The Canadian Plastic Surgery Workforce Survey: Interpretation and Implications

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Background: Few studies have monitored physician supply in Canada, and no studies have specifically examined the Canadian plastic surgery workforce.
Methods: In this study, data were gathered by three methods. A survey was distributed to all members of the Canadian Society of Plastic Surgeons in October of 2004. Opinions on the availability of plastic surgery services were solicited. A second survey that focused on demographics and workload was distributed in December of 2004. Finally, the locations of all Canadian trainees graduating between 1995 and 2005 were reviewed.
Results: The response rate to the first survey was 42 percent. Seventy-eight percent of respondents felt that there was a shortage of plastic surgeons in their community. The response rate to the second survey was 40 percent. Twenty-eight percent of respondents were within 5 years of retirement and 3.2 percent stated that they planned to emigrate by 2010. The mean waiting time for an elective consultation was 32 ± 33 weeks. Review of all 179 plastic surgery graduates over the past 10 years revealed that 23 percent now practice outside of Canada.
Conclusions: When these results are projected to the total workforce, they indicate that there will be a future shortage of plastic surgeons in Canada. To prevent a further deficit, there is a need to increase the number of plastic surgery trainees in Canada, to offer incentives for graduates to stay in Canada, and to possibly recruit more foreign-trained plastic surgeons to practice within Canada. (*Plast. Reconstr. Surg.* 119: 2299, 2007.)

The general Canadian perception is that the Canadian health care system ranks among the world leaders in terms of quality. However, in a recent World Health Organization study on health care delivery and accessibility, Canada ranked 30th in the world for overall health system performance.[1] The cause of the decline in service delivery is believed to be a shortage of human resources. This in part stems from policies enacted in the 1990s based on recommendations made by the Barer Stoddart report.[2] This report recommended limiting the growth of physician supply by decreasing medical school enrolment and restricting international medical graduates entering Canada. In addition to health care policies, increased rates of physician migration and early physician retirement have further decreased the number of available physicians over the past 20 years. Considered together, this has a direct effect on physicians (workload) and patients (access to specialist care).

The reality of the current physician workforce shortage in Canada is evidenced by the nation's overcrowded emergency rooms, long waiting lists, and frequent transportation of patients to the United States for treatment. The field of plastic surgery is not immune to these issues. An aging workforce, increased frequency of early retirement, and more time spent in noninsured arenas have decreased the number of "full-time equivalent" plastic surgeons in Canada.

The international literature indicates that medical workforce issues are a common problem.[3–6] In recent years, a strong interest has developed in medical workforce planning in

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health care systems around the world. Forecasting the future supply of and demand for physicians and the effect of this balance on patient care is complex. Perceptions of the Canadian medical workforce have fluctuated from predictions of surplus to warnings of shortage over the past two decades. The United Kingdom, Australia, and the United States have experienced similar variations in opinion.[7–12] Australia is similar to Canada in its health care system, with a high number of doctors in metropolitan areas and a shortage of doctors in rural communities. Several European countries have a surplus of physicians, which has led to significant levels of practitioner unemployment.[13]

Physician resource planning requires a dynamic approach that monitors key factors affecting supply and demand that ranges from system intake (i.e., residency enrolment) to planned exit/retirement from practice. The purpose of this study was to determine whether there is a shortage of plastic surgeons in Canada. It is hoped that government agencies and training programs will be able to use the information generated from this study to develop a sustainable plastic surgery workforce.

MATERIALS AND METHODS

Survey Participants and Design

This study consisted of three parts. Part 1 consisted of a self-reported survey that was distributed as a single mail-out to all 338 practicing members of the Canadian Society of Plastic Surgeons in October of 2004.

Part 2 involved a second survey (the Canadian Plastic Surgery Workforce Survey) in the format of an electronic questionnaire that could be accessed from the Internet. Canadian plastic surgeons were solicited to complete the survey by means of e-mail or facsimile between December of 2004 and June of 2005. The facsimile and e-mail lists were generated from the Canadian Society of Plastic Surgeons membership list and from the individual plastic surgery training programs across Canada. Surgeons were contacted initially in December of 2004 and two subsequent reminders were sent to physicians who had not replied. Responses returned by June 30, 2005, were captured in an electronic database file. The file created by physicians completing the online questionnaire and the file created by the returned paper responses were merged to create a single database.

