PHYSICIAN RESOURCE PROJECTION MODELS

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The Manitoba Centre For Health Policy

The Manitoba Centre for Health Policy (MCHP) is located within the Department of Community Health Sciences, Faculty of Medicine, University of Manitoba. The mission of MCHP is to provide accurate and timely information to healthcare decision-makers, analysts and providers, so they can offer services which are effective and efficient in maintaining and improving the health of Manitobans. Our researchers rely upon the unique Population Health Research Data Repository (Repository) to describe and explain patterns of care and profiles of illness, and to explore other factors that influence health, including income, education, employment and social status. This Repository is unique in terms of its comprehensiveness, degree of integration, and orientation around an anonymized population registry.

Members of MCHP consult extensively with government officials, healthcare administrators, and clinicians to develop a research agenda that is topical and relevant. This strength along with its rigorous academic standards enable MCHP to contribute to the health policy process. MCHP undertakes several major research projects, such as this one, every year under contract to Manitoba Health. In addition, our researchers secure external funding by competing for research grants. We are widely published and internationally recognized. Further, our researchers collaborate with a number of highly respected scientists from Canada, the United States and Europe.

We thank the University of Manitoba, Faculty of Medicine, and Health Research Ethics Board for their review of this project. MCHP complies with all legislative acts and regulations governing the protection and use of sensitive information. We implement strict policies and procedures to protect the privacy and security of anonymized data used to produce this report and we keep the provincial Health Information Privacy Committee informed of all work undertaken for Manitoba Health.

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Table of Contents

List of Tables

List of Figures

EXECUTIVE SUMMARY

Introduction

There is considerable interest in health human resource planning at the local, provincial, national and international levels. This is based to a large extent on the widespread perception that there are shortages of physicians, nurses and other health care professionals that may result in negative impacts on the health of the population. In response to the shortage of physicians in Manitoba, the number of training positions for medical students at the University of Manitoba has increased from 85 positions to 110 positions within a five year period. After completion of the four year medical program, students require further residency training before entering practice.

This report provides information to help medical education planners decide how to distribute the available residency positions among the various specialties. The projections for the growth of service requirements in the specialties can be used to actively manage the training of different specialists and family physicians who will provide medical services to the population of Manitoba.

The projections for service requirements are based on the historical trends in service provision over the past 23 years and the future population projections developed by Statistics Canada with the Manitoba Bureau of Statistics. There is no claim that any of the projected service levels represent the "correct" number of services needed. In fact, there is evidence to suggest that historically there has been a continual shortage of services in many areas of medical practice and that modeling our projections on this state of shortage will perpetuate the physician shortage. The purpose of this study, however, is to use the evidence available to project service requirements based on the projected population changes, not to speculate on an optimal service provision level.

Our Approach

We developed projections of the amount of services required based on the past trends of service use rather than the number of physicians needed. Many different ways have been used to count the number of physicians required to serve a population. The most common being the ratio between the population and the number of physicians serving that population. This crude measure does not take into account the characteristics of either the population being served (e.g., population age distribution) or the work productivity of the physicians included (e.g., part-time or full-time service provision). In order to address some of these shortcomings, we separated the two measures: the number of services required and the number of physicians needed to provide those services. In this two step process, we first developed models of service provision based on past patterns of service provision. Then a separate calculation is proposed that would determine how many physicians would be needed to meet the projected service requirements.

The Equivalent Services Measure (ESM)

Physician services are captured in the Population Health Research Data Repository (Repository) based on the tariffs used by physicians for billing purposes. These tariffs change over time based on the fee negotiations between the Manitoba Medical Association and Manitoba Health and Healthy Living. New tariffs may be added for new procedures, a group of services may be bundled into a single billing package or tariff, or bundled services may be unbundled into multiple tariffs. Each change makes longitudinal comparisons using these tariffs less valid. For example, only 37% of the services provided by family physicians in 2004 were recorded in the Repository using tariffs that had been used consistently over the previous 20 years. In order to address this challenge, we created the Equivalent Services Measure (ESM). The ESM represents clinical activity that is comparable over time. The numerical value of the ESM reflects the intensity of the clinical activity.

Modeling the ESM

Mathematical models describe the behaviour of a system based on theory and historical data. The system is usually described by a set of variables and a set of equations that establish relationships between the variables. In this study, we built models describing the total ESM provided by each of the physician specialties that we studied, for each year of data available. The models included the age and sex of the patients who were recipients of the services. The models were then used to project the ESM (amount of physician services) that would be supplied if the trend of service delivery described in the model were continued. The trend is based on the projected population composition (by age and sex) provided to us. Thus, models use past service delivery patterns to project future service need based on projected population changes. We developed separate models for each of the four specialty groups studied; family physicians[1], pediatricians, general surgeons and orthopedic surgeons.

Physician Productivity

Ultimately, planners need to be able to project the number of physicians needed in addition to the number of services required by the population. Where possible we developed mechanisms to transform our service needs projections into projections for the number of physicians. These calculations are based on several key factors influencing physician productivity over the past 20 years, such as physician gender, length of time in practice and method of payment. However, patterns of productivity are complex and they vary considerably among the different physician specialties. We were not

[1] In this deliverable, 'family physician' includes general practitioners and primary care physicians.

able to develop mathematical models for the surgical groups because of the relatively low numbers of physicians in these groups. Fortunately, there are changes in productivity over time that could be taken into account and are reflected in this report.

Services Provided by Family Physicians

Service projections

Service provision to different age groups by family physicians has changed significantly over the past 20 years. Patients who under the age of 40 are receiving fewer services than they did previously, while those between 41 and 80 years of age are consuming considerably more services. While this has implications for the projected service need based on the population projections, it may also suggest that the system has not been able to meet the needs of all segments of the population. Greater demands for service by some age groups may have resulted in decreased service provision to others. If this is the case, then our projections, which are based on current and past physician resources where physician supplies may have been suboptimal, are likely to underestimate true service needs.
The increase in ESM projected for family physicians is quite similar to the absolute population increase. However, the overall increase in ESM is limited by the system capacity which has resulted in redistribution of services between different age groups as the needs of a particular age group grows. Based on population projections, our model projected a 20% increase in required ESM by 2020.

Physician projections

Physician projections are limited by two factors. Firstly, family physicians provide services across the province. The number of physicians required is influenced both by the absolute number of services required and by the geographical distribution of the population and service providers. In this study, we could not take the geographical distribution of the physicians into account because we used provincial population projections rather than local or regional projections. Secondly, an absolute number of physicians cannot be calculated as we cannot project the ratio of males to females, the ages of the physicians in the workforce, or other factors that influence their productivity. We have developed a mechanism to calculate the number of physicians that would be required to meet a specified level of service when these factors are known.

Interpretation

A caution needs to be raised about using models of trends within the data. Our models are based on data that demonstrate a significant recent increase in service provision over the past 10 years. Therefore, projections provided in this study are based on the assumption that this trend will continue.

Services provided to the pediatric population

Service projections

Both pediatricians and family physicians provide services to the pediatric population. There are also pediatric specialists who provide more specialized services. In a small province like Manitoba, the number of these tertiary care specialists needed is usually dictated by the need for adequate on-call coverage and other factors rather than by the absolute number of services required to meet the population needs. Thus, this study only includes the pediatric services provided by generalist pediatricians and family physicians.

Over the period included in the study, there has been a significant decrease of service provision for pediatric patients by family physicians. The number of services provided by pediatricians does not compensate for the loss in services provided by family physicians. This has resulted in a trend of reduced service provision to this population over time, with a 13% reduction in total services (provided by both physician groups) projected by 2020. This suggests one of the following: the pediatric population has been over-serviced in the past; this population is becoming significantly healthier and, therefore, needing less service; or the pediatric population will not receive the number of services it requires according to our projections.

Service Provision by Orthopedic Surgeons

Service projections

As with the other groups, we initially calculated the ESM per year and then developed a model of the ESM. The model closely matched the real ESM when validated. It projected an 88% increase in ESM by 2020.

Physician projection

We also attempted to determine the number of orthopedic surgeons required to meet the ESM needs as projected by the model. This was done as much to demonstrate the challenges and limitations of our ability to perform this task as to provide valid projections. We used the "average productivity" approach for orthopedic surgeons rather than developing a model of productivity. Once again we encountered significant challenges based on differences in productivity. The productivity of orthopedic surgeons varies considerably depending on age and how long they have been in practice. Based on the pattern of orthopedic surgeon utilization over the last 14 years, the demographics of the current workforce, and the population projections, we projected the need for 83 orthopedic surgeons to meet the projected ESM for 2020.

Services Provided by General Surgeons

Service projection

For this projection, we included all services provided by the general surgeons identified in the Physician Resource Database. Additionally, we included other physicians who were not formally registered as surgeons, but whose work includes services that are essentially the same as those provided by registered general surgeons. The ESM model for general surgeons projected a 27% increase in service provision by 2020.

Physician projections

The pattern of productivity for general surgeons is related to the amount of time the surgeon has been working in Manitoba, as was the case with orthopedic surgeons. This means that the average productivity we would use to calculate the number of surgeons required to supply the projected ESM will vary depending on which surgeons we include in the calculations. If all 33 surgeons present between 1991 and 2005 are included in the calculation of productivity, only 63 surgeons would be required to provide the projected ESM for 2020. This is fewer surgeons than are currently working in Manitoba.

Conclusions

The projection of physician resource needs for the future is at best an inexact science. While we have used past patterns of use to project future use for the four groups of physicians, there are many factors that influence the accuracy of these projections. Most of these could not be incorporated into our projections. Our results suggest that there are wide variations in the patterns of care across different types of physician. We projected service needs for each of the four clinical specialties and, where feasible, provided estimates (or methods to calculate them) of the number of physicians needed to meet the projected service requirement. These projections will be valuable tools when planning medical and other health human resource education and training programs.

CHAPTER 1: INTRODUCTION

The number of health care providers in an area affects the health of the population as well as the health care budget. For example, too many physicians can lead to extra costs to the system, while too few can lead to reduced access for patients. As with all other services, careful planning for the future is important to ensure there are adequate resources to provide the necessary services.

Physicians enter the system in Manitoba either through training in one of our education programs or moving here after they receive their training elsewhere. While we function in an environment where physicians who train in one Canadian jurisdiction have the freedom to move to other jurisdictions, there is still significant merit in determining the number of physicians to meet Manitoba's future requirements and to distribute the available residency spots in medical school to best reflect those requirements. To do this, we require a suitable mechanism for projecting the number of required physicians. This need was recognized in the Barer-Stoddard report (1991) that was commissioned to help guide medical resource policies in Canada. However, selective implementation of the report's recommendations is at least partly responsible for the current cross-country shortage (Chan, 2002; Tyrell & Dauphinee, 1999).

We regularly see news headlines and articles on the topic of waiting lists and the concerns of Canadians about our health care system and the way it is currently being administered (Ontario Medical Association Human Resources Committee, 2002; Godley, 2005). Manitobans are having difficulty finding family physicians—a fact that has prompted the Manitoba Government to develop a central phone registry that links patients looking for a family doctor with physicians who are currently accepting new patients. Physicians are also suffering the consequences of the current shortage. They report having to work more hours than they would ordinarily choose to and experience high levels of stress and dissatisfaction with their practices (Chan, 2002; Ontario Medical Association Human Resources Committee, 2002; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Watson et al., 2004; National Physician Survey 2007, 2008).

In order to plan appropriately, we need to know how many physicians and services are required to meet the needs of the population. Measuring the health care needs of a population is extremely difficult. Because there is wide variability between the uses of health services by patients with similar illnesses and demographic characteristics, it is very difficult to determine how many physician services are required for any patient or group of patients. Many factors influence how people use the system, but we are unable to define an accepted "correct" pattern of use for any particular patient.

This has led to the use of proxy measures intended to reflect the needs of the population. One such measure is of current utilization of services. Another measure focuses on demand. The demand for service is a combination of the services supplied (utilization) and the unmet demand, often represented by waiting times for services. The issue of the needs of the population is addressed in more detail in the section on "needs-based planning" on page 12.

