Multispecialty physician networks in Ontario

Therese A Stukel, Richard H Glazier, Susan E Schultz, Jun Guan, Brandon M Zagorski, Peter Gozdyra, David A Henry

ABSTRACT

Background: Large multispecialty physician group practices, with a central role for primary care practitioners, have been shown to achieve high-quality, low-cost care for patients with chronic disease. We assessed the extent to which informal multispecialty physician networks in Ontario could be identified by using health administrative data to exploit natural linkages among patients, physicians, and hospitals based on existing patient flow.

Methods: We linked each Ontario resident to his or her usual provider of primary care over the period from fiscal year 2008/2009 to fiscal year 2010/2011. We linked each specialist to the hospital where he or she performed the most inpatient services. We linked each primary care physician to the hospital where most of his or her ambulatory patients were admitted for non-maternal medical care. Each resident was then linked to the same hospital as his or her usual provider of primary care. We computed "loyalty" as the proportion of care to network residents provided by physicians and hospitals within their network. Smaller clusters were aggregated to create networks based on a minimum population size, distance, and loyalty. Networks were not constrained geographically.

Results: We identified 78 multispecialty physician networks, comprising 12 410 primary care physicians, 14 687 specialists, and 175 acute care hospitals serving a total of 12 917 178 people. Median network size was 134 723 residents, 125 primary care physicians, and 143 specialists. Virtually all eligible residents were linked to a usual provider of primary care and to a network. Most specialists (93.5%) and primary care physicians (98.2%) were linked to a hospital. Median network physician loyalty was 68.4% for all physician visits and 81.1% for primary care visits. Median non-maternal admission loyalty was 67.4%. Urban networks had lower loyalties and were less self-contained but had more health care resources.

Interpretation: We demonstrated the feasibility of identifying informal multispecialty physician networks in Ontario on the basis of patterns of health care–seeking behaviour. Networks were reasonably self-contained, in that individual residents received most of their care from providers within their respective networks. Formal constitution of networks could foster accountability for efficient, integrated care through care management tools and quality improvement, the ideas behind "accountable care organizations."

Therese A. Stukel, PhD, is a Senior Scientist at the Institute for Clinical Evaluative Sciences, Toronto, Ontario; an Adjunct Professor at the Dartmouth Institute for Health Policy and Clinical Practice, Giesel School of Medicine at Dartmouth, Hanover, New Hampshire; and a Professor at the Institute for Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario. **Richard H. Glazier,** MD, MPH, FCFP, is a Senior Scientist at the Institute for Clinical Evaluative Sciences; a Professor in the Department of Family and Community Medicine and the Dalla Lana School of Public Health, University of Toronto; a Scientist at the Centre for Research on Inner City Health in the Keenan Research Centre of the Li Ka Shing Knowledge Institute, St. Michael's Hospital; and a Clinician Scientist and Family Physician in the Department of Family and Community Medicine, St. Michael's Hospital, Toronto, Ontario. **Susan E. Schultz**, MA, MSc, is an Epidemiologist at the Institute for Clinical Evaluative Sciences, Toronto, Ontario. **Jun Guan,** MSc, is a Lead Analyst at the Institute for Clinical Evaluative Sciences, Toronto, Ontario. **Brandon M. Zagorski,** MS, is a Data Analyst at the Institute for Clinical Evaluative Sciences, Toronto, Ontario. **Peter Gozdyra,** MA, is a Medical Geographer at the Institute for Clinical Evaluative Sciences and the Centre for Research on Inner City Health in the Keenan Research Centre of the Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario. **David A. Henry,** MBChB, FRCPE (Edin), is the CEO of the Institute for Clinical Evaluative Sciences and a Professor in the Department of Medicine, University of Toronto, Toronto, Ontario.

Correspondence: Dr. Therese A. Stukel, Institute for Clinical Evaluative Sciences, G106–2075 Bayview Ave., Toronto ON M4N 3M5; stukel@ices.on.ca

➤ ACCORDING TO WIDESPREAD EVIDENCE, QUALITY OF care for patients with chronic disease is suboptimal,[1–3] with large variations in the provision of evidence-based services.[3–8] Serious gaps in the quality of chronic disease management have been attributed to poor coordination and fragmentation of care.[1,2,9–11] Effective chronic disease management requires coordinated, longitudinal care and the engagement of multidisciplinary teams across different sectors.[11–13] Large multispecialty physician group practices have been shown to achieve high-quality, low-cost care. Through better ambulatory management of patients' care, such practices reduce complications and avoid costly readmissions to the hospital and emergency department (ED).[13–19]

The development of multidisciplinary accountable care organizations in the United States has illustrated the central role of primary care.[20] Strong primary care systems are associated with higher quality of care for chronic disease, including increased preventive care and fewer avoidable ED visits and hospital admissions.[21–24] Ontario leads other Canadian provinces in deploying a range of primary care models, such as Family Health Teams, using financial incentives to reward continuity and comprehensiveness of care, after-hours coverage, and electronic medical records.[25–28] However, primary care reform has paid little attention to integrating specialists and hospitals into the management of patients with chronic disease.

The current health care structure and payment system is focused on acute care and is poorly aligned with the needs of patients who have chronic disease. To incentivize health care providers to offer integrated, coordinated care and to promote collective accountability will require a major reorganization of traditional health care delivery and payment systems.[11–13]

Although formal multispecialty physician networks are uncommon in Canada, health care providers tend to form informal networks based on the sharing of patients and information. These "virtual" networks, behaving as informal, organic, "self-organizing" systems that consist of primary care physicians, specialists, and the hospitals where their patients are admitted, have likely developed naturally through patients' travel patterns, long-standing referral patterns, information-sharing, and admission of patients to local hospitals.

Our objective was to identify naturally occurring multispecialty physician networks in Ontario by using health administrative data to exploit linkages among patients, physicians, and hospitals based on existing patient flow and to characterize these networks in terms of population and physician characteristics.

We postulated that this "natural" model of physician organization would reflect the way in which primary care physicians, specialists, and hospitals actually practise together to care for a defined population and that such a structure would permit more accurate and robust evaluation of quality and costs of care. Our overarching goals are to identify which networks provide high-quality, low-cost care and to examine the factors contributing to their efficiency. Understanding what constitutes a high-performing system provides an opportunity to focus policy reforms on promoting and sustaining the best systems.[29]

Methods

We identified physician networks with the idea of defining "medical neighbourhoods" for chronic disease care.[30] A medical neighbourhood consists of primary care physicians (representing patients' medical homes) and the specialists and hospitals from which their patients receive most of their care. The reason for including hospitals was to foster accountability for hospital readmissions among the multiple providers who might take responsibility for reducing the rates of such events.[31,32] While improving the quality of chronic disease care is important, one of the markers for excellent care is avoidance of costly readmissions. Our algorithm for defining networks was similar to that used to derive networks in the United States[33,34] but was adapted to reflect the Ontario health care system.

