used for the site visits (Table 1). The interviewer took detailed notes of the interviewee's responses, transcribing verbatim responses as much as possible and checking back with the interviewees to ensure that their responses were accurately recorded. Interview notes were typed immediately after the end of the interview.

Table 1
Follow-Up Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 1. What kind of changes have you made since participating in the Genetics in Primary Care (GPC) project? | a. to your teaching?  
b. to your practice?  
c. Did these changes surprise you?  
d. Did you have goals when you began the project that you were not able to complete? |
| 2. How has the reception been to genetics at your institution?            |                                                                       |
| 3. What was your background/interest in genetics prior to participation? | a. Where do you think your interest is now?                              |
| 4. How has it been to work across disciplines at your institution?       |                                                                       |
| 5. What has been the hardest thing about the GPC project?               |                                                                       |
| 6. What has been the most fun or interesting?                           |                                                                       |
| 7. If one of your colleagues was considering participating in a similar faculty development effort, how would you say to him/her? |                                                                       |
| 8. Did you end up using the GPC curriculum materials?                   | a. If yes,  
                        i. Under what circumstances?  
                        ii. What worked well  
                        iii. What would you have liked to have seen?  
b. If not,  
                        i. Why not?  
                        ii. Would anything have made you more likely to use them? |
| 9. What is your primary care specialty?                                  |                                                                       |
| 10. Do you teach medical students, residents, or both?                  |                                                                       |
of the interview. Once all interviews were done, two individuals reviewed the notes and performed a conventional content analysis of the responses. Exhaustive lists of all the responses obtained were created for each question. Similar responses were grouped together to come up with a final list of distinct responses for each question; the frequency of each response in our sample was quantified.

**Results**

**Demographics**

Teams from 20 institutions participated in the GPC project. Using both site visits and phone interviews, we obtained follow-up feedback from 19/20 teams (95%). During site visits, interviewers met with a median of two team members at each site (range two to four), for a total of 20 respondents. During phone interviews, the interviewer spoke with a median of two team members per site (range 0–five), for a total of 27 individual respondents.

Follow-up respondents included 16 family physicians, 10 pediatricians, five internists, five internal medicine/pediatrics specialists, and one obstetrician-gynecologist. Fifteen of these individuals were interviewed during site visits, while 22 were interviewed by phone. All of the interviewed respondents have ongoing teaching responsibilities. We also obtained follow-up responses from 10 genetics experts (five during site visits, five during phone interviews).

Due to differences in data collection methods, the results of the site visits and phone interviews were not combined. In each subsection that follows, results are presented separately for site visits and phone interviews. Results for PCPs are presented first, followed by results for genetics experts.

**Effects of GPC on Teaching Practices of PCPs**

During site visits, all teams reported changes in teaching practices at their institution as a result of their participation in the GPC project. Examples of changes include the formalization of existing teaching collaborations between geneticists and primary care faculty, addition of new genetics material to medical school curriculum and/or residency training programs, and a generally increased sensitivity to family history and genetics in clinical teaching situations. Some respondents had used GPC materials for teaching, including modules about developmental delay, hearing loss, breast cancer, cystic fibrosis, and ethical, legal, and social issues.

During phone interviews, all primary care respondents reported having made changes to their teaching practices, as a direct or indirect result of their participation in the GPC project (Table 2). All have used the GPC materials for teaching. All eight modules were used: breast cancer (59%), colon cancer (32%), hemochromatosis (27%), developmental delay (including fragile X syndrome) (32%), cardiovascular disease (23%), hearing loss (18%), senility/dementia (14%), and ethical, legal, and social issues (14%). Some teams used the GPC approach to develop additional modules on the topics relevant to their practice, such as Huntington disease, thrombophilia, addiction/alcoholism, depression, and cystic fibrosis.

**Effects of GPC on Clinical Practice of PCPs**

During site visits, changes in clinical practice were mentioned by half of the teams. For example, respondents mentioned a greater awareness of genetics when seeing patients, asking different questions about family history. During phone interviews, the majority of primary care respondents (86%) reported changes to their clinical practice (Table 3).