Comparing physician resource needs between different jurisdictions is even more difficult due to issues such as a population's geographical distribution, socioeconomic structure, and age distribution, as well as differences in governance and funding of the health care system. Contrary to the United States where patients can make appointments with specialists directly, in Canada, family physicians[1] serve as "gate-keepers" to the health care system. This results in a different balance between the number of **family physicians**[2] and **specialist physicians** in the two countries. Many services that are provided by specialists in the United States are provided by family physicians in Canada; thus, more specialists are required in the United States. The **capitation system** of funding **primary care** services used in the United Kingdom is also quite different from Canada's **fee-for-service (FFS)** system. Whereas Canada pays family physicians only for the services they themselves provide, capitation allows for the development of primary care teams. Under this model a "practice" may hire alternative/other providers (e.g., nurses and health educators) to support the physicians, thereby allowing them to care for a larger group of patients. The larger practice size, in turn, provides further funding for these alternative providers. Consequently, projections of physician requirements and the relative proportions of specialists to family physicians made in other jurisdictions should not be used as a substitute for Canadian resource projections.

Some Canadian recommendations on an appropriate number of physicians have been made. For example, the Ontario and Canadian Medical Associations have recommended an overall target physician-to-population ratio of 180 to 190 per 100,000 people (Tyrrell et al., 1999; Ontario Medical Association Human Resources Committee, 2002). In contrast, Roos, Bradley et al. (1998) determined that based on the age and sex of the population, Manitoba required only 160.1 physicians per 100,000 people. The above examples use one of a variety of potential methods to describe the number of physicians serving a community, namely, the physician to population ratio. A more detailed discussion of this and the other ways of describing physician resources can be found in Chapter 3.

[1] In this deliverable, the term 'family physician' includes general practitioners and primary care physicians.

[2] Throughout this report, terms in **bold** typeface and acronyms are defined in the glossary located at the end of the report.

1.1 Study Objective

This study sought to develop mathematical models to project the services required by the Manitoba population as well as the number of physicians required to provide these services. The models are based on the historical pattern of use, regardless of whether the number of services provided in the past has been adequate to meet the population's need, and the projected demographic characteristics (i.e., age and sex). Other characteristics such as **socioeconomic status** and **comorbidity**, which are known to affect health or service use, could not be included in the models as there are no population projections for these characteristics. Models were developed for four key physician specialties identified by Manitoba Health and Healthy Living: family medicine, pediatrics, **general surgery** and **orthopedic surgery**.

Chapter 2: Factors Affecting the Supply of Physician Services

Physician supply exists as a dynamic equilibrium; the size of the workforce changes over time based on physicians entering and exiting the pool. For example, the physician workforce in 2010 will be equal to the current workforce plus any additions to the workforce pool and minus any departures from it. Physicians enter Manitoba's workforce either directly from medical school or by emigrating from other jurisdictions. They leave the pool by moving to another jurisdiction, retiring from their practice or, on rare occasions, dying.

The productivity of the workforce plays a significant role in any discussion of the future needs for medical services as not all physicians are equal in terms of the workload they undertake. Individual physician productivity is determined by a complex set of factors, some of which are difficult to measure and predict. These include personal values in terms of work/life balance, personal financial resources and expectations, and individual physician response to greater demand on their time than they may prefer. There are, however, several factors that have already affected, or have the potential to significantly affect, the supply of medical services. These factors must be taken into account in any projections particularly because nearly all of these changes are in the direction of reducing physician productivity (Cooper et al., 2002). A few of these factors are described below:

i) The average age of the physician workforce is increasing (Watson et al., 2004). Currently, in Canada, the average physician age is 48 years old (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005). It is expected that the percentage of physicians over 55 will increase from 26% in 1999 to 43% in 2021 (Tyrrell et al., 1999). This trend is important because, in general, as physicians age, they are inclined to reduce their work hours. (Chan, 2002; Ontario Medical Association Human Resources Committee, 2002; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Lurie et al., 2002; Cooper et al., 2002; Slade and Busing, 2002). Traditionally, younger and older physicians tend to show less output in production than middle aged physicians (Chan, 2002; Watson et al., 2004). Thus, when one plots physician age against physician productivity, the resultant graph reveals an inverted U-shaped curve (Ontario Medical Association Human Resources Committee, 2002; Watson et al., 2004). Therefore, following these patterns, a physician workforce that is aging would be expected to produce less output as a whole.

ii) There is an increasing number of women in the physician workforce. Some researchers predict that women will compose 40% of the total physician workforce in Canada by 2015 (Tyrrell et al., 1999; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005). Female physicians in most areas of medicine deliver fewer services than their age-matched male counterparts. This is partly because they work fewer hours and tend to accept part-time rather than full-time positions (Tyrrell et al., 1999; Ontario Medical Association Human Resources Committee, 2002; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Goodman, 2005; Lurie et al., 2002; Cooper et al., 2002; Freed et al., 2003). On average, compared to their male counterparts, female physicians practice approximately seven to eight fewer hours per week and have a 21% lower overall practice activity (Chan, 2002; Tyrrell et al., 1999; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Slade and Busing, 2002; Liu et al., 2004). Further, female physicians, especially during childbearing years, are more likely to take leaves of absence from work to care for their children (Chan, 2002; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005).

Although the number of women in all specialties of medicine is increasing, women are pursuing medical specialist roles more than surgical roles, giving new shape to the future specialty workforce (Chan, 2002; Tyrrell et al., 1999; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005). For certain specialties, specifically family medicine, pediatrics, obstetrics and gynecology, and laboratory medicine, the majority of recent post-graduate trainees have been women (Tyrrell et al., 1999; Ontario Medical Association Human Resources Committee, 2002; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Goodman, 2005; Cooper et al., 2002). Some American researchers are predicting that women will soon comprise two thirds of the pediatric workforce in the United States (Goodman, 2005). Surgery is beginning to experience an increase in its numbers of female physicians though to a lesser degree than these other areas (Chan, 2002). Orthopedic surgery, however, remains a largely male dominated specialty; in Ontario for example, 94% of orthopedic surgeons are male (Shipton et al., 2003). The same has been true in Manitoba over time (see Table 2.1). Given the different impact of female physicians on the various specialties and their practice patterns, workforce projections must be made within each of the specialties.

Table 2.1: Percent of Female Physicians in Manitoba by Specialty

	1995*		2005*	
	Total physicians	% Female	Total physicians	% Female
Family Physicians	976	26.4	1,066	31.0
General Surgeons	82	6.1	64	6.3
Orthopedic Surgeons	32	0.0	43	2.3
Pediatricians (PC)**	76	30.3	90	41.1

* Fiscal year

** Pediatricians providing primary care

Source: Manitoba Centre for Health Policy, 2009

iii) More recently, there is a trend, particularly among younger physicians, towards placing a greater emphasis on family and personal time and therefore working fewer hours (Cooper et al., 2002). When compared on most productivity measures, younger physicians are working less than their age-matched cohorts in the past (Tyrrell et al., 1999; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Cooper et al., 2002; Slade and Busing, 2002). A previous MCHP study documented that, in Winnipeg, family physicians aged 30-49 years provided 20% fewer visits than their age-matched cohort did only ten years prior (Watson et al., 2004). If the majority of the workforce is delivering fewer services, in order to achieve the same level of overall service provision to the population, either another cohort of the workforce will have to provide more services than in the past or the size of the workforce needs to be increased. Thus, the importance of workforce productivity, as illustrated in the above two examples, is self-evident.

iv) Younger physicians also have a tendency towards **alternate payment plans** (**APP**) rather than fee-for-service positions (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Cooper et al., 2002). Physicians who are paid by the number of services they deliver have a built-in incentive to provide more services in order to maximize their income since it is directly tied to output (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Gosden et al., 1999). The salaried method of payment breaks the link between payment and output (Gosden et al., 1999). Physicians paid under this method have been shown to deliver fewer services than their fee-for-service counterparts (Gosden et al., 1999). The implications of this trend for human resource planning are, at least for the time being, unclear. While salaried physicians deliver fewer services (which would have a negative impact on physician supply as more physicians would be needed to supply the same number of services), they spend more time with their patients, order fewer tests, have lower levels of hospitalization, provide more after-hours care, and do more preventative care than their fee-for-service counterparts (Gosden et al., 1999). All of these factors combined might have an overall positive effect on medical service provision and health care costs. Also, they could mitigate the negative effects of salaried physicians working reduced hours.

v) A fifth factor affecting the supply of physician human resources is the concept of market share (Shipman et al., 2004; Committee on Pediatric Workforce, 2005). Market share, as it relates to physician care, might be explained as the proportion of demand for a certain health service that is filled by specific medical specialties. Take, for example, the provision of pediatric primary care services to children in Manitoba. Currently, both family physicians and pediatricians are involved in children's primary care; accordingly, each group has a certain market share for the delivery of these services. If, however, Manitoba pediatricians were to stop providing primary care, the market share would shift towards family physicians. This would result in a greater demand for family physicians. Competition for market share exists between physicians and non-physician healthcare providers. The use of these alternative practitioners (such as **nurse practitioners** and **physician assistants**) to provide primary care is a growing trend (Goodman, 2005; Cooper et al., 2002). Thus far, the ability of these individuals to substitute for physicians has been limited largely due to licensing requirements and the small number of practitioners (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Cooper et al., 2002; Way et al., 2001). If, however, the government were to remove licensing barriers and support increasing the numbers of these professionals, this could may well produce a substantial substitution effect. Numerous practitioners (e.g., nurse practitioners, physician assistants and mid-wives) may be capable of providing substitution for various physician services (Chan, 2002; Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Cooper et al., 2002). Cooper et al. (2002) estimate that the cumulative effects of such practitioners in the United States will be equivalent to 65 physicians per 100,000 people by 2015. Consequently, these practitioners may have a great impact upon physician resource planning in Canada although the extent of the substitution effect that they will have remains to be seen (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005).

vi) Finally, the geographical distribution of physicians has an important effect on the availability of medical services and, thus, physician resource planning. While a region may have an adequate supply of doctors overall, it may still have some areas of relative surplus and others with a shortage (Tyrrell et al., 1999; Ontario Medical Association Human Resources

Committee, 2002; Shipman et al., 2004; Shipton et al., 2003). The geographic layout of an area may also be relevant in determining an adequate number of physicians. That is, a large population in a small area may be able to make more efficient use of fewer physicians than a similar population spread over a larger area and, thus, the latter region would require more physicians. In particular, the need to have sufficient numbers of physicians available in rural areas to maintain 24-hour service coverage may require a greater number of physicians than the area warrants, in terms of number of patients or level of service that the population in the area requires.

While all these factors are important in determining the number of physicians needed to provide a predetermined number of services, their effects cannot be predicted or included in predictive models. This study does, however, include a separate model that describes the productivity of family physicians based on their age and sex. Therefore, it is possible to calculate the number of physicians required to provide a projected level of service taking the age and sex distribution of the workforce into consideration. In addition, the number of services "needed" is problematic to project.

There are several limitations of service projection efforts in general. First, although any decision on the "right number" of services remains highly dependent on the values of the society (Roos, Bradley et al., 1998; Goodman et al., 2005), there is no mechanism to measure or reflect these values. For example, societal values about what an acceptable wait time for health services should be compared to the costs of providing more easily accessible services. As services are made more readily available, the costs of providing these services grow. Second, we are unable to account for changes that may take place in the system. Such factors include the future impact of technological advancements, including expanded indications for treatment, and improvements in therapeutic efficiencies (Liu et al., 2004). Furthermore, estimates are based on past patterns of use which means that their degree of accuracy depends on how well future trends follow those of the past. The last key limitation to physician workforce projections is our inability to predict the impact of future policy on the health of the population or service provision. The future physician workforce will be affected by policies made by provincial governments across Canada, as well as, by job opportunities across North America and even around the world as "the market for physicians is global." (Ontario Medical Association Human Resources Committee, 2002). The degree to which our human resource projections will be successful might not depend as much on our degree of accuracy in forecasting the effects of measurable variables, as on the relative importance of those variables we cannot predict.