Data sources. Multiple Ontario health administrative databases containing information on all publicly insured hospital and physician services were linked using unique, anonymized, encrypted identifiers for patients and physicians. These databases were the Discharge Abstract Database (available through the Canadian Institute for Health Information) for hospital admissions, procedures and transfers; the National Ambulatory Care Reporting System for ED visits; the Ontario Health Insurance Plan (OHIP) database of physician billings for type and location of service, diagnosis codes, and procedures; the Ontario Drug Benefits Plan for outpatient drug prescriptions for those over 65 years of age; the provincial Registered Persons Database for patient demographic information and deaths; the provincial Client Agency Program Enrolment registry to identify rostered patients and primary care models; the Ontario Physician Workforce Database[35] and the

Institute for Clinical Evaluative Sciences Physician Database to identify physician activity status, self-designated and functional specialties, and full-time equivalency. Neighbourhood income was derived from Statistics Canada 2006 census estimates. We used the 2008 Rurality Index of Ontario (RIO) to measure rurality, accounting for population size and travel time.[36] These data sets were held securely in a linked, de-identified form and were analyzed at the Institute for Clinical Evaluative Sciences.

Eligible residents and physicians. The eligible population consisted of residents of Ontario who were alive and aged less than 100 years on April 1, 2008, including newborns and immigrants who registered with OHIP during the period from fiscal year 2008/2009 to fiscal year 2010/2011, excluding those who had had no contact with the health care system since 2000/2001. Ontario physicians with a valid physician number were eligible for inclusion if they had been in active practice during the period of interest (2008/2009 to 2010/2011), defined as having an active Client Agency Program Enrolment patient roster or at least one OHIP billing. All acute care inpatient institutions, including general, cardiac, children's, and psychiatric hospitals, were eligible.

Linkage of residents to usual providers of primary care. Primary care physicians were those whose self-designated or functional specialty was general practice, family practice, or community medicine. Pediatricians were considered primary care providers if they billed more than 30 well-baby or well-child visits between 2008/2009 and 2010/2011.[37] In the spirit of defining medical homes, we linked Ontario residents to their usual providers of primary care in the following hierarchical manner. Each resident was linked to the primary care physician to whom he or she had been rostered at the midpoint of the period, because that physician was contractually responsible for the resident's primary care; any rostered resident who died before the midpoint was linked to his or her last primary care physician. Each nonrostered resident was linked to the primary care physician who provided most of the resident's core primary care services, on the basis of the billing codes used by the Ontario Ministry of Health and Long-Term Care to determine virtual patient rosters (online Appendix A). Each remaining unlinked resident was linked to the primary care (preferentially) or other physician who provided the greatest number of ambulatory services, including visits, laboratory tests,

diagnostic tests, and prescriptions, counting each type of service once per patient per day. Any resident who had no ambulatory contact with a physician was not linked to a usual provider of primary care.

Linkage of physicians to hospitals. We linked each specialist to the acute care hospital where he or she had provided the highest volume of inpatient services, including visits, procedures, imaging, and diagnostic tests billed during the admission. We did not include same-day surgery or ED visits. Several specialists could provide services to the same inpatient.

Each primary care physician was linked to the hospital where most of his or her patients (defined according to the linkage between residents and usual providers of primary care, described above) were admitted. We reasoned that this hospital would be responsible for discharge planning for the primary care physician's patients. We used non-maternal medical admissions for hospital assignment, since the focus for patients with chronic disease is avoidable medical admissions, whereas surgery is often regionalized and maternal admissions are not avoidable. Each admitted patient was counted once, to ensure that those who were admitted more frequently would not bias the assignment; for those admitted to more than one hospital, we weighted each admission proportionally to the total number of admissions for that patient. Each unlinked rostering primary care physician was linked to the hospital where most physicians in his or her primary care model were assigned. Each unlinked specialist was linked to the hospital where most of his or her ambulatory patient panel was admitted.

Linkage of residents to hospitals. Each Ontario resident was linked to the hospital where his or her usual provider of primary care was assigned, as this was likely to be the hospital responsible for the patient's discharge planning. Each unlinked resident who was admitted to a hospital or seen in the ED during the period 2008/2009 to 2010/2011 was directly linked to that hospital.

Aggregation of provider clusters to form networks. A provider cluster comprised the population and physicians linked to a particular hospital. We combined provider clusters to derive multispecialty physician networks, aggregating small clusters that shared patients and were in close proximity, so that the resulting network had a minimum population size and included at

least one medium or large hospital. A network consisted of the combined population, physicians, and hospitals linked to its component provider clusters. A satellite network was a collection of small, rural provider clusters that were geographically distant from the large hospital upon which they depended for complex services. For these satellite networks, the population served and the local services provided were very different from those in the nearest large provider cluster. Depending on the purpose, a satellite network could always be aggregated to the nearest network. See the glossary of terms (online Appendix B) for additional detail.

We defined 3 indexes of localization that measured the extent of self-containment of provider clusters and networks. Admission loyalty was defined as the percentage of total admissions within a provider cluster's (or network's) population that were to the linked hospital (or to network hospitals). Physician loyalty was defined as the percentage of ambulatory visits by a provider cluster's (or network's) population that were to physicians linked to the cluster (or network). Primary care loyalty was defined as the percentage of ambulatory visits by a provider cluster's (or network's) population that were to primary care physicians linked to the cluster (or network) (online Appendix B). High loyalty implied that network providers delivered most of the care for their assigned population.

To aggregate provider clusters, we reviewed the top 4 admission and physician loyalties of each cluster's population to itself and other clusters to determine where the population was primarily seeking care. We computed travel times between centroids of hospital postal codes with a geographic information system (GIS) that used posted speed limits on the road network. Using a combination of high admission and physician loyalty, indicating shared patients, close geographic proximity, and GIS mapping, we aggregated small provider clusters to form networks of minimum population size 50 000, where possible, respecting hospital governance structures. The minimum population size was based on having sufficient patients to accurately measure network performance for chronic diseases with prevalence less than 10% and being sufficiently large to provide a range of health care services and to implement system improvements.[29]

Table 1 shows an example of aggregating provider cluster A, which had 27 473 patients (fewer than the specified minimum), with a larger cluster. Provider cluster A's admission loyalty to itself was moderate (53.8%), since it was small and had few specialists

Table 1
Data used to aggregate provider cluster A to a larger provider cluster

Provider cluster	No. of residents	No. of physicians		Medical non-maternal admissions for cluster A residents			Ambulatory visits to physicians by cluster A residents			Visits to primary care physicians by cluster A residents			Travel time from provider cluster A (min)
		Total	Primary care	No. of admissions	Admission loyalty,* %	Rank	No. of visits	Physician loyalty,* %	Rank	No. of visits	Primary care loyalty,* %	Rank	
A	27 473	32	28	2 373	53.8	1	286 120	67.1	1	277 205	87.4	1	0
B	181 060	612	246	1 199	27.2	2	89 190	20.9	2	21 792	6.9	2	70
C	119 223	211	104	282	6.4	3	22 550	5.3	3	7 710	2.4	3	53
D	56 405	100	57	201	4.6	4	4 765	1.1	4	706	0.2	4	73

* Loyalty does not sum to 100% since only visits and admissions by cluster A residents to physicians and hospitals in clusters A, B, C, and D are reported, and residents also sought care from physicians and hospitals in other provider clusters. See Appendix B for details about calculation of the three types of loyalty.

(n = 4), so that patients were admitted to larger nearby hospitals for serious conditions. Hospital B was a large tertiary care centre and was further away than hospital C but was linked to hospital A by a major highway. Provider cluster A's residents received more services from cluster B than cluster C, as evidenced by a higher percentage of admissions and ambulatory visits to providers in cluster B. We therefore aggregated provider cluster A with provider cluster B.

