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The supply of physicians and care for breast cancer in Ontario and California, 1998 to 2006

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Introduction: We examined the differential effects of the supply of physicians on care for breast cancer in Ontario and California. We then used criteria for optimum care for breast cancer to estimate the regional needs for the supply of physicians.
Methods: Ontario and California registries provided 951 and 984 instances of breast cancer diagnosed between 1998 and 2000 and followed until 2006. These cohorts were joined with the supply of county-level primary care physicians (PCPs) and specialists in cancer care and compared on care for breast cancer.
Results: Significant protective PCP thresholds (7.75 to ≥ 8.25 PCPs per 10 000 inhabitants) were observed for breast cancer diagnosis (odds ratio [OR] 1.62), receipt of adjuvant radiotherapy (OR 1.64) and 5-year survival (OR 1.87) in Ontario, but not in California. The number of physicians seemed adequate to optimize care for breast cancer across diverse places in California and in most Ontario locations. However, there was an estimated need for 550 more PCPs and 200 more obstetrician–gynecologists in Ontario's rural and small urban areas. We estimated gross physician surpluses for Ontario's 2 largest cities.
Conclusion: Policies are needed to functionally redistribute primary care and specialist physicians. Merely increasing the supply of physicians is unlikely to positively affect the health of Ontarians.

Introduction : Nous avons étudié les effets différentiels de l'offre de médecins sur le soin du cancer du sein en Ontario et en Californie. Nous avons ensuite utilisé les critères de soin optimal du cancer du sein pour estimer les besoins régionaux en médecins.
Méthodes : Les registres de l'Ontario et de la Californie ont fourni 951 et 984 cas de cancer du sein diagnostiqués entre 1998 et 2000 et suivis jusqu'en 2006. Ces cohortes ont été reliées à l'offre de médecins de première ligne (MPL) et de spécialistes en soin du cancer au niveau des comtés et comparées en termes de soin du cancer du sein.
Résultats : On a observé des seuils protecteurs importants de MPL (7,75 à ≥ 8,25 MPL pour 10 000 habitants) dans le cas du diagnostic du cancer du sein (rapport de cotes [RC] 1,62), de la réception d'une radiothérapie d'appoint (RC 1,64) et de la survie à 5 ans (RC 1,87) en Ontario, mais non en Californie. Le nombre de médecins semblait suffisant pour optimiser le soin du cancer du sein à divers endroits en Californie et à la plupart des endroits en Ontario. On a toutefois estimé qu'il fallait 550 MPL de plus et 200 obstétriciens-gynécologues de plus dans les régions rurales et les petites villes de l'Ontario. Nous avons estimé l'excédent brut en médecins dans les deux plus grandes villes de l'Ontario.
Conclusion : Des politiques s'imposent pour redistribuer de façon fonctionnelle les médecins de première ligne et les médecins spécialistes. Il y a peu de chances que le simple fait d'augmenter l'offre de médecins ait un effet positif sur la santé de la population de l'Ontario.

Introduction

Social policy analysts in Canada and the United States have identified apparent problems related to the supply of physicians.[1–4] Canadian advocates

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have called for more physicians overall, and their counterparts in the US have called for more primary care physicians (PCPs). What are the population health effects of such physician shortages, if indeed they do exist? How strong are the relations between physician supply and sentinel health indicators in Canada and the US? Valid answers to such questions are needed to help inform policies on physician supply in both countries. This observational study makes opportunistic use of surveillance systems on physician supply and cancer in Canada and the US. It explores the effects of one critical health care resource, physician supply,[5,6] on one important aspect of health care, cancer care, in Ontario and California.

