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Kevin M. Gorey
University of Windsor

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Associations of Physician Supplies With Breast Cancer Stage at Diagnosis and Survival in Ontario, 1988 to 2006

Kevin M. Gorey, PhD, MSW[1], **Isaac N. Luginaah, PhD**[2], **Eric J. Holowaty, MD**[3], **Karen Y. Fung, PhD**[4], and **Caroline Hamm, MD**[5]

[1] School of Social Work, University of Windsor, Windsor, Ontario, Canada

[2] Department of Geography, University of Western Ontario, London, Ontario, Canada

[3] Division of Preventive Oncology, Cancer Care Ontario, Toronto, Ontario, Canada

[4] Department of Mathematics and Statistics, University of Windsor, Windsor, Ontario, Canada

[5] Clinical Trials and Research, Windsor Regional Cancer Center, Windsor, Ontario, Canada

Abstract

BACKGROUND—The authors examined whether the supply of primary care physicians had protective effects on breast cancer stage and survival in Ontario and whether supply losses during the 1990s were associated with diminished protection.

METHODS—Random samples of the Ontario Cancer Registry, respectively, provided 879 women and 951 women who were diagnosed with breast cancer between 1988 and 1990 (followed until 1996) and 1998 and 2000 (followed until 2006), respectively. Active physician supply data (1991 and 2001) joined to each woman's census division of residence was taken from the Scott's Medical Database.

RESULTS—Protective thresholds were observed among the earlier cohort for supplies of general practitioners (7 per 10,000 population) and supplies of obstetricians/gynecologists (6 per 100,000 population) at or above which women with breast cancer were significantly more likely to have been diagnosed with localized disease and to have survived for ≥5 years. These protective effects seemed generally attenuated among the more recent cohort. The risk of living in primary care physician-undersupplied areas increased significantly between 1991 and 2001 (10%–30%), and such physician supply losses were associated with reduced cancer care protection, including less prevalent early diagnoses (odds ratio [OR], 1.60; 95% confidence interval [95% CI], 1.00–2.58) and lower 5-year survival rates (OR, 1.62; 95% CI, 1.03–2.55).

CONCLUSIONS—Primary care physician supplies appeared to matter very much in the effective provision of cancer care in Canada. Community healthcare service endowments that include adequate physician supplies may be particularly critical to the performance of a healthcare system such as that in Canada, which provides universal accessibility to medically necessary care.

Corresponding author: Kevin M. Gorey, PhD, MSW, School of Social Work, University of Windsor, 401 Sunset Avenue, Windsor, Ontario, N9B 3P4, Canada; Fax: (519) 973-7036; gorey@uwindsor.ca.

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Keywords

physician supplies; primary care; general practitioners; family physicians; obstetrician/gynecologists; healthcare service endowments; breast cancer; stage at diagnosis; survival; Ontario; Canada

Research into Canada's physician supply problem, whether it is real or merely perceived, has been nearly exclusively descriptive, with opinionated and often self-interested advocates typically debating the possible effects of various identified supply shortages. However, what are the actual sentinel, population-level health effects of any such developing shortages? Clearly, the rational development of evidence-based physician supply policies will require not only knowledge regarding prevalent changes in primary care and specialist physician supplies and practice patterns but also knowledge concerning the effects that any such changes may have on key population health indicators. Essentially, an answer still is needed to this field's "so what?" question. Much already is known regarding physician supply trends in Canada, but very little is known regarding important physician supply/population health relations. The objective of this study was to begin to fill this critical policy-relevant knowledge gap.

Primary care physician supplies have been associated consistently and significantly with improved health outcomes (all-cause, cancer, heart disease, stroke, and infant mortality) over the past generation in the United States.[1] Several US studies focused on a sentinel health indicator of great public health significance—breast cancer—and observed that community, typically county-level, primary care physician supplies were associated significantly with more prevalent screening mammography, more localized disease at diagnosis, and longer breast cancer survival.[2–5] These advantages appeared to be fairly specific to primary care, and overall physician supplies generally were not predictive. We are not aware of any such Canadian physician supply/cancer care knowledge. It certainly appears plausible that, in a single-payer, universally accessible healthcare system such as that in Canada, community healthcare service endowments, a key element of which is physician supply, would be critical. In fact, having consistently observed that personal economic resources explain very little of the regional or temporal variability in Canadian cancer care, although they are highly predictive in the United States,[6–11] our research group theorized that key community-level resources, such as physician supplies and other healthcare resources, would be even more predictive in Canada. Others have theorized that good primary care predicts not only more effective prevention but also more effective referral and continuity of care.[12–14] We therefore hypothesized the following: 1) Primary care physician supplies in Canada are associated significantly with localized breast cancer at the time of diagnosis and with more prevalent 5-year breast cancer survival (Hypothesis 1). 2) Regions in which primary care physician supplies had decreased significantly during the 1990s were significantly disadvantaged on both breast cancer stage at diagnosis and survival (Hypothesis 2).