Characteristics of physician networks. We report network population characteristics, in terms of the median and 10th and 90th percentiles, weighted by network population. Characteristics include network size, loyalty, distance between residents and providers, socio-demographic information, prevalence of chronic diseases (including diabetes mellitus, acute myocardial infarction, congestive heart failure, hypertension, chronic obstructive pulmonary disease, and asthma) based on chart-validated algorithms,[4,38–42] and primary care model affiliation.[26,43]

Physician supply was calculated as full-time equivalents (FTEs) per capita network population. FTEs were calculated using total physician payments from all sources, assigning an FTE of 1.00 to physicians who fell between the 40th and 60th percentiles of their specialty.[44,45] Primary care continuity was measured as the proportion of ambulatory visits that were with a resident's usual provider of primary care.[5]

Ethics approval. The study was approved by the Research Ethics Board of Sunnybrook Health Sciences Centre.

Results

We began with 12 971 629 Ontario residents (including 359 963 immigrants and 435 381 newborns), 27 437 physicians, and 175 acute care hospitals that were eligible to be linked to a network. Overall, 97.5% of primary care physicians (11 888 of 12 193) and 100% of primary care pediatricians (n = 373) were designated as usual providers of primary care. A total of 12 845 793 (99.0%) of the residents were linked to a usual provider of primary care; of these, 70.8% were linked through rostering, 27.1% through use of core primary care services, and 2.1% through other physician services. We were unable to link 125 836 (< 1%) of eligible residents to a usual provider of primary care because they had received no ambulatory physician services over the 3-year period.

The majority of specialists (13 904 of 14 871 [93.5%]) were linked to a hospital through their hospital activity, and the majority of primary care physicians, including primary care pediatricians (12 340 out of 12 566 [98.2%]), were linked to a hospital through admissions of the patients for whom they were the usual providers of primary care. An additional 70 primary care physicians were linked to a hospital through their primary care model, and 783 specialists were linked to a hospital through admissions of their ambulatory patient panel. Most residents (98.8%) were linked to a provider cluster and therefore to a network. For the majority (92.0%) of specialists, inpatient activity was in one hospital. Admissions of patients linked to an individual primary care provider were often to several hospitals, but on average, more than half of admissions for a particular provider (58.0%) were to one hospital. Primary care physicians who could not be linked typically had small, healthy patient panels; since the networks were created to foster chronic disease care, these physicians remained unlinked.

We began the next stage with 175 provider clusters, each containing one acute care hospital, which were aggregated into 78 multispecialty physician networks. The final networks comprised 12 410 primary care physicians, including primary care pediatricians, and 14 687 specialists serving 12 917 178 people. Some networks (n = 38) were large and comprised only one hospital. Other networks (n = 33) comprised more than 1 hospital and appear as "spiders" in Figure 1. There were 7 satellite networks. Although most hospitals in a network were located inside boundaries of the relevant Local Health Integration Network (LHIN), this was not true of the primary care physicians or the population served. Figure 2, which plots the envelope of primary care providers linked to each network on the basis of physicians' billing postal codes, shows that residents did not seek care within distinct LHIN boundaries and that there was substantial geographic overlap among network catchment areas in urban areas.

The numbers of residents and physicians linked across networks varied widely (Table 2). In general, admission and physician loyalty were high. Median non-maternal medical admission loyalty was 67.4%. Median network loyalty was 68.4% for all physicians and 81.1% for primary care physicians. Urban networks had large populations, many primary care physicians, and large numbers of specialists, hospital beds, and ICU beds (data not shown), with residents living close to their providers; however, physician and admission loyalties were
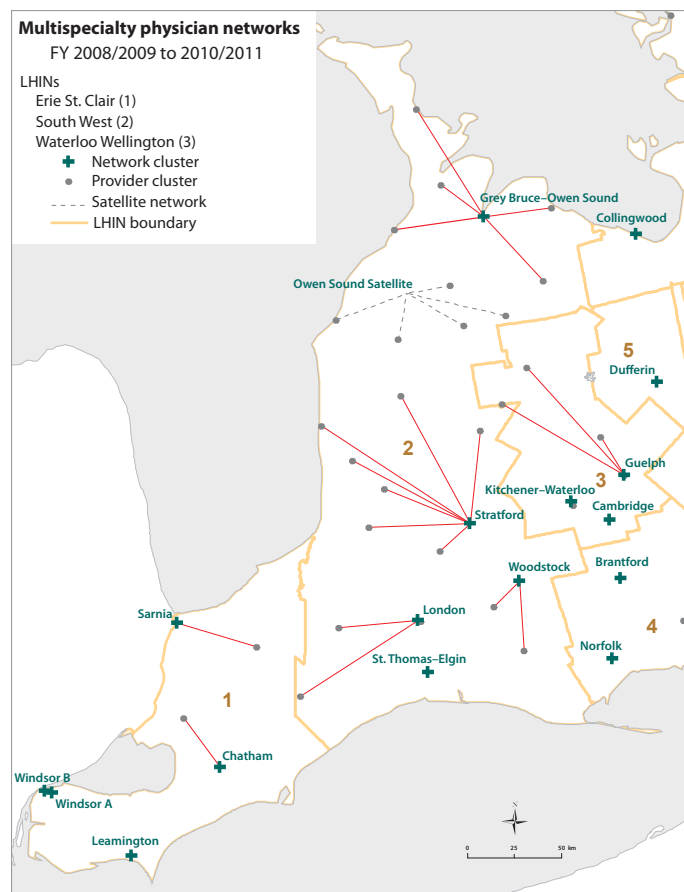
Figure 1 (7 maps)

