Health Human Resources Planning: an examination of relationships among nursing service utilization, an estimate of population health and overall health status outcomes in the province of Ontario

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Key Implications for Decision Makers

♦ The goal of this study was to develop and test a way to establish, monitor, and predict need for nursing services by using the health needs of the population.

♦ This can be done with considerable data manipulation and sophisticated analysis based on the health needs of the population. Population health surveys offer a viable vehicle for both understanding and predicting nursing health human resources when data is linked with use, supply, census, and other data at the public health unit catchment area.

♦ Planning for health human resources should be based on the health needs of the population, and needs to consider factors that affect use of healthcare services, including social, political, geographical, technological, and economic factors.

♦ The findings suggest that decisions about the deployment of nursing resources are associated with differences in outcomes. Greater intensity of nursing resources is associated with shorter lengths of stay (other things being equal).

♦ There was no evidence that greater intensity of nursing resources resulted in poorer patient outcomes as measured by higher rates of readmission, lower levels of patient satisfaction, or lower levels of self reported health. This information is important to both health care managers and health human resource planners in considering the planning and use of health human resources.

♦ Use of community and hospital nursing services can be predicted by using factors that indicate need for healthcare services (such as health utility index score, self-rated health status, disability, and chronic conditions). Socioeconomic factors (age, gender, education, income, employment) also influence nursing services use.

♦ Although nursing staff is often the easiest thing to cut back on during hard fiscal times, and not always the easiest thing to justify expanding when times get better, increases and decreases in their caregiving has tangible effects for both patients and systems.

♦ Populations that have high rates of chronic conditions (such as diabetes or heart disease) and disabilities, and that have high proportions of elderly people, tend to use more nursing services. Decision makers should consider giving more resources to hospitals that serve populations with high levels of chronic conditions and disabilities, as these factors appear to increase the number of overnight hospital stays in those hospitals.

♦ Catchment areas for healthcare facilities and providers should be defined in a way that takes account of overlapping service areas and which gives greater weight to the populations that use the facilities more.

♦ There needs to be a significant investment in creating and maintaining readily accessible databases that allow us to compare differences between and across jurisdictions to understand the health needs of the population, and to determine whether the system is working in effective and efficient ways to meet these needs. There needs to be more effective ways to access data on healthcare use and factors that influence need for healthcare.
Executive Summary

The goal of this study was to develop and test a way to establish, monitor, and predict need for nursing services by using the health needs of the population. This study explored the relationship between the health needs of Ontarians, their use of community and hospital nursing services, and variations in outcomes.

The findings suggest that decisions about the deployment of nursing resources are associated with differences in outcomes. Greater intensity of nursing resources is associated with shorter lengths of stay (other things being equal). There was no evidence that greater intensity of nursing resources resulted in poorer patient outcomes as measured by higher rates of readmission, lower levels of patient satisfaction, or lower levels of self-reported health. This information is important to both healthcare managers and health human resource planners in considering the planning and use of health human resources. These findings emphasize that although nursing staff is often the easiest thing to cut back on during hard fiscal times, and not always the easiest thing to justify expanding when times get better, increases and decreases in their caregiving has tangible effects for both patients and systems. Therefore, greater attention needs to be paid to the mix of inputs: there is no use having more beds, theatres, MRIs, or physicians if we do not have the appropriate number of nurses with which these can be combined to generate optimal service outputs and health outcomes.

When looking at the effect that need for healthcare had on use of overnight hospital services, the study found that population areas with a large elderly population and high rates of severe chronic conditions and disabilities had more overnight hospital stays than areas with lower rates. Therefore, decision makers should consider giving more resources to hospitals that serve populations with high levels of
chronic conditions and disabilities, as these factors appear to increase the number of overnight hospital stays in those hospitals.

The study also looked at variations in hospital mortality, readmission rates, length of stay, and patient satisfaction. It found that the patient severity levels affected in-hospital mortality; the sicker the patient population, the more patient deaths that hospital will have. Areas with less unemployment were also more likely to have high inpatient mortality.

The only factor that affected readmission was education, in that hospitals where the population has more education are less likely to have readmissions than hospitals where there are fewer high school graduates.

The mean relative intensity weight was significant when looking at length of stay — the higher the severity of patient illness in a hospital, the longer the average length of stay. Nursing hours per patient day had a significant negative effect, meaning that the more nursing hours worked on a daily basis in a hospital, the shorter the average length of patient stay in that hospital.

