Human Resources Planning and the Production of Health: A Needs-Based Analytical Framework

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Dans le domaine de la santé, l'approche traditionnelle en planification des ressources humaines accorde une très grande importance aux effets des changements démographiques sur les besoins en ressources humaines. La planification est largement basée sur la taille et la composition démographique de la population, appliquées à de simples ratios population/fournisseur de soins ou population/utilisation des soins. Dans cette étude, nous proposons un cadre d'analyse plus large basé sur la production de services de soins de santé et sur les multiples facteurs qui déterminent les besoins en ressources humaines. Nous posons comme hypothèse que les besoins dépendent de quatre facteurs distincts : la démographie, l'épidémiologie, les standards de soins

et le niveau de productivité des fournisseurs de soins. Pour illustrer notre propos, nous appliquons le cadre théorique à des scénarios hypothétiques concernant l'ensemble de la population des provinces atlantiques canadiennes.

Traditional approaches to health human resources planning emphasize the effects of demographic change on the needs for health human resources. Planning requirements are largely based on the size and demographic mix of the population applied to simple population-provider or population-utilization ratios. We develop an extended analytical framework based on the production of health-care services and the multiple determinants of health human resource requirements. The requirements for human resources are shown to depend on four separate elements: demography, epidemiology, standards of care, and provider productivity. The application of the framework is illustrated using hypothetical scenarios for the population of the combined provinces of Atlantic Canada.

Introduction

Health Human Resources Planning (HHRP) is aimed at having the right number of people with the right skills in the right place at the right time to provide the right services to the right people (Birch 2002). It involves comparing estimates of future requirements for and supplies of human resources as well as considering policy options for addressing any differences between requirements and supplies (Lomas, Stoddart and Barer 1985). The focus of HHRP to date has been on the impact of demographic change on individual health-care professions; for example, the effect of an aging population on the requirements for particular health-care providers, and the effect of an aging workforce on the capacity to meet requirements (e.g., Denton, Gafni and Spencer 1993, 1994, 1995; Ryten 1997; Newton and Buske 1998; Kazanjian 2000; Kazanjian *et al.* 2000; Shipman, Lurie and Goodman 2004). The general approach followed has tended to focus exclusively on particular provider groups and consists of estimating shortfalls or surpluses in those groups and calculating changes in the sizes of training programs required to eliminate any such imbalances in human resources. As a result, HHRP has occurred largely in isolation of, or separately from, matters relating to other aspects of health-care policy and population health (Birch *et al.* 2003). In this way, the research questions that HHRP has aimed at addressing have usually been unclear or poorly defined (Birch *et al.* 1994; Lavis and Birch 1997). Research questions about "How many health-care providers are required?" need to be developed and refined to incorporate the objectives for the use of health-care providers and the contexts in which they will be used (i.e., How many providers are required to do what, and how, for whom, and under what circumstances?).

The requirements for providers are endogenously determined through the political or social choices that underlie the health-care system being studied (Markham and Birch 1997). Systems that ration access to health care according to ability and willingness to pay will have different requirements for providers than systems that ration access according to relative needs for care, even where the levels and distribution of health in the populations are the same. Funding arrangements that influence the production of health care (the level and mix of different resources) will affect the requirements for a particular type of provider. Only where the social and political choices about the access to and delivery of care are explicit can scientific methods be used systematically to derive the requirements for health-care providers in a particular population.

In the absence of clear, contextualized research questions it is not surprising that most studies have focused on the current numbers and demographic profiles of providers in the context of the current size and demographic mix of the population (e.g., provider to population ratios, in some cases adjusted for age and gender of populations and/or providers) applied to the future projected population. As a result, HHRP has been largely an exercise in demography based on implicit assumptions that population age structure determines the service needs of the population and that the age of providers determines the quantity of care provided (Birch 2002). By failing to incorporate health-care needs and service provision into the analytical framework, it further assumes that the relationships between age and needs, and between the numbers of providers and the quantity of services, are exogenous, independent of other factors and hence constant over time. However, if epidemiology and production processes are not "fixed," then HHRP based on these assumptions will estimate human resource requirements inaccurately.

For example, much attention has been given to the challenges of an aging population for health-care systems. Because health risks differ by age and, after childhood, generally increase with age, an older population will generally have greater needs for care than a younger population, all other things being equal (Eyles *et al*. 1991). Denton and Spencer (2000) show that even on the assumption that age-specific needs of the population remain the same over time (i.e., epidemiology constant) the impact of aging on health-care expenditures will be modest and more than offset by savings arising from the impact of demographic change in other areas of government expenditures. However, an aging population has other implications for HHRP. Observed cross-sectional or "point in time" differences in age-specific needs cannot be used as a basis for modelling the needs of a future population if the levels of health of particular age groups change over time. Health risks and hence the needs for care change over time. Life expectancies have increased over time at all ages (Evans 1984). Dramatic improvements in health status have been reported over the last 10 to 15 years (Roos *et al*. 2001). Similarly, it has been argued that over time morbidity in populations has been increasingly compressed into the later years of life (Fries 1980). Not only have years been added to life but also life to years. In terms of the production of health in populations, the effect of age on health has changed over time; for example, 65-year-olds *on average* can expect to be healthier, and hence have less health-care needs, than 65-year-olds *on average* 20 years ago. Hence, models for HHRP need to embrace the dynamic nature of the health-care needs of populations.