A number of within-country analyses of physician supply and cancer care have focused on the sentinel health indicator of breast cancer care.[7–9] The supply of PCPs was directly associated with timely diagnosis and survival in Canada and the US, but stronger associations were observed in Canada.[10–14] Neither overall supply of physicians nor the supply of specialists were associated with breast cancer care in either country after the supply of PCPs was accounted for. These findings were systematically replicated in the US for another important health indicator, care for colon cancer.[15,16] We are aware of only one between-country analysis of physician supply and cancer care.[17] The authors observed a direct association between PCP supply and adjuvant chemotherapy, as well as a direct association between gastroenterologist supply and early diagnosis and survival in Ontario, but not in California. The authors suggested that, first, more health care resources, including more PCPs, would probably not fix the central health care problem in the US (that so many people do not have access). Second, in Canada, where health care resources seem to matter more to the health of the population, research to identify specific areas of undersupply of physicians is needed.[17] The present study responds with an examination of the differential effects of supply of physicians (PCPs and key specialists) on care for breast cancer in Ontario and California.

It seems plausible that adequate supplies of PCPs and key specialists could positively affect the availability, accessibility and continuity of breast cancer screening, treatment and survival.[18–23] This study aims to observe independent relations between physician supply and breast cancer care in Ontario and California. Accounting for income is probably critical, because income has consistently explained little of the variability in Canadian cancer care, and it has been highly predictive of cancer care in the US.[14,24–28] The effects of the supply of PCPs have also been moderated by region and by characteristics of places within regions, such as urbanity.[13,29–32] Gorey and colleagues have theorized that the effects of the supply of physicians adjusted for place are stronger in Canada than in the US.[13,14,17] The theory essentially posits that with guaranteed access, personal income and its correlates matter less, and the availability of community resources, including physicians, matter more. For the present study, we hypothesized that the supply of PCPs and specialist physicians is more strongly associated with breast cancer care (early diagnosis, treatment access and survival) in Canada than in the US. The magnitude of regional physician shortages or surpluses were then estimated for diverse urban and rural places in Ontario and California.

METHODS

We randomly selected from Ontario and California cancer registries instances of breast cancer that had been diagnosed between 1998 and 2000 and followed until 2006 (Ontario, n = 951; California, n = 984). Samples were stratified by places that included large metropolitan areas (e.g., Toronto and San Francisco), small metropolitan areas (e.g., Windsor and Modesto) and rural areas. We defined rural areas in Ontario and California according to Statistics Canada criteria:[33,34] fewer than 10 000 inhabitants and population densities of fewer than 400 people per km^2. We calculated the distance between each patient's residence and the nearest urban centre with an ArcGIS Euclidean algorithm, with categories of remoteness defined as follows: remote (100–199 km), very remote (200–299 km) and extremely remote (≥ 300 km).[35,36] The Ontario and California cancer registries comprehensively survey the most populous Canadian province and US state with demonstrated validity. Both ascertain nearly all instances of breast cancer with nearly perfect rates of microscopic confirmation.[37–40] Variables related to stage of disease at diagnosis and treatment routinely coded by the California registry were abstracted from patient charts for the Ontario sample.[41–43] Reliability assessments of 150 randomly selected health records among 3 abstractors found κ coefficients that ranged from 0.88 to 0.96. The following treatment variables were also included: receipt of initial cancer-directed surgery, receipt of adjuvant chemotherapy and radiotherapy, and wait time from diagnosis to treatment.

Patients with breast cancer were matched to Canadian or US censuses (from 2001 and 2000, respectively) based on their residential census tracts.[44,45] Rural patients in Ontario were matched to census subdivisions. We constructed low to high annual household income quintiles using Statistics Canada's low-income criterion and the US Census Bureau's poverty threshold. Median incomes, adjusted for purchasing power, were very nearly identical in Ontario's and California's lowest-income neighbourhood quintiles: US$30 725 and US$31 050, respectively.[46,47] Counts of active physicians in Ontario and California were based on physician databases of the Canadian Institute for Health Information and the American Medical Association physician databases (from 2001 and 2000, respectively).[48,49] We defined PCPs as physicians who reported their primary specialty area as general or family practice. Because they often provide primary care for women, we also categorized obstetrician–gynecologists (Ob–Gyns) as PCPs.[11,13,50–52] Physicians who reported that most of their clinical time was spent in the practice of general surgery, medical oncology or radiation oncology, or who were so board certified in 2000/01 were defined accordingly. We calculated physician supply densities per 10 000 inhabitants for PCPs and per 100 000 inhabitants for specialists for Ontario's 49 census divisions or districts and California's 58 counties.[44,45]