CHAPTER 3: QUANTIFYING PHYSICIAN REQUIREMENTS

Several methods have been used to "count" the current number of physician resources and to project future physician supply. There is little agreement on how to describe the current supply of physicians, resulting in even larger disagreements when attempting to estimate physician resource requirements for the future. This is illustrated by an ongoing debate in the United States where some sources are predicting huge surpluses of pediatricians and family physicians and are calling for cuts in medical school enrollment (Lurie et al., 2002; Shipman et al., 2004). Others predict quite the opposite—a deficit of physicians in these areas and other areas such as general surgery (Cooper and Getzen, 2002; Cooper et al., 2002; Freed et al., 2003; Liu et al., 2004). It is readily apparent, then, that physician resource planning is not a perfect science. Much of the variation between predictions is due to the type of approach used, the assumptions made by the approach, and the quality of data used. Incorporating additional variables into the model used by a particular approach results in greater complexity. This, in turn, is thought to improve the validity of the projections.

Unfortunately, additional variables may only add more uncertainty to the results, as each additional variable brings its own set of assumptions. One of the differences between models that is fundamental to this discussion is the different ways in which physician resources are described. To better understand the different approaches that have been used, we will take a brief look at five of them along with their respective pros and cons.

i) **Physician head counts**: This method involves taking a simple census or count of the number of physicians practicing in a region or jurisdiction. It can be used to quantify the numbers in the various specialties and the sex and age distributions of practitioners. It can also be linked to the population via physician-to-population ratios. The advantage of this method is that it is relatively simple to perform. It can be easily extracted from existing databases without debate or assumptions. Similarly, it is a relatively simple calculation to keep track of head counts based on new entries and departures. The major disadvantage of using head counts and physician-to-population ratios is that they do not reflect productivity (Chan, 2002; Lurie et al., 2002). As noted in the previous section, several factors, including the fact that not all physicians work full-time, affect productivity. The census approach also does not address population needs, nor does it account for sub-populations with higher burden of illness (such as the elderly, Aboriginal people, and those of lower socioeconomic status). In addition, similar to many other models, there is an assumption that the current demand is being met appropriately (Chan, 2002; Lee et al., 1998).

ii) **Needs-Based Planning**: This approach involves planning physician resources based on the number of services deemed necessary for a population given its characteristics (e.g., health status, age, sex, ethnicity, etc.) and burden of illness (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005). Needs-based planning has the advantage that incorporating changes in health care delivery, such as work patterns amongst physicians, can be taken into account. It can also be used to compare the needs and burden of illness of different populations in a region (Lee et al., 1998; Roos et al., 1996; Roos et al., 1999).

One application of needs-based planning is to use **sentinel services** as a proxy for need. Sentinel services are defined as "**non-discretionary**" services; in other words, services that must be provided based on medical need rather than on a physician's opinion or a patient's preference. Examples of sentinel services include hip replacement surgery and bowel cancer surgery. Given their nondiscretionary nature, age-standardized population rates for these surgeries should be stable across populations. We were unable to use this approach as there is wide variability in the numbers of these procedures performed by different surgeons (e.g., some orthopedic surgeons performing none while others perform over 100 hip replacements per year). As a result, all the work done by orthopedic surgeons needs to be taken into account.

The main challenge for this approach is to define the needs of the population, particularly in relation to physician services for which norms have not yet been established. This method is more practical for planning services, such as hospital and personal care home beds, where standards of need for specific population characteristics have been defined. Previous studies at MCHP have demonstrated large variations in the numbers and types of services provided to patients with very similar characteristics (e.g., Roos, & Gilbert, 1979; Roos, Carriere et al., 1998). If we are, indeed, to plan health service delivery based on what we perceive the need to be, then we must define that need for different populations or individual characteristics. To date, our best estimation of need is previous system use.

iii) **Utilization- or Demand-based Projecting**: This approach considers the measures of actual service capacity and is the most common type of projecting (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Goodman et al., 2005). It assumes that current demand for services is being met by the current levels of utilization. Unmet demand is not addressed, but can be gauged from other qualitative measures of system functioning and the presence of wait lists. There are several underlying assumptions in this approach. Demand for service is not a true measure of need for medical services, but rather an indication of perceived need. Thus, the assumptions are that current service delivery is maximizing the health of the population and that current demand and delivery patterns will continue in the future (Goodman et al., 2005). There are two main advantages to this method: 1) data are readily available, and 2) there is the assumption that the market place currently delivers services that are consistent with societal values (Goodman et al., 2005). One disadvantage, however, is its assumption that people are only using the amounts of health care resources they need to maintain or restore maximal health (i.e., there is no "excess use"). A second flaw is that it implies that both the current system and the health status of the population are optimal, and that they should be maintained when, in reality, there is likely room for improvement (Goodman et al., 2005).

iv) **Benchmarking**: This method sets benchmarks or standards based on areas with relatively low physician-to-population ratios and fairly good overall health (Roos, Bradley et al., 1998; Goodman et al., 2005). The main advantage is that it allows for direct comparisons of physician resources between regions (Canadian Labour and Business Centre and Canadian Policy Research Networks, 2005; Roos, Bradley et al., 1998; Goodman et al., 2005). Its main disadvantage, however, is its assumption that the health of the considered population is desirable for all regions and can be attained with equivalent numbers of physicians after adjusting for demographic variations. Thus, benchmarking does not account for important regional differences in health care systems (e.g., between Manitoba and Alberta) or in infrastructure. It also does not account for the geographic distribution of the population; the area used as the benchmark may have the 'desired' situation because of efficiencies that might not be attainable for all regions. For example, regions with greater population density tend to be able to build efficiencies into the system that are not available to less densely populated areas. This means that the predicted number of physicians required for less efficient areas may be higher than projected.

v) **Economic Trend Analysis**: This method attempts to link the growth of the economy, measured by the gross domestic product, to the demand for physician services. It also tries to use the projected economic growth to predict future physician workforce requirements (Goodman et al., 2005; Cooper et al., 2002; Freed et al., 2003). This approach is based on the theory that economic expansion is the dominant factor driving health care use (Freed et al., 2003). There are several advantages to trend analysis. First, it is a macroeconomic method, relatively simple, and requires little data in comparison to the other approaches

(Cooper et al., 2002). Second, by using long-term trends, the projections are less affected by short term fluctuations (Cooper et al., 2002). Third, the resulting models can be tested retrospectively to see if they worked (Freed et al., 2003). Lastly, and perhaps most significantly, classical trend analysis does not make any judgments or predictions on the appropriate number of physicians; instead, it focuses on the number of physicians there are likely to be and how much demand there will likely be for services (Cooper et al., 2003).

In spite of these advantages, two main criticisms have been leveled at the use of trend analysis. Its basic premise of equating health care demand with GDP and a country's economic status has been challenged as an oversimplification of the drivers of health care usage (Goodman et al., 2005). Secondly, this approach may be difficult to apply to a single payer health care system, such as Canada's. Under our system, the ability of the individual to afford health care services is irrelevant since most required physician delivered care is government-funded. This removes a primary motivator that would link utilization of health services by the general public to and economic growth. Thus, while this method may make sense in the US, its usefulness in Canada has not been established. The concept of trends over time has been adopted to develop models of past utilization to project future need. In their study, Tate, MacWilliam, and Finlayson (2005) adapted trend analysis using patterns of hospital bed use rather than the economic trends. This method combines our third and fifth approaches in providing a trend analysis of the services used in relation to population changes.

The present study is based upon the data available (see Chapter 4). Thus, we have used the trend in utilization as a proxy for the need for services, but recognize the limitations in this approach. We have addressed each of the physician groups (family physicians, pediatricians, general surgeons, and orthopedic surgeons) separately because of the differences inherent in their work and the factors that influence the trends in their work over time. For each category of physicians, we built mathematical models that describe the use of services provided by that group over the past 15 or 20 years (depending on the data availability for different physician groups). These models were then used to project the need for services based on the changes in population demographics that have been predicted by the Manitoba Bureau of Statistics (MBS). For family physicians, we developed a model that describes their productivity based on their age and sex. Similar models were not developed for the other physician groups due to the lack of variability in physician sex.

Chapter 4: General Methods

4.1 Overview

As mentioned in the previous chapter, this study uses mathematical models to describe past use of the health care system and to project future requirements for these services. The projections are based on the application of the models of past use to the projected population age distribution from MBS. This chapter describes the methods used to achieve these goals; we describe the data used and provide an overview of the modelling process. Before we were able to use the data in our models, we needed to make various adjustments to them. These were necessary to compare data over time (longitudinal comparisons) for each physician group. Other adjustments were specifically relevant for family physicians (e.g., method of payment) but not for others.

A description of the modelling process is provided following the descriptions of the data sources and required data adjustments .

4.2 Data Sources and Study Period

4.2.1 Administrative Data

This study used administrative data contained in the **Population Health Research Data Repository** (**Repository**) housed at MCHP. The Repository is a comprehensive database that contains records for all Manitobans' contacts with physicians, hospitals, home care, personal care homes and pharmaceutical prescriptions dispensed in retail pharmacies. The Repository records are anonymous; prior to data transfer, Manitoba Health and Healthy Living (MHHL) processes the records to encrypt all personal identifiers and remove all names and addresses. In this study, we used **physician claims** and pharmaceutical claims (from the **Drug Programs Information Network** (**DPIN**). The **Physician Resource Database** provided other information about physicians such as specialty, age, sex, and years of practice in Manitoba.

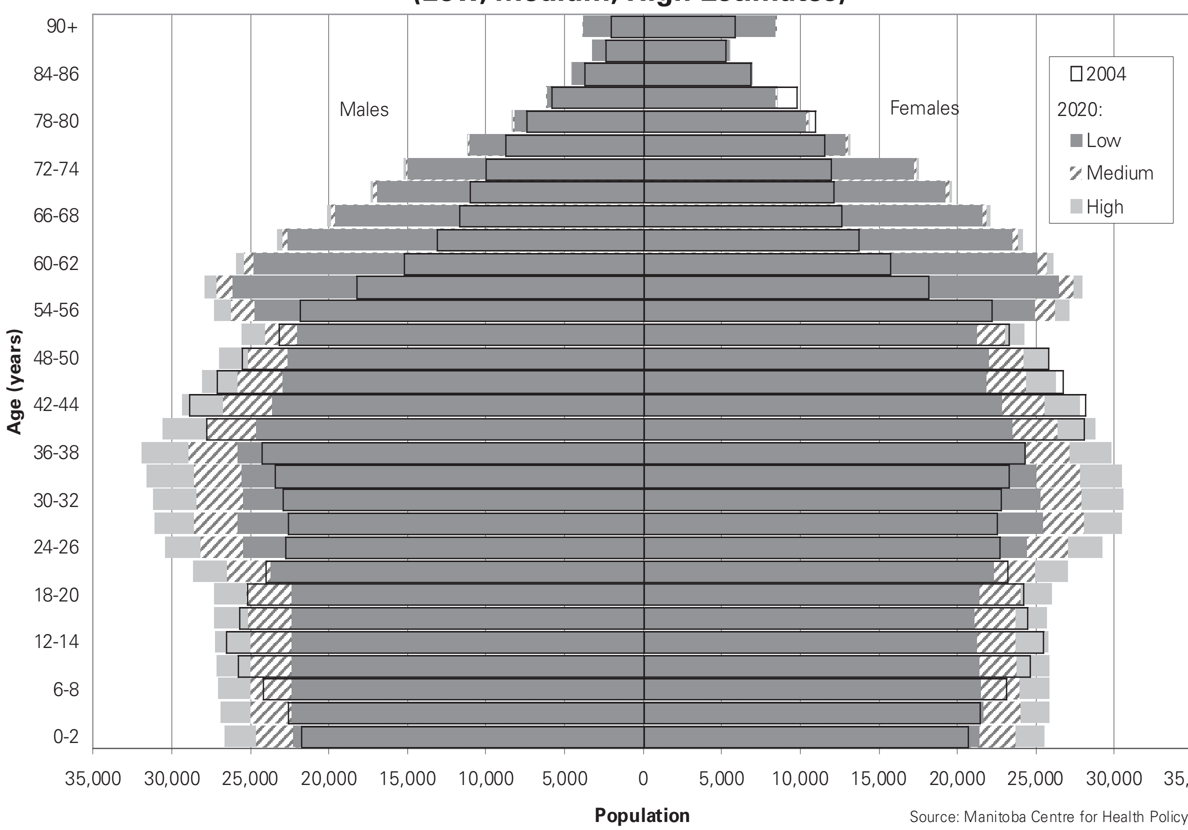
The validity of the physician claims data used in this study has been verified in previous studies (Roos, 1979; Roos et al., 1979). This validity is, however, believed to be based, to a large extent, on the fact that physicians are paid according to these billing claims. Therefore, it is easy to understand why the vast majority of physician services are reflected in the claims data. Furthermore, any claims in the Repository which do not reflect the provision of physician services would be fraudulent. Clearly, any alteration to this relationship between the claims submitted and physician income could put the validity of the data in jeopardy.