**Strengths and Challenges of the GPC Project**

The main strength of the GPC project identified during the site visits was its interdisciplinary nature and the opportunity to work with faculty members from other disciplines at their institution. The GPC created institutional leaders at each site, in which primary care faculty, in many cases, became champions for the inclusion of genetics information in clinical teaching and practice. Challenges identified during site visits include convincing their colleagues to follow suit, adapting the material to make it their own, tapping into timely examples (eg, obesity), and dealing with the lack of time, resources, and the production pressure felt by physicians.

During phone interviews, the most appreciated aspect of the project was also the interdisciplinary collaboration (55%). Some found interdisciplinary collaboration challenging, however, due to lack of leadership (5%) and use of uniform teaching approaches (“one size does not fit all”) (5%). A few (14%) complained that the interdisciplinary team was not able to stay together after

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>n (%)</th>
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<tbody>
<tr>
<td>More genetics in medical school curriculum</td>
<td>8 (36%)</td>
</tr>
<tr>
<td>More genetics in bedside teaching</td>
<td>7 (32%)</td>
</tr>
<tr>
<td>Increasing residents’ awareness of genetics</td>
<td>7 (32%)</td>
</tr>
<tr>
<td>Stressing the importance of family history</td>
<td>5 (23%)</td>
</tr>
<tr>
<td>Showing on-line resources to residents</td>
<td>5 (23%)</td>
</tr>
<tr>
<td>Incorporating genetics into formal residency teaching</td>
<td>4 (18%)</td>
</tr>
<tr>
<td>Teaching when/how to refer</td>
<td>2 (9%)</td>
</tr>
<tr>
<td>Stressing the importance of genetic counseling</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>Any change in teaching</td>
<td>22 (100%)</td>
</tr>
</tbody>
</table>

PCP—primary care physician
the end of the project. Respondents found it challenging to maintain the level of enthusiasm for the project over time (36%), to find time to work on the project (27%), and to convince other primary care providers of the relevance of genetics in their practice (23%). They also found it difficult to find resources/money (18%), sustain and adapt the project over time (14%), push the primary care perspective (9%), and deal with the lack of data and material relevant for underserved minorities (5%).

Overall Impression of the GPC Project

The overall impression of the GPC project obtained from the site visits was positive, especially in terms of its effects on teaching practices. Participation in the GPC project was seen as “worth the investment.”

Overall, the majority of phone interview respondents would recommend similar projects to their colleagues. Four respondents (18%) spontaneously reported that participation in GPC was the launching point to either a new position at their institution (9%) or for participation in at least one other project (9%).

However, a subgroup (32%) would recommend it with caution. They would advise participants to consider certain factors before agreeing to participate, such as their personal motivation, the required responsibilities and workload, the amount of funding available, and the availability of protected time for the project.

Effects of GPC Project on Participating Genetics Experts

During site visits, genetics experts were interviewed with the rest of the team, which makes it difficult to assess the effects of the project on their teaching and clinical practices. Nevertheless, the importance of teaching genetics from the primary care perspective came up repeatedly.

During phone interviews, all genetics experts (5/5) reported making changes to their teaching practices as a result of their involvement in GPC. Changes mentioned include presenting material in a language appropriate for primary care (1/5), thinking more about general health issues (1/5), realizing the importance of assessing your audience (1/5), using more case-based material to teach primary care providers (1/5), and incorporating more genetics content in the medical school curriculum (1/5). As opposed to PCPs, only one of the genetics experts reported having made changes in his clinical practice (1/5). This change was described as a greater involvement with adult patients.

Genetics experts found interdisciplinary collaboration to be the strength of the project (4/5). Maintaining enthusiasm over time and working with vaguely defined goals were their main challenges (2/5 each).

All would recommend a similar project to their colleagues, but 2/5 would advise their colleague to consider specific issues before agreeing to participate (for example, presence of well-defined goals and availability of funding). Two genetics experts spontaneously reported that their participation in GPC was the launching point to getting a new position (1/5) or participating in another project (1/5).

Discussion

Respondents reported lasting changes in their teaching and clinical practices 3 years after their participation in the GPC project, suggesting that participation in a relatively time-limited faculty development initiative can have significant long-term effects. Although the project was designed to train primary care faculty, the genetics experts interviewed also made changes to their teaching: they learned to adapt their teaching strategy to their audience’s needs. A possible explanation for the lasting effects of the GPC project is the collaboration of genetics experts and primary care faculty in the development of the GPC materials to assure both accuracy and relevance for PCPs.