In the same way that need per capita population is not constant, the service output per provider will vary among providers and over time. For example, nurses do not provide care alone. Instead, they use their skills in combination with other human and non-human resources to provide services to meet the needs of the population. The average rate of service delivery per nurse will depend on the availability and use of other resources (Birch *et al*. 2003). Similarly, innovation involves the identification of new ways of production aimed at increasing the productivity of resources (i.e., more output from a given level or combination of resources). Improvements in the productivity of human resources provide a source of increased output in the health-care sector. For example, Gray (1982) found that changes in the delivery of dental care services in the UK were associated with substantial increases in dentist productivity. Similarly, the widespread introduction of day surgery for particular procedures (e.g., cataract replacements) has increased the number of procedures that a given team of providers can deliver, and hence the number of patients that can be treated per time period. Sources of improvements in productivity are not confined to major technological innovations. A family physician who manages a fixed roster of patients continuously over time will increase productivity since the average age,

and hence the risks to health and health-care needs, increases over time. The human resources required to meet the needs of a population will therefore be dependent on the role human resources play in serving needs and the other resources available to use in combination with human resources in providing services.

Failure to identify changes in needs and productivity undermines HHRP processes by overestimating HHR requirements and the costs of health-care services. Newton and Buske (1998) suggested that Canada faced a possible future shortage of physicians based on an estimated 31 percent reduction in the estimated physician-population ratio over the next 25 years. However, if age/gender-specific needs were to be reduced by 1 percent per annum and average productivity of physicians increased by 1 percent per annum, the physician-population ratio, after adjusting for changes in activity level and changes in needs, would *increase* by 27 percent over the same period! Hence, current plans for physician training would be associated with more than enough physicians to maintain levels of services per capita after allowing for aging of the population. Consequently, consideration might need to be given to reductions in, as opposed to expansion of, training programs.

Shipman, Lurie and Goodman note that the number of general pediatricians in the US will expand by nearly 64 percent by the year 2020 compared to an increase of only 9 percent in the child population: a substantial increase in the physician-population ratio. The authors note that if pediatricians are to maintain workloads they may need to "provide expanded services to the children currently under their care, expand their patient population to include young adults, and/or compete for a greater share of children currently cared for by nonpediatricians" (2004, 441). No consideration is given to the appropriateness of these required changes to maintain workloads from a societal perspective. Maybe instead of focusing attention on maintaining provider workloads, consideration could be given to reducing the number of practising pediatricians and/or the size of pediatric training programs. Birch and Maynard (1985) previously noted the risk of planning for too many providers as a result of failing to take account of changes in needs and provider productivity in an appraisal of UK government plans to increase admissions to dental schools.

The focus of this paper is to build upon existing HHR frameworks in order to relax the strict assumptions about epidemiology and production embodied in the current practice of HHRP in order to accommodate changes in the levels and distribution of health-care needs in the population and changes in levels of productivity of health-care providers.

The Needs-Based Analytical Framework

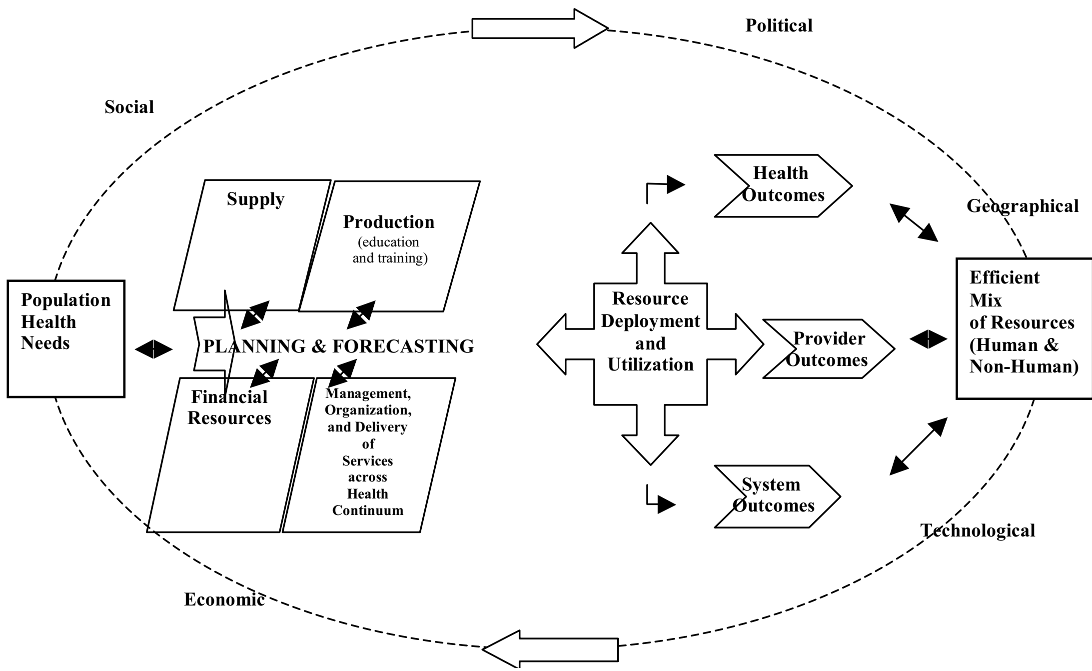
The purpose of the analytical framework is to provide a link between principles identified in theoretical models and the application of these principles in health human resources policy development. The theoretical basis of the analytical framework developed here is the HHRP conceptual model presented in O'Brien-Pallas *et al.* (2001). (See Figure 1.)