MATERIALS AND METHODS

A study of female breast cancer survival in Ontario provided population-based data for this retrospective cohort analysis of women ages ≥25 years who were diagnosed in the late 1980s (January 1, 1988 to December 31, 1990) or in the late 1990s (January 1, 1998 to December 31, 2000; International Classification of Diseases, 9th Edition code 174).[10,11] The study originally was powered to detect a 15% difference in the survival rate between 3 socioeconomic strata within 3 types of places ($\alpha = .05$ [2-tailed] and power $[1 - \beta] = .80$).[15] Comprehensive and valid Ontario Cancer Registry (OCR) samples, stratified by 3 unique

places, were selected randomly from the greater metropolitan Toronto (GMT) megalopolis, a relatively small metropolitan area (Windsor-Essex County) and small rural places with populations of <10,000 and population densities <400 individuals per km^2.[16–25] Summary stage at the time of diagnosis was reliably abstracted from hospital and physician office-based patient charts to enhance the OCR database.[26,27] Cases were joined to a census tract-based measure of socioeconomic status (prevalence of "low-income" households based on census subdivisions in rural areas) to account in part for personal economic status.[19–22,28–30] Respective samples from the 1980s and 1990s samples of 879 and 951 invasive breast cancer cases were followed until January 1, 1996 and January 1, 2006, respectively. Organized breast cancer screening began in Canada in 1988,[31] so systemic screening access differences are not likely to confound any cohort effects.

On the basis of the Scott's Medical Database, Ontario active physician supply counts for the years 1991 and 2001 (and 2006 for descriptive purposes) were obtained from the Canadian Institute for Health Information (CIHI). A series of interagency validity checks (CIHI and Scott's Directories) and CIHI edit checks ensured that error rates were almost nonexistent for all variables (only 0.2% for primary care physicians and specialists).[32] Each physicians' preferred business mailing address served as a proxy for their practice location. Primary care physicians or general practitioners (GPs) (physicians without a current medical specialty certified in Canada) included family medicine and emergency family medicine physicians. In addition, because they often provide primary care for women, the independent effects of those whose current medical specialty was obstetrics and gynecology (OB/GYN) were explored. Rates per 10,000 population for GPs and per 100,000 for OB/GYN specialists were calculated for Ontario's 49 census divisions (CD), which correspond to counties, districts, or regional municipalities.[19,20] When the original rural sample of breast cancer cases was reaggregated by CDs, it formed 2 rather distinct groups: places in which the majority reside in rural areas, as originally defined (rural), and other places, largely representative of the exurban fringes of Ontario's other metropolitan areas (other). The predictive importance of these 2 groups was explored in the current study. Maximum likelihood logistic regression models were used to estimate the respective associations of 1991 and 2001 physician supplies with stage at diagnosis (localized vs regional or metastasized disease) and 5-year survival of patients with incident breast cancer diagnosed between 1988 and 1990 and between 1998 and 2000. Age-adjusted and income-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were estimated from regression statistics.[33] Because preliminary analyses suggested probable threshold effects, each incrementally higher physician supply category was compared with the average effect of the previous categories. In addition to maximizing statistical power, using reverse Helmert contrasts allowed for the identification of any such thresholds.[33,34] Physician supply categories (physician integer increments per population standards) were constructed to maximize the comparability of the study's 2 cohorts with each other as well as with previously studied cohorts and, thus, to maximize the intuitive policy interpretation of the findings.

RESULTS

Physician supply rate parameters are displayed in Table 1. First, the loss that the province of Ontario experienced during the 1990s of approximately 1.5 physicians per 10,000 population appears to have been maintained, essentially, up to the present. Second, it appears that this loss was nearly exclusively a loss of GPs. Specialist physician supplies did not change significantly, except in the Windsor metropolitan area, which lost approximately 1 such specialist per 10,000 population between 1991 and 2006. Third, the supply of GPs in rural areas, which already were relatively undersupplied in 1991, were unaltered for the most part during this era. Fourth and finally, on average, most nonrural areas of the province

lost approximately 1 OB/GYN specialist physician per 100,000 population. However, the overall supply rates varied widely across the province's 49 CDs or regions by a factor of 3, for example, for GPs (5 to 15 per 10,000 population) and by a factor of 10 for OB/GYN specialists (0 to 10 per 100,000 population) in 2001. The covariance of such physician supply variance with cancer care variance is examined below.