In part 3 of the study, the location of all Canadian trainees graduating between 1995 and 2005 was obtained from the Royal College of Physicians and Surgeons of Canada. The purpose was to ascertain the number of graduates that had left Canada to work in the United States or overseas.

Questionnaire Content

The first survey polled respondents for their opinions on the supply of plastic surgeons in their community by the following questions:

Do you think there are enough plastic surgeons in your community?
Is there currently a vacancy or active recruitment for a plastic surgeon in your area?
Do you feel that your hospital/provincial government would provide the resources for a new plastic surgeon?
Do you feel there is/will be a shortage of plastic surgeons in your province?
Should we be training more plastic surgeons in Canada?
Should we accept more foreign-trained plastic surgeons into Canada?

The second survey focused on three main areas: demographics, workload, and future plans. Physicians were asked to report their age, gender, training program, area of subspecialization, and practice location. Workload was assessed by polling hours of work per week including on-call, weeks worked per year, wait-list times, and the number of patient encounters. Physician distribution of time including nonclinical duties and time spent providing noninsured services was also solicited. Future plans of Canadian plastic surgeons were assessed by questions pertaining to planned age of retirement and plans for emigration.

SURVEY RESULTS

Response Rate

In 2004, the Royal College of Physicians and Surgeons of Canada listed 445 practicing plastic surgeons within Canada. Of these, 338 are members of the Canadian Society of Plastic Surgeons. In the initial component of the study, the first questionnaire was mailed to all Canadian Society of Plastic Surgeons members, and 143 responded with a single request, for a response rate of 42 percent (32 percent of practicing plastic surgeons).

In part 2 of the study, the second survey was sent to 331 Canadian Society of Plastic Surgeons members (e-mail and facsimile information was missing for eight members). Of these, 131 replied,

for an overall response rate of 40 percent (29 percent of practicing plastic surgeons).

Part 1

The first survey asked respondents to comment on their impression of the adequacy of the number of plastic surgeons in their community to fulfill the need for plastic surgery services. Seventy-eight percent of respondents to this survey stated that there are not enough plastic surgeons in their hospital/community, but only 25 percent of respondents felt that their government/hospital would provide the resources for another plastic surgeon. Fifty-four percent of respondents were actively recruiting for another plastic surgeon for a vacancy in their hospital/community. Eighty-nine percent felt that we should be training more plastic surgeons in Canada and 30 percent felt that more foreign-trained plastic surgeons should be recruited to work in Canada.

Part 2

The second survey (Canadian Plastic Surgery Workforce Survey) examined demographics, workload, and future plans. The mean age of respondents was 50 ± 10.8 years. The mean age of male respondents was 51 ± 11 years and that of female respondents was 45 ± 9 years. Thirty-four percent of respondents were older than 55 years (Fig. 1). The gender distribution was 85 percent male and 14 percent female, and one respondent did not specify gender. Eighty-four percent of respondents were trained in Canada. Six percent of respondents stated that they completed their plastic surgery residency outside of Canada and 10 percent did not specify their place of training. Forty-six percent of respondents did not report completing a fellowship, 42 percent reported they had completed one fellowship, and 12 percent stated they had completed two fellowships. Of those subspecialty trained, the majority of respondents completed extra training in the fields of hand/wrist/upper extremity (33 percent) and cosmetic surgery (24 percent), with a minority training in the fields of craniofacial surgery (14 percent), breast reconstruction and microsurgery (15 percent), burn reconstruction (7 percent), pediatric plastic surgery (3 percent), surgical education/research (3 percent), and Mohs surgery (1 percent).