This conceptual model identifies the constructs that influence the requirements for and supply of human resources (population health needs, education and training, supply of providers, organization of work and production, and the prevailing contexts in which all these constructs are experienced) and the pathways, both direct (independent) and indirect (interactions between influences), through which these influences operate. In particular, the framework emphasizes that:

- HHRP occurs within, as opposed to independent of, health-care planning, and
- health-care planning occurs within, as opposed to independent of, other public policy planning.

There are a number of key features of this model.

FIGURE 1
Health Human Resources Conceputal Model



Evidence-based approaches to needs. Needs cannot be assumed to be indicated by (or to correlate with) measures of service delivery (i.e., utilization measures), expenditures on care (i.e., demand measures) or availability of providers (i.e., supply measures) (Birch, Eyles and Newbold 1996). Need is measured independently of these other health-care constructs.

The derived nature of requirements. Requirements for health human resources are derived from the need for health-care services that health human resources produce.

The production of health care. Health-care services are produced from the use of a range of health-care inputs that include both human and non-human resources.

The contextual nature of requirements. The production of health-care services and the use of human resources in the production of those services occur in prevailing social, cultural, economic, and political contexts. These contexts are largely determined outside the immediate remit of human resources policymakers and planners. However, the particular contexts will define the opportunities and constraints within which HHRP occurs.

The range of policy levers. The capacity of training programs is just one of many policy levers available to human resources policymakers aiming to

respond to estimated gaps between future human resource requirements and supplies.

The model incorporates the essential elements of HHRP in a way that captures the dynamic interplay among factors that have previously been conceptualized as separate and independent. The framework considers the prevailing levels of supply in the context of educational policies as well as the prevailing social, political, geographic, and economic contexts.

The analytical framework consists of two independent components: provider supply and provider requirements.

Provider Supply

This part of the analytical framework asks: "How many providers are (or will be) available to deliver health-care services to the population?" Supply can be seen as the outcome of two determinants:

- The *stock* of individuals M_{ij}, representing the number of providers in each age, i, and sex, j, group who are potentially available to provide health-care services, and

- the *flow* of activities, L^s_{ij}, generated from the stock, representing the quantity of input (e.g., time spent in the production of services).

The flow of activities depends on (a) the proportion of the current stock, l_{ij}, that is active in the provision of health care (i.e., the participation rate) and (b) the level of activity, k_{ij}, of those active in the provision of health care (i.e., the activity rate). Hence, the supply of providers measured in hours of labour is given by

$$\sum_{ij} L^s_{ij} = \sum_{ij} [l_{ij} \times k_{ij} \times M_{ij}] \qquad (1)$$

If a full-time equivalent (FTE) provider contributes W hours of labour per year then the provider supply N^s is given by

$$N^s = \frac{\sum_{ij} L^s_{ij}}{W} = \frac{\sum_{ij}\left[l_{ij} \times k_{ij} \times M_{ij}\right]}{W} \qquad (2)$$

Both participation and activity rates represent policy levers for HHR policymakers and hence alternative or complementary approaches for changing provider supply N^s.

In addition to changes in the flow of activities, the size of the stock in age group i and gender j at time t, M^t_{ij}, also changes over time. This is the result of new entrants to the stock at time t, I^t_{ij} (inflows of providers from other regions and other countries together with new graduates within the region) and those leaving the stock, O^t_{ij} (outflows of providers to other regions and other countries, retirements, and deaths among providers). Hence,

$$M^t = \sum_{ij} M^t_{ij} = \sum_{ij}\left[M^{t-1}_{ij} + I^t_{ij} - O^t_{ij}\right] \qquad (3)$$

where M^{t-1}_{ij} is the stock of providers by age and gender in the previous time period, $t-1$. This provider supply component is a common element of most approaches to HHRP research. However, unlike previous models, in this framework the levels of participation and activity are allowed to vary over time. Hence, the supply of FTE providers at time t, N^{st} is given by

$$N^{st} = \frac{\sum_{ij} L^{st}_{ij}}{W^t} = \frac{\sum_{ij}\left[l^t_{ij} \times k^t_{ij} \times M^t_{ij}\right]}{W^t} \qquad (4)$$