Ample support for Hypothesis 1 was observed among the late 1980s cohort (Table 2). Threshold effects were observed for both GPs (≥7 per 10,000 population) and OB/GYN specialists (≥6 per 100,000 population). Patients with breast cancer in areas that enjoyed such supplies were significantly more likely to be diagnosed with localized disease (GPs: OR, 1.58 [95% CI, 1.12–2.24] and OB/GYNs: OR, 1.59 [95% CI, 1.12–2.26]). In addition, the practically significant physician supply/5-year survival associations approached statistical significance (GPs: OR, 1.30 [95% CI, 0.96–1.76] and OB/GYNs: OR, 1.22 [95% CI, 0.83–1.79]). A generally attenuated and, for the most part, not statistically significant pattern was observed among the late 1990s cohort. It appeared that GP supply losses may have been large enough to diminish the overall population preventive impact of GPs on breast cancer care. The exception was that the highly significant OB/GYN supply/breast cancer survival effect was even larger than it had been a decade previously (OR, 1.99; 95% CI, 1.22–3.23). Perhaps when GP supplies diminish, certain specialists, such as OB/GYNs, increasingly fill primary care gaps.

The risk of living in undersupplied areas increased significantly during the 1990s: <7 GPs per 10,000 population (2001/1991 age-adjusted rate ratio [RR], 0.597/0.452 = 1.32; 95% CI, 1.21–1.44) and <6 OB/GYNs per 100,000 population (2001/11991 age-adjusted RR, 0.800/0.732 = 1.09; 95% CI, 1.02–1.14). No other physician supplies (additional primary care physicians [GP or OB/GYN] above identified thresholds, total physicians, or other specialists) added significantly to the explanatory power of any of the displayed models.

Observational support for Hypothesis 2 is displayed in Table 3. Women who were diagnosed with breast cancer in the late 1990s, who were followed until 2006, and who lived in regions in which primary care physician supplies (GPs and OB/GYNs) had decreased by <1 physician per 10,000 population during the 1990s were significantly more likely to be diagnosed with localized disease (OR, 1.60; 95% CI, 1.00–2.58) and to survive for >5 years (OR, 1.62; 95% CI, 1.03–2.55] than their counterparts in regions that experienced greater losses. After physician supply variables were accounted for, place (greater metropolitan Toronto, Windsor, rural, or other places), per se, did not enter any of the regression models.

DISCUSSION

In this retrospective cohort study, we observed significant threshold effects for GPs (7 per 10,000 population) and OB/GYNs (6 per 100,000 population) at or above which women with breast cancer were significantly more likely to have been diagnosed with localized disease and to have survived for ≥5 years. In addition, in an era of increased specialization, the evidence-based risk of living in such undersupplied areas increased significantly during the 1990s. The respective GP and OB/GYN 2001/1991 undersupply RRs were 1.32 and 1.09. This study also demonstrated that primary care physician losses during the 1990s were associated with significantly reduced cancer care protections. Consistent with this field's historic-theoretical context,[12–14] this study's physician supply stage and stage-adjusted physician supply/survival associations implicate both preventive effects and treatment effects. It appears likely that primary care physicians support more effective breast cancer screening as well as more effective initial and adjuvant treatment, most likely through their brokering of more effective specialist referrals, treatment advocacy, and ongoing follow-up.

Such clearly identified physician supply/health threshold effects sentinel policy hope that identified physician undersupplies can be rectified through rational, cost-effective planning. That is, beyond a certain necessary investment in provincial and national healthcare, including physician supplies, additional investments most likely will not necessarily pay greater population health dividends. However, we ought to continue to work toward building knowledge that allows us to identify and then make such necessary investments.

An exemplary look at a place that was identified clearly as experiencing a primary care physician shortage—Windsor/Essex County—may be instructive. During the 1990s, the Windsor metropolitan area moved from an evidence-based, adequate GP supply of 7 per 10,000 population in 1991 to only 5.8 per 10,000 population in 2001. With a population of 390,500 in 2001, 47 additional GPs would be needed to rectify the shortage. In fact, half of that shortage already had been filled by 2006. So, it could be estimated rationally and empirically that, at least in terms of maximizing cancer control and care in the area, approximately 23 more GPs would be needed. The similarly computed OB/GYN estimate would be 4 to 5 additional OB/GYNs. In addition to providing additional evidence for decision-making and policy planning, such reasonable estimates also may serve to direct the vaguer emotional responses that understandably sometimes accompany advocacy in this field.