Locations of multispecialty physician networks in Ontario. For each network, the large green cross represents the location of the largest hospital, and small grey dots indicate locations of other hospitals. Each network has either one provider hub or an aggregation of provider hubs linked by straight lines to the largest hospital, resulting in "spiders." Satellite networks are represented by dotted lines between provider clusters and the centroid of their respective provider hubs. FY = fiscal year. LHIN = Local Health Integration Network. Within the legend for each map, only complete LHINs (designated by number) are specified.
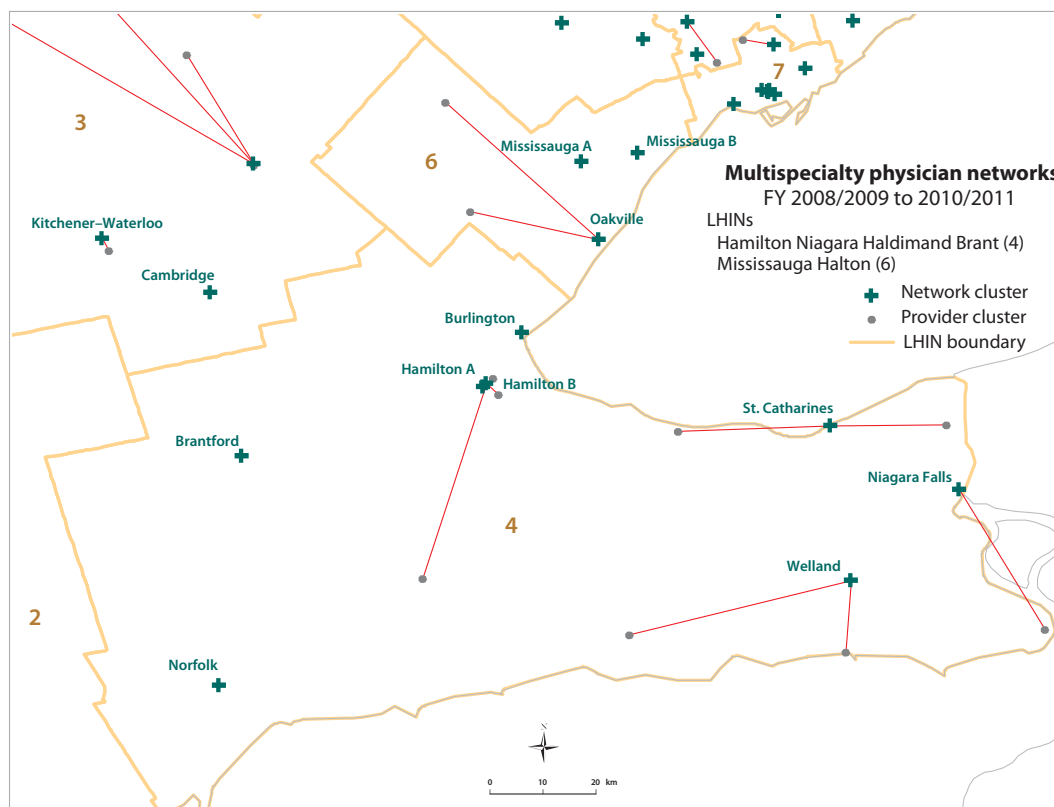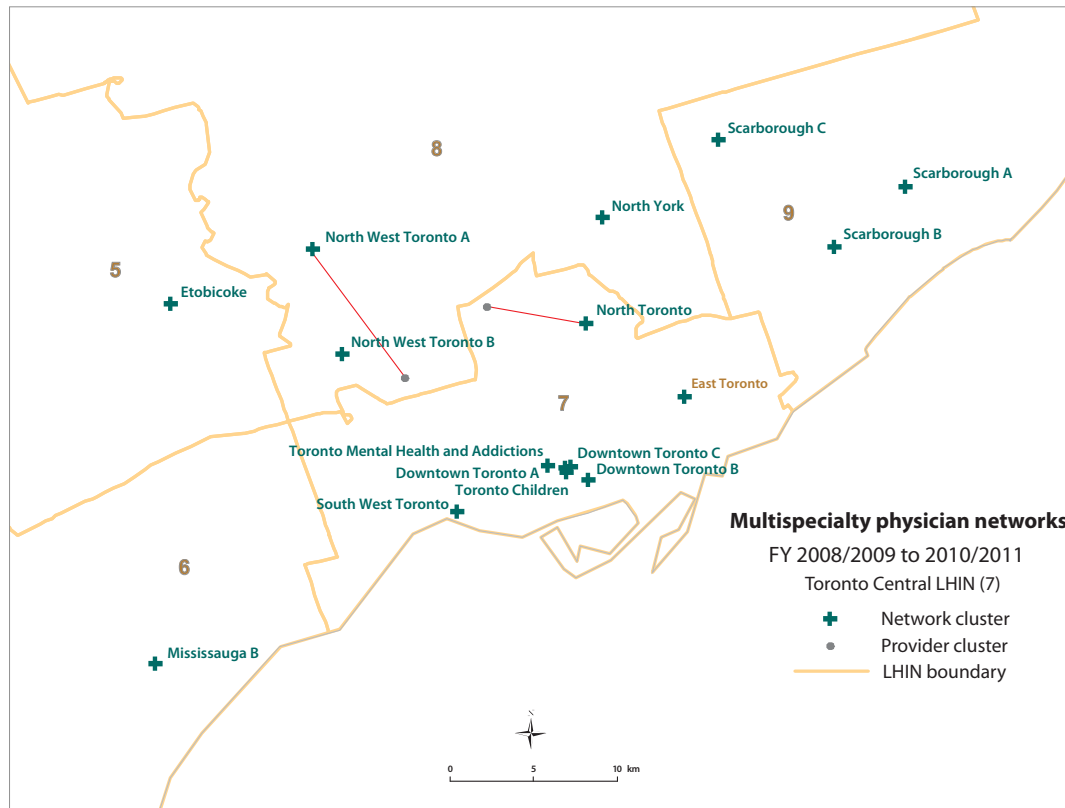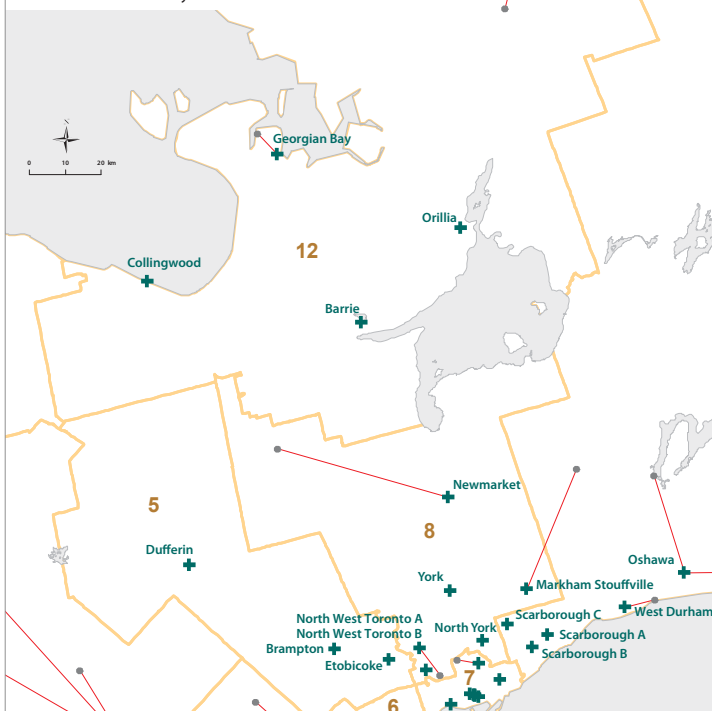
Multispecialty physician networks
FY 2008/2009 to 2010/2011
Toronto Central LHIN (7)

Multispecialty physician networks

FY 2008/2009 to 2010/2011

LHINs
South East (10)
Champlain (11)

✚ Network cluster
● Provider cluster
- - - Satellite network
— LHIN boundary

13

11

Pembroke

Ottawa A
Ottawa C
Ottawa B   Ottawa D
Ottawa Children
Ottawa Satellite

Cornwall

Perth and Smiths Falls

9

10

Brockville

Peterborough

Kingston

Quinte

Cobourg

0   25   50 km

Multispecialty physician networks

FY 2008/2009 to 2010/2011

LHINs
North East (13)
North West (14)