Service projection calculations were based on data from **fiscal year** 1984[3] to 2005 for primary care and from 1991 to 2005 for surgical specialties. Data analyses were performed using SAS® statistical analysis software, version 9.1.

4.2.2 Population Projections

The population projections used in this study, which were developed by MBS, take into account factors such as immigration and emigration, birth and death rates, and inter- and intra-provincial migrations. The projections provide estimates of the number of people by sex and age that will live in the province in each year up to 2020. When reading our projections for the changes in services and/or physicians, it is important to keep in mind that they are based on the MBS data.

Figure 4.1: Manitoba Projected Population Distribution 2004 (Medium Estimate) & 2020 (Low, Medium, High Estimates)



Source: Manitoba Centre for Health Policy, 2009

[3]Fiscal years were used in this study but are shown as one year.

Recent estimates from Statistics Canada indicate that the inter-provincial migration and immigration rates may be changing. Any errors regarding population movements and immigration in the MBS projections will lead to incorrect population projections. High, medium, and low population projections were provided by MBS. Figure 4.1 presents the three 2020 projections along with the medium population projection for 2004 for comparison purposes. We used the medium projections in this study.

4.3 Measuring Physician Services and the Need for Standardization: Equivalent Services Measure (ESM)

Physician services may be described in terms of volume or intensity. While volume is a straight count of the number of services[4] provided, the intensity of the service is reflected in the cost for that service. Each service is associated with a **tariff** (and corresponding **tariff code**) based on the expertise and time required to perform that service. The tariff for a subsequent visit will be less than that of a comprehensive visit and the tariff for a surgical procedure will be more than a visit. Over the short term (1-2 years), tariffs tend to remain constant. Over the longer term, however, they may change for a variety of reasons: their value (i.e., cost or fee) changes, new tariffs are introduced, old ones are replaced or deleted, several services may be combined into one "bundled" tariff, or a "bundled" package of services may be divided into separate tariffs. These changes would affect both volume and intensity. For example, until 1999, each Papaniculaou test generated two records (one for the visit and one for the test). Since then, only one bundled service record (or tariff) is generated. In the ensuing discussion, we have used the terms "claim", "tariff" (or "tariff code"), "record", and "service" synonymously.

When measuring volume or intensity over an extended period, one must somehow make the tariff fees equivalent over that time. To this end, we developed the **Equivalent Services Measure (ESM)**. The ESM is a standardized measure of service provision that enables researchers to use tariff codes over time regardless of any changes in the corresponding fee associated with the tariff that have occurred. The ESM is a standardized numerical value based on the actual dollar value of a tariff code in 2004[5] (or in the most recent year that the tariff code was used if prior to 2004) which accounts for the effects of inflation and reflects the intensity of the service. The following section uses the tariff codes used commonly by family physicians to detail the process we followed and to describe the consequences of standardizing tariffs over time. The process is identical but less complex for specialist services because there are significantly fewer changes and especially less bundling and unbundling of

[4] For family physicians, the number of services is the same as the number of records or claims.

[5] This was the most recent year of data available at the time of calculation.

services over time. Nevertheless, it is equally important in describing specialist services over time so changes in tariff value can be accommodated.

4.3.1 Constructing the ESM

The ESM represents clinical activity that is comparable over time. The numerical value of the ESM reflects its intensity. While the details of how to construct the ESM may be of limited interest, an understanding of the process is instructive and should help readers follow the application of the concept. The following example uses data up to 2004, for illustrative purposes only.

Step 1: *Categorize the tariff codes according to their time of use* (see Figure 4.2):

i) *Whole period:* Those present throughout the entire period of available data (1984-2004)

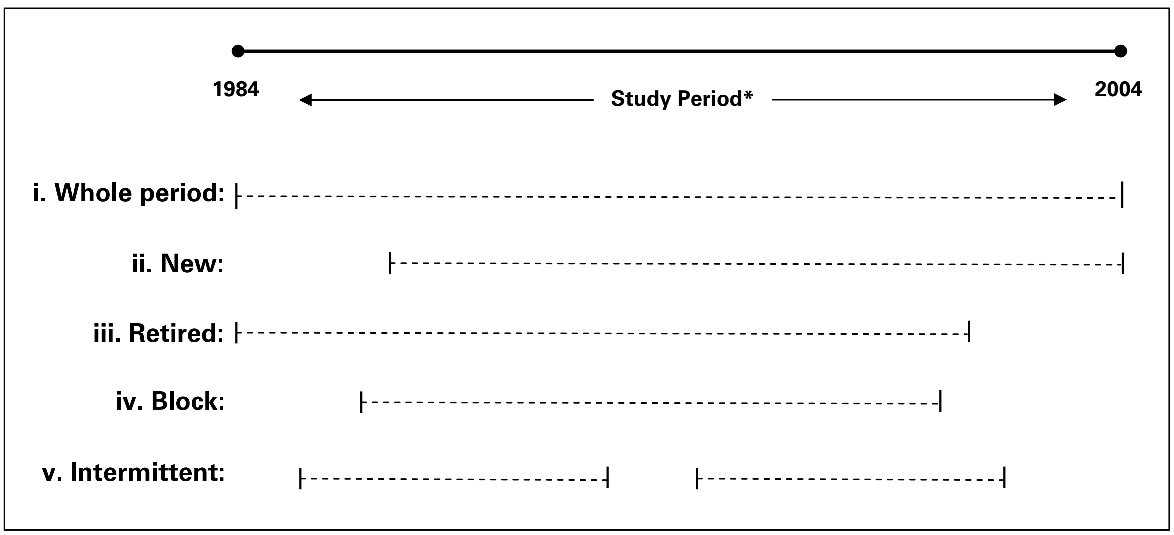
ii) *New*: Those introduced after 1984 and present, up to and including 2004

iii) *Retired*: Those present in 1984, but removed before 2004

iv) *Block*: Those present for a limited consecutive block of time between (but not including) 1984 and 2004

v) *Intermittent*: Those present intermittently between, but not including, 1984 and 2004 (i.e. they appear for a few years, then not for others, and then reappear).

Figure 4.2: Tariff Categories Based on Length of Time in Use



* Study period uses fiscal years

Source: Manitoba Centre for Health Policy, 2009

In summary, family physicians used 3119 tariff codes between 1984 and 2004:

- 29% of the codes were present for the entire period and were adjusted based on changes in value and changes due to inflation in the construction of the ESM
- 10% of the tariff codes accounted for 99.5% of the medical claims
- 1.7% (n=54) were modified (substitution of alternate tariff codes)

Figure 4.3: Use of Tariff Categories by Family Physicians

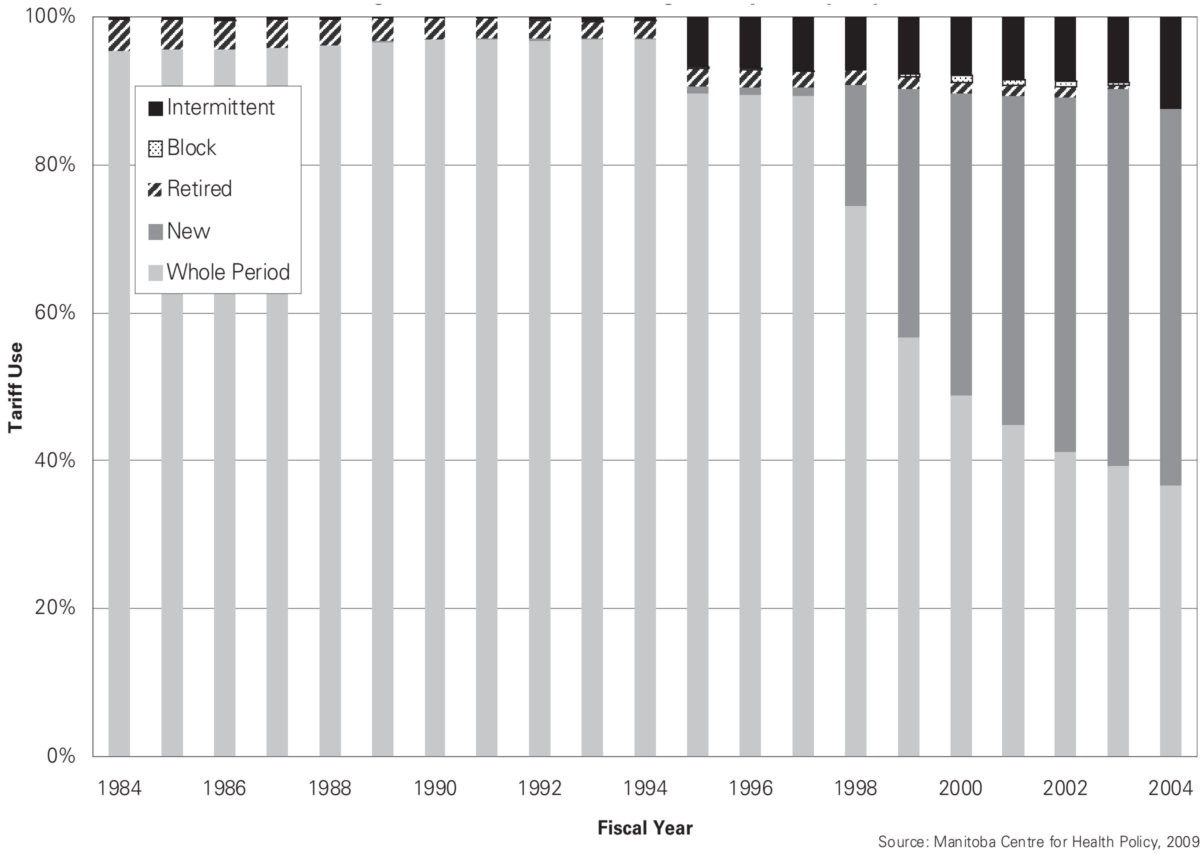


Figure 4.3 shows the distribution of the above categories from 1984 to 2004 for family physicians. In 2004, tariffs that were present throughout the period represented 37% of the total volume.

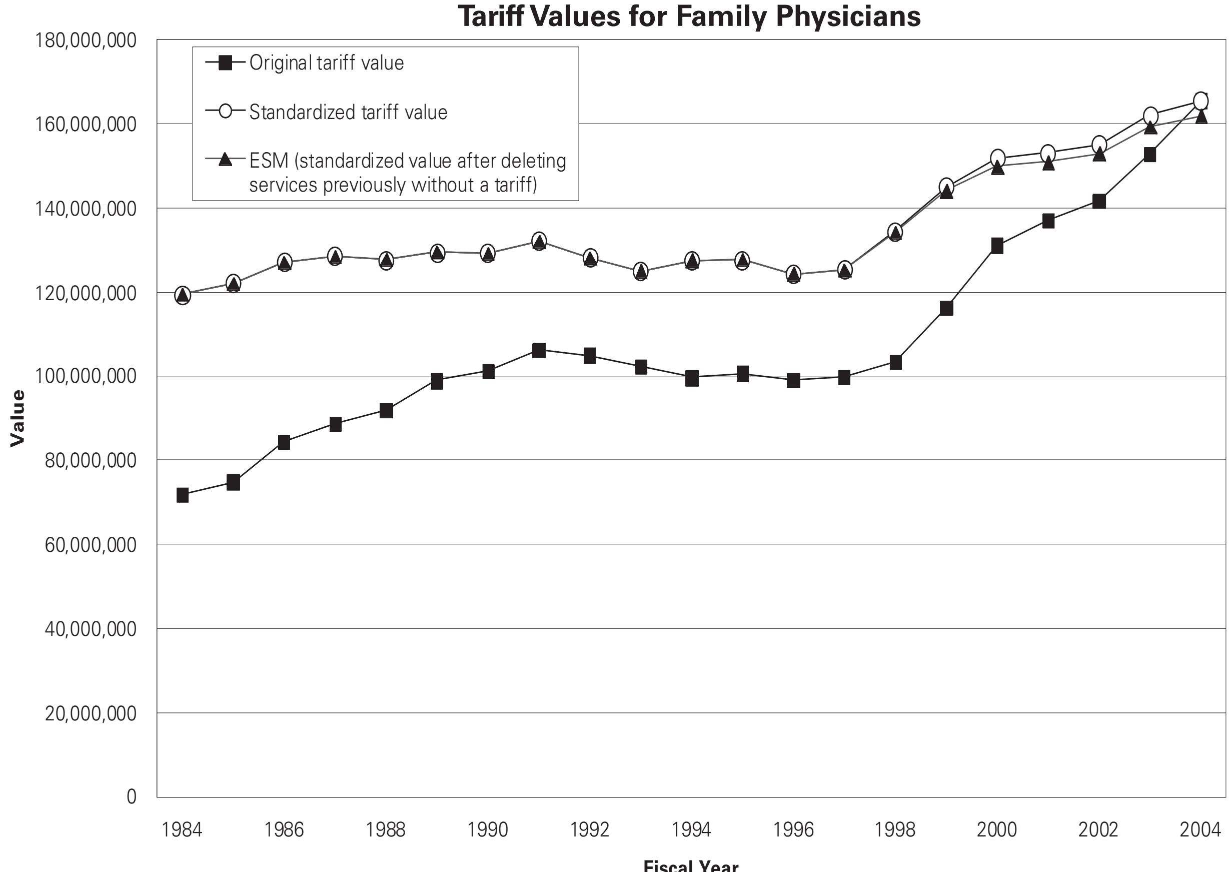
Step 2: *Adjust for inflation*. Calculate the mean value for each tariff code for the most recent year of occurrence up to 2004. Apply this 'standardized' value to all previous and sub sequent occurrences.