The findings of the current study generally were consistent with the only other Canadian provincial study of which we are aware that explored a population-based physician supply/health relations.[35] Notwithstanding its potential limitations (it was based on a cross-sectional assumption of a linear physician supply/health outcome relation, it was not adjusted for socioeconomic status, and it focused on mortality, which potentially confounded incidence and survival), the authors of that study observed modest primary care physician and cardiologist supply associations with cardiac morbidity, but not mortality. Perhaps not surprisingly, because they studied a different area of medical care—cardiovascular health services—those authors observed a different pattern of physician supply/population health relations than we observed by studying breast cancer care. There appear to be obvious policy-planning benefits for future, similar studies of primary and diverse specialist physician care across other prevalent health problems and healthcare domains.

Limitations

This study's sample of women with breast cancer is not necessarily representative of the province of Ontario as a whole, and its physician supply/cancer care findings may not be generalizable to all of its diverse places. Our original Ontario sampling frame randomly selected individuals from purposively diverse and potentially policy-important places, over-sampling large (Toronto) and small (Windsor) urban and rural places. Admittedly, our findings are most generalizable to such places. It should be noted, however, that, after accounting for key elements of health-care service endowments (that is, physician supplies), place, per se, did not seem to matter in any of this study's analytic models. And because this study systematically replicated established physician supply trends in Ontario (increased specialization with identifiable geographic areas of undersupply), it did appear to be closely representative of the province's population of active physicians.[36,37] The physician counts in the current study were just that: "head counts" of active physicians. That approach conceivably may have been problematic, because it did not allow for the estimation of full-time physician equivalents, a measure of physician workload. In fact, it has been demonstrated that head-count data result in Canadian physician/population ratios that are overestimates of the truth; however, it also has been demonstrated that such overestimation is the least problematic in Ontario (5%–10%).[38] Any such slight overestimation could be accounted for easily in planning future physician supplies.

The measures of physician supply that were used in the current study were CD aggregates and, thus, did not directly examine individual physician-patient relationships. However, those measures were conceived as proxies of community-level phenomena, that is, of regional healthcare service endowments, and we believe that tentative, population-level, policy-relevant inferences may be drawn most appropriately from this study, although any clinically relevant inferences made concerning the behaviors of physician's themselves are thought of best as screened hypotheses that remain for future research testing. Finally, although this study was able to account for several important factors (age, income, place, and disease stage at diagnosis), it could not account for notable others such as marital status and race/ethnicity. However, previous studies by our research group and others[7–10,39,40] have indicated consistently that marital status and race/ethnicity are cancer care gradients that tend to be quite steep in the United States tend to be nil to null in Canada. Therefore, we believe that such factors and their correlates most likely are not potent alternative explanations for the central physician supply/cancer care findings in the current study.

In conclusion, primary care physician supplies seem to matter very much in the effective provision of cancer care in Canada. Community healthcare service endowments that include adequate physician supplies may be particularly critical to the performance of a healthcare system such as that in Canada, which provides universal accessibility to medically necessary care.

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Table 1

Supply Rates of General Practitioner and Specialist Physicians by Place in Ontario

	Rate per 10,000 Population			RD	
Physician Type/Place*	**1991**	**2001**	**2006**	**2001–1991**	**2006–1991**
All physicians	19.7	18.1	18.2	−1.6	−1.5
GMT	22.1	19.6	19.4	−2.5	−2.7
Windsor	14.0	11.9	12.2	−2.1	−1.8
Rural	10.6	10.4	11.0	−0.2	0.4
Other	20.1	18.8	19.1	−1.3	−1.0
General practitioners	10.2	8.5	8.7	−1.6	−1.5
GMT	11.1	8.8	8.8	−2.3	−2.3
Windsor	7.0	5.8	6.4	−1.2	−0.6
Rural	8.1	7.8	8.3	−0.3	0.2
Other	10.1	8.7	8.9	−1.4	−1.2
Specialist physicians	9.5	9.6	9.6	0.1	0.1
GMT	11.0	10.8	10.6	−0.2	−0.4
Windsor	7.0	6.1	5.8	−0.9	−1.2
Rural	2.5	2.6	2.7	0.1	0.2
Other	10.0	10.2	10.2	0.2	0.2
	Rate per 100,000 Population				
OB/GYN specialists	6.4	5.6	5.6	−0.8	−0.8
GMT	7.0	6.1	6.1	−0.9	−0.9
Windsor	5.5	4.9	4.8	−0.6	−0.7
Rural	1.6	1.4	1.9	−0.2	0.3
Other	7.2	6.1	6.0	−0.9	−0.8

RD indicates rate difference; GMT, Greater Metropolitan Toronto; OB/GYN, obstetricians and gynecologists.