✚ Network cluster
● Provider cluster
- - - Satellite network
— LHIN boundary

14

Moose Factory

13

Thunder Bay Satellite–NW

Thunder Bay Satellite–S

Thunder Bay
Satellite–E

Timmins Satellite

Thunder Bay

Timmins
& District

Sault Ste. Marie   Sudbury

North Bay

Sudbury Satellite

Muskoka

0   100   200 km
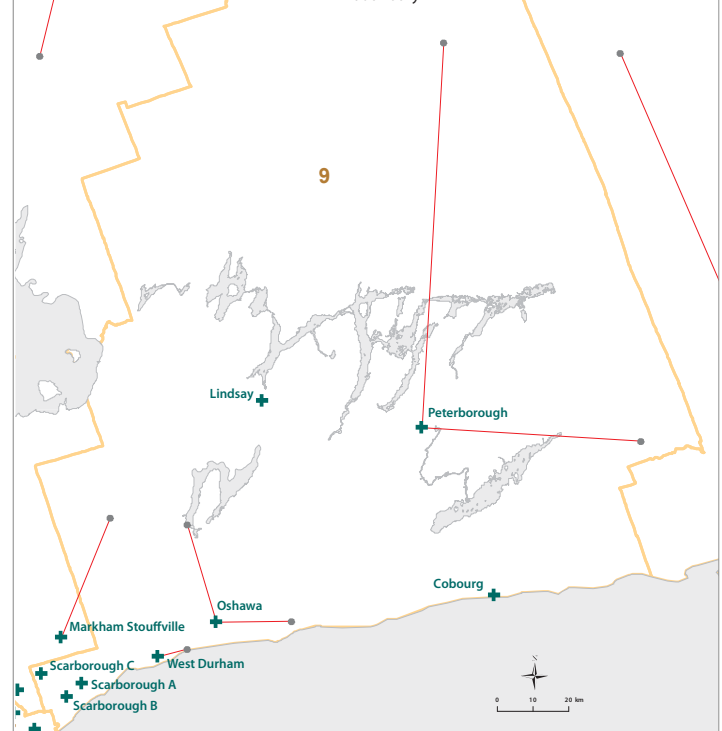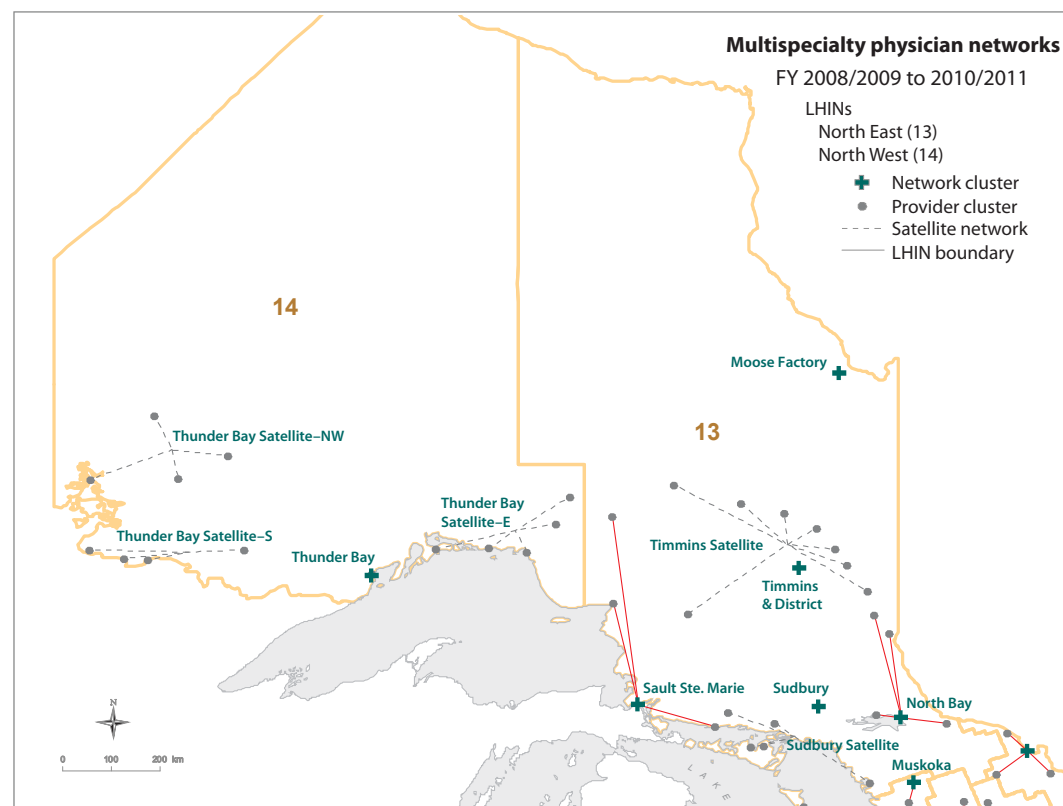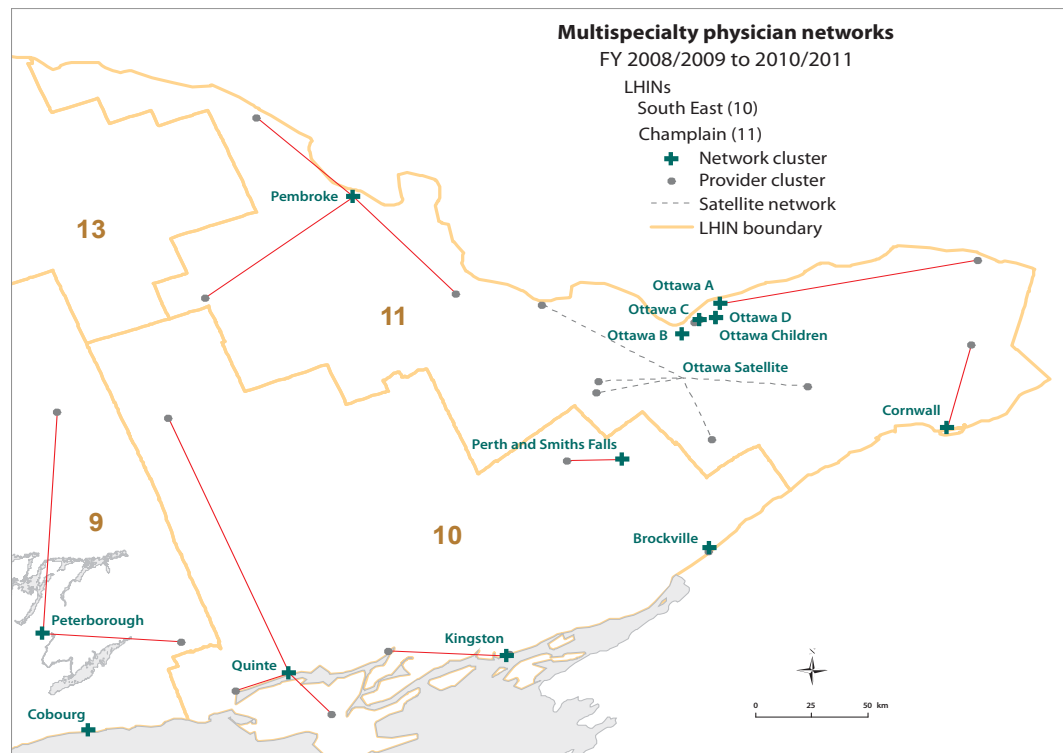
Figure 2 (6 maps)