Workload and Practice Profiles

Twelve percent of respondents stated that they worked in a rural setting and 88 percent stated that they worked in an urban setting. Twenty-three percent of respondents reside in one of Canada's three largest cities: Vancouver (5 percent), Toronto (13 percent), or Montreal (5 percent). The majority of respondents (68 percent) reside in Ontario and British Columbia (Fig. 2). There were no respondents from Prince Edward Island or Newfoundland. Eighty-seven percent of respondents work more than 50 hours per week including on-call (Fig. 3), and the mean number of patients seen per week was 88 ± 42 (range, 20 to 250 patients). On average, 15 ± 8 hours per week (range, 1.5 to 40 hours per week) were spent in the operating room, 8 ± 12 hours (range 0 to 80 hours) performing noninsured services, 13 ± 13 hours (range, 0 to 50 hours) in the clinic, 6 ± 4 hours (range, 0 to 16 hours) on

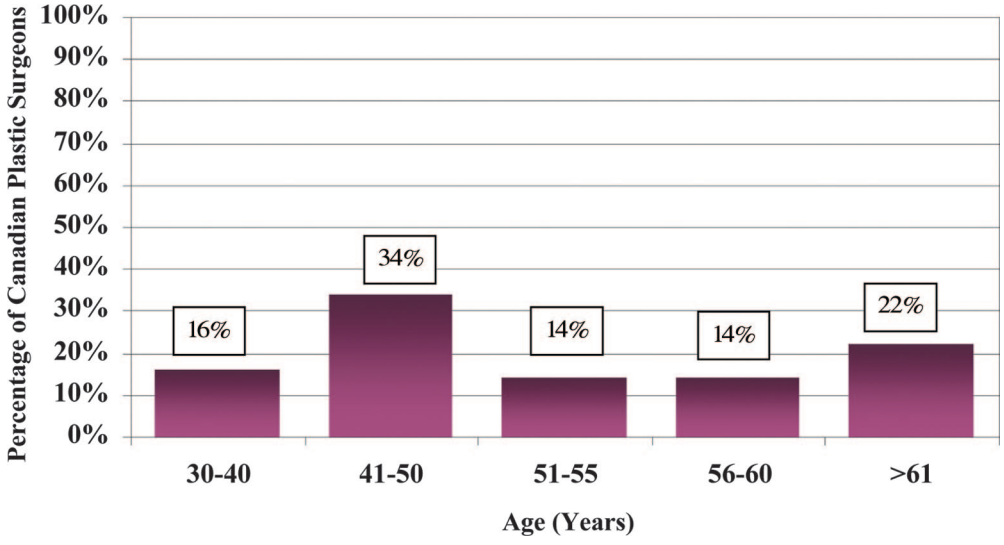

Fig. 1. Canadian Plastic Surgery Workforce Survey: age distribution.

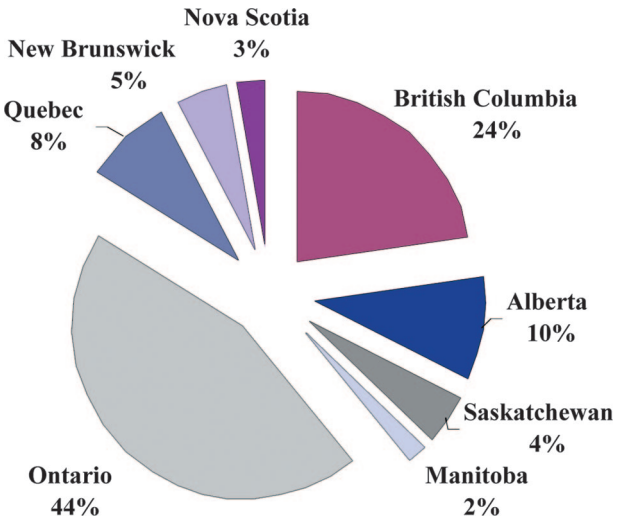

Fig. 2. Canadian Plastic Surgery Workforce Survey: respondents by province.

minor procedures, 5 ± 5 hours (range, 0 to 80 hours) teaching, and 5 ± 12 hours (range, 0 to 80 hours) performing research. Data regarding number of hours spent on-call and performing administrative duties were not collected. The mean wait-list time for an elective, noninsured, and urgent consultation was 32 ± 33 weeks (range, 2 to 200 weeks), 11 ± 11 weeks (range, 0 to 56 weeks), and 11 ± 17 days (range, 0 to 150 days), respectively. When wait-list time for an elective consultation was examined by province, Saskatchewan and New Brunswick have the highest and Manitoba, Alberta, and Ontario the lowest wait-list times (Fig. 4).

