An Integrated Primary Care Workforce Planning Toolkit at The Regional Level (Part 2) Quantitative Tools Compiled for Decision-Makers in Toronto, Canada

Sarah Simkin (ssimk047@uottawa.ca)
Canadian Health Workforce Network  https://orcid.org/0000-0002-7770-7747

Caroline Chamberland-Rowe
University of Ottawa Telfer School of Management

Ivy Lynn Bourgeault
University of Ottawa  https://orcid.org/0000-0002-5113-9243

Research

Keywords: Integrated Health Workforce Planning, Primary Care, Population Health Needs, Regional Planning, Multi-Professional, Service-Focused, Practice Patterns, Population Mobility

Posted Date: October 19th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-92111/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Version of Record: A version of this preprint was published at Human Resources for Health on July 21st, 2021. See the published version at https://doi.org/10.1186/s12960-021-00595-y.
Abstract

Background: Health workforce planning capability at a regional level is increasingly necessary to ensure that the healthcare needs of defined local populations can be met by the health workforce. In 2016, a regional health authority in Toronto, Canada identified a need for more robust health workforce planning infrastructure and processes. The goal of this project was to develop an evidence-informed toolkit for integrated, multi-professional, needs-based primary care workforce planning for the region. This article presents the quantitative component of the workforce planning toolkit and describes the process followed to develop this tool.

Methods: We first developed a framework for quantitative health workforce planning to assess the alignment of regional service requirements with the service capacity of the workforce. We then conducted an environmental scan to identify datasets addressing population health need and profession-specific health workforce supply that could contribute to quantitative health workforce modeling. We assessed these sources of data for comprehensiveness, quality, and availability.

Results: The quantitative model developed as part of the toolkit includes components relating to both population health need and health workforce supply. Different modules were developed to capture the information, including an allocation process for optimizing service delivery. Only data elements meeting criteria for quality, availability, and comprehensiveness were integrated into the model.

Conclusions: A quantitative health workforce planning model is a necessary component of any health workforce planning toolkit. In combination with qualitative tools, it supports integrated, multi-professional, needs-based primary care workforce planning.

Background

The goal of health workforce planning is to ensure alignment between population health needs and the capacity of the health workforce to meet those needs. While it is typical for workforce planning models to operate at national, provincial or state scales, regional workforce planning – at sub-national and sub-provincial planning geographies – helps to focus on the more proximate healthcare needs of cities, communities, and neighbourhoods. Unmet regional needs have highlighted the inadequacies of planning at broader scales. Planning at a regional level promotes both accuracy and equity by ensuring that the healthcare needs of defined local populations can be met by the locally available health workforce. Regional planning can also guide efficient deployment of resources – health workforce and otherwise – where they are most needed. When the responsibility for planning, coordinating, integrating, and funding services is assumed by organizations at the regional level, the need for infrastructure, processes, and capability to support health workforce planning at the regional level becomes apparent.

In Canada, a country with universal health coverage, healthcare falls under provincial jurisdiction. Each province organizes, funds, and administers the provision of healthcare services. In Ontario, Canada's most populous province, crown agencies called Local Health Integration Networks (LHINs) planned,
integrated, and funded health services at a local level until a health system transformation early in 2019 (Fig. 1). The LHINs had an administrative role in diverse healthcare services including hospitals, Community Health Centres, long term care homes, mental health and addiction agencies, and community support service agencies. After the Patients First Act (Bill 41) passed in 2016, health workforce planning was added to the mandate of these regional health authorities and they became involved in administering the organization and integration of primary care health services.

The Toronto Central LHIN (TC LHIN) (LHIN #7 in the Figure) was responsible for administering health care services for the 1.15 million people living in the core of the city of Toronto. Highly urbanized, the TC LHIN shared boundaries with four other suburban LHINs. Itself, the TC LHIN was divided into five sub-regions (Fig. 2) and was located entirely within the boundaries of the City of Toronto. The City of Toronto is divided into 140 neighbourhoods, of which 72 are within the former borders of the TC LHIN (Fig. 3).

Rapidly changing demographics and disparities in access to integrated primary care between sub-regions provided the impetus for the development of a comprehensive Primary Care Strategy. This strategy, which was developed with patient and provider input, aimed to improve patient access to care, service integration, and system efficiency. The TC LHIN recognized that successful implementation of this strategy was contingent upon adequately planning for the health workforce needs of the future and that a robust, regional-level planning framework was necessary.