The only variable that affected patient satisfaction was age. The higher the proportion of the hospital catchment area population that is over 65, the higher patients rate their satisfaction with that hospital’s unit-based care.

The study’s final question looked at the effect use of hospital and community nursing services had on health status. The study found that using more (or fewer) services than average had a statistically significant effect, but that it was not large enough to be practically significant.
Self-reported health status was generally lower for older patients. Females were significantly less likely to report better health than males. Respondents who were unemployed were significantly less likely to report better health than employed respondents. Respondents not living in metropolitan areas were more likely to report better health than respondents living in urban non-metropolitan areas. Lower-middle-, middle-, higher-middle-, and higher-income respondents were all more likely to report better health than lower-income respondents, though in the case of lower-middle-income respondents, the difference was not significant. Those respondents with a university degree were most likely to be healthy, followed by those with a trade school or community college diploma and those with a high school diploma. All three groups of respondents were significantly more likely than respondents without a high school diploma to report better health.

This study suggests that with considerable data manipulation and sophisticated analysis, it is possible to model needs for nursing health human resources based on the health needs of the population. Population health surveys offer a viable vehicle for both understanding and predicting nursing health human resources when data is linked with use, supply, census, and other data at the public health unit catchment area.

The results may be used by policy makers, decision makers, and researchers to help them create effective mechanisms and policies for establishing, monitoring, and predicting the variety of needs for nursing services at the population level. These findings are important to both healthcare managers and health human resources planners in their efforts to deploy efficient mixes of healthcare resources and identify future human resource requirements to support the efficient provision of health human resources. This study also highlights infrastructure and organizational barriers that need to be addressed if health human resources planning is to be conducted in ways that meet the needs of the populations.
Context

In the face of growing expectations and technological innovations in healthcare, and an aging population with varying and different needs than previous generations, decision makers are increasingly challenged to improve efficiency in the use of healthcare resources. Part of this is done by changing the level and mix of healthcare staff delivering services and by ensuring there is an adequate number of staff to meet the needs of the population. Decisions about the level and deployment of health human resources are often made in response to short-term financial pressures as opposed to evidence of the effect healthcare staff have on health outcomes.

There are three general approaches to determining staff levels and mix: use-based (how many nurses are required to maintain current service levels?); needs-based (how many nurses are required to meet the health needs of the population?); and, effective demand-based (how many nurses are required to meet society’s commitment to healthcare?). While, as Lavis and Birch have suggested, there is no unambiguous “right” way to model human resources, there is growing consensus that in order to be effective, morally justifiable, and politically defensible, health human resource planning must be matched as closely as possible with population health needs. And, unless we understand the needs of the population, it is difficult to plan for a workforce and system to meet those needs.

However, the recurrent cycles of over- and undersupply of health professionals that continue to plague Canada and other countries can in part be traced to the fact that while the stated goal of health human resources planning is to match human resources to need for services, decisions on how to allocate healthcare staff are primarily based on demand for services. It is being increasingly acknowledged that the factors which affect the matching of supply to need are many and varied. This suggests the need for the development, testing, and use by decision makers of a dynamic model that adequately accounts for both the number of influencing factors and how each factor is likely to influence the others.
This study is informed by, and tests elements of, a conceptual framework developed by O’Brien-Pallas, Tomblin Murphy, Baumann, and Birch [Fig. 1]. The framework was adapted from earlier work by O’Brien-Pallas and Baumann, and builds upon earlier work including Anderson’s service utilization model, Donabedian’s quality of care framework, Leatt and Schneck’s conceptualization of technology in human services organizations, and the work of a Canadian think-tank summarized by Kazanjian, Pulcins, and Kerluke. The framework is designed to include the essential elements of health human resource planning in a way that captures the way factors interact.

The framework provides researchers and planners with a guide to decision-making that takes account of current circumstances (such as supply of workers) as well as those factors which need to be accounted for in making predictions about future requirements (for example, fiscal
resources, changes in worker education and training). This open-system framework considers factors that have not always been part of the planning process. These include social, political, geographical, economic, and technological factors. At the core of the framework is the recognition that health human resources must be matched as closely as possible to the health needs of the population.

It is necessary to define briefly some of the key elements of the framework to highlight the complex and dynamic nature of health human resources planning and to indicate which particular elements of the framework are most relevant to the study.