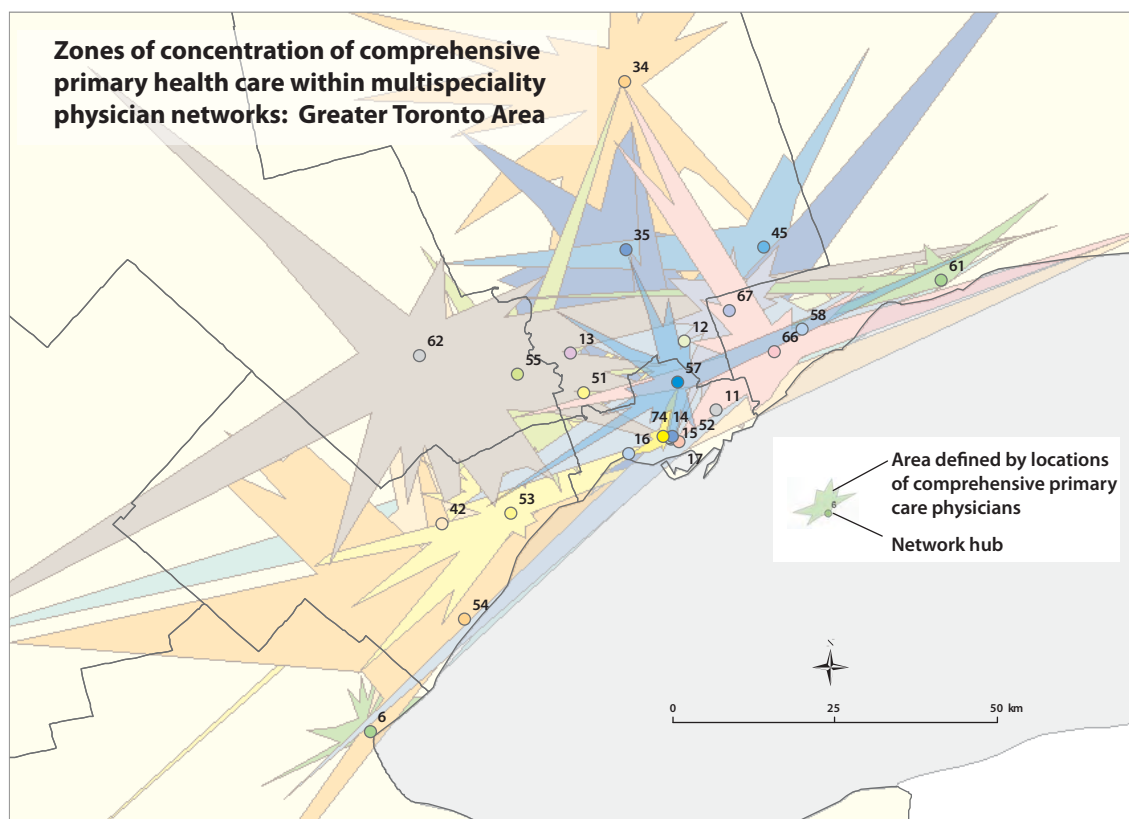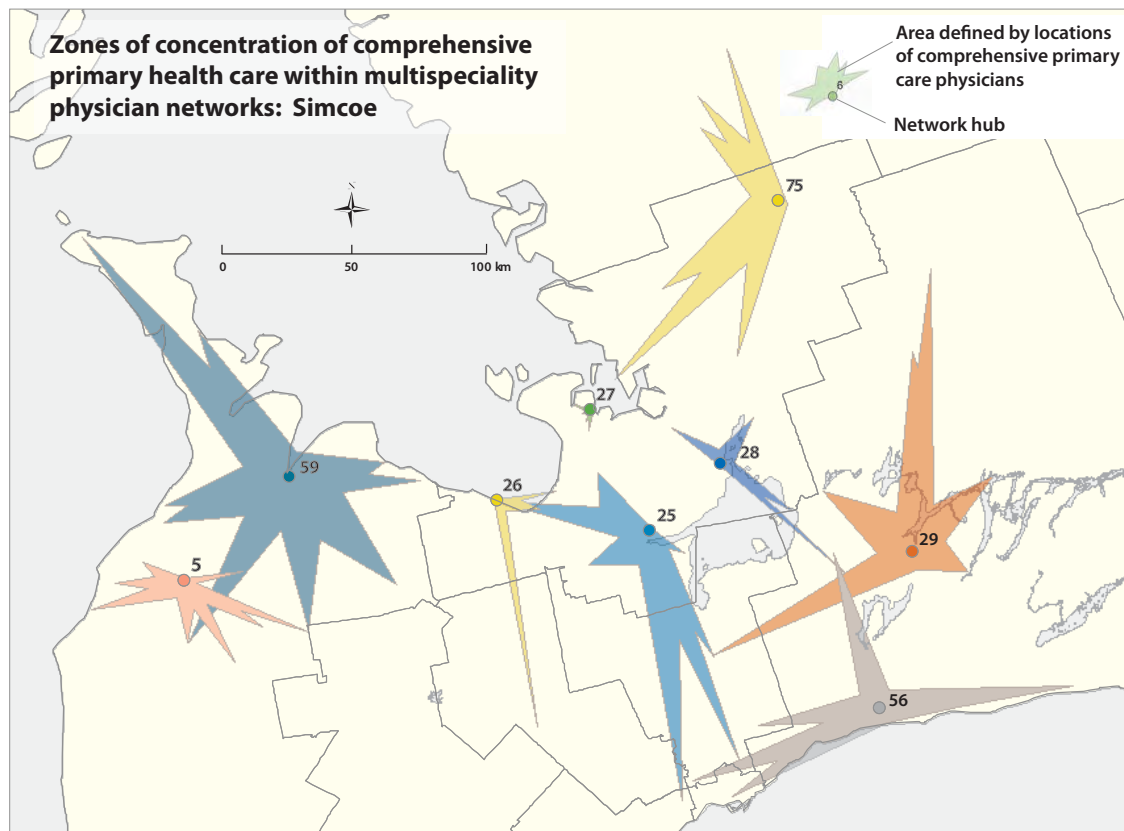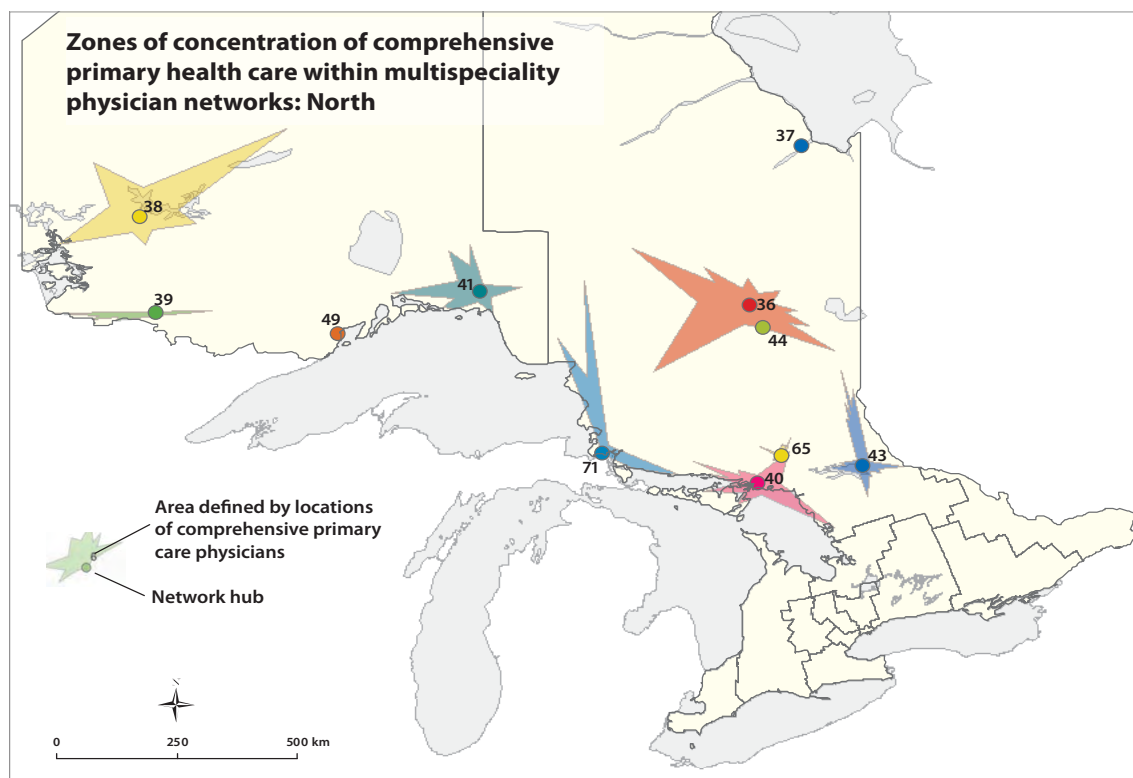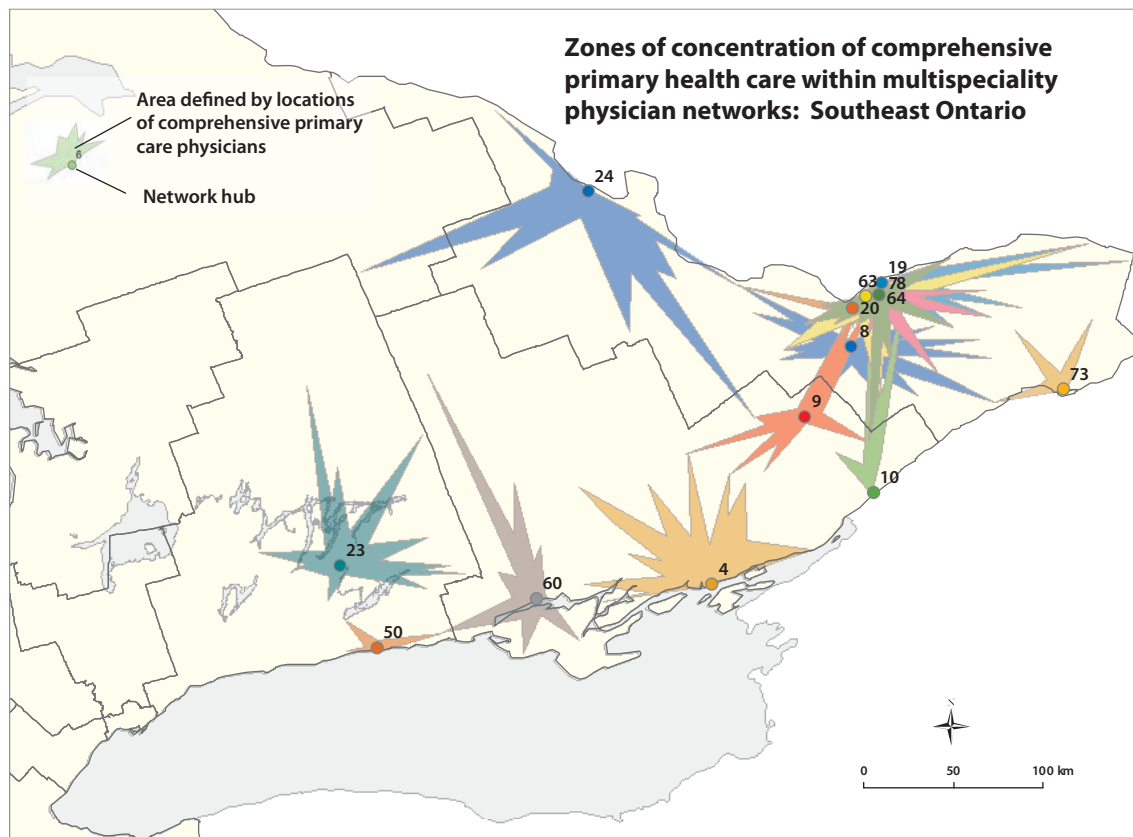**Concentration of primary care physicians within networks.** Lines were drawn between the billing postal codes of primary care physicians and the postal code of the primary network hospital, after removal of outliers (defined as those for whom this distance was more than 100 km). The "stars" show locations of the primary care physicians linked to a network.