It is possible that long-term effects are overestimated, however, for two reasons. First, the level of motivation required to participate in the GPC program (submitting an application, demonstrating institutional support, and committing to 6 months of participation) might have increased the likelihood that those who participated were more likely to benefit. Second, GPC participants who perceived benefit from the program may have been more likely to consent to a follow-up interview. However, our team response rate is high: we interviewed participants from 19 of the 20 different sites (95%). We believe our data reflect a true positive outcome of the GPC project, although we cannot rule out less positive outcomes in the subset who did not agree to be interviewed.

Table 3

Changes in Clinical Practice Among PCP Faculty (Data From Individual Phone Interviews, n=22)

<table>
<thead>
<tr>
<th>Type of Change</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased awareness of genetics</td>
<td>8 (36%)</td>
</tr>
<tr>
<td>Change in referral pattern</td>
<td>6 (28%)</td>
</tr>
<tr>
<td>Greater confidence in ability to deal with genetics</td>
<td>5 (23%)</td>
</tr>
<tr>
<td>Greater importance given to family history</td>
<td>5 (23%)</td>
</tr>
<tr>
<td>Greater attention to genetics in differential diagnosis</td>
<td>5 (23%)</td>
</tr>
<tr>
<td>Increased use of on-line resources for patient management</td>
<td>4 (18%)</td>
</tr>
<tr>
<td>More attention to need for counseling</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>Any change in clinical practice</td>
<td>18 (82%)</td>
</tr>
</tbody>
</table>

PCP—primary care physician
During phone interviews, four primary care respondents and two genetics experts spontaneously reported that their participation in GPC was the launching point to either a new position or participation in other projects, although the interview did not address either of these topics. Potential benefit for a participant’s career path may be an important outcome of faculty development projects, and should be evaluated in future projects, in addition to teaching and clinical practices outcomes.

The major problem encountered by participants seems to have been the long-term sustainability of the project. Interdisciplinary collaboration is hard to maintain over time, partly because team members have competing demands on their time and little opportunity to meet in other circumstances. They might also lack the time and resources needed. Continued contact with other teams or project organizers might have helped maintain a greater level of motivation.

All of the respondents have used the GPC materials for teaching. All of the eight original modules were used by at least one of the participants interviewed. The most frequently used modules had to do with common complex diseases, frequently encountered in primary care settings (for example, breast and colorectal cancer). These observations suggest that the materials succeeded in achieving relevance for primary care teaching settings. The original eight modules have since been adapted to a Web-based format and integrated in an expanded resource of 41 case-based modules.26

In summary, more than 3 years after it took place, the “Genetics in Primary Care” faculty development initiative has had lasting effects on participants’ teaching and clinical practices. GPC is an example of a successful educational intervention to promote the integration of genetics in primary care. The program has also had a positive impact on some participants’ careers. Future faculty development initiatives can build on this success.

Interdisciplinary collaboration was a great strength of the project but may be one of the factors adversely affecting its long-term sustainability. Future efforts will have to address sustainability issues, including ways of supporting interdisciplinary initiatives, maintaining enthusiasm over time and ensuring that participants have the necessary time and resources to continue the project.

Acknowledgments: Funding for this project came in part from a contract with the Maternal and Child Health Bureau of the Health Resources and Services Administration.

Professional meetings at which partial content of this manuscript was presented (only the phone interview data was presented) include the American Society of Human Genetics, Salt Lake City, October 2005, and the Annual Clinical Genetics Meeting, San Diego, March 2006.

The GPC Project is administered by the Society of Teachers of Family Medicine, and GPC Training Program curriculum materials can be found online at http://genes-r-us.uthscsa.edu/resources/genetics/primary_care.htm.

Corresponding Author: Address correspondence to Dr Laberge, Service de Génétique Médicale, 6e bloc 7, CHU Sainte-Justine, 3175 Côte-Ste-Catherine, Montreal, Quebec, Canada H3T 1C5. 514-345-4727. Fax: 514-345-4766. anne-marie.laberge.hs@ssss.gouv.qc.ca.

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