**Elements of the Framework**

- **Population health needs** reflect people’s various characteristics that create the need for curative as well as preventive health services. Addressing the health needs of the population provides the motive, context, and justification for health human resources planning practices.

- The *production* element of the framework highlights the fact that future population health needs must be considered when setting targets for health education and training programs.

- The *supply* element reflects the actual number, type, and geographic distribution of healthcare providers. It recognizes that supply is fluid and is related to production elements, as well as to factors such as recruitment/retention, licensing, regulation, and scope of practice.

- *Planning and forecasting* reflects the varieties of available health human resources planning practices and models, their assumptions, methods, data requirements, and limitations.

- *Health, provider, and system outcomes* refer to establishing the effectiveness and quality of health human resource practices by examining the effect on population health, provider health, job satisfaction, etc., and system costs and efficiencies.

- *Efficient mix of human and non-human resources (such as fiscal resources, physical plant, space, supplies, equipment, and technology)* reflects the number and type of resources that must be developed in order to achieve the best population, provider, and system outcomes.
Context elements (represented in the outer broad band of the framework) speak to the need to recognize factors outside the healthcare system that influence population health, the health system, and the health human resource planning process.

Goal: The goal of this study was to develop and test an approach to establishing, monitoring, and predicting how many nurses are needed at the population level, based on population health needs. Using a systems framework, this study explored the relationship between the health needs of Ontarians, their use of community and hospital nursing services, and variations in outcomes. This study highlighted the value of including selected health status indicators (functional ability, general health, and presence of severe chronic conditions) from the 1996 National Population Health Survey and the 2001 Canadian Community Health Survey in using population health needs as the basis for health human resources modeling. Such a needs-based approach to health human resources planning gives policy makers the means to develop human resource strategies to meet the needs of the population and respond to changing needs of populations over time.

Earlier Research and the Contribution this Research Makes

Canada’s healthcare system has undergone enormous changes over the past few years through reform and economic rationalization. These initiatives created new challenges for health human resources planning. Every health profession has been affected in terms of demand for their services, roles played, and skills required. Positions have been downsized, restructured, and in some cases eliminated. The nature and scope of practice within and among health professions have been altered, often dramatically. Effective health human resource planning is critically important in this environment of change.

However, current work in this area is intermittent and there is little evidence that current planning practices consider societal trends, determinants of health, needs of consumers, and the unique and shared knowledge and skills of providers. Typically, planning has been based on healthcare system use patterns and/or current fiscal commitment. There is growing consensus in the literature that the continuous cycles of over- and undersupply of healthcare professionals worldwide reflects the inadequate methods used to estimate future requirements for expanding health systems and/or the failure to consider the evidence supplied by ongoing labour market
trends. Health human resource planning in most countries has been poorly conceptualized, intermittent, varying in quality, profession-specific, and without adequate vision or data upon which to base sound decisions.14

Most health human resources planning in Canada continues to rely on outdated approaches. Most jurisdictions employ approaches based on supply (such as nurse-population ratios), since these data are readily available and are, in some cases, the only data available. In other cases rates of service use are also used; however such data are not generally available, and when they are, they are typically confined to physician use. Furthermore, current approaches to health human resources planning tend to be intermittent, based on invalid assumptions, one-time-only estimates focusing on single disciplines, and are often in violation of even the most basic measurement principles. Reliance on these approaches has led to repeated cycles of shortage and surplus of providers. Simplistic approaches which ignore the complexity of the healthcare system have avoided consideration of why we provide health services and the impact of these services. It is critical that we improve our ability to predict health human resource requirements.15 In Canada, recognition of the serious consequences of poor health human resources planning practices has led the Canadian Institutes for Health Research and the Canadian Health Services Research Foundation to identify health human resource planning as the dominant health policy issue for the next five years.16 To ensure system efficiency and effectiveness, planning activities should be needs-based, responsive to a changing system, and outcome-directed.17

This work makes use of research done on needs-based allocation of resources, carried out by Birch and colleagues in the early 1990s in Ontario,18 19 and it uses needs to explain variations in nursing service use.20 We were also influenced by Carr-Hill et al who developed a method for determining the influences supply variations have on use.21 22 Funding — which determines supply — has typically been based on variables such as distribution of health needs, socio-economic conditions, and past use. Therefore, past use influences supply and supply influences current use. According to Smith et al,23 no study that only examines the use of healthcare can adequately capture variations in health needs, because there is the possibility that some health needs will not be met by hospitals. They conclude that allocating resources based on where people live will always be inferior to an approach that takes into account the characteristics of
individual patients. His team developed ways to determine what effect supply has on use. Given that how much healthcare people use and the relationship between that use and population health needs may be affected by variations in supply (such as hospital beds and nurses) between communities, the relationship between needs and use of services must be estimated after allowing for variations in supply in small areas.