Accordingly, our team at the Canadian Health Workforce Network (CHWN) was contracted to develop an evidence-informed toolkit for integrated, population needs-based, multi-professional primary care workforce planning in the TC LHIN. The toolkit developed is a fit-for-purpose collection of qualitative, descriptive and quantitative processes to guide and support the TC LHIN in conducting health workforce planning activities.

A comprehensive review of existing models and methods in health workforce planning was conducted to leverage leading practices in the development of a workforce planning process (Chamberland-Rowe, Simkin & Bourgeault REFERENCE TO Part 1 PAPER). Our intention was to acknowledge and address key challenges faced by our regional partners and to tailor the approach to the local planning needs of the TC LHIN. As a result, the toolkit presents a fit-for-purpose planning process that mobilizes the best and most relevant tools available to allow for integrated, multi-professional, needs-based primary care workforce planning at a regional level.

Embedded within the health workforce planning toolkit developed for the TC LHIN is a quantitative model that assesses the alignment of population service requirements with workforce service capacity (Fig. 4). An allocation step facilitates exploration of alternative allocations of services across providers with relevant scopes of practice. Scenarios can be introduced at key decision-points in the model to assess the impact of changing population health profiles, changing workforce profiles, and alternate models of care. Data sources supporting scenario analyses may be descriptive and of either a quantitative or qualitative nature.
This article describes the process we followed to identify the data necessary to render the quantitative tool functional and the process by which alignment of workforce requirements with workforce supply can be assessed.

**Methods**

Using an approach informed by a participatory action research framework\[1\], we collaborated closely with TC LHIN leadership and staff, primary care physician community leaders, and representatives from the City of Toronto throughout the project. We adopted a hybrid set of methodologies, refined at each stage, to produce an end product that is fit for the different purposes our partners intended.

The first step in developing the quantitative workforce planning tool was a comprehensive environmental scan of data sources and elements that could be used to inform health workforce planning in the TC LHIN. While wide-ranging, our scan was not exhaustive; its goal was to identify exemplars of data that could be considered for use in quantitative workforce planning models.

We identified sources of data related to the population of patients using primary care services in the TC LHIN, including:

- the Census of Population, the National Household Survey, the Canadian Community Health Survey, each managed by Statistics Canada;
- the City of Toronto Open Data Catalogue; and
- the Ontario Community Health Profiles Partnership.

Various data elements were examined, including variables related to demography, socioeconomic and cultural diversity, health status, health services utilization and needs, and metrics of unmet health care need. We specifically sought population variables (such as gender, race, and disability) that would facilitate the addition of a health equity dimension to workforce planning activities in the TC LHIN.

We also identified sources of data related to the health workforce in the TC LHIN. These sources included health workforce data from:

- the TC LHIN Health Provider Census;
- the Health Professions Database, held by the Ontario Ministry of Health and Long Term Care (MOHLTC);
- the Ontario Physician Resource Data Centre (OPHRDC);
- the Institute for Clinical Evaluative Sciences (IC/ES), a not-for-profit research institute that maintains an array of Ontario's health-related data; and
- the College of Nurses of Ontario (CNO), the Canadian Federation of Nurses Unions (CFNU), the Canadian Association of Schools of Nursing (CASN), and the Canadian Council of Registered Nurse Regulators (CCRNR).
We examined data elements related to the stock of providers, their activity and participation rates, their scopes of practice, inflows to and outflows from the workforce, provider practice patterns, and productivity. As with our scan of population data, we specifically sought workforce variables – such as gender, race, and language – that would bolster the capacity of the TC LHIN to conduct workforce planning with a health equity dimension.

We used three criteria to assess the datasets and data elements identified in the scan: quality, availability, and comprehensiveness. For each criterion, we elaborated an approach based on principles of sound health workforce planning to guide the TC LHIN in making decisions about the inclusion of data in the quantitative modeling tool:

- **Quality**: The highest quality data should be chosen to populate the model, with due consideration of the source, strengths, and limitations of each variable. If quality data are not available, planning strategies other than quantitative modelling should be considered.