We used logistic regression models to estimate the associations of the supply of physicians with indices of care for breast cancer. Age, income and place-adjusted odds ratios and their 95% confidence intervals were estimated from regression statistics.[53] Previous analyses found threshold, rather than linear effects, so we compared each incremental quarter physician supply category with the average effect of the previous categories (7.00, 7.25, 7.50, etc., PCPs per 10 000 inhabitants). In addition to bolstering statistical power, such reverse Helmert contrasts allowed for the identification of threshold effects.[53,54] The study had the statistical power to detect rate differences of 10% (α = 0.05 and power [1-β] = 0.80).[55] We then used criteria for optimum physician supply to identify undersupplied and oversupplied places.[56]

This study was approved by the University of Windsor's research ethics committee and the Ontario Cancer Research Network's research ethics board.

RESULTS

Supply of PCPs and breast cancer care

The association between supply of PCPs and indices of care for breast cancer in Ontario is shown in Table 1. Protective PCP supply thresholds clustered around 8 PCPs for every 10 000 inhabitants. The odds of 5-year survival among women with breast cancer who resided in Ontario districts with 8.25 or more PCPs per 10 000 inhabitants was 87% greater than among their counterparts of similar age, stage and income who resided in otherwise similar places, but with fewer than 8.25 PCPs per 10 000 inhabitants. Moreover, protective effects of PCPs seemed apparent during pre- and postdiagnostic phases of breast cancer care. Patients in Ontario districts with a supply of physicians at or above 7.75 PCPs per 10 000 inhabitants or 8.00 PCPs per 10 000 inhabitants were significantly more likely to have been diagnosed with node-negative breast cancer or to have received adjuvant radiotherapy, respectively.

There were 5 null findings that may be important in terms of policy-making. First, no level of

Table 1. Association between supply of primary care physicians and indices of care for breast cancer in Ontario

Physician density threshold	Index of breast cancer care	
	Odds ratio	95% confidence interval
7.75 PCPs per 10 000 inhabitants	Node-negative disease at diagnosis	
	1.62	1.00–2.63
8.00 PCPs per 10 000 inhabitants	Receipt of adjuvant radiotherapy	
	1.64	1.06–2.55
8.25 PCPs per 10 000 inhabitants	5-year survival	
	1.87	1.09–3.22

PCP = primary care physician.
Notes: All effects were adjusted for age, income, place (large urban, small urban, rural, remote, very remote and extremely remote) and total supply of physicians. Treatment and survival effects were also adjusted for the stage of disease at diagnosis. Fifty-one logistic regression models were run with the California data (17 for each breast cancer care index, quarter physician supply increments from 6.00 to 10.00 PCPs per 10 000 inhabitants). PCP supply was null in them all so they are not shown.

physician supply was associated with the receipt of surgery or chemotherapy, or with any wait times. Second, additional supplies of PCPs above thresholds did not further improve any aspect of care for breast cancer. Third, no aspect of care for breast cancer was further explained by the supply of physicians. Fourth, remoteness was not significantly associated with any aspect of breast cancer care, so rural needs are probably not defined merely by the levels of isolation that can occur in northern Ontario. Finally, no aspect of physician supply was significant when associated with any aspect of breast cancer care in California.