Provider Requirements

This part of the analytical framework asks: "How many providers are required to ensure sufficient flow of health-care services to meet the needs of the population?" Traditional approaches to estimating the required number of providers at time t, N^{rt}, have largely been based on an implicit analytical frame-

work based on just two elements – demography (P^t_{ij} the size of the population by age and gender) and the current level of providers (N^t_{ij}/P^t_{ij} the provider-population ratio by age and gender of population group), that is,

$$N^{rt} = \sum_{ij} N^{rt}_{ij} = \sum_{ij}\left[\left(\frac{N_{ij}}{P_{ij}}\right)^t \times P^t_{ij}\right] \qquad (5)$$

In this way the provider requirement is simply a weighted average of the size of different age-sex groups in the population, irrespective of any changes in needs within population subgroups and changes in productivity among provider groups. In some cases the provider-population element is replaced by a utilization-population element, Q_{ij}/P_{ij} (where Q_{ij} is the number of services required for the population in age group i and gender j) also assumed to be constant. Hence,

$$N^{rt} = \sum_{ij} N^{rt}_{ij} = \sum_{ij}\left[\left(\frac{N_{ij}}{Q_{ij}}\right)^t \times \left(\frac{Q_{ij}}{P_{ij}}\right)^t \times P^t_{ij}\right] \qquad (6)$$

However, the link between services and providers, N_{ij}/Q_{ij} i.e., the productivity of providers, is also assumed to be constant over time. As a result, the estimated requirements for providers is determined entirely by demographic factors applied to existing levels of utilization per capita and output per provider, that is,

$$N^{rt} = \sum_{ij} N^{rt}_{ij} = a \times b \times \sum_{ij} P^t_{ij} \qquad (7)$$

Where $a = Q_{ij}/P_{ij}$ and $b = N_{ij}/Q_{ij}$.

It is important to note that the need for services does not appear in equations (5) to (7). Yet, as argued above, both needs and the service requirements to meet needs (and hence the providers required to satisfy these service requirements) are dynamic concepts. Hence, if H_{ij} represents the average level of needs of individuals in age group i and gender j then the required number of providers, N^{rt}, can be presented as

$$N^{rt} = \sum_{ij}\left[\left(\frac{N_{ij}}{Q_{ij}}\right)^t \times \left(\frac{Q_{ij}}{H_{ij}}\right)^t \times \left(\frac{H_{ij}}{P_{ij}}\right)^t \times P^t_{ij}\right] \qquad (8)$$

Where each expression on the right-hand side of (8) represents a separate determinant of the provider requirements:

Demography. P_{ij} represents the *demographic* determinant of provider requirements. This captures the size and age distribution of the population, and changes to the distribution over time as a result of population aging, changes in migration, birth and death rates.

Epidemiology. H_{ij}/P_{ij} introduces the levels and distribution of needs in the population explicitly as a determinant of provider requirements into the analytical framework. In this way different levels of need are incorporated into the estimation independent of the demographic mix in the population, P_{ij}.

Level of service. Q_{ij}/H_{ij} represents a *level of service* determinant of provider requirements. If we want to increase service provision to a particular group, say by instituting more frequent screening of various risk factors, this increases Q_{ij}/H_{ij}, the service weight applied to this population group. With all other things being equal, this increases the required number of providers.

Productivity. N_{ij}/Q_{ij} represents the inverse of the average level of productivity of providers serving population group P_{ij}. Productivity depends on a variety of factors, including the intensity of work (proportion of paid hours given to patient care), how work is organized, technological inputs, and inputs of other types of professionals.

This enhanced, needs-based analytical framework estimates the number of health-care providers required to meet the health-care needs of each age and sex group in the population. These estimated requirements are summed over all age and gender groups to generate the total provider requirements.

Because levels of activity vary among providers (e.g., part-time, full-time, overtime) requirements are measured in activity-standardized units of providers (e.g., FTE providers), the same units used to measure provider supply in (2). Although older populations may require more provider inputs (e.g., hours of care) to produce the same service output (i.e., address the same health condition), this variation in resource intensity by population age-sex group can be incorporated into the framework in terms of a severity or complexity adjustment to the levels of service component. Thus, in terms of equation (8) it is reasonable to treat N_{ij}/Q_{ij} as invariant across population age-sex groups where Q_{ij} incorporates some measure of resource intensity adjustment. In this way equation (8) can be expressed as

$$N^{rt} = \left(\frac{N}{Q}\right)^t \times \sum_{ij}\left[\left(\frac{Q_{ij}}{H_{ij}}\right)^t \times \left(\frac{H_{ij}}{P_{ij}}\right)^t \times P^t_{ij}\right] \quad (9)$$

Provider requirements at time t, N^{rt}, can now be seen as the result of two empirical components — the *production component* $(N/Q)^t$, and the *need for services component* — covering the three separate determinants of *level of service*, *epidemiology,* and *demography*.

Applying the Framework

A simulation approach is used to apply the analytical framework to available data for the Atlantic region of Canada (the provinces of New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island combined). The simulation model specifies the mathematical relationships for the components of the analytical framework. The model is based on estimating and comparing provider supply, based on simulation modules for training and supply of labour components; and provider requirements based on simulation modules for production of, and needs for, services components.