- **Availability**: Priority should be given to data that are readily available. These include data in the public domain as well as those datasets curated by the TC LHIN. Custom data requests should be assessed for feasibility in terms of timely access to data, comparability and linkability of data, and cost.

- **Comprehensiveness**: Selected datasets should facilitate the analysis of a wide range of scenarios. Variables should be as comprehensive as possible, incorporating diverse factors related to both the population and the health workforce. Data should be as current as possible, with historical data included when available. Data should be comprehensive enough to allow for analysis at multiple geographies – including the neighbourhood, the sub-region, the LHIN, and supra-LHIN (entire City of Toronto) levels – depending on the scenario in question. Not all data will be necessary for all scenarios, but datasets may be included with a view to providing contextual information or contributing to future evaluation of policy decisions.

We also reviewed population grouping methodologies, including the Canadian Institute for Health Information (CIHI) Population Grouping Methodology and the Johns Hopkins ACG (Adjusted Clinical Groups) System, with a view to identifying the methodology most suitable for use by the TC LHIN in a quantitative workforce planning model. Both the CIHI Population Grouping Methodology and the Johns Hopkins ACG System use clinical and demographic profiles to assign patients to clinically coherent case-mix groups. However, the CIHI Population Grouping Methodology also includes a tool, based on Canadian data, that connects population health characteristics with requirements for health services. The tool predicts the need for visits to a family physician, the anticipated number of Emergency Department visits, and the probability of admission to Long-Term Care.

Our scan for data elements and assessment of their quality, availability, and comprehensiveness informed the development of a fit-for-purpose conceptual model ready to be populated with data contemporaneously available to the TC LHIN.
Results

Data Scan and Assessment: Population

Many comprehensive, high-quality data on population health characteristics are available for use in population needs-based, health workforce planning, though most (if not all) are not designed explicitly for these purposes. The results of the scan for data related to population demography, cultural and socioeconomic diversity, population health status, and health service utilization are shown in Tables 1, 2, and 3.

Multiple sources of data are available to the TC LHIN to support planning. The information is available at various levels of geography and for a variety of time periods.

We identified several populations for which data are not available, or the available data are not of sufficient quality, to allow for quantitative modeling. These populations include Indigenous patients, homeless patients, and non-insured patients. For these populations, we suggest that other sources of data – such as local surveys – be considered and that decision-makers advocate for better data to support planning for equitable provision of healthcare for these groups of patients.

Population Grouping Methodology

We assessed the CIHI Population Grouping Methodology\(^2\) as the most promising method to project needs-based primary care service requirements within the TC LHIN. This innovative, made-in-Canada grouping methodology uses individual-level clinical and demographic data to estimate population health needs, including the predicted number of visits to a family physician (Table 4). Application of this methodology to a region, such as the TC LHIN, with plentiful neighbourhood-level data on population health characteristics, including the social determinants of health, would allow decision-makers to develop a thorough understanding of the influence of various characteristics of the local population on the need for physician services, and to plan accordingly.

Data Scan and Assessment: Workforce

Some high-quality data on the health workforce are available for use in health workforce planning. The results of the scan for data related to physicians, nurses, nurse practitioners, and other regulated health professionals, including those in two inter-professional primary care delivery models operating in Ontario are shown in Table 5.

Data related to the health workforce are comprehensive, generally of high quality and may be accessed by regional planners through an application and approval process. Capturing practice activities of different health worker cadres is more challenging, and quantitative data on service provision, and on where practice activities overlap between professions, are less robust.

Building a Health Workforce Planning Model
Using data elements related to population health characteristics and health workforce profiles, as well as the CIHI Population Grouping Methodology, the model examines the alignment of the service requirements of the population with the service capacity of the workforce. An additional module allows for allocation of services across providers before the final examination of alignment. This exercise is an important but often overlooked part of planning. By including this step, our model embeds a systematic approach to minimizing the gap between workforce requirements and supply and optimizing the alignment of the health workforce with the needs of the population.