Similarly, Hofer, Wolfe, Tedeschi, McMahon, and Griffith\textsuperscript{24} support the argument that variations in hospitalization rates depend significantly on socio-economic status effects, and that community-level measures of variables are reasonable proxies for individual measures. Like Carr-Hill et al, they also reinforce the need to adjust for supply when comparing regions.

This study sought to rectify some of these limitations by using data on population characteristics to predict nursing services in Ontario, and to examine the effect of nursing services on population health. In addition to developing useful methodological approaches to incorporating population health needs into determining nursing requirements, this study also examined the opportunities and barriers to doing such modeling using data resources currently available in Ontario. The barriers identified include limitations to the data themselves, organizational barriers to the use of the data, and methodological challenges in developing functional models.

**Research Questions**

**Research Question 1**

Does need for healthcare, as measured by the National Population Health Survey (1996) and the Canadian Community Health Survey (2001), explain variation in self-reported use of overnight hospital services (as a proxy for use of hospital nursing services)?

**Research Question 2**

Does use of hospital nursing services explain variation in a) mortality; b) readmission; c) length of stay; and d) patient satisfaction?
**Research Question 3**

Does variation in use of nursing services (hospital and community) explain variation in health utility index scores and self-reported health status?

**Implications**

This study has the potential to significantly affect health human resources planning policy in Canada, as it highlights the value of including health status indicators in approaches to nursing planning that are based on the health needs of the population. The findings suggest that decisions about the deployment of nursing resources are associated with differences in outcomes. Greater intensity of nursing resources is associated with shorter lengths of stay (other things being equal). There was no evidence that greater intensity of nursing resources resulted in poorer patient outcomes as measured by higher rates of readmission, lower levels of patient satisfaction, or lower levels of self reported health. This information is important to both healthcare managers and health human resource planners in considering the planning and use of health human resources.

Although nursing staffs are often the easiest thing to cut back on during hard fiscal times, and not always the easiest thing to justify expanding when times get better, our work consistently shows that this results in tangible adverse effects for both patients and systems. In other words, policy makers need to pay greater attention to the mix of inputs: there is no use having more beds, theatres, MRIs, or physicians if we do not have the appropriate number of nurses with which these can be combined to generate optimal service and health.

The results may be used by policy makers, decision makers, and researchers to help them create effective mechanisms and policies for establishing, monitoring, and predicting the variety of needs for nursing services at the population level. These findings are important to both healthcare managers and health human resources planners in their efforts to deploy efficient mixes of healthcare resources and identify future human resource requirements to support the efficient provision of health human resources. This study also highlights infrastructure and organizational barriers that need to be addressed if health human resources planning is to be conducted in ways that meet the needs of the populations.
Methodological implications

1. The types of data available, and constraints on accessing the data, significantly limit the ability to incorporate needs-based approaches to nursing resources modeling.

   a. Nursing service use may be most objectively measured through management information systems. However, these systems are not available in all jurisdictions outside of Ontario and are not comparable between and across jurisdictions. Self-reported nursing use is routinely collected as part of the National Population Health Survey and the Canadian Community Health Survey and may prove to be helpful in future health planning.

   b. Canada has strong protections on personal survey and health information to protect the confidentiality and privacy of individuals. While clearly important, these procedures come at a price. In this study, policies on data access and linkage severely limited the ability of the research team to make use of the best data available in a timely manner. For example, to model the effect of population health needs on the use of nursing resources, the team had to rely on aggregated data on population health characteristics at the public health unit level of analysis. Access to individual health survey data for this purpose clearly would have been preferable.

Some improved mechanisms for data access were implemented by Statistics Canada during the term of this study and partially address some of the constraints we faced. The recent development of regional data centres by Statistics Canada and the Social Sciences and Humanities Research Council now facilitates a level of data access that would have enhanced this study.