The simulation results emerge from the interactions of different components of the analytical framework and provide an evidence base for the relative impact of different policies over time. The approach is concerned with integrating knowledge of different components of the conceptual model in order to improve understanding of the dynamics of the system and analyze strategies and inform health human resource policies. In this way the simulations provide insights on how to change the future to address current and emerging problems.

In the rest of this section, attention is focused on the provider requirements part of the analytical framework since this represents the main departure from existing approaches to health human resources planning. Details of the application of the entire framework can be found in Birch, Tomblin-Murphy and O'Brien-Pallas (2004).

The Need for Services Component of Provider Requirements

Data for the demography determinant are taken from Statistics Canada population estimates. For the epidemiology determinant, appropriate indicators of health status or risks of morbidity will vary depending on the type of health-care provider under consideration. The range of possible indicators cover health risks, morbidity, mortality, and subjective measures of health status. For example, for health-care providers whose services are predominantly in the primary-care sector, and hence "driven" largely by the demands of the population, measures of self-assessed health status are used since such self-assessments often provide the trigger that leads to consultations with primary-care providers and have been found to correlate with a wide range of health

and socio-economic variables at the population and individual levels (Birch, Eyles and Newbold 1996). The intention is to identify data that will reflect or influence differences in needs for services within population groups and changes in needs over time.

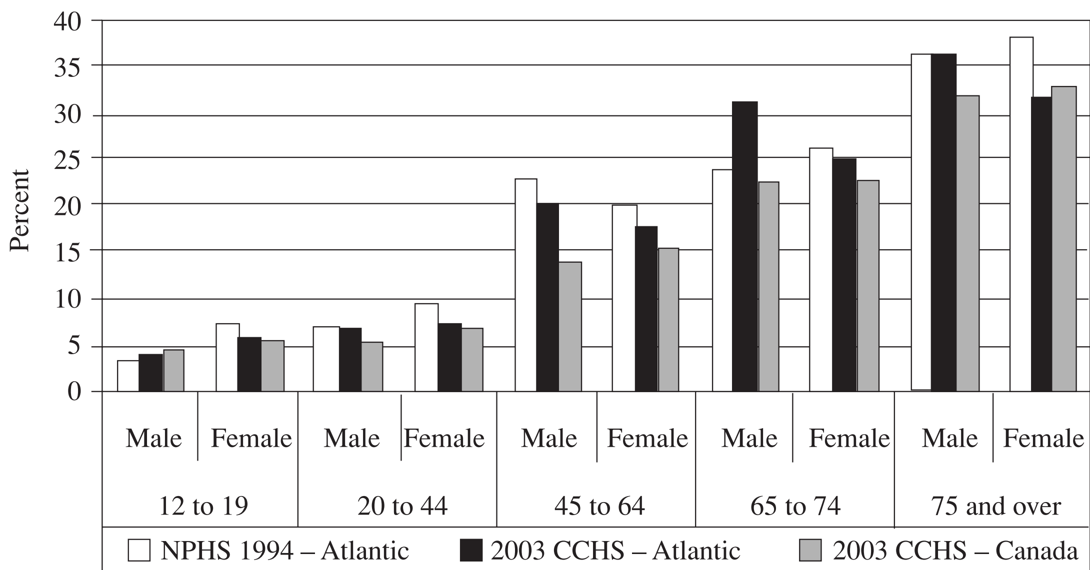
Generally, health status has been improving across age-gender groups over the last decade, but the Atlantic population remains well behind the Canadian population (see Figure 2). The only age group where the proportion of the Atlantic population reporting their health as fair or poor in 2003 was substantially greater than in 1994 was for 65- to 74-year-old males. However, the 2003 levels of fair or poor health for the Atlantic population were consistently higher than the corresponding rates for all of Canada except for very small Atlantic "advantages" in teenage males and older females.

Because there is no crystal ball with which to identify the future levels and distributions of needs for care, three alternative scenarios for the epidemiology determinant are used:

1. age- and gender-specific levels of health remain constant over time,
2. age- and gender-specific levels of health move to current levels observed for Canada as a whole over the next decade, and
3. age- and gender-specific levels of health change in accordance with the observed trend in the Atlantic region over the last decade.

The purpose of the level of service determinant is to translate data on needs for health care into requirements for services. For the current application, the prevailing distribution of services by level of need is used based on combining data on the quantity and resource intensity of service use by age and gender with survey data on self-reported use of

FIGURE 2
Weighted Proportions of Respondents Rating their Health as Fair or Poor



services by needs for a sample of population. This assumes that the distribution of actual utilization across needs groups is the same as the distribution of self-reported utilization by self-reported health status in health survey data. For the purpose of the simulations the observed quantity of service by level of need was adopted. By holding this constant in the simulations, the effects of changes in needs for care and provider productivity can be estimated without the effects of some of these changes being "concealed" through unplanned changes in levels of service. Plans to change levels of service can, however, be entered into the model where appropriate.