Step 1: Estimation of Population Service Requirements

The movement of patients across boundaries – between the urban TC LHIN and the four adjacent suburban LHINs, between sub-regions within the LHIN, and between neighbourhoods within the LHIN or beyond – was identified by the TC LHIN as a unique planning challenge. For the purposes of planning, the global population of patients who receive primary care within the TC LHIN is necessarily approached as two distinct populations: (1) residents of the TC LHIN, and (2) patients who do not reside in the geographic area of the TC LHIN but who seek and receive their care within the LHIN’s borders. This approach recognizes that the TC LHIN must plan to provide services to the patients who reside within its borders, while also acknowledging the reality that patients travel from outside the LHIN to access care.

To estimate service requirements, it is necessary to define a geographic planning region. This may be a single neighbourhood, a group of neighbourhoods, one or more LHIN sub-regions, the TC LHIN, or the entire City of Toronto. Service requirements are defined as the number of primary care visits needed for patients receiving care within the planning geography. These patients may be residents or non-residents and may receive a variable proportion of their care in the region in question. Service requirements are derived using the CIHI Population Grouping Methodology, which produces individual-level outputs – predicted number of visits to a family physician in the next year – that are then aggregated to the population level.

Thus, in a given year \( y \) in a defined geography \( g \), Service Requirements can be expressed by the following equation:

\[
V_{TOT} = V_{RES} (P_{RESg}) + V_{NRES} (P_{NRESg}) + U_s
\]

Where:

\( V_{TOT} \) is Total visits required

\( V_{RES} \) is Visits required by the resident population

\( P_{RESg} \) is % care residents receive within the defined geography

\( V_{NRES} \) is Visits required by the non-resident population receiving care within the defined geography

\( U_s \)
\( P_{NRESg} \) is \% care non-residents receive within the defined geography

\( U_s \) is a Subjective measure of unmet need

Unmet health care needs are an important contributor to service requirements, and estimates of service requirements are strengthened by explicit consideration of these needs. As such, a subjective measure of unmet health care needs – informed by data from the Canadian Community Health Survey and through local consultations – can be added to the calculations.

**Step 2: Estimation of Workforce Service Capacity**

Estimation of the service capacity of the workforce is conducted on a uni-professional basis and begins with identification of the stock of providers available to provide service. Adjustments are then applied to account for each factor that influences the service capacity of the workforce. These factors include inflows (immigration), outflows (emigration), and attrition due to death and retirement. Additional adjustments may be applied to account for activity rates, participation in the provision of care within the TC LHIN, and scope of practice that varies between providers. More detailed adjustments, such as an adjustment to account for changing practice patterns, may be applied, subject to available data. Finally, a subjective productivity variable allows for scenarios related to productivity to be incorporated into the model, adjusting the workforce service capacity according to productivity assumptions.

The end result of these calculations is an estimate of the total service capacity of the workforce. Due to the variability of the data elements in the available datasets, the unit of analysis for physicians is **visits** per year, while for other regulated primary healthcare professionals, the unit of analysis is **hours** per year. The unit of analysis of Activity for NPs may be either **visits** or **hours** per year, depending on the dataset employed. These estimates would have to be integrated prior to proceeding further in the model.

**Step 3: Assessment of Alignment Between Service Requirements and Service Capacity**

The next step in the model is an assessment of the alignment between service requirements and service capacity. In the case of perfect alignment, no further action is necessary. It is more likely, however, that a gap exists between the requirements of the population for healthcare services and the capacity of the workforce to deliver these services. In this case, an allocation process is suggested to explore ways of minimizing this gap.

**Step 4: Allocation of Services Across Providers**

The goal of this step in the planning process is to optimize the distribution of services, such that service capacity approximates service requirements as closely as possible.

Allocation may be conducted quantitatively, qualitatively (descriptively), or both. The leading practice quantitative allocation methodology uses a ‘plasticity matrix’[i]. This methodology compares actual workforce activities with a standard or benchmark activity distribution to examine the sufficiency of the
existing workforce, accounting for flexible and overlapping scopes of practice within and between professions and specialties. The methodology enables the shifting of services within a given specialty or between specialties or professions to achieve an optimal distribution of services.