Nonresponders

Telephone contact information was available for 124 plastic surgeons that did not reply to the Canadian Plastic Surgery Workforce Survey. This represents 62 percent of the total number of nonresponders ($n = 200$). The offices of the nonresponders were contacted by telephone and surveyed for physician age, total years in practice, practice location, and university affiliation. The mean age of the nonresponders was 49.5 ± 8.9 years. The mean age of the responders was 50 ± 10.8 years. This difference was not a statistically significant difference when compared to the responders ($p = 0.5$). Nonresponders reported being in practice for a mean of 17.7 ± 9 years versus a mean time in practice of 16.7 ± 10.3 years for the responders ($p = 0.43$). Eighty-eight percent of the responders and 89 percent of the nonresponders worked in an urban setting ($p = 0.819$). Thirty-one percent of nonresponders had a university affiliation, whereas 63 percent of responders had a university affiliation ($p < 0.001$).

Part 3

The Royal College of Physicians and Surgeons of Canada provided us with a list of 179 Canadian-trained plastic surgery graduates who graduated between 1995 and 2005. Of these, 28 are now practicing in the United States and 14 are practicing in Saudi Arabia or Europe. This equates to approximately four graduates per year, or a 21 percent emigration rate per year.

Future Workforce Projections

The surveys conducted in this study focused on practicing Canadian Plastic Surgeons that are members of the Canadian Society of Plastic Surgeons. Twenty-four percent of Canadian Plastic

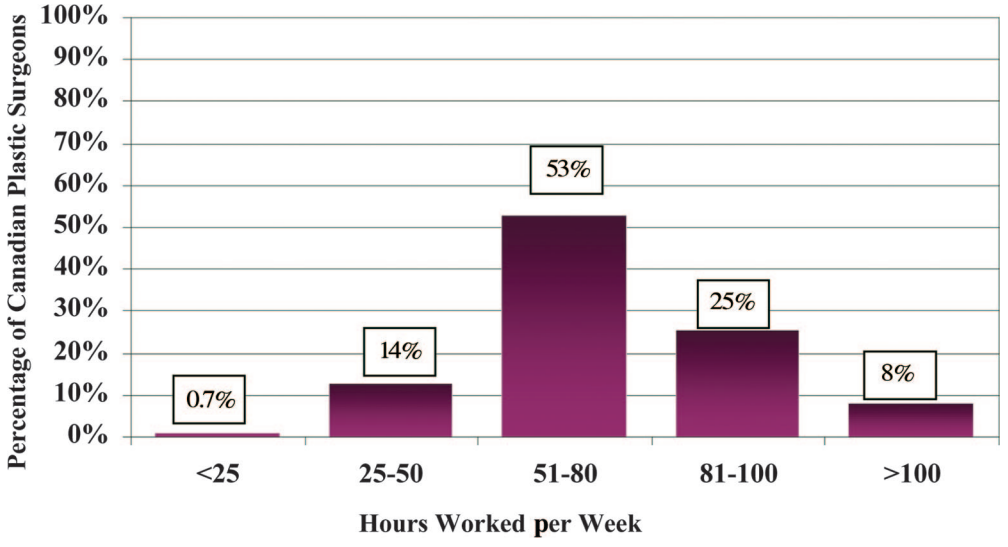

Fig. 3. Canadian Plastic Surgery Workforce Survey: hours worked per week.