However, even with the centres, some important barriers need to be considered. In particular, health human resources research requires coding the place of residence of survey respondents according to geographic units that can be used for health human resources planning purposes (such as public health units). Confidentiality risks
associated with the release of geographic identifiers make this difficult (in this study, for questions 1 and 2, we had to rely on Statistics Canada to aggregate survey data to the population level). Given that health human resources planning is among the most serious issues facing the Canadian healthcare system, and the centrality of Statistics Canada survey data to health human resources modeling, additional mechanisms need to be explored to facilitate the access to critical data in a timelier manner.

2. To incorporate indicators of population health needs into health human resources planning, particularly at the local level, it is critical to define the population served by various healthcare facilities. This is usually done by defining population “catchment areas” for healthcare facilities or providers. However, service areas tend to overlap, and people use the facilities less, the farther away they are from the centre of the catchment area. An important contribution of this study was the development of a new method of defining hospital catchment areas that allows for overlapping service areas and gives greater weight to populations that are more frequent users of a particular facility. This method could be used to define catchment areas for other types of healthcare delivery.

3. Effective health human resources planning must distinguish between the need for services and the current pattern of service use. This requires modeling strategies that jointly consider the nursing services that are required to meet the health service delivery needs of the population, the population health results associated with nursing health human resources, and non-need factors that affect service use. Joint consideration of these factors poses the most significant methodological challenge to health human resources modeling. This study explored some new strategies to meet this challenge.

**Approach**

The study used secondary data sources and employed both longitudinal and cross-sectional designs to address the research questions posed. The study was limited to Ontario. Because the research questions are substantially different, details on the study design and methods used for each objective are addressed below. The approach used for research questions 1 and 2 will be discussed separately from question 3.
Questions 1 and 2

The unit of analysis for questions 1 and 2 is acute-care hospitals in Ontario. During numerous meetings with co-investigators and decision makers, we discussed how, in our current system, the inequity in resource allocation and service provision is perpetuated. This study of population health needs within public health catchment areas in the province of Ontario allowed us to examine need independently from use. Populations with different risks should receive different levels of funding, independent of existing levels of services. These allocations should respond to changes in relative needs over time. These discussions continued to inform our approach throughout the process.

Approach for Question 1

Research question 1 examined whether needs — as measured by the 1996 National Population Health Survey and the 2001 Canadian Community Health Survey — explain variation in self-reported use of overnight hospital services (as a proxy for use of nursing services). The unit of analysis for this question was the hospital and the population age 20 and older which it serves. The population served was defined according to a new method for defining hospital “catchment areas” developed as part of this study (described below). The control variables were, for persons age 20 and older in the catchment population, the proportions that are in low-income households, age 65 and older, female, and that that have less than a secondary education. The unemployment rate, standardized mortality rate, and nurses-to-population ratio (number of nurses per 10,000 people) were also used as control variables. Variables that acted as proxies for need were the proportion of people with limited functional ability, lower self-rated health status, reporting at least a day of disability within the two-week period preceding the administration of the survey, and reporting one or more severe chronic conditions. The dependent variable was the proportion of overnight hospital stays. (See Appendix 1 for detailed descriptions of the variables and Tables 1, 2, 3, and 4 in Appendix 2 for descriptive statistics.)
**Approach for Question 2**

Research question 2 examined whether use of hospital nursing services explains variation in a) mortality rates; b) readmission rates; c) length of stay rates; and d) patient satisfaction. The unit of analysis for this question was also the hospital and its catchment population (defined using the catchment area methodology described below). The control variables were, for persons age 20 and older in the catchment population, the proportions that are in low-income households, age 65 and older, female, and that have less than a secondary education. The unemployment rate, standardized mortality rate, nurse-to-population ratio (number of nurses per 10,000 people), the mean resource intensity weight (levels of care required for patients based on different levels of severity), hospital type (small, large, and teaching), and interactions between resource intensity weight and hospital types were also used as control variables. The independent variable of interest was nursing-service use, measured by number of nursing hours worked per patient day. The outcome variables were the hospitals’ mortality rate, readmission rate, average length of stay, and average patient satisfaction. (See Appendix 1 for a detailed description of the variables, and Tables 1, 2, 3, and 4 in Appendix 3 for descriptive statistics.)