In the context of primary care services in the TC LHIN, shifting visits between family physicians and nurse practitioners presents an opportunity to optimize allocation of services (and the scope of practice of each). In order to accomplish this allocation using a plasticity matrix, detailed quantitative data regarding the scopes of practice of both family physicians and nurse practitioners and an understanding of where these scopes overlap and where they differ is necessary. Unfortunately, quantitative data of this sort is not of high enough quality and sufficient detail at this time. As such, we suggest that a descriptive allocation process be undertaken locally, with the goal of defining unique and overlapping scopes of practice and shifting services to minimize the gap between workforce requirements and workforce supply, to optimize skill mix, and to facilitate all providers practicing to the optimal extent of their scopes of practice. This can be integrated into a scenario analysis at the allocation phase.

The descriptive allocation process in the planning toolkit is inspired by adjusted service target-based planning. The process estimates the requirements of a specific population for a defined package of primary care services. Services are then iteratively allocated to providers with relevant scopes of practice until optimal alignment between service requirements and service capacity is achieved. This approach accounts for factors that are often at play in health systems, including skill mix within the workforce, current or projected workforce availability, service costs, and emerging models of care.

**Step 5: Final Assessment of Alignment Between Workforce Requirements and Workforce Supply**

The gap between workforce requirements and workforce supply offers important insights into the state of local health systems and can be helpful in informing policy development. If requirements exceed supply in a defined geographic planning region, then plans can be made to supplement existing resources to better meet the needs of the population. Conversely, if workforce supply exceeds workforce requirements, then resources can be diverted to other areas experiencing greater need. In a system with limited resources, such analyses are foundational to effective and equitable distribution of healthcare resources. Local health leaders, primary care providers, and patients themselves can validate the gap analysis, indicate whether the results resonate with their experiences, and provide local intelligence to guide the planning process and offer potential solutions to local health service issues.

**Scenario Analyses**

As described in Chamberland-Rowe, Simkin & Bourgeault PAPER 1, scenario analyses are designed to simulate the potential implications of changes that could occur within the system. Policy-makers can test the impact of different scenarios, at different points in the model, such as changing population characteristics, changing workforce profiles, or alternate models of care. Altering the value of various parameters within the model and examining the results facilitates decision-making that accounts for a range of possible futures. Scenario analyses may be supported by quantitative or descriptive data and
provide an opportunity to engage stakeholders and incorporate local intelligence into decision-making. This promotes greater understanding and acceptance of planning and resource allocation decisions.

**Discussion**

The toolkit is a fit-for-purpose collection of descriptive and quantitative processes to guide and support the TC LHIN in conducting health workforce planning activities. By assembling a selection of multi-methodological tools, and providing guidelines and support for their use, we have established a transparent and accessible approach that can help to make the complexities of health workforce planning manageable for a regional health authority.

Our approach is consistent with extant population needs-based health workforce planning models. In particular, our scan for data sources to support the calculation of population service requirements yielded results very similar to the three data inputs – population, health status, and level of service – characterized by Tomblin Murphy and colleagues.[i]

Addressing the specific objectives and planning needs of the TC LHIN, the toolkit we developed mobilizes a variety of processes to allow for integrated primary care workforce planning. The quantitative model is comprehensive and explicitly considers a multiplicity of factors influencing both service requirements and service capacity. To the extent permitted by the availability of high quality data, these factors are considered quantitatively; when data are not available, a detailed descriptive modeling process is offered.

The model we developed is foundational and versatile; expansion of the model through the addition of more variables and data (when they become available) will yield a more complex model capable of addressing more complex scenarios. It also facilitates the interfacing of primary care planning with other health workforce planning efforts within the broader health system.

While the data sources we identified are specific to the TC LHIN, and the toolkit explicitly addresses the unique needs and priorities of the TC LHIN, the planning processes we describe are eminently transferrable. The principles are adaptable to other contexts and jurisdictions and represent a robust and dynamic collection of tools for iterative, integrated, needs-based health workforce planning.

**Challenges**

One of the first challenges we encountered was in defining primary care and identifying which professions and services should be included in primary care planning activities within the TC LHIN. Recognizing that primary care is different in different contexts, we ultimately took an inclusive and pragmatic approach, including data sources on all professions and services that could possibly be of value in planning. The modular nature of the toolkit allows those primary care providers and primary care tasks most relevant to a given planning exercise to be included when necessary.

A second challenge, common to many jurisdictions in Canada and abroad, was data availability. We identified currently available sources of the highest quality data to populate the quantitative model.
However, we also identified significant data gaps related to certain populations, professions, and professional activities.