Cancer care–based estimates of the adequacy of the supply of physicians in Ontario

Ontario physician population parameters within 3 groups of regions that correspond with our analytic strata are displayed in Table 2. Using a criterion of 8 PCPs per 10 000 inhabitants that was associated with optimum care for breast cancer between 1998 and 2006, we estimated that the province of Ontario did not have an overall shortage of PCPs in 2006. With highest-quality care for breast cancer as the criterion, the province as a whole was probably adequately supplied, perhaps even oversupplied, by more than 1500 PCPs. However, nearly half of the province's census divisions or districts seemed inadequately supplied (21 of 49 districts). Ontario's problem with physician supply seems to be one of inequitable distribution, rather than of inadequate overall supply.

Although we did not find any significant effects related to the supply of specialists, previous studies have observed protective effects in breast cancer care where there are 6 or more Ob–Gyns per 100 000 inhabitants in Ontario.[13,14] The distribution of Ob–Gyns in 2006 is also displayed in Table 2. Again, with provision of highest-quality care for breast cancer as the criterion, the overall supply of Ob–Gyns in urban areas seemed about right, with rural areas modestly undersupplied. The province's aggregate supply discrepancy of 45 Ob–Gyns amounted to additional average needs of only 1 to 2 more Ob–Gyns per district. Again, the real problem seemed to be one of inequitable distribution. Nearly all of Ontario's districts (42 of 49) had less than the optimum supply of Ob–Gyns in 2006, yet the overall provincial supply discrepancy was modest. A small number of districts probably had a relative glut of specialist physicians.

Table 3 groups Ontario physician parameters by places that were either below or above criteria for optimum physician supply in 2006. Slightly more than 40% of the province's population lived in districts that were probably inadequately supplied with PCPs. The aggregate shortage was estimated to be 563 PCPs. The other nearly 60% of the province's population lived in adequately supplied districts that, at least in terms of the provision of optimum care for breast cancer, may have had a surplus of

Table 2. The supply of physicians in 49 Ontario census divisions in 2006, grouped by urbanity

Variable	Primary care physicians	Obstetrician–gynecologists
Optimum supply of physicians per inhabitants	8.00/10 000	6.00/100 000
Greater metropolitan Toronto*		
Physician density† (range in census divisions)	9.44/10 000 (6.18–12.42)	6.14/100 000 (2.76–9.79)
No. of inadequately supplied census divisions	3	4
Actual supply – optimum supply	1.44/10 000	0.14/100 000
Supply discrepancy	800	8
Other urban areas‡		
Physician density† (range in census divisions)	9.30/10 000 (6.08–15.57)	5.96/100 000 (0.00–10.43)
No. of inadequately supplied census divisions	9	19
Actual supply – optimum supply	1.30/10 000	–0.04/100 000
Supply discrepancy	698	–2
Rural areas§		
Physician density† (range in census divisions)	8.52/10 000 (5.61–12.99)	1.87/100 000 (0.00–7.76)
No. of inadequately supplied census divisions	9	19
Actual supply – optimum supply	0.52/10 000	–4.13/100 000
Supply discrepancy	64	–51
Provincial supply discrepancy	1562	–45

*Population: 5 555 912 people in 5 census divisions.
†Physician density (no. of physicians per inhabitant population) was the sum of the physician densities in the census divisions weighted by their populations.
‡Population: 5 371 699 people in 24 census divisions.
§Population: 1 230 449 people in 20 census divisions.

more than 2000 PCPs. The 2 districts that included Toronto and Ottawa accounted for nearly three-quarters of the surplus (1525/2125 = 71.8%). The same pattern was observed for Ob–Gyns, but the distributional problem seemed even more severe. Toronto and Ottawa again accounted for most of the supply surplus (127/157 = 80.9%).