In most of the cases, one record represents one service. Thus, the mean price and the mean price per service in any one year are identical. In other cases, such as hospital, psychiatric and concomitant care, one record could include two or more services. For example, if a patient is hospitalized for five days, the record would include the daily fee for caring for the patient over those five days. In such cases, it is more appropriate to use mean price per service rather than simply mean price.

In Figure 4.4, the bottom line (squares) represents the total of all claims using each year's actual tariff fee values. The line with open circles shows the total for the tariffs, after assigning the mean value for each tariff for the most recent year of occurrence up to 2004.

Step 3: *Delete new tariff codes that do not represent new services.* Where a service has traditionally been provided without a tariff or charge being applied, there is no record of the service being provided. Thus, it is not possible to apply the tariff or the ESM retrospectively. For example, phone calls were always done by physicians, but a tariff for telephone calls only appeared after 1997. Before that time, the service was not directly remunerated. Figure 4.4 shows how the line of mean values shifts downward after making this deletion (circles to triangles).

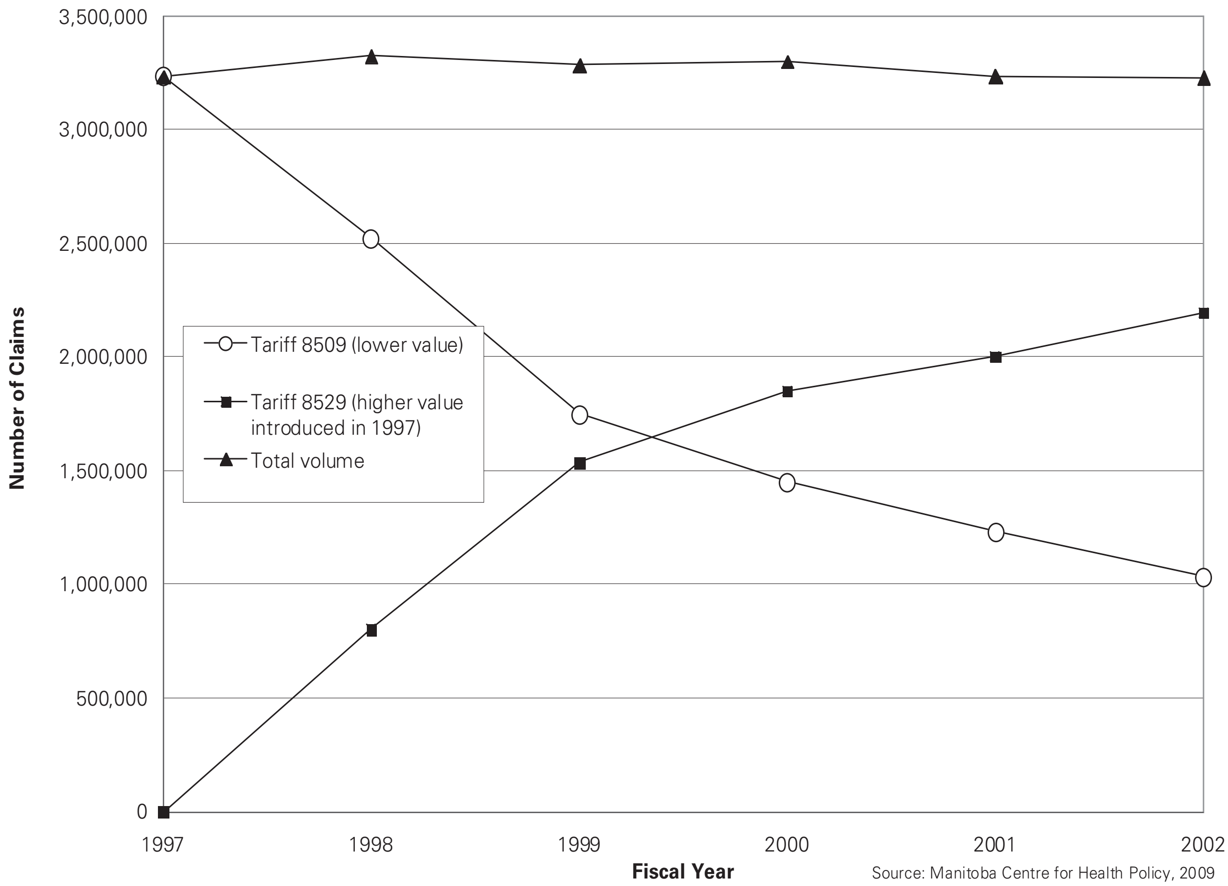
Figure 4.4: Constructing the Equivalent Services Measure (ESM): Tariff Values for Family Physicians



Source: Manitoba Centre for Health Policy, 2009

Step 4: *Substitute tariff codes that represent equivalent work*. Figure 4.5 presents an example of the substitution of tariff codes for visits due to a change in tariff codes. An intermediate office visit tariff code (8529) was introduced in 1997. Prior to that time there was a regular office visit tariff code (8509) and a longer visit (complete assessment) tariff code (8540). With the introduction of the new intermediate visit tariff code, there was a decline in the use of 8509, which corresponds to the increase in the use of the intermediate visit tariff code. Thus, there was a significant change in fees, while the number and intensity of services remained stable.

Figure 4.5: Constructing the Equivalent Services Measure (ESM): An Example of Substituting High Paying for Low Paying Tariffs (with No Effect on Services)



We substituted tariff code 8529, which only appears after 1997, with the original tariff 8509. Similar changes were made to reflect the introduction of different tariff codes based on patient age (i.e., new tariffs for patients aged 75 years or older), changes to the tariffs for hospital care, pregnancy care, and for gynecological services. These modifications accounted for 99% of the tariff fees and 97% of the services in 2004.

4.4 Adjusting for Physicians' Payment Method and Sex

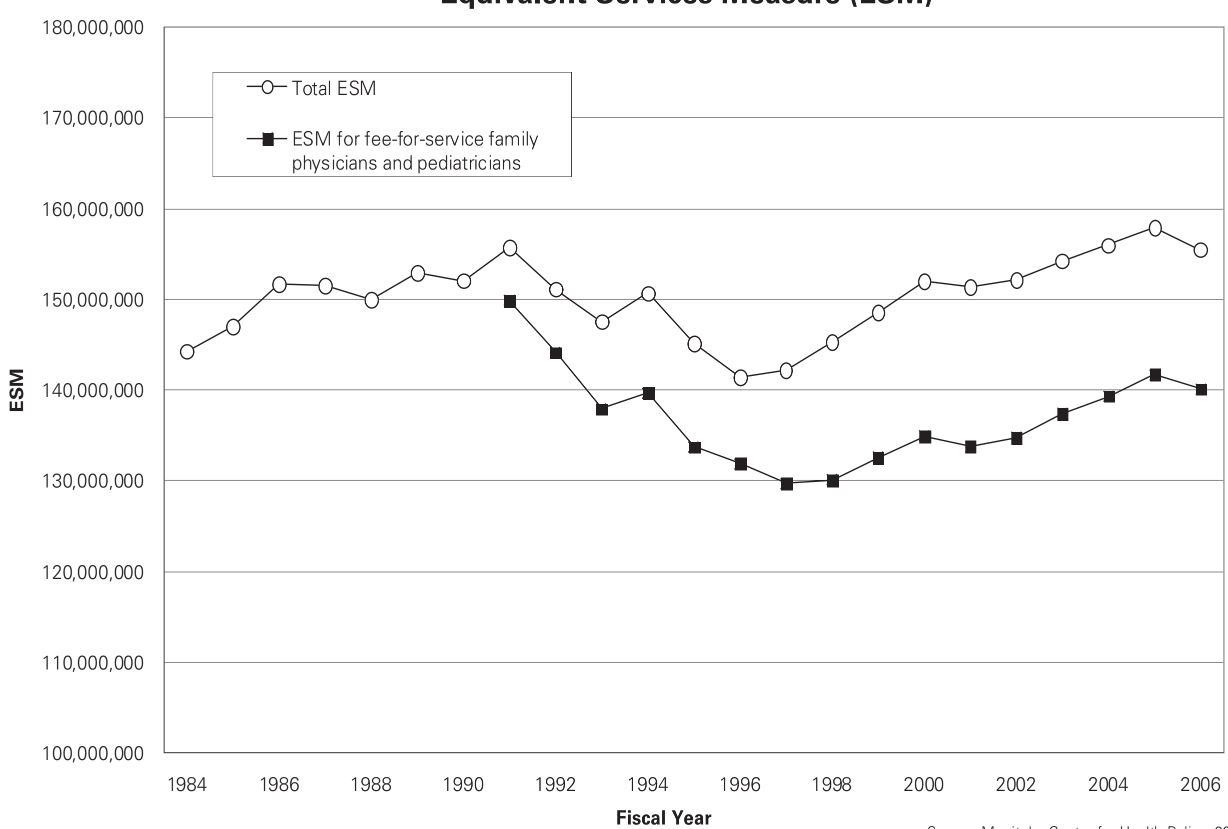
This section provides further information on the methods we used to build our models with reference to the adjustments needed to accommodate physician payment method and physician sex specifically for family physicians. The payment method impacts directly on the ESM calculation and subsequent modelling, while the impact of physician sex is reflected in the later projections of physician productivity.

4.4.1 Physician Payment Method

Physicians have traditionally been paid on a fee-for-service (FFS) basis. FFS is a method of payment whereby physicians bill for each service rendered, according to a pre-arranged schedule of fees and services. For each service there is a designated tariff code which is used to identify the service provided by a physician or a **nurse practitioner**. Each tariff code has an assigned fee (amount paid) for provision of that service or group of services. Physicians who are paid on an FFS basis file a claim for each service rendered and are responsible for their own operating costs. Other physicians are compensated under a variety of **alternate payment plans** (**APP**).

Physicians who are paid via an APP are expected to submit claims specifically for administrative purposes. These **shadow billings** are not directly related to their income, which casts some doubt on their validity and whether the ESM accurately reflects the true level of services they provide. The number of APP family physicians in Manitoba has doubled since 1995. Figure 4.6 presents the difference between the total ESM and the FFS ESM for primary care physicians; the gap between the two lines represents the ESM for APP physicians and reveals the growth in APP claims over time.