**Limitations**

One notable difference between our quantitative model and that of Tomblin Murphy and colleagues is that ours lacks a module related to training. The TC LHIN had no levers related to training and was not able to make decisions related to health professional education. As such, our model assumes that the health workforce in the TC LHIN was not limited in any way by the training pathway. This assumption, while arguably reasonable for the City of Toronto, may not be applicable in other jurisdictions, particularly those more rural or underserved.

A recognized limitation of the CIHI Population Grouping Methodology is that it does not yet capture other primary care providers beyond family physicians. As a result, our ability to use quantitative tools to model the need for primary care services delivered by providers other than physicians is currently limited.

**Addendum**

Since the completion of this phase of the project, a change of government has taken place in Ontario and a program of health system transformation under a new government is underway. The role of regional agencies with respect to health workforce planning continues to evolve. Although the ultimate result of this evolution is still unclear, the integration of our approach into ongoing planning activities presents an opportunity to address inequities in access and outcome for regional populations.

**Conclusions**

The objective of health workforce planning is not to predict the future but instead to allow policy-makers to understand how various factors interact to influence the population need for health care services and the ability of the workforce to meet this need. We have assembled a fit-for-purpose toolkit – including a quantitative model – that will enable regional health authorities to understand the population and the workforce and to generate scenarios related to both, to undertake planning that considers a range of potential future states, and to make evidence-informed policy and planning decisions for the delivery of regional primary care services.

**List Of Abbreviations**

ACG: Adjusted Clinical Groups

CASN: Canadian Association of Schools of Nursing

CCNR: Canadian Council of Registered Nurse Regulators

CFNU: Canadian Federation of Nurses Unions
CHWN: Canadian Health Workforce Network
CIHI: Canadian Institute for Health Information
CNO: College of Nurses of Ontario
HWP: Health Workforce Planning
IC/ES: Institute for Clinical Evaluative Sciences
LHIN: Local Health Integration Network
MOHLTC: Ministry of Health and Long-Term Care
OPHRDC: Ontario Physician Human Resources Data Centre
TC LHIN: Toronto Central Local Health Integration Network

Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Availability of data and material: Data sharing is not applicable to this article as no datasets were generated or analysed.

Competing interests: The authors declare that they have no competing interests.

Funding: This study was funded by the Toronto Central Local Health Integration Network, in partnership with St. Michael’s Hospital. Both funders were consulted throughout the toolkit development process, and the organizational needs expressed by the funding agencies informed the authors’ assessment of the relevance of identified health workforce planning models and datasets.

Authors’ contributions: SS developed the quantitative HWP model. IB supervised the development of all presented tools. IB, CCR, and SS prepared the manuscript. All authors read and approved the final manuscript.

Acknowledgements: The authors would like to acknowledge the contributions Chantal Demers and Hossein Salehi to the consultation which formed the basis for this manuscript

References

1. Baum F, MacDougall C, Smith D. Participatory action research. Journal of Epidemiology & Community Health 2006; 60(10): 854-857. doi: 10.1136/jech.2004.028662
2. Canadian Institute for Health Information. *Population Grouping Methodology* [information sheet]. Ottawa, ON: CIHI; 2020.

3. [https://www.hopkinsacg.org](https://www.hopkinsacg.org)

4. Holmes GM, Morrison M, Pathman DE, Fraher E. The contribution of "plasticity" to modeling how a community’s need for health care services can be met by different configurations of physicians. *Academic Medicine* 2013; 88(12): 1877-1882.

5. Dreesch N, Dolea C, Dal Poz M, Goubarev A, Adams O, Aregawi M et al. An approach to estimating human resource requirements to achieve the Millennium Development Goals. *Health Policy & Planning* 2005; 20(5): 267-276.

6. Guerra Arias M, Nove A, Michel-Schuldt M, de Bernis L. Current and future availability of and need for human resources for sexual, reproductive, maternal and newborn health in 41 countries in Sub-Saharan Africa. *International Journal for Equity in Health* 2017; 16(1): 69.

7. ten Hoope-Bender P, Nove A, Sochas L, Matthews Z, Homer CSE, Pozo-Martín F. The 'Dream Team' for sexual, reproductive, maternal, newborn and adolescent health: an adjusted service target model to estimate the ideal mix of health care professionals to cover population need. *Human Resources for Health* 2017; 15:17.