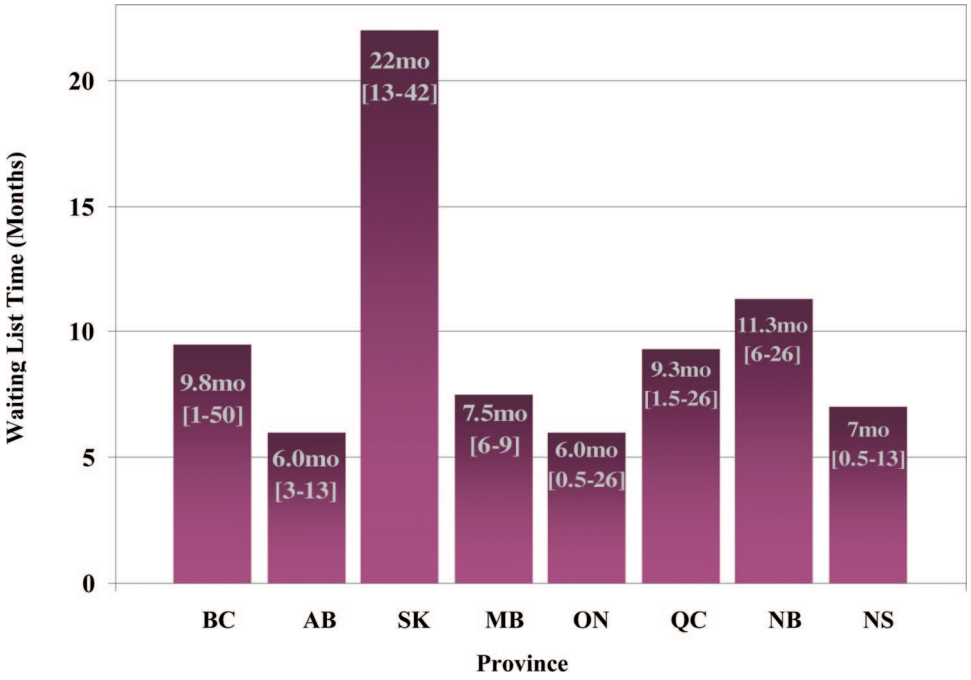

Fig. 4. Canadian Plastic Surgery Workforce Survey: wait-list times by province.

Surgeons are not members of the Canadian Society of Plastic Surgeons and were not contacted. Although our response rates were 42 percent for the first survey and 40 percent for the second survey, this in actual fact represents 32 percent and 29 percent of all Canadian plastic surgeons, respectively. The data generated in this study were extrapolated to the total number of Canadian plastic surgeons to make future projections; however, the small study population is a limitation when making more general inferences.

Respondents listed a mean planned age of retirement of 63 ± 6 years. In 2005, 28 percent of respondents stated that they were within 5 years of their planned retirement age. Three percent stated that they plan to leave Canada within the next 5 years. This equates to an overall attrition rate of 31 percent over the next 5 years. If this number (31 percent) is projected to our total workforce ($n = 445$), 138 plastic surgeons will exit the current workforce by 2010. If we assume the current number of plastic surgery graduates per year ($n = 19$) remains constant and all remain in Canada, we will add 95 new graduates to our workforce by 2010. There is therefore an expected decrease in our numbers from 445 in 2005 to 402 in the year 2010 (445 − 138 + 95), which equates to a 10 percent attrition rate (Table 1). If we apply the 21 percent per year emigration rate that we have seen in graduating Canadian plastic surgeons over the past 10 years, an additional 20 surgeons will be lost to emigration over the next 5 years, leaving us with 382 plastic surgeons in 2010, or a 14 percent attrition rate.

DISCUSSION

The results of this study indicate that there is a shortage of plastic surgeons in Canada. According to our data, the current wait-list time for a nonurgent plastic surgery procedure is 8 months. The average work week of the Canadian plastic surgeon is between 50 and 100 hours, with no evidence of decreased workloads for new graduating surgeons. By 2010, a further 10 percent decrease in our workforce is estimated if we apply the projections generated from this study to our current total number of plastic surgeons.

A recent survey[14] conducted by the College of Family Physicians of Canada, the Canadian Med-

Table 1. Predicting the Future: Changes in the Canadian Plastic Surgery Workforce by 2010

	2010
2005 workforce	445
28% retire	125
3% emigrate	13
No. of graduates over next 5 years	95
Total remaining	402
Canadian population in 2010	33,010,000
Plastic surgeons/population in 2010	1/82,000 = 1.2/100,000

ical Association, and the Royal College of Physicians and Surgeons of Canada yielded a 33.6 percent response rate from Canadian plastic surgeons. The data generated from this survey yielded results similar to those in our study. The survey indicated that Canadian plastic surgeons encounter a mean of 85 patients in a typical week (range, four to 250 patients) and work a mean of 57 hours per week excluding on-call and a mean of 31 hours of on-call time spent in direct patient care per month. Twenty-six percent of respondents stated that they had decreased the scope of their practice in the 2 years preceding the survey (2002 to 2004), and 33 percent stated that they planned to do this in the 2 years following the survey (2004 to 2006).