DISCUSSION

We based this study on the theory that personal economic resources trump community health care resources in the US. Our consistent findings that the supply of physicians was not significantly associated with any aspect of care for breast cancer in California robustly support our theory. Given Canada's access guarantee, our theory alternatively predicted that community resources for health care, including the supply of physicians, matter more here. Our study's consistent results of independent protective associations of the supply of PCPs with breast cancer diagnosis, adjuvant radiotherapy and survival across diverse urban and rural areas in Ontario serve to cross-validate the theory. We estimated a provincial surplus of 1562 PCPs as well as a shortage of 45 Ob–Gyns in 2006. Physician surpluses were most pronounced in Ontario's 2 largest cities. Application of the same criteria to California estimated surpluses of 1825 PCPs and 2920 Ob–Gyns. Californians may not practically benefit more from such seemingly affluent regional health care service endowments than Ontarians do from their more efficient health care system that puts a greater emphasis on primary care. At the time of this study, PCPs constituted nearly half of Ontario's physicians (47.0%) and just over one-quarter of California's (27.2%).[17] The overall supply of physicians in Ontario seems adequate to provide effective care for breast cancer. However, we estimated that 563 more PCPs and 202 more Ob–Gyns, principally for the primary care they provide, were needed in Ontario's rural and small urban areas.

Policies to functionally redistribute physicians are called for. Merely increasing physician populations is unlikely to positively affect the health of Ontarians. Our study shows that clinically meaningful criteria could be used to rationally inform policy on physician supply. The criterion of breast cancer care used in this study is not the only important indicator of high-quality health care. More population-based studies are needed to cross-validate and systematically replicate this study's findings across other clinically meaningful health outcomes.

Policy context

The Canadian Medical Association's (CMA's) "More doctors. More care" campaign[1] alleged an enormous physician shortage and argued that the shortage was bound to grow far worse. The association estimated that another 20 000 physicians were needed to keep pace with other member nations of the Organisation

Table 3. The supply of physicians in 49 Ontario census divisions in 2006, grouped according to inadequate and adequate supply

Variable	Primary care physicians	Obstetrician–gynecologists
Optimum supply of physicians per inhabitants	8.00/10 000	6.00/100 000
Inadequately supplied places		
Population	5 119 283	7 633 130
No. of census divisions	21	42
Physician density* (range in census divisions)	6.90/10 000 (5.61–7.96)	3.35/100 000 (0.00–5.41)
Actual supply – optimum supply	–1.10/10 000	–2.65/100 000
Supply discrepancy	–563	–202
Adequately supplied places		
Population	7 038 777	4 524 930
No. of census divisions	28	7
Physician density* (range in census divisions)	11.02/10 000 (8.05–15.57)	9.46/100 000 (7.76–10.43)
Actual supply – optimum supply	3.02/10 000	3.46/100 000
Supply discrepancy	2125	157
Provincial supply discrepancy	1562	–45
California supply discrepancy†	1825	2920

*Physician density (no. of physicians per inhabitant population) was the sum of the physician densities in the census divisions weighted by their populations.
†Theoretical comparison based on the application of Ontario's criteria for optimum supply.

for Economic Co-operation and Development (OECD). One might fairly wonder about the validity of that criterion. Other policy analysts have convincingly refuted its validity. For example, there seems to be little evidence to support the contention that any meaningful relation exists between physician supply and avoidable mortality among OECD nations.[57] It is well known that more is not necessarily better. Moreover, the per capita supply of all physicians as well as the ratio of PCPs to specialists has remained surprisingly constant over the past 20 years in Canada.[58] Within such a policy context, specific district or regional shortages may be misperceived as provincial or national shortages. This study's findings are consistent with those of policy analysts who have contended the CMA's projections of impending, very large physician shortages. What if, hypothetically, Ontario's share of the CMA's recommended 20 000 physicians were instituted? Where would these additional 7000 physicians practise? Would they rationally fill the gaps that exist throughout Ontario's smaller urban and rural areas? It seems more likely that they would continue to preferentially practise in places that already have physician surpluses. This would only serve to dramatically increase health care costs without producing any health benefits.