8. Jansen C, Codjia L, Cometto G, Yansané ML, Dieleman M. Realizing universal health coverage for maternal health services in the Republic of Guinea: The use of workforce projections to design health labor market interventions. *Risk Management and Healthcare Policy* 2014; 7: 219-32.

9. Tomblin Murphy G, MacKenzie A, Alder R, Birch S, Kephart G, O’Brien-Pallas L. An applied simulation model for estimating the supply of and requirements for registered nurses based on population health needs. *Policy, Politics and Nursing Practice* 2009; 10(4): 240-251.

**Tables**
| Population Profile Data | Geographies     | Variables                      | Source                                      | Years                                      | Quality |
|-------------------------|-----------------|--------------------------------|---------------------------------------------|--------------------------------------------|---------|
| Demography              | Neighbourhood   | Age                            | Census                                      | 1996, 2001, 2006, 2011, 2016, Projections 2016–2041 | High    |
|                         | Sub-Region      | Gender                         |                                             |                                            |         |
|                         | LHIN            |                                |                                             |                                            |         |
| Cultural & Socioeconomic Diversity | LHIN           | Language                        | Census                                      | 1996, 2001, 2006, 2016                      | High    |
|                         | Neighbourhood   | Immigration                    | Census                                      | 1996, 2001, 2006                           | High    |
|                         |                 |                                | NHS                                         | 2011                                       | Moderate|
|                         | Neighbourhood   | Visible Minority Status        | Census                                      | 1996, 2001                                | High    |
|                         |                 |                                | NHS                                         | 2011                                       | Moderate|
|                         | Neighbourhood   | Education                      | Census                                      | 2006, 2016                                | High    |
|                         |                 |                                | NHS                                         | 2011                                       | Moderate|
|                         | Neighbourhood   | Employment                     | Census                                      | 2006, 2016                                | High    |
|                         |                 |                                | NHS                                         | 2011                                       | Moderate|
|                         | Neighbourhood   | Income                         | Census                                      | 1996, 2001, 2006, 2016                    | High    |
|                         |                 |                                | NHS                                         | 2011                                       | Moderate|
|                         | Neighbourhood   | Social Assistance              | Toronto Employment & Social Services, Data Mart | 2008, 2012 |         |
|                         |                 |                                |                                             |                                            |         |
|                         | Neighbourhood   | Equity                         | Census, Urban HEART                         | 2008                                       | High    |
|                         |                 |                                |                                             |                                            |         |
|                         | Neighbourhood   | Child Development              | City of Toronto                             | 2008, 2011, 2015                          | High    |
| Population Profile Data | Disease Condition | Variable | Geographies | Years | Source | Quality |
|-------------------------|------------------|----------|-------------|-------|--------|---------|
| Health Status           | • Diabetes       | Prevalence| Neighbourhood| 2015, 2012, 2011, 2007, 2001–2003 | Ontario Health Profiles | High |
|                         | • Asthma         |          |             |       |        |         |
|                         | • Hypertension   |          |             |       |        |         |
|                         | • Mental Health and Addiction-Related Visits |          |             |       |        |         |
|                         | • COPD           |          |             |       |        |         |
|                         |                  | Sub-region|             | 2015  |        |         |
|                         |                  | LHIN     |             | 2015, 2012, 2007 |        |         |
| Non-resident            | • Chlamydia     |          | Neighbourhood| 2008–2012 | Ontario Health Profiles | High |
|                         | • Gonorrhea      |          |             |       |        |         |
| Breast Cancer           | Screening       | Neighbourhood|             | 2013/14-2014/15, 2009–2011 | Ontario Health Profiles | High |
|                         |                  | Sub-region|             | 2013/14-2014/15 |        |         |
|                         |                  | LHIN     |             | 2013/14-2014/15, 2009–2011 |        |         |
| Cervical Cancer         | Screening       | Neighbourhood|             | 2012/13-2014/15, 2008–2011 | Ontario Health Profiles | High |
|                         |                  | Sub-region|             | 2013/14-2014/15 |        |         |
|                         |                  | LHIN     |             | 2013/14-2014/15, 2009–2011 |        |         |
| Colorectal Cancer       | Screening       | Neighbourhood|             | 2015, 2011 | Ontario Health Profiles | High |
|                         |                  | Sub-region|             | 2015, 2011 |        |         |
|                         |                  | LHIN     |             | 2015, 2011 |        |         |
| Population Profile Data | Disease Condition | Variable | Geographies | Years       | Source            | Quality |
|-------------------------|-------------------|----------|-------------|-------------|-------------------|---------|
|                         | Eye Exams Among People with Diabetes | Neighbourhood | 2006, 2010–2012 | Ontario Health Profiles | High |