The Production Component of Provider Requirements

The production component considers the average rate of service delivery per hour of work within provider groups. So, for example, in the case of hospital-based registered nurses the average number of RIW-standardized episodes of care per 1,000 worked hours will form a measure of average productivity of registered nurses (Birch *et al.* 2003). The level of productivity is influenced by several factors, including the way human resources are used and the availability of other resources for use in service production. For example, O'Brien-Pallas *et al.* (2003) found that inpatient length of stay was higher in hospital units where over 90 percent of registered nurse (RN) time was devoted to direct patient care, even after allowing for differences in other factors such as patient acuity. In other words, productivity falls where the intensity of work exceeds this threshold. Similarly, average productivity of nurses was observed to be lower for units where a greater proportion of RN time was made up of overtime hours. As with the epidemiology determinant, we use existing levels of productivity as a starting point for the simulations, but also consider the effect of rates of productivity change of 0.5 percent per annum and 1.0 percent every five years (or 0.2 percent per annum). These represent modest levels of productivity change compared to the economy as a whole.

The Simulation Model

The simulation model was implemented using Vensim 2002 software based on a series of mathematical equations that are solved to run the simulation. Vensim was selected because of its programming flexibility, ability to handle complexity and its graphical interface. Input data for the Vensim simulation model are incorporated into Microsoft Excel spreadsheets. This software is readily available and easy to use. Thus, users are able to update and modify data and run alternative scenarios using a distributable run-time version of the Vensim application.

The adoption of current levels of variables in the simulation model (e.g., provider productivity and level of service) is used to provide a baseline for simulations. It is not intended to imply that these levels represent some notion of an efficient use of health-care resources. The modular nature of the simulation model, however, means that these levels can easily be replaced by other values in order to consider the effect of changing current practice on the supply of, and requirements for, providers.

Simulations are used to understand the relative impact of different policies and combinations of policies on imbalances between human resource requirements and supplies. Based on the separate estimates of provincial ministries of health, there was a shortage of RNs in the Atlantic region of 2,475 in 2003. The provider gap in the simulation model was therefore initialized at –2,475. This gap is anticipated to increase over time under all three needs scenarios (see Figure 3), largely due to the considerable losses to retirement expected in the next 15 to 25 years. Although the non-constant needs scenarios both result in slightly smaller gaps, even under the most optimistic needs scenario, in the absence of other changes in the model there will be a shortage of over 5,000 RNs in 15 years time.

Figure 4 shows how this estimated shortfall in the number of RNs is affected by various alternative

FIGURE 3
Number of Activity-Adjusted RNs Required in Atlantic Canada Under Various Needs Scenarios

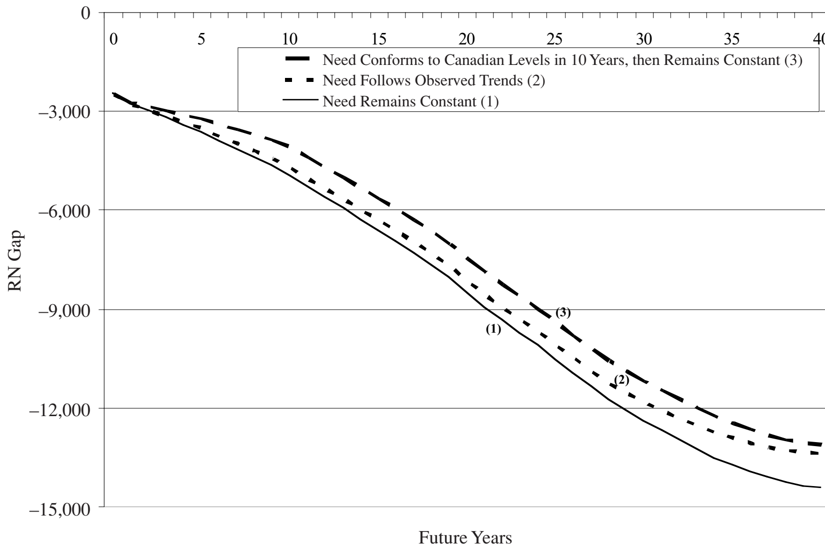
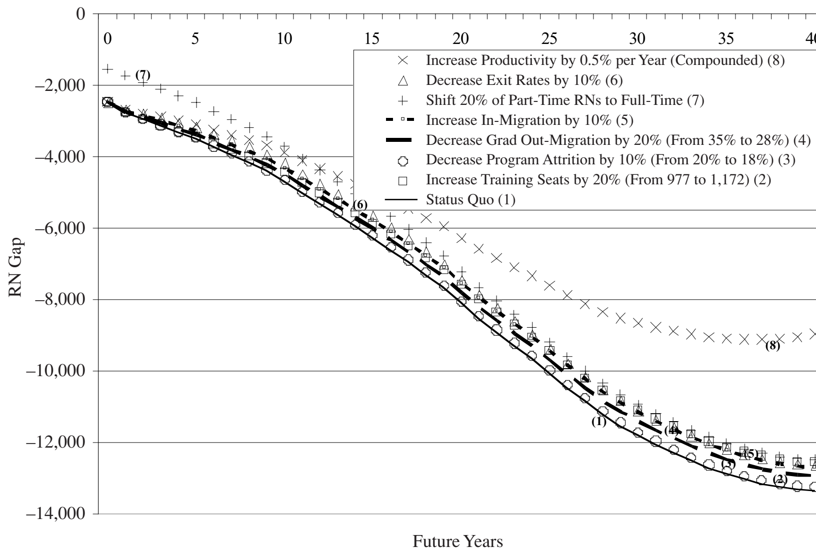


FIGURE 4
Individual Effects of Policies on RN Gap in Atlantic Canada: Need Follows Observed Trends



policies. The estimated gaps in this figure are all based on simulations using the "needs follows observed past trend" scenario.