These numbers indicate that Canadian plastic surgeons are in high demand, work long hours, and are unable to see patients on an elective basis in a timely manner. The physician-to-population ratio is a crude measure of the balance between supply and demand. In 2005, the Canadian population was listed as 32 million by Statistics Canada,[15] and the plastic surgeon-to-population ratio was one per 72,000. Although this ratio falls within the target set in 1986 by the Canadian Society of Plastic Surgeons, the long hours worked by the average Canadian plastic surgeon and the long wait-list times for a consultation indicate that this ratio is inadequate. To maintain this ratio for 2010 (estimated population of 33 million), we need to increase the number of plastic surgery trainees by approximately 50 percent, assuming all graduates stay in Canada (Fig. 5). This equates to an additional 10 trainees per year.

This study has also identified an undersupply of plastic surgeons in rural areas. Approximately 9 million Canadians, or 30 percent of our population, reside in rural communities. According to our survey, only 12 percent of respondents stated that they practice in what they considered a rural location. This may reflect factors such as lifestyle, practice viability, or limited access to clinical facilities in these areas. We recommend the implementation of incentives such as retention bonuses, practice overhead support, retirement/pension plans, and spousal support to recruit plastic surgeons in rural communities within Canada. In addition, incorporation of mandatory "rural electives" to the training programs across Canada would be beneficial in order to increase resident exposure to the rural setting.

Debates continue regarding the optimal method for predicting the supply of and demand for physicians in the future.[16–20] Traditionally, two general approaches have been used to estimate the future demand of physicians. Cooper et al. are proponents of the demands-based model. In this model, past use of physician services is assessed, and attrition, physician productivity, technological trends, and changes in health care systems are monitored. Future need is predicted by projecting these factors forward. The needs-based model relies on expert opinion to estimate the number of

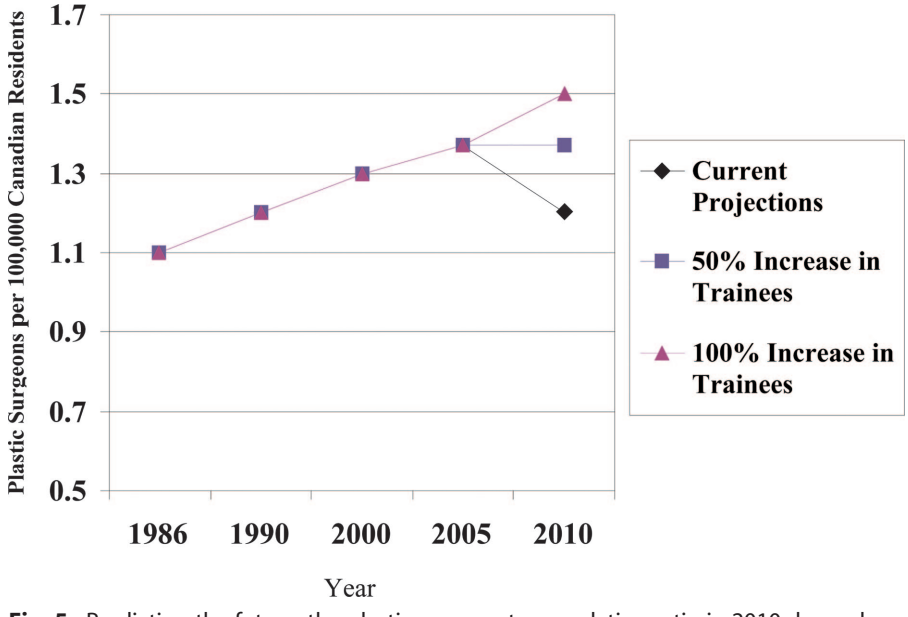

Fig. 5. Predicting the future: the plastic surgeon-to-population ratio in 2010 depends on increasing the number of plastic surgical trainees.

physicians needed to deliver necessary health services to the population.[21] This approach assumes that the relationship between physician supply, the delivery of services, and health outcomes may be determined and predicted through research.[22] Recently, a third model has evolved in which predictions are based on proposed benchmarks.[23,24] Systems or geographic areas with low health care expenditures and physician-to-population ratios that provide optimal health care are identified, and reform is based on such systems.