**Hospital Catchment Areas**

Defining the population served by a hospital is difficult. This has traditionally been addressed by defining population “catchment areas” for healthcare facilities or providers as all persons residing within a particular distance or within specific geographic boundaries. However, the service areas of hospitals tend to overlap, and the use of facilities tends to get lower as the distance from the facility increases. The research team developed a new method of defining hospital catchment areas that allows for overlapping service areas and gives greater weight to populations that make greater use of the facility. Moreover, this method facilitates the measurement of “need” indicators for the catchment population.

The method is constructed using small geographic areas (in our case, public health units) for which we know how many people there are and for which we have data on variables that indicate “need” for healthcare. The catchment population for the hospital is defined as the sum of a share of the population of all public health units from whom the hospital receives patients. The shares
are defined using “share weights.” The share weights are computed as the proportion of all inpatient episodes received by residents of a public health unit that are at a given hospital.

Need indicators (for example, the proportion of the catchment population over age 65) for a hospital’s catchment population was computed as the weighted average of the value of the need-indicators for all public health units that contributed patients to the hospital. Share weights, computed as the percent of the hospital’s inpatient episodes that came from each public health unit, were used for weights.

Based on the strong support from the policy makers on our team, we successfully negotiated a contract with Statistics Canada to produce summary characteristics of need indicators for public health units, from both the National Population Health Survey and the Canadian Community Health Survey. We spent a great deal of time determining the most appropriate level of geography to use. We wanted to be working at the lowest level of data possible (individual, county). However, in some instances issues of confidentiality did not allow us to work with small geographic areas. After consultation with our team members and with Statistics Canada, it was decided that public health units in Ontario would be the most appropriate level for the data (which we used to form hospital catchment areas).

**Question 3**

Our third research question used individual level survey data from the 1996 National Population Health Survey and the 2001 Canadian Community Health Survey. The individual was the unit of analysis. Data was accessed through Statistics Canada’s remote access service.

The analysis assessed if variation in the amount of nursing services used (hospital and community) explain variations in health utility index scores and self-reported health status. The challenge in conducting this analysis is that health status (the dependent variable) is the main factor that determines the amount of hospital and community nursing services used (the key independent variables). This so-called “endogeneity” — where the outcome being studied (health status) affects the input being studied (use of nursing services) — must be removed to estimate the effect of nursing services use on health. A variety of approaches can be used to account for
endogeneity, and they vary in their data requirements and applicability.\textsuperscript{25,26} We adjusted for the endogeneity of health status by looking at whether survey respondent used nursing services, and if so, did they use more or fewer nursing services than the average respondent with the same level of need.

A two-step approach was used to estimate the amount of nursing services people are expected to use. In the first step, 1996 survey data were used to estimate the effect of need on the use of nursing services. The models used the following factors to determine need: income (low, low-middle, middle, high-middle, high), age (18-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85+), sex and education (no high school diploma, a high school diploma with no further certification [including some university/trade school], a post-secondary diploma or other certification, university). Health status variables included derived health status index, derived health description index (poor/fair, good, very good, excellent), and one of six severe chronic conditions (chronic bronchitis or emphysema, high blood pressure, diabetes, heart disease, cancer, ulcers). Geographical location (major metropolitan area; non-metropolitan urban area; non-metropolitan rural area) was included as a control variable to capture variations in access to services.

To model the effect of use of nursing services on health status in the context of individual differences in needs, regression models were employed using 2001 survey data. The dependent variables were the health utility index score (with 0.8 as the cut-off between ‘healthy’ and ‘not healthy’) and self-reported health status (excellent, very good, good, and fair/poor). The key independent variables were the use of hospital and community nursing services relative to need. These were defined as the difference between the amounts of self-reported services used in the previous year minus the amount of services expected to be used. Expected use was estimated by relating observed use to sex, five-year age group, income, education level, employment status, location type, and chronic conditions. In this way we were able to consider whether, for example, ‘greater than expected’ use was associated with better health status.
An ordinal logit regression was used for self-reported health status (as it has four categories: excellent, very good, good, and fair/poor), and a logistic regression was used for health utility index score (as it is split into ‘healthy’ and ‘not healthy,’ with the score of 0.8 as the cut-off value). Each model was run twice: once with hospital nursing use as the key independent variable, and once with community nursing use as the key independent variable.