Figure 4.6: Change in Alternate Payment Plans as a Total Proportion of Equivalent Services Measure (ESM)



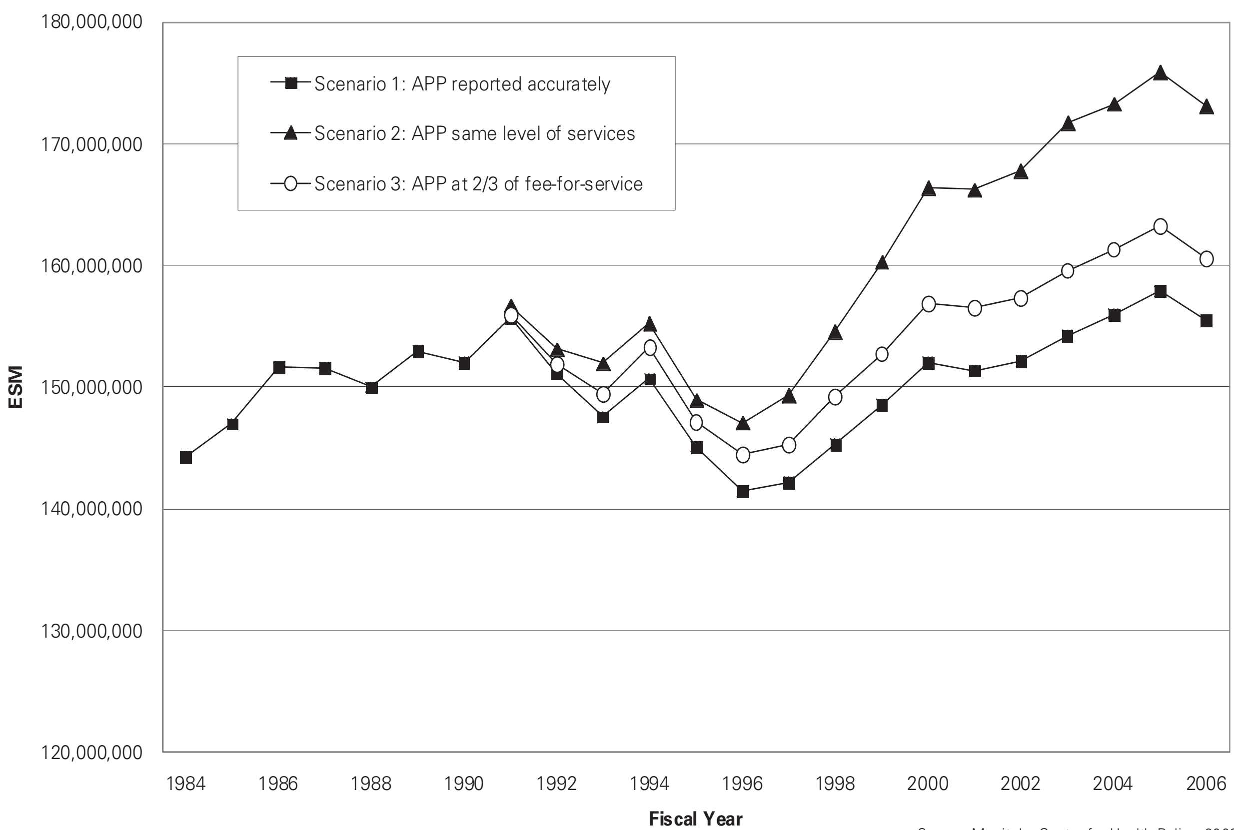
Source: Manitoba Centre for Health Policy, 2009

When we compared the average ESM and the average number of patients per APP physician to the same for FFS physicians, the APP physicians appeared to provide less service than FFS physicians. There are three possible explanations for these findings:

1. APP physicians are shadow billing accurately and provide fewer services than FFS physicians (squares in Figure 4.7).
2. APP physicians actually provide the same level of services as the average FFS physician but fail to submit claims for the difference (triangles in Figure 4.7).
3. APP physicians provide 2/3 the services provided by FFS physicians (circles in Figure 4.7).

We examined the number of prescriptions filled using the DPIN data. Based on the assumption that FFS and APP physicians have the same ratio of patients seen to prescriptions filled (there is no evidence to suggest that this is not the case), APP physicians appear to see 2/3 the number of patients seen by FFS physicians. This has been fairly stable since 1996. Consequently, the ESM value of each record belonging to an APP physician from 1991 to 2004 was bumped up according to the 2/3 rule (circles in Figure 4.7). For example, if the ESM for an average FFS physician was 100, and the ESM for an average APP physician was 48, then the ESM for the APP physician was increased to 66 (2/3 of 100).

Figure 4.7: Three Potential Scenarios for Alternate Payment Plan (APP) Billing Patterns



Source: Manitoba Centre for Health Policy, 2009

4.4.2 Physician Sex

In general, female family physicians provide a lower volume of services than their male counterparts. One reason is that more female physicians work part-time rather than full-time. They also tend to spend more time with each patient, thus, seeing fewer patients, and providing fewer services than male physicians within an equivalent period of work (Watson, 2006).

The importance of this difference is not in determining the ESM for the population either over time or at any point in time rather, in determining the number of practitioners that would likely be needed to provide a certain amount of ESM. Consequently, the required adjustment is not to the ESM or the projected ESM, but to the number of physicians needed to meet the projected ESM requirement. See section 5.5.

4.5 Using Models to Make Resource Projections

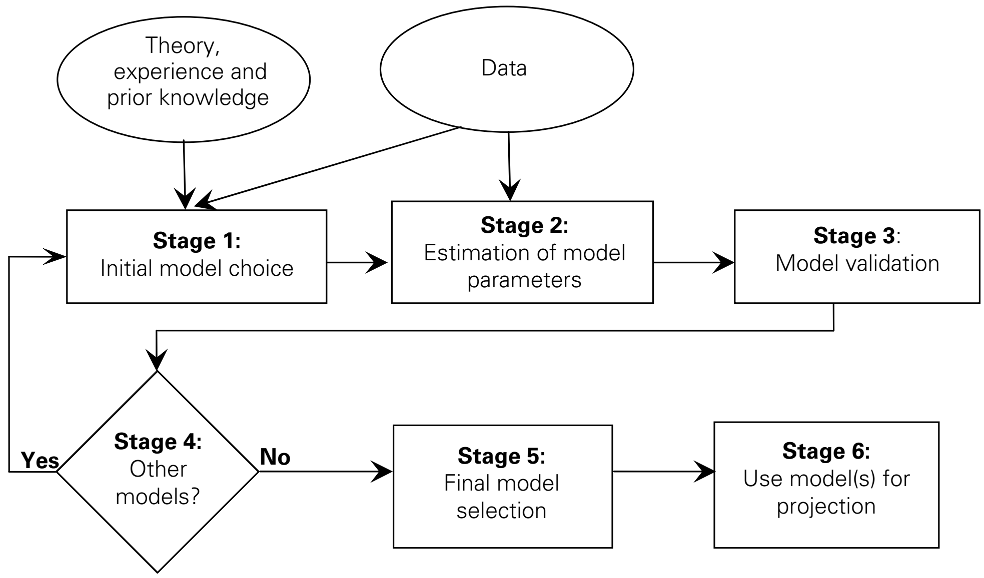
The utilization-based approach of projecting the number of required physicians at any given time point in the future centers around understanding the trends in ESM. With this knowledge, one can forecast the needed ESM in 2020, for instance, and hence project the required number of physicians. We adopted a mathematical or statistical modelling approach in order to understand the nature of the trends in ESM. The following sections provide a brief description of modelling and discuss the strategies that we adopted to model the orthopedic, general surgery, pediatric, and family physician work. Additional details on the methods are found in the Appendix.

4.5.1 What is Modelling[6]

A mathematical model is a simplified description of the behaviour of a system based on theory and historical data. The system is usually described by a set of variables and a set of equations that establish relationships between the variables. Techniques for mathematical modelling include regression analysis, decision theory, and simulation models to mention a few. Mathematical modelling is a process and can be illustrated with the following diagram:

[6] This section was adapted from a previous MCHP deliverable by Finlayson et al. (2007).

Figure 4.8: Modelling Process



Source: Manitoba Centre for Health Policy, 2009

Stage 1: Based upon existing theory, the nature of available data and knowledge and experience of the system to be modelled, an initial model or models are selected. For example, based on what we know about the costs of orthopedic or general surgeries, we would expect to use a special type of distribution for modelling (e.g., a **lognormal** or **gamma distribution**) to capture the skewed nature of the data. A model is made up of a dependent variable and one or more predictor (independent) variables. It is usually preferable to use as much a priori information as possible to make the model more accurate.

Stage 2: At this stage, the available data are used to estimate the model parameters that may represent the unknown population quantities such as the means and variances. The method of **maximum likelihood** is often used in the estimation; this method estimates the model parameters that are "most likely" for a given set of data. The end product of this stage is usually a predictive model which can also be used for projection.

Stage 3: The adequacy of the predictive or projective model from Stage 2 is validated to ensure that it will accurately predict or project the dependent variables of future subjects (individuals).

Stage 4: The model that is validated in Stage 3 may be one that has age and sex as the only predictors. This model however, may have poor predictive ability when compared to one with age, sex, and a measure of socioeconomic status as predictors for instance. Therefore, this stage of the process explores all other possible model options. If Stage 4 reveals that the current working model is inadequate, then other possible models are considered and Stages 1 to 3 are repeated. However, if this stage reveals that the existing model is adequate, the process moves to the next stage.

Stage 5: A final model is selected at this stage. This is done by comparing all models considered in Stages 1 through 4 using statistical tests. The principle of parsimony should also be taken into account at this stage. This principle states that unless there is a very good reason to do otherwise, the more parsimonious model (the model with fewer parameters) should be selected. All other models that were considered but not ultimately selected are retained for sensitivity analyses.

Stage 6: One of the objectives of building a mathematical model could be to obtain a predictive model that could be used for projection. At this stage, the selected model is used for projecting the ESM for future years and, as a consequence, the required number of physicians.

4.6. The Models Used in this Study

The modelling approach and goodness of fit tests used in this work are described in the Appendix. The independent variables for all models were limited to age, sex, and year because they were the only ones for which we have population projection estimates in the extrapolative years. All variables were entered in the models as continuous. Since the frequency of claims and the number of the claims both impact health care utilization, we modelled them separately. All stages described in section 4.5.1 were employed in our modelling.

We used **generalized linear models** in our analyses. Therefore, the method of estimation used in this work is the maximum likelihood method. We also used the value of the deviance statistic divided by the degrees of freedom to judge the goodness of fit of our models. Our models were considered a good fit to our data as the values of this statistic were between 0.9 and 1.3.

Validation of the orthopedic and general surgeries models was done by splitting our data set into a model development data set (periods 1991 to 2002) and a test data set (periods 2002 to 2005). For pediatric work, the model development data set covered 1984 to 2002 and the test data set covered 2003 to 2005. After developing our models using the development data set, we used the test data set to apply the coefficients to the actual Manitoba population distributions stratified by age, sex, and year to predict the annual ESM. These predicted values were then compared with the actual ESM. Another test of the validity of our predictive models used the correlation coefficient between the actual and the predicted ESM for the test data set. Our final models were then developed using the entire data set (i.e., 1991-2005 for orthopedic and general surgeries, and 1984-2005 for pediatrics). The Appendix provides a more detailed description of the models used.

The following chapters present the results of the models for each of the physician specialties included in the study. Each specialty group is presented in a separate chapter to reflect the significant differences between them in terms of the models developed and in terms of the results and their interpretation.

Chapter 5: Services Provided by Family Physicians

5.1 Introduction

The focus of this chapter is on family physicians (including general practitioners) who provide most primary care in Manitoba. Primary care provision to the pediatric population is a little more complex and is discussed in more detail in Chapter 6.

Factors, such as geographical location, need to be considered in developing and interpreting our projections. For example, rural family physicians often do tasks other than primary care. In one example we looked at, only 57% of the work done by the family physicians, which together constituted 28 **full-time equivalent** (**FTE**) individuals, was primary care. *Primary care* includes 'clinic' practice activities and obstetrics. This example included the following *secondary activities*: on-site emergency department coverage, family practice/anesthesia (2 full slates per day, preoperative consultations, on-call), family practice surgery, surgical assistance, renal dialysis unit, regional chemotherapy, palliative care, secondary obstetrics (including caesarian sections and call), intensive care unit/coronary care unit coverage at the local hospital, rehabilitation unit director, emergency department director, medical administration, nursing home care/administration, cardiac stress testing and industrial medicine. Each of these activities by itself accounts for only a fraction of an FTE.