An increase in the average productivity of RNs by 0.5 percent per year would produce the largest long-term impact on the level and trend in the RN gap. Such a change would cut the projected deficit by about 30 percent relative to the baseline scenario over 40 years. Higher increases in productivity (not presented in Figure 4) would, of course, reduce the gap further.

Figure 5 presents the cumulative effect of these policies and shows that policies affecting the deployment and productivity of RNs can greatly amplify the benefits of increasing the size of training programs and improving recruitment and retention. Productivity improvements of 0.5 percent per year, when combined with changes in training and supply variables, would reduce this RN gap by over 60 percent.

An alternative way of interpreting these estimates is to calculate the number of additional training places needed in order to remove the RN gap within the next 15 years. Tables 1 and 2 provide these estimates for each individual policy and for the combination of policies, respectively. An increase of between 2,475 and 2,975 training seats would be required to eliminate the RN gap in 15 years — between two and three times the 2002 training capacity of the region of 977 seats. Thus, increasing training seats alone would appear to be infeasible as a means of eliminating the RN shortage. However, implementing other policy changes dramatically alters the number of training seats that would be required to eliminate the gap in 15 years. Increasing productivity has the largest impact on the number of training seats required. If productivity increases by 0.5 percent per year, the number of additional seats required would be reduced by 20 percent, from 3,073 to 2,448. Moreover, changing needs, due to improvements in health status, further reduces the number of additional seats required by a further 450 seats.

FIGURE 5
Cumulative Effects of Policies on RN Gap in Atlantic Canada: Need Follows Observed Trends

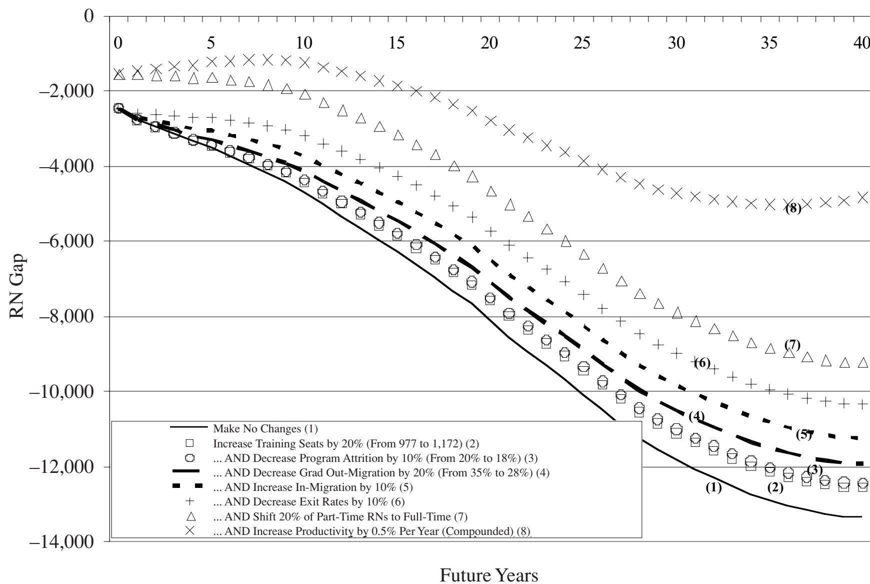


TABLE 1
Effects of Policy Scenarios on Number of Training Seats in 15 Years in Atlantic Canada by Needs Scenario

	NEEDS SCENARIO		
	Constant	*Follows Observed Trends*	*Canadian Levels*
Increase training seats only	2,975	2,825	2,475
Decrease training program attrition by 10% (from 20% to 18%)	2,850	2,725	2,400
Decrease graduate out-migration by 20% (from 35% to 27%)	2,475	2,450	2,100
Increase RN in-migration by 10%	2,725	2,625	2,250
Decrease working RN exit rates by 10%	2,600	2,500	2,150
Shift 20% of part-time RNs to full-time	2,075	2,000	1,650
Increase productivity by 0.5% per year (compounded)	2,400	2,275	1,950

TABLE 2
Cumulative Effects of Policy Scenarios on Number of Training Seats in 15 Years in Atlantic Canada by Needs Scenario

Potential Policy Scenario	*Need Remains Constant*	*Need Follows Observed Trends*	*Need Conforms to Canadian Levels*
Make no changes	2,975	2,825	2,475
Decrease training attrition by 10%	2,850	2,725	2,400
Decrease graduate out-migration by 20%	2,400	2,350	2,025
Increase RN in-migration by 10%	2,250	2,150	1,800
Decrease RN exit rates by 10%	1,950	1,875	1,575
Shift 20% of part-time RNs to full-time	1,225	1,125	800
Increase productivity by 0.5% per year	825	750	450

While these represent substantial reductions in the number of seats required, an increase of 1,950 seats is more than double current capacity.