As the dependent variable is dichotomous, logistic regression was employed. The regressions were weighted using the Canadian Community Health Survey sample weight to adjust for unequal probabilities of inclusion in the sample. Standard errors for the regression coefficients were estimated using a bootstrap method. The bootstrap employed 500 sets of bootstrap sample weights, each representing an independent bootstrap sample. Standard errors were computed as the standard deviation of the parameter estimates from 500 bootstrap samples.

It should be noted that our method probably does not fully remove the bias due to endogeneity. This is true for two reasons. First, the models estimated using the 1996 survey may not fully estimate the need for nursing services; there may be unmeasured need associated with the dependent variable. Second, although the effects of need variables are estimated using 1996 data, the computed values of expected nursing services use employ the characteristics of the 2001 respondents at the time of the survey. So, we are essentially using expected use at the time of the survey interview to predict self-reported nursing services use in the previous year. It would be preferable to use longitudinal National Public Health Survey data, so that expected use could be computed based on respondents’ attributes prior to the measurement of the dependent variable. As a result of residual endogeneity, the effect of nursing services used is expected to be biased towards a negative effect (because unmeasured need is likely to increase the amount of nursing services used). Thus, if we find that observed minus expected nursing services use is associated with better health status, then we can be fairly confident in a positive effect. However, if we find a null or negative effect, we will not be able to infer whether or not this is due to endogeneity bias.
Results

Question 1

This research question was run with data from both 1996 and 2001 to compare changes between the two time periods. See Table 5 in Appendix 2 for regression results.

Overnight Stay — 1996

In 1996, unemployment rate was negatively associated with overnight stay, meaning that the lower the unemployment rate in a catchment area, the higher the overnight stays. Mortality rate had a positive relationship with overnight stay. Hence, the higher the mortality rate in a catchment area, the more overnight stays there are. Having a severe chronic condition was positively statistically significant. This means people in catchment area with higher rates of severe chronic conditions have more overnight hospital stays compared to populations with lower rates of those conditions, other things being equal.

Overnight Stay — 2001

In 2001, age had a significant positive effect, meaning that catchment areas with a greater proportion of people older than 65 are more likely to have higher numbers of overnight patient stays than areas with lower proportions of people older than 65. Nurse-to-population ratio (number of full-time equivalent nurses per 10,000 people) also had a positive effect, so that hospitals with more nurses per capita have more overnight stays than hospitals with fewer nurses per capita.

Chronic condition had a positive effect (just as in 1996), as did disability. Hence, catchment area populations with higher proportions of chronic conditions and disabilities had higher proportions of overnight patient stays compared to catchment areas with lower proportions of chronic conditions and disabilities.

Based on these results, decision makers should consider giving more resources to hospitals that serve populations with high levels of chronic conditions and disabilities, as these factors appear to increase the number of overnight hospital stays in those hospitals. Decision makers should
recognize that some of the variation in use is associated with variation in needs. However, investing more money in acute-care hospitals may not be the most effective and efficient way of treating people with chronic illness and disabilities. Decision makers should note that the capacity of areas to serve the needs of the population is constrained by nursing supply.

**Question 2**

This research question examined four hospital-level outcomes: mortality, length of stay, readmission, and patient satisfaction. See Tables 5 and 6 in Appendix 3 for regression results.

**Mortality**

Mean relative intensity weight (levels of care required for patients based on different levels of severity) had a statistically significant positive effect on mortality in the population. This means that hospitals that provide care to sicker patients have more patients who die in hospital than hospitals with patients who are less sick. Unemployment rate has a significant negative effect. Thus, more people die in hospital where there is less unemployment than in hospitals in catchment areas with more unemployment.

**Length of Stay**

Just as in the mortality model, mean relative intensity weight was significant — the higher the severity of patient illness in a hospital, the longer the average length of stay. For small and large hospitals, relative intensity weight is positively associated with length of stay. However, there are insufficient numbers to measure the association between length of stay and relative intensity weight for teaching hospitals.