Thus, we considered performing separate analyses for urban projections and rural projections. Further justification for doing separate analyses can be based on the fact that visit rates differ between rural and urban patients and on the need, in some communities, for additional physicians to ensure adequate 24-hour coverage for their emergency departments. A community with an emergency department ideally requires a minimum of four physicians to limit the frequency of overnight calls. In terms of the total services provided to that community, fewer physicians may be enough to provide the services, however the emergency department's needs translate into the community requiring the extra physician(s).

Despite these considerations, separate analyses were not possible as we were limited by the available population projections which are for the province as a whole. We did, however, choose to include all the services provided by the rural physicians (primary and secondary) as this is the reality of rural practice. This is unlikely to change so projections of future family physician requirements should include all of these activities.

5.2 ESM Projections

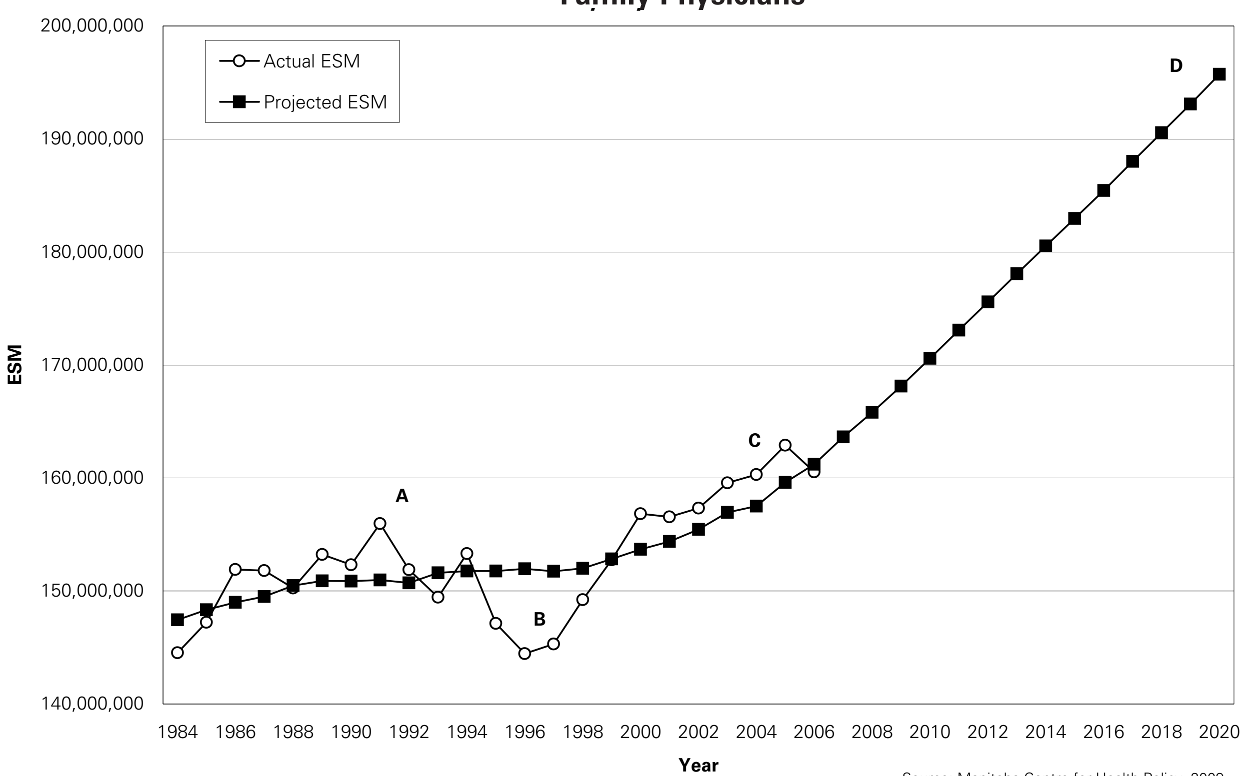
In this section, we present the historical and projected ESM based on the modelling process described above.

Figure 5.1 shows the actual ESM (circles) for family physicians and primary care pediatricians (see Chapter 6) combined, for the period 1984 to 2004 inclusive, and the projected values (squares) resulting from the model for the period 1984 to 2020. The scale in this graph is exaggerated for illustrative purposes. The period from 1995 to 1999 marks a well documented period of instability in physician resources in Manitoba. This period is characterized by a sharp decline in services due to a decrease in supply.

In contrast, the period 2000 to 2004 shows the beginning of a significant influx of resources and then less fluctuation with the sustained increase in services and supply.

The ESM for 1991 (point A) is 3.3% above the model projected value, for 1996 (point B) it is 4.9% below the projected value, and for 2004 (point C) it is 1.9% above the projected value. Point D, the projected value for 2020, is 19.5% higher than that projection for 2004 and 18.1% higher relative to the actual ESM value for 2004 (point C).

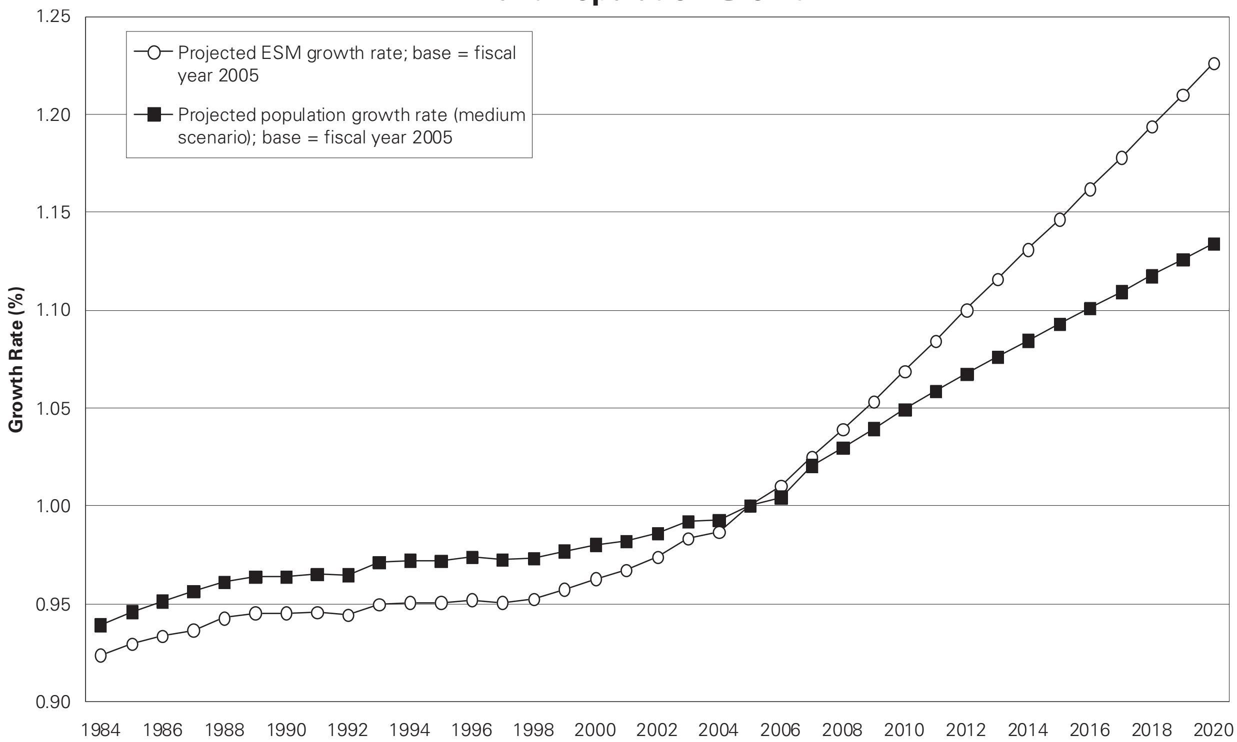
Figure 5.1: Actual and Projected Equivalent Services Measure (ESM) Growth: Family Physicians



Source: Manitoba Centre for Health Policy, 2009

Figure 5.2 shows the rate of growth (base=2005) of both the ESM and the population. The values for the ESM up to and including 2005 are the real values while the population estimates are the medium estimates provided by MBS. Both the population and the ESM prior to 2005 are of a lesser value than those of 2005, so the rate of growth of the population and services are both less than 1.0.

Figure 5.2: Change in Equivalent Services Measure (ESM) for Family Physicians and Population Growth



Note: Scale does not start at 0.

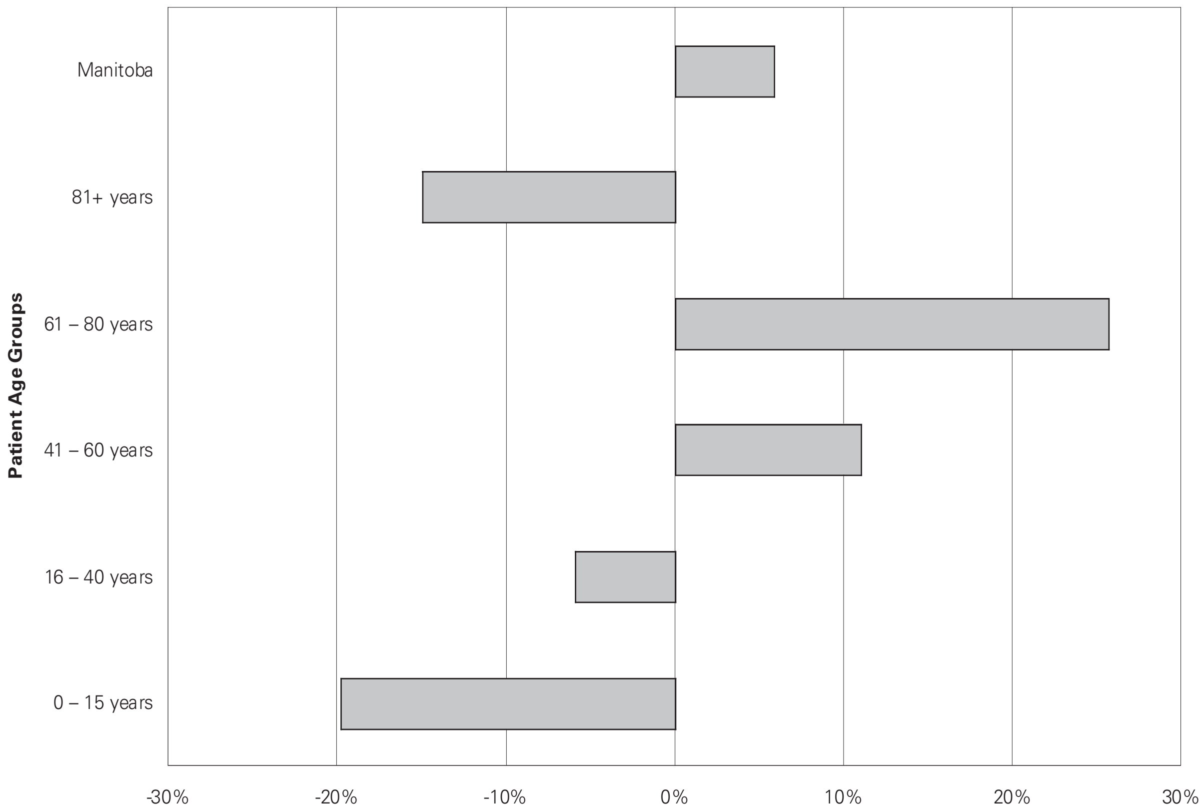
Source: Manitoba Centre for Health Policy, 2009

5.3 Analysis by Age

The model is a reflection of the services provided in relation to the population size and the age and sex of those making up the population each year. It thus presents the changes in the ESM by age and sex from 1984 to 2005 inclusive.

During that period the population aged, but more interestingly, there was a notable shift in the share of services (ESM) between several age groups; some gained at the expense of others. Because the total physician services available are finite, an increase in service use by one age group must be matched by a decrease in service use by another age group.