Functional redistribution policies

Simply redistributing physicians, especially specialists, is probably not a sufficient practical solution to the problem of geographic inequity. Even if specialist–population ratios were increased, a number of challenges specific to rural and remote places would remain. Patients in remote areas would still have long distances to travel to visit a physician, and practice volumes in rural and even in certain small urban areas might be so small as to preclude their quality.[59] Rural outreach strategies in Ontario have included the establishment of the Northern Ontario School of Medicine as well as visiting specialist programs that proliferated in the province during this study's time frame.[60,61] These efforts are expected to have beneficial effects.[36,62] Rural practice innovations that integrate telehealth strategies may potentiate the benefits of such efforts, serving to further functionally redistribute physician resources, if not actually redistribute the supply of physicians.[63,64]

Limitations

The most significant inferences from this study in terms of policy pertain to Canada, but the study's Ontario samples are not necessarily representative of Canada as a whole. The Ontario samples were randomly selected from a deliberately selected pool of diverse places. Large and small urban and rural places were oversampled; our results are most generalizable to them. However, we think the results are externally robust for the following reasons. Independently, place did not seem to matter in our study's analyses. Physician supply distributions seen in our study seemed consistent with the province's physician populations reported elsewhere.[65,66] This study's findings of ample overall physician supply with identifiable areas of significant undersupply have also been observed in Manitoba.[67] Finally, Ontario ranks close to the bottom of Canadian provinces on the population density of PCPs and close to the top on specialist physician densities.[54] Our study's inferences about surplus PCPs and specialist supply shortages in Ontario may actually be underestimates of the truth across Canada.

Our results converged with the observation of the Canadian Community Health Survey of a very strong association between having a regular doctor and receiving a mammogram within the past 2 years (odds ratio 3.48).[68] A number of potential confounders identified by that study were accounted for by ours. Still, some error probably intruded into our analyses. For example, although physicians play a key roll in mammography referrals, other health care professionals and patients themselves (self-referrals account for 1 of every 5 screening mammograms in Ontario) play an important role that was not assessed in this study.[69] Also, at the time of our study the guidelines for screening mammograms were different in Canada and the US. The Canadian guidelines recommended biennial mammograms beginning at age 50, and the US guidelines recommended annual mammograms beginning at age 40.[70,71] It is unlikely that such prediagnostic processes could confound our study's central within-Ontario results, particularly its results relevant to postdiagnostic care for breast cancer.

Our physician counts were head counts of active physicians that did not allow for estimation of full-time physician equivalents. Head-count data have been shown to result in Canadian physician–population ratios that are overestimates of the truth; however, such overestimation has also been demonstrated to be least problematic in Ontario (5%–10%).[72] Such slight overestimation could easily be accounted for in planning the future supply of physicians. Also, our study's physician supply mea-

sures were community-level aggregates and so did not directly examine individual physician–patient relationships. The measures were conceived as proxies of community-level phenomena; that is, of regional health care service endowments. Therefore, we think that population-level policy inferences can be most appropriately drawn from the findings.

We were not able to resolve clinical versus nonclinical (teaching, research and administration) physician counts. It seems that much of the physician supply surpluses that were identified, particularly in large urban centres of medical education and research such as Toronto and Ottawa, may reflect the much greater prevalence of active, but nonclinical, physicians there. Such confounding seems far less likely in Ontario's small urban and rural areas. Inferences concerning inadequate supply of physicians in small urban and rural areas are probably the most valid inferences of this study.

CONCLUSION

The supply of physicians matters in Ontario. Rhetoric about gross physician shortages seems a distraction from the probable truths that the adequate supply of physicians is inequitably distributed, that undersupplied places are identifiable and that the magnitude of their shortages is calculable. Functional redistribution policies serving to encourage and support more equitable geographic distributions of physicians are called for in Ontario and across Canada.

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Competing interests: None declared.

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