Nursing hours per patient day had a significant negative effect. In other words, the more nursing hours provided per day in a hospital, the shorter the average length of patient stay in that hospital. Based on this finding, decision makers should take into account that although it may increase costs to have more nursing hours, costs may be decreased by the shorter average length of patient stay and potential increased patient turnover. Increased patient turnover may lead to improved access to hospital services and decreased wait time in populations. Studies completed
at the micro and meso levels have also supported the finding that the more care patients receive on a daily basis the shorter patients’ length of stay in hospital and in community homecare environments.27 28 29

**Patient Satisfaction**

The patient satisfaction model had a smaller number of cases than the first three models because the Hospital Report (from which the patient satisfaction data was taken) only had 65 hospitals that fit the criteria for inclusion in the study (that is, acute-care hospitals outside of Toronto). The only significant variable was age. The higher the proportion of the hospital catchment area population that is older than 65, the higher patients rate their satisfaction with that hospital’s unit-based care.

**Readmission**

The only significant variable for readmission was education. Hospital catchment areas where more people have at least a high school education have less probability of readmission than hospitals with catchment areas that have smaller proportions of high school graduates.

**Question 3**

The goal of this question was to examine the effect of hospital days (as a proxy for exposure to hospital nursing care) and community nursing use on patients’ self-reported health status and health utility index score.

What we are really interested in was the effect that receiving more (or less) exposure to hospital or community nursing care has on groups of patients equally likely to need the same amount of care. Therefore, the difference between expected days of care and actual days of care (and the difference between expected community nursing contacts and actual community nursing contacts) was incorporated as the independent variables of interest in our model (in addition to our control variables of age, sex, income, education, and location type). An ordinal logit model was used for self-reported health status (as it has four categories: excellent, very good, good, and fair/poor), and a logistic model was used for health utility index score (as it is split into ‘healthy’
and ‘not healthy,’ with the score of 0.8 as the cut-off value). Each model was run twice; once with hospital nursing use as the key independent variable, and once with community nursing use as the key independent variable.

**Dichotomous Health Utility Index Score**

The model found that spending more (or fewer) days in hospital had no practical effect on health status. The same is true for community nursing use. Because our modeling strategy may not have fully measured the need for nursing services (that is, there is residual need not captured by our double hurdle model), the effect of nursing services use may still be biased by endogeneity. Thus, we cannot conclude that nursing use is not associated with a higher health utility index score.

Respondents aged 40-64 and 75+ were significantly less likely to be healthy than respondents in the 18-24 age group. Females were less likely to be healthy than males. Unemployed respondents were less likely to be healthy than employed respondents. Respondents living in non-metropolitan areas, both urban and rural, were significantly more likely to be healthy than respondents living in major metropolitan areas. Respondents who were more highly educated and had higher incomes were more likely to be healthy than lesser-educated and lower-income respondents.

**Self-Reported Health Status**

In predicting self-reported health status, as with the health utility index score, the difference between observed and expected use was statistically significant, but not practically significant. The effects of the difference between expected and actual community nursing contacts were the same, as well — statistically but not practically significant. Again, because our modeling strategy may not have fully measured the need for nursing services (that is, there is residual need not captured by our double hurdle model), the effect of nursing services use may still be biased by endogeneity. Thus, we cannot conclude that nursing use is not associated with a higher self-reported health status.
Respondents in all population age groups from 25 and older were significantly less likely to report a higher category of health status than respondents aged 18-24. This generally followed a trend, so that self-reported health status was generally lower for older patients; that is, selecting any two respondents, the older one is likely in poorer health. Females were significantly less likely to report better health than males. Respondents who were unemployed and not looking for work were significantly less likely to report better health than employed respondents, but the difference between employed respondents and respondents who were unemployed and looking for work was not significant. Respondents not living in metropolitan areas were more likely to report better health than respondents living in these areas, significantly so for respondents living in urban non-metropolitan areas. Lower-middle-, middle-, higher-middle-, and higher-income respondents were all more likely to report better health than lower-income respondents, though in the case of lower-middle income respondents, the difference was not significant. Those respondents with a university degree were most likely to be healthy, followed by those with a trade school or community college diploma and those with a high school diploma. All three groups of respondents were significantly more likely to report better health than respondents without a high school diploma.

Additional Resources

The reader is referred to the appendices for additional details on the models run in this study.

Further Research

The next step in this research is to link the needs-based factors as defined in the model guiding this study to supply and use data in such a way that simulations of the data will allow us to determine ranges and types of nurse supply most likely to lead to improved outcomes. The methodology needs to be expanded to include all provinces and territories in Canada. All statistical and simulation models should be updated every two years to ensure that changes in population needs and characteristics are considered in planning for health human resources. The model needs to be tested on other provider groups so that the impact of substitution of different providers can be evaluated.
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