*GMT includes the city of Toronto and the regional municipalities of Peel, York, Durham, and Halton. Windsor is comprised of Essex County, including the city of Windsor. The rural population includes the 20 of 49 Ontario census divisions in which the majority reside in Statistics Canada-defined rural areas. Other places are diverse, but their populations are represented predominantly by other Ontario metropolitan areas with medical schools (Ottawa, Hamilton, London, Kingston, Sudbury, and Thunder Bay).

Table 2

Associations of the Supply of General Practitioners and Obstetrician/Gynecologists With Localized Breast Cancer Stage at Diagnosis and 5-year Survival in Ontario*

	1988–1990 Incidence Cohort			1998–2000 Incidence Cohort		
Physicians per 10,000 Population	**No.**	**OR†**	**95% CI**	**No.**	**OR†**	**95% CI**
General practitioners						
Associations with localized breast cancer at diagnosis‡						
<7.0	398	1.00	—	568	1.00	—
7.0–7.9	126	1.58	1.12–2.24	72	1.27	0.74–2.18
8.0–8.9	70	1.09	0.68–1.74	112	1.12	0.69–1.83
9.0–10.9	81	1.26	0.72–2.21	24	1.21	0.48–3.03
≥11.0	204	1.58	0.92–2.73	175	1.11	0.45–2.76
Associations with 5-y breast cancer survival						
<7.0	398	1.00	—	568	1.00	—
≥7.0	481	1.30	0.96–1.76§	383	1.30	0.92–1.85
Physicians per 100,000 Population						
OB/GYN specialists						
Associations with localized breast cancer at diagnosis‡						
<3.0	137	1.00	—	190	1.00	—
3.0–4.9	142	0.92	0.56–1.50	547	0.78	0.55–1.12
5.0–5.9	365	1.16	0.74–1.81	25	1.09	0.46–2.59
6.0–7.9	32	1.59	1.12–2.26	9	1.74	0.35–8.70
≥8.0	203	1.82	0.80–4.14	180	0.82	0.47–1.44
Associations with 5-y breast cancer survival						
<6.0	644	1.00	—	762	1.00	—
≥6.0	235	1.22	0.83–1.79	189	1.99	1.22–3.23§

No. indicates the number of women with incident breast cancer; OR, odds ratio; 95% CI, 95% confidence interval; OB/GYN, obstetricians and gynecologists.

*Women who were diagnosed between 1988 and 1990 and between 1998 and 2000 were followed until January 1, 1996 and January 1, 2006, respectively. All effects were adjusted for age and income.

†An OR of 1.00 is the baseline.

‡Each physician supply category was compared with the average effect of all previous categories.

§ 90% CI does not include the null (1.00–1.68; $P < .10$).

Table 3

Associations of Changes in the Supply of Primary Care Physician With Localized Breast Cancer Stage at Diagnosis and 5-year Survival in Ontario*

		1998–2000 Incidence Cohort		
Changes in the Supply of Primary Care Physician, 1991 to 2001	**Median Change per 10,000 Population**	**No.**	**OR†**	**95% CI**
Association with localized breast cancer at diagnosis‡				
Decreased ≥2.0	−2.8	244	1.00	—
Decreased 1.0–1.9	−1.2	480	1.54	0.83–2.83
Decreased 0.1–0.9	−0.4	158	1.60§	1.00–2.58§
Increased ≥0.1	0.7	69	1.57	0.72–3.45
Association with 5-y breast cancer survival				
Decreased ≥1.0	−1.3	724	1.00	—
Decreased <1.0	−0.2	227	1.62§	1.03–2.55§

Primary care indicates general practitioners plus obstetrician/gynecologists; No., the number of women with incident breast cancer; OR, odds ratio; 95% CI, 95% confidence interval.

*Women who were diagnosed between 1998 and 2000 were followed until January 1, 2006. All effects were adjusted for age, income, and the baseline (1991) supply of primary care physicians. The survival effect also was adjusted for stage.

†An OR of 1.00 is the baseline.

‡Each physician supply category was compared with the average effect of all previous categories.

§Statistically significant (P <.05).