Table 3  
Population Health Services Utilization

| Population Profile Data | Geographies | Years       | Source            | Quality |
|-------------------------|-------------|-------------|-------------------|---------|
| Interprofessional Care  | Neighbourhood | 2016       | Ontario Health Profiles | High |
| Enrolment and Continuity | Neighbourhood | 2011–2013 | Ontario Health Profiles | High |
|                         | Sub-region |             |                   |         |
|                         | LHIN       |             |                   |         |
| Preventable Hospitalizations | Neighbourhood | 2012–2014, 2014–2016 | Ontario Health Profiles | High |
|                         | LHIN       |             |                   |         |

Table 4  
CIHI Population Grouping Methodology

| Inputs                   | Outputs                                                                                                                                 |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Demographic              | • Registered Persons Database                                                                                                                                 |
| Clinical                 | • Ontario Health Insurance Plan (OHIP) Claims Database  
|                          | • Discharge Abstract Database  
|                          | • National Ambulatory Care Reporting System  
|                          | • Continuing Care Reporting System                                                                                                                                 |
|                          | • Health Profile Group  
|                          | • Predicted healthcare costs  
|                          | • Predicted use of selected health system resources:  
|                          | o Number of visits to a family physician  
|                          | o Number of Emergency Department visits  
|                          | o Probability of admission to Long-Term Care |
### Table 5
Health Workforce Data

| Health Service Provider | Variables                                                                 | Years                 | Source                                      | Quality |
|-------------------------|---------------------------------------------------------------------------|-----------------------|---------------------------------------------|---------|
| Physicians              | Demographic, Geographic, Specialty, Practice                              | 1992-present          | ICES: IPDB, CPDB                            | High    |
| Nurses                  | Membership Statistics                                                     | 2016, 2017           | CNO                                         | High    |
|                         | LHIN Regional Summaries                                                  | 2016                 | CNO                                         | High    |
| Nurse Practitioners     | Graduates                                                                | 2016                 | CASN                                        | High    |
|                         | Practice Analysis                                                         | 2015                 | CCRNR                                       | High    |
| Regulated Health        | 59-element minimum dataset**                                             | 2008-present          | MOHLTC: Health Professions Database         | High    |
| Professionals*          |                                                                           |                       |                                              |         |
| Family Health Teams     | MD, NP, RN, RPN, Mental Health Worker, Educator, Pharmacist, RD, Social Worker | 2016                 | ICES                                        | High    |
| Community Health Centres| Controlled Dataset – Accessible by Custom Request                         |                       | ICES                                        | High    |

* Audiologists, Chiropodists/Podiatrists, Chiropractors, Dental Hygienists, Dental Technologists, Dentists, Denturists, Dieticians, Kinesiologists, Massage Therapists, Medical Laboratory Technologists, Medical Radiation Technologists, Midwives, Nurse Practitioners, Occupational Therapists, Opticians, Optometrists, Pharmacists, Pharmacy Technicians, Physiotherapists, Psychologists, Registered Nurses, Registered Practical Nurses, Respiratory Therapists, Speech-Language Pathologists, Traditional Chinese Medicine Practitioners and Acupuncturists

** Minimum dataset elements: demographics, language of care, registration status and class, postal code of residence, geographic history of registration and practice, specialty certification, education within and outside the profession, employment history, current employment, practice activities, practice characteristics.

---

**Figures**
Figure 1

Ontario’s 14 Local Health Integration Networks (LHINs)
Figure 2

Sub-regions of the Toronto Central LHIN (pre 2019)
Figure 3

City of Toronto Neighbourhoods Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.
Figure 4

Primary Care Health Workforce Planning Model