Zones of concentration of comprehensive primary health care within multispeciality physician networks: Southwest Ontario

Area defined by locations of comprehensive primary care physicians

Network hub

Zones of concentration of comprehensive primary health care within multispeciality physician networks: Hamilton and Niagara

Area defined by locations of comprehensive primary care physicians

Network hub

Zones of concentration of comprehensive primary health care within multispeciality physician networks: Simcoe

Area defined by locations of comprehensive primary care physicians

Network hub

Zones of concentration of comprehensive primary health care within multispeciality physician networks: Greater Toronto Area

Area defined by locations of comprehensive primary care physicians

Network hub

Zones of concentration of comprehensive primary health care within multispeciality physician networks: Southeast Ontario

Area defined by locations of comprehensive primary care physicians

Network hub

Zones of concentration of comprehensive primary health care within multispeciality physician networks: North

Area defined by locations of comprehensive primary care physicians

Network hub

low. Northern rural networks (RIO ≥ 40) were small, with few specialists, hospital beds, and ICU beds; they had similar loyalties to suburban networks (RIO 10–39). Distances between residents and providers were generally short; 99.1% of primary care physicians practised less than 100 km from their respective network hubs. The prevalence of chronic conditions varied about 2-fold across networks (Table 3). There was modest variability in the proportion of patients rostered to a primary care model. The supply of primary care physicians varied

about 1.5-fold, and specialist supply about 4-fold, across networks (Table 4). The supply of acute care and intensive care beds varied 3- to 5-fold.

Interpretation

We identified and characterized informal, multi-specialty physician networks in Ontario, which can be viewed as "self-organizing systems of care" that collectively serve their large panels of patients. Physicians in these networks were associated by virtue of sharing

Table 2
Network size, loyalty, and distance measures*

Characteristic	10th percentile	50th percentile	90th percentile
Network size			
No. of residents			
Total	48 016	134 723	343 527
Newborns	1 311	4 261	11 561
New immigrants	301	1 844	14 380
No. of physicians			
Total	75	294	822
Primary care	51	125	294
Specialist	20	143	527
Loyalty, %			
Admission loyalty to network hospital(s)			
Overall	36.0	58.7	81.3
RIO < 10 (urban)	31.3	42.5	87.9
RIO ≥ 10 (suburban and rural)	55.9	69.5	81.0
Admission loyalty to network hospital(s) for non-maternal medical admissions			
Overall	34.5	67.4	88.0
RIO < 10 (urban)	33.0	45.0	88.5
RIO ≥ 10 (suburban and rural)	66.1	75.9	87.9
Loyalty to primary care physicians in network			
Overall	72.8	81.1	92.4
RIO < 10 (urban)	72.3	77.0	90.0
RIO ≥ 10 (suburban and rural)	81.2	88.5	91.3
Loyalty to all physicians in network			
Overall	59.4	68.4	86.3
RIO < 10 (urban)	56.4	64.7	77.9
RIO ≥ 10 (suburban and rural)	65.5	78.1	86.3
Distance, km†			
Between residents and usual primary care provider, 90th percentile	20.8	26.7	43.1
Between residents and provider cluster, 90th percentile	20.9	28.0	47.8
Between physicians and provider cluster, 90th percentile	8.7	18.5	71.7

RIO = Rurality Index of Ontario.[36]

* Characteristics were computed at the network level, with weighting by network population, before the percentiles were computed.