Implementing changes in multiple policy variables can dramatically reduce the number of training seats required to eliminate the RN gap in 15 years (see Table 2), but even the best-case scenario would require increasing the number of seats by 450 or over 50 percent.

DISCUSSION

An important contribution of the needs-based approach to HHRP is the central role played by the needs of the population in driving provider requirements. Previous approaches to health human resources planning have implicitly adopted age and sex as proxy measures of need. However, this fails to allow for variations in needs within age and sex subgroups of the population (e.g., needs among 35–

45-year-old-males may differ according to economic, behavioural, social or environmental factors) and changes in these needs over time (Birch *et al*. 2003). The levels and distribution of needs in the population are introduced into the analytical framework explicitly as a determinant of provider requirements. So, for example, if the average health status of 65–75-year-old males increases over time, the number of providers required to serve a fixed size of population in this age group would fall, other things being equal, because the number of services required by this age group to meet current levels of service would be lower.

Introducing different levels of need explicitly into the analytical framework means that some method is required for translating need into requirements for services. There are no "gold-standard" weights for this translation. Although we might expect populations with lower levels of health status to be provided with greater quantities of services, the size of the health status-service provision" relationship is largely the result of provider discretion guided by professional guidelines and ethics, and subject to the constraints imposed by prevailing budgets. Because *level of service* is a determinant of provider requirements, changes in the level of service will affect requirements for providers. Suppose research suggests that more frequent screening of diabetic patients would improve patient outcomes and decision-makers seek to change service delivery to this patient group accordingly. Such a change increases the level of service and, with all other things being equal, this increases the required number of providers.

Similarly, a method is required for translating estimated service requirements into provider requirements. This translation will depend on the rate of productivity of providers (i.e., services per unit of provider activity). Productivity depends on a variety of factors, including the intensity of work (measured by, for example, the proportion of paid hours devoted to patient care), how work is organized, technological inputs, and inputs of other types of professionals. For example, research by O'Brien-Pallas *et al*. (2003) found that above certain thresholds, increases in intensity of work (as measured by MIS workload measurement systems) reduce nursing productivity. In New Brunswick, the introduction of an automated pharmacy project was associated with a reduction in requirements for pharmacists to maintain service levels for the population (T. Maston, River Valley Health Care, personal communication).

Planning for specific improvements in future productivity is problematic, particularly in the health-care sector where outcomes are difficult to measure and care is required to avoid the quality of service production being compromised for increases in service quantity. However, approaches have been developed and applied for monitoring the quality of service provision in the context of changing service volumes using data on, for example, hospital readmissions, patient self-assessed health status, and satisfaction with care (Birch, Tomblin-Murphy and O'Brien-Pallas 2004; Tomblin-Murphy 2005). Moreover, traditional approaches to HHRP have failed to identify productivity as an important determinant of human resource requirements, and, hence, have failed to accommodate improvements in productivity that have already occurred. In this way, changes that reduced the unit cost of services have tended to generate cost increases, as "surplus" human resources have been absorbed in the production of unplanned expansions in service types and levels.

By identifying the separate determinants of provider requirements, the analytical framework helps to avoid HHRP falling for the "illusions of necessity" of self-perpetuating increases in provider requirements (Evans 1984). Moreover, it enables policymakers to evaluate the basis of, and justification, for increases in the sizes of provider stocks and increases in education and training programs as a method of increasing stocks. In addition, it provides important information on the nature of any observed gap between expected supplies of and requirements for providers (e.g., long-term versus short-term shortages) and broadens the traditional focus on

training seats to encompass a wide range of policy influences. In this way it provides the opportunity for a policy portfolio aimed at matching policies with the nature of the underlying problems and avoiding time lags in responsiveness to current problems (see Birch, Tomblin-Murphy and O'Brien-Pallas 2004).

Finally, because it is substantially more comprehensive than traditional methods of HHR planning, the data requirements of the extended analytical framework presented here are considerably greater than those of, for example, the simple application of aggregate population-provider ratios and age-gender-specific levels of service utilization. However, in the health-care systems in many industrialized countries, the data required to "populate" the additional elements of the extended framework are available either directly from existing data sources (population health surveys) or could be constructed from other sources (data on levels of service provision and levels of provider inputs). Although the application of the framework would benefit from the collection of prospective data on these variables on a regular basis, this would represent a refinement of the frameworks application rather than a barrier to its current use.

Acknowledgements

This manuscript is based on research funded by the Atlantic Health Human Resources Association. We also acknowledge research and administrative assistance of Jenny Buckley, Jill Casey, Shoba Ranganathan and Megan Rogers. The final manuscript benefited from the constructive comments of two anonymous referees.

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