In Westernized countries, the plastic surgeon-to-population ratios are variable. It has been reported that the United States has a ratio of approximately one plastic surgeon per 50,000 population.[25] In Australia, France, and Sweden the ratio is approximately one per 80,000 and in Switzerland one per 58,000.[26,27] In the United Kingdom, there is a ratio of one plastic surgeon for 270,000 population, with a target recommended by the British Association of Plastic Surgeons of one per 100,000.[15,28] These apparently low figures for the United Kingdom may be explained, in part, by a system of training where house officers remain in subordinate positions for additional years before attaining consultant status.

These extreme variations are unexplained by known differences in population characteristics. The wide variation in physician supply across regions makes benchmarking an attractive strategy for workforce planning. Workforce studies that evaluate quality of care according to standardized outcome measures such as patient wait-list times and physician work hours are needed to make meaningful international comparisons. A geographic region with an efficiently sized workforce that delivers high-quality care could then be chosen as the standard from which to base projections.

At the current time, the issue of supply of specialists, and specifically plastic surgeons within Canada, is not on the platform of federal and provincial policymakers. Historically, the government has waited for overwhelming evidence of public distress and/or a firm professional consensus before acting to change the number of physicians. One must keep in mind the length of training required to become a plastic surgeon and the inevitable lag time between the implementation of policy interventions and resultant changes in the number of physicians. Until now, experts and professional groups have not examined our projected numbers and the adequacy of our current numbers to meet the needs of the Canadian population.

We have attempted to address this issue; however, it must be kept in mind that this study has several limitations. Most importantly, we were able to gather information on only a small subset of the total Canadian plastic surgery workforce. Although projections are important for future workforce planning, they have been based on data gathered from 29 percent of all plastic surgeons in Canada. When basing projections on a small response rate, it is important to compare the responders to the nonresponders to address nonresponder bias. Sixty-two percent of the nonresponders to the Canadian Plastic Surgery Workforce Survey were contacted. When this population was compared with the responders, the groups did not differ significantly with respect to age, practice location, or years in practice. However, there was a significantly larger proportion of responders that had a university affiliation. Practice setting may affect perception of workforce need, and the large proportion of responders based in academic centers may have affected the results of the survey. Despite these limitations, we have revealed that the age of our respondents can be extrapolated to the nonresponders, and in the coming 5 years we will be facing a shift of a large proportion of Canadian plastic surgeons toward retirement.

CONCLUSIONS

This study has identified serious concerns regarding the current and projected number of plastic surgeons in Canada. A sustained, national approach to plastic surgery manpower is needed to ensure adequate patient access to plastic surgery services. Recommendations include increasing the number of Canadian plastic surgery trainees by an additional 50 percent, offering incentives for graduates to stay in Canada, and the possible recruitment of more foreign-trained plastic surgeons to practice within Canada.

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DISCLOSURE

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this article.