† For each network, the authors first computed the 90th percentile for each of the 3 distances listed (residents to primary care providers, residents to provider cluster, and physicians to provider cluster) to estimate where most residents and physicians were located. Reported in the table are the 10th, 50th, and 90th percentiles of these values across all networks.

Table 3
Characteristics of network residents, as of April 1, 2008

Characteristic	10th percentile	50th percentile	90th percentile
Demographic			
Age, mean, yr	34	37	41
Sex, % female	50.6	51.6	52.7
Household income, mean, $	55 886	67 818	80 948
Rurality, RIO*	1.1	4.3	28.2
Primary care			
% of residents whose usual provider of primary care was a primary care physician	94.4	98.4	99.5
% of residents rostered to a primary care model†	63.1	70.1	79.9
Prevalence of chronic conditions, % of residents‡			
None	52.6	60.4	64.5
Diabetes mellitus	6.1	7.8	9.1
Acute myocardial infarction	0.9	1.5	2.2
Congestive heart failure	2.4	3.4	4.6
Chronic obstructive pulmonary disease	6.6	10.3	15.6
Asthma	11.3	13.4	16.4
Hypertension	21.8	25.4	31.6
Cancer	2.3	3.4	4.5
≥ 3 chronic conditions	3.5	4.9	7.2
Other clinical characteristics			
% preterm babies (among residents aged ≤ 5 yr)	5.2	6.1	7.2
% of patients with Charlson comorbidity score ≥ 3§	6.0	8.1	10.5

RIO = Rurality Index of Ontario.[36]

*RIO values 0–9 designate urban settings, 10–29 suburban, and ≥ 40 rural.

†Rostered as of midpoint of study period (Oct. 1, 2009).

‡For diabetes, asthma, and cancer, based on population of all ages; for acute myocardial infarction and hypertension, based on population aged ≥ 20 years; for chronic obstructive pulmonary disease and congestive heart failure, based on population aged ≥ 40 years.

§Among those who were admitted to hospital

Table 4
Network supply of health care resources

Characteristic	10th percentile	50th percentile	90th percentile
Physician supply, FTEs per 100 000 population			
Primary care physicians	70.6	81.1	104.7
Specialist physicians	48.3	73.6	202.3
Primary care physicians			
No. of patients in physician's panel,* mean	923	1358	1773
Continuity of care, %	88.8	92.6	94.9
Belonging to a primary care model, %†	70.8	78.0	87.5
Hospital resource supply			
Acute care beds per 1000	0.8	1.2	2.4
ICU beds per 10 000	0.5	1.0	2.3

FTE = full-time equivalent, ICU = intensive care unit.

*The patient panel for each primary care physician was defined according to the linkage between residents and usual providers of primary care, as described in the Methods section.

†As of midpoint of study period (Oct. 1, 2009).

care for common patients and admitting patients to the same hospital. Not every physician shared patients or consulted with every other physician in their network, but collectively they shared important resources such as acute care beds, specialists, and inpatient medical technologies that affect patients' outcomes. Networks were not constrained geographically but were based on where patients sought care, since health care is not delivered according to geographic boundaries. These informal networks provide a snapshot of how care was organized during this period, rather than prescribing how it should be organized.

The main strength of this work lies in its high face validity, based on high loyalty and close proximity among patients and providers. The other main strength is that it permits the identification of a target population (denominator) for reporting quality and performance rates. Most networks had sufficient patients with chronic disease to measure performance and outcomes. Primary care loyalty was high, because such care was provided locally. Physician loyalty was moderately high, since patients could be referred to specialists outside their network; nevertheless, care was generally concentrated among local providers since primary care physicians often refer to the specialists working in the local hospitals where their patients are admitted. Admission loyalty was lower for urban networks, since patients may be admitted to and physicians may have privileges at many nearby hospitals. Other researchers have created physician networks on the basis of shared patients, but they did not aggregate provider clusters to networks, and some did not include hospitals or residents less than 65 years of age.[33,46,47]

The primary limitation of this study was the fluid nature of health care–seeking behaviour. We linked residents and physicians on the basis of average utilization patterns over 3 years; however, patients may have switched primary care physicians, and both patients and physicians may have moved over this period. Nonetheless, as long as there are no major hospital openings or closures, or changes to workforce policy, the basic network organization should persist. In fact, we applied the same method over the period 2005/2006 to 2007/2008 and obtained similar networks. Another limitation was the possibility that the patients linked to individual primary care physicians were admitted to more than one hospital, so the specificity of assignment to a single hospital was only moderate in urban areas; however, this is the nature of patient flow in large urban areas. We could not link long-term care,

Community Care Access Centres, or public health units to the networks, since we did not have the appropriate data to do so. It will be important to add these services in the future, as they play a support role in the community that may help to reduce hospital admissions and readmissions.

This work is aligned with a systems-minded approach to providing chronic disease care and promoting accountability.[29,48] The overarching aim is to explore virtual multispecialty physician networks as functional and organizational units for chronic disease care and to better understand systems factors and strategies associated with efficient networks. Large multispecialty physician networks may be the most practical level for targeting reforms for integration of care, since providers are already connected by virtue of caring for the same patients. Such networks comprise large, multidisciplinary groups that work together to manage patients with chronic disease and might be more conducive to evaluation, system interventions, and physician accountability frameworks. These networks could provide the context and information to engage hospitals, physicians, interdisciplinary care providers, and policy-makers in discussions of how to better align medical practice with evidence and how to address resource use and integration across hospital and ambulatory sectors.

It will be no small task to exploit these networks for the purpose of improving care. There is currently no accountability framework that encompasses hospitals, specialists and primary care physicians, and interdisciplinary care providers. The current payment system is a patchwork of global budgets for hospitals, fee for service, capitation, and incentives for primary care, with fee-for-service and alternate funding plans for specialists; none of these modes of payment are aligned with multidisciplinary physician practices. In addition, regional jurisdiction over primary care may be at odds with the locations where patients seek care and where their providers are located. Ontario has recently shown a willingness to embrace new structural models through the creation of a set of pilot Health Links that, in some respects, resemble these networks, to improve care for complex high-needs patients and to reduce avoidable readmissions to hospital.[49] The developments in Ontario may provide a nascent organizational structure for vertically integrated networks.

In summary, formal constitution of multispecialty physician networks around existing patterns of patient flow could foster accountability for efficient, integrated

care, investment in electronic medical records, care coordination, performance measurement, care management tools, and quality improvement, the concepts behind "accountable care organizations."[29]

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