Figure 5.3: Change in Equivalent Services Measure (ESM) in 2005* Relative to 1984*: Family Physicians

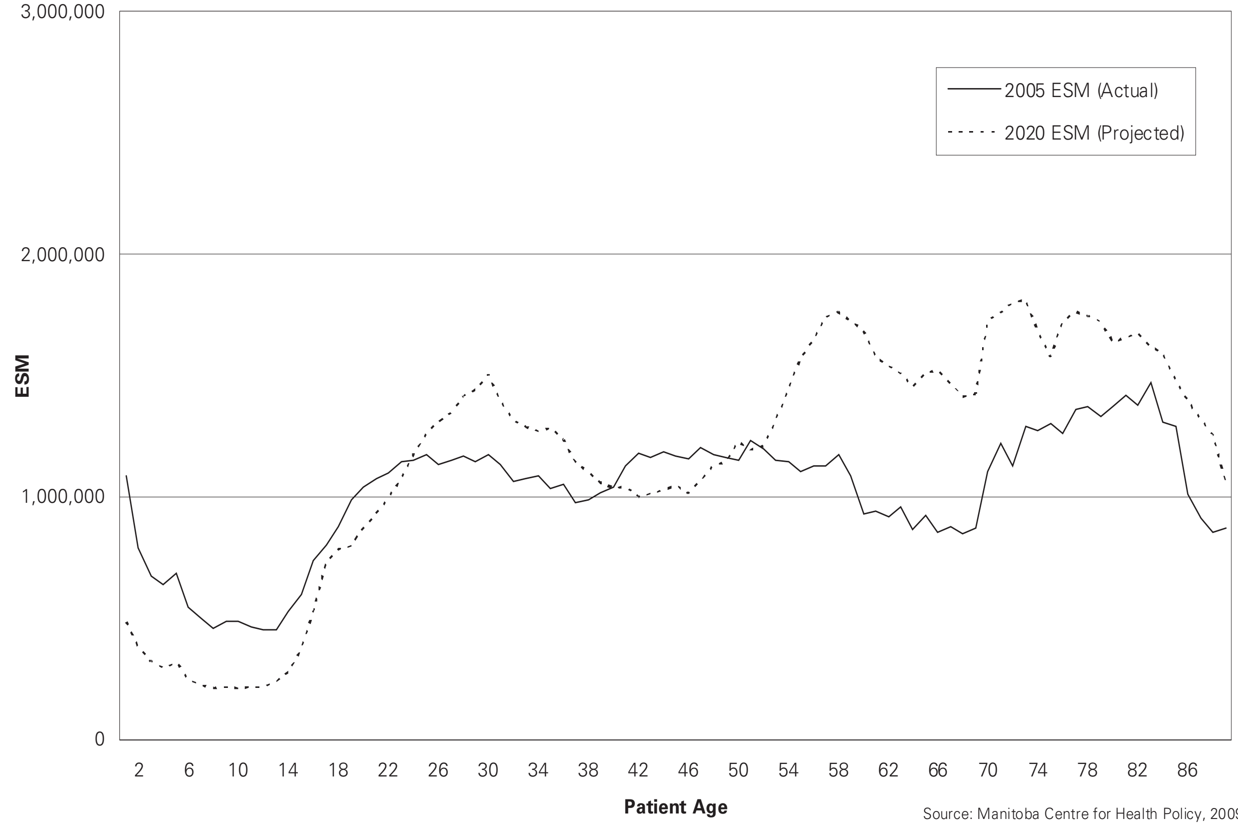


* Fiscal Year

Source: Manitoba Centre for Health Policy, 2009

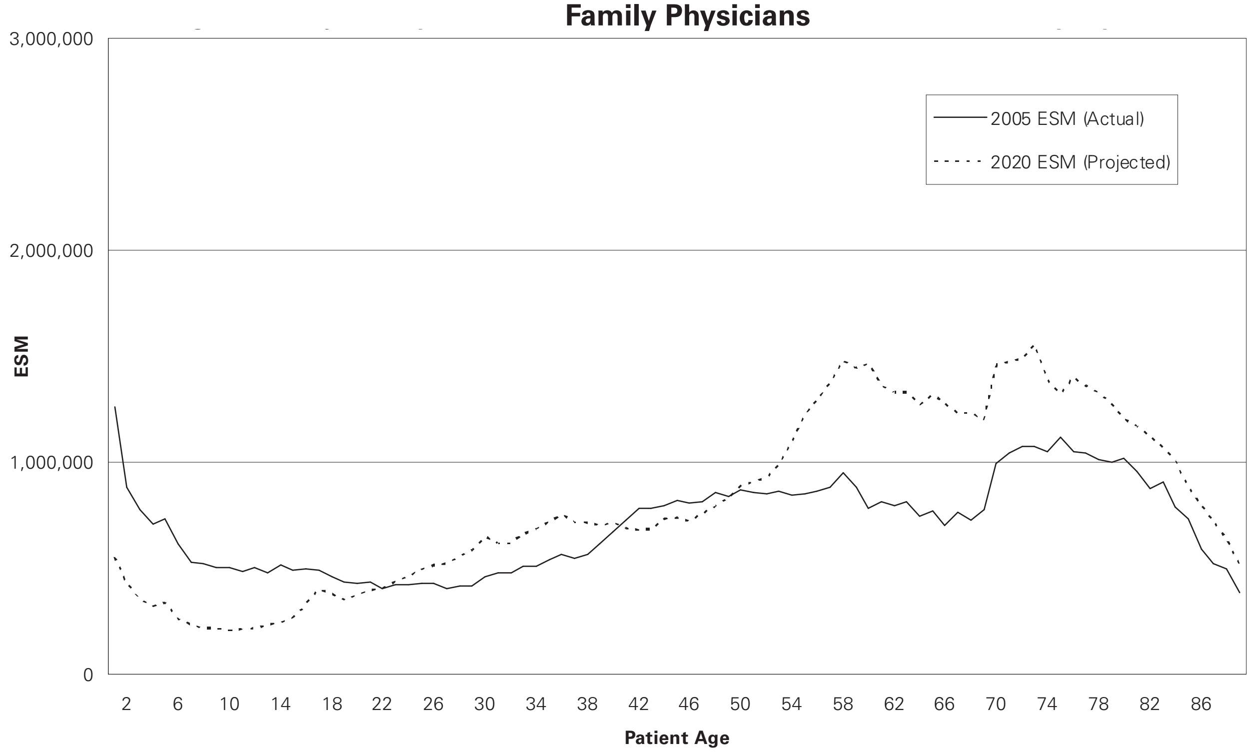
Figure 5.3 shows the gains and losses of services relative to 1984 values after population growth was factored in. Thus from 1984 to 2005, age groups 41-60 and 61-80 increased their relative share of the services available which resulted in decreased service use by both the young and the very old. Presuming an ongoing finite level of service, our projections also reflect the results of this competition for care between different age groups. This will result in some age groups getting less service than was previously the case. For that reason the model is able to reflect the population change, the overall change in ESM, and the changes in ESM specific to different age-sex categories. The distribution in ESM between these categories is determined by the way physicians and their patients have responded to the demand for services within a limited supply environment. As the demand for services in older patients has increased, there has been a corresponding decrease by services to younger patients. This is due to the system's limited capacity to meet demand as well as other significant changes over the past 20 years, namely the closure of hospital beds and a decrease in the length of hospital stays. As a result, patients, who have been discharged into the community need more attention from their community-based physicians.

Figure 5.4: Projected Equivalent Services Measures (ESM) for Female Patients of Family Physicians



Source: Manitoba Centre for Health Policy, 2009

Figure 5.5: Projected Equivalent Services Measure (ESM) for Male Patients of Family Physicians



Source: Manitoba Centre for Health Policy, 2009

There has also been an increase in the prevalence of chronic disease as patients live longer and the boomers (a bulge in the population) are now of an age where chronic illness is common. Medical practice has also changed in that more patients are being prescribed drugs for prevention of cardio-vascular disease and are, as a result, seen more often to monitor the effects of these drugs. The results of these changes have affected the distribution of services provided to Manitobans dependent on patient age. These changes are reflected in the model and in our projections. See Figures 5.4 and 5.5.

5.4 Looking Beyond the Trend

The model uses the trends from previous system use to project future use. There are clear patterns that vary over the past 20 years which that influence the overall trend. For example, 2005, the last year of utilization data included, had the highest ESM of a period that started in the year 2000 due to a significant influx of resources in 2000 relative to 1999. In contrast the year 1996 marks the low-est point.

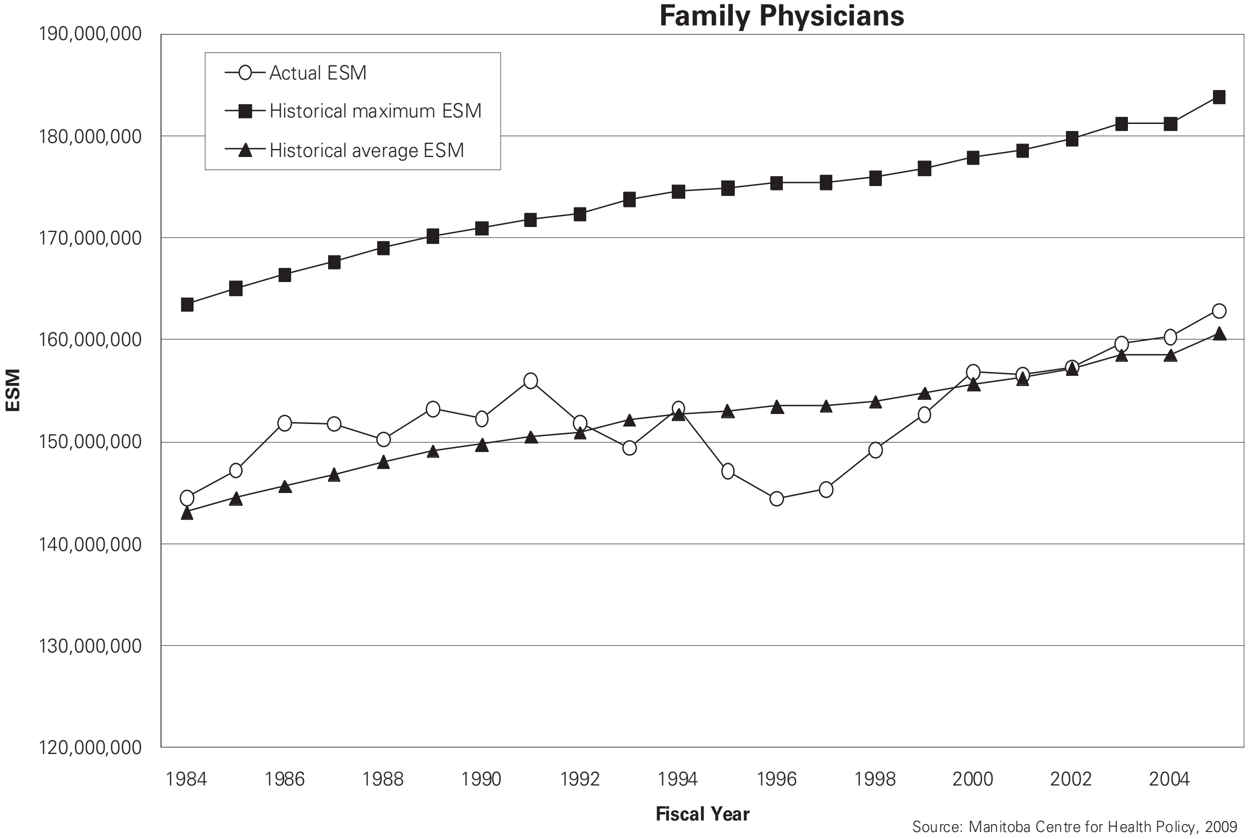
What if the year 2004 was a 'good' year? A year that was in fact not a midpoint of an ongoing pat-tern of highly available resources, but the last year of this pattern to be followed by a series of years with reduced resources. This would result in our projections being less accurate. As an alternative, we could project the ESM based not on the trend of past use adjusted for population changes, but on the actual average or maximal use over time; i.e., the maximum level of service that each age group ever received during the period 1984 to 2005 (squares in Figure 5.6) or the average level of service that each age received during the period 1984 to 2005 (triangles in Figure 5.6).

Figure 5.6 shows, in an exaggerated scale, the ESM values from 1984 to 2005.
The projected differences, relative to the maximum ESM, points out what we do not know. If for the sake of argument, we assume that the historical utilization (the historical maximum) equals the 'need' and everything less is due to supply constraints (i.e., not enough doctors available and hence unmet needs) then the amount of ESM (services) required would be considerably higher than the model projection.

5.5 Physicians Needed to Supply the ESM: Physician Productivity Analyses