REFERENCES

1. World Health Report. *Health Systems: Improving Performance.* Geneva, Switzerland: World Health Organization, 2000.

2. Barer, M. L., and Stoddart, G. L. Toward integrated medical resource policies for Canada. Report prepared for the Federal/Provincial/Territorial Conference of Deputy Ministers of Health, 1991.
3. Goldacre, M. Planning the United Kingdom's medical workforce. *B.M.J.* 316: 1846, 1998.
4. Brooks, P. M., Lapsley, H. M., and Butt, D. B. Medical workforce issues in Australia: Tomorrow's doctors—Too few, too far. *Med. J. Aust.* 179: 206, 2003.
5. McGrath, M. H. Presidential address: Plastic surgical workforce. Too many or too few? *Ann. Plast. Surg.* 42: 349, 1999.
6. Sommerlad, B. C. Plastic surgery in the UK and the USA: Comparisons and contrasts—Some thoughts for the future in the UK. *Br. J. Plast. Surg.* 52: 583, 1999.
7. Blumenthal, D. New steam from an old cauldron: The physician-supply debate. *N. Engl. J. Med.* 350: 1780, 2004.
8. Cooper, R. A. There's a shortage of specialists: Is anyone listening? *Ac. Med.* 77: 761, 2002.
9. Rivo, M. L., and Kindig, D. A. A report card on the physician workforce in the United States. *N. Engl. J. Med.* 334: 892, 1996.
10. Tarlov, A. R. The increasing supply of physicians, the changing structure of the health services system, and the future practice of medicine. *N. Engl. J. Med.* 308: 1235, 1983.
11. Schwartz, W. B., and Mendelson, D. N. No evidence of an emerging physician surplus: An analysis of change in physicians' work load and income. *J.A.M.A.* 263: 557, 1990.
12. Schwartz, W. B., Sloan, F. A., and Mendelson, S. N. Why there will be little or no physician surplus between now and the year 2000. *N. Engl. J. Med.* 318: 892, 1988.
13. Australian Medical Workforce Advisory Committee and Australian Institute of Health and Welfare. Medical workforce supply and demand in Australia: A discussion paper, AMWAC report 1998.8. AIHW Catalogue no. HWL 12, Sydney, Australia, 1998.
14. CFPC/CMA/RCPSC National Physician Survey Database, 2004. Available at: http://www.cfpc.ca/nps/English/home. asp. Accessed February 18, 2006.
15. Statistics Canada. Available at: http://www40.statcan.ca/l01/cst01/demo02.htm?sdi=population. Accessed December 15, 2005.
16. Council on Graduate Medical Education. Evaluation of specialty physician workforce methodologies: Resource paper. Washington, D.C.: Council on Graduate Medical Education, September 2000.
17. Cooper, R. A., Getzen, T. E., and Laud, P. Economic expansion is a major determinant of physician supply and utilization. *Health Serv. Res.* 38: 675, 2003.
18. Cooper, R. Perspectives on the physician workforce to the year 2020. *J.A.M.A.* 274: 1534, 1995.
19. Cooper, R., Laud, P., and Deitrich, C. Current and projected workforce of nonphysician clinicians. *J.A.M.A.* 280: 788, 1998.
20. Cooper, R. A., Getzen, T. E., McKee, H., et al. Economic and demographic trends signal an impending physician shortage. *Health Aff.* 21: 140, 2002.
21. Politzer, R. M., Gamliel, S., Cultice, J., et al. Physician workforce projections: Too many or just right? *J.A.M.A.* 275: 685, 1996.
22. Wennberg, J. E. Outcomes research, cost containment, and the fear of health care rationing. *N. Engl. J. Med.* 323: 1202, 1990.
23. Grumbach, K., and Lee, P. R. How many physicians can we afford? *J.A.M.A.* 265: 2369, 1991.
24. Goodman, D. C., Fisher, E. S., Bubolz, T., et al. Benchmarking the US physician workforce: An alternative to needs-based or demands-based planning. *J.A.M.A.* 276: 1811, 1996.
25. Sommerland, B. C. Plastic surgery in the UK and the USA: Comparisons and contrasts. Some thoughts for the future in the UK. *Br. J. Plast. Surg.* 52: 583, 1999.
26. Petit, F., Magalon, G., and Raulo, Y. Démographie médicale et chirurgie plastique en France: Situation actuelle et prévisions. *Ann. Chir. Plast. Esthet.* 45: 69, 2000.
27. Petit, F., Magalon, G., and Raylo, Y. Répartition géographique et densité des chirurgiens plasticiens en France. *Ann. Chir. Plast. Esthet.* 45: 494, 2000.
28. Report by the Royal College of Surgeons of England: The surgical workforce in the New NHS. London, England: The Royal College of Surgeons of England, 2001. Available at: www.rcseng.ac.uk. Accessed February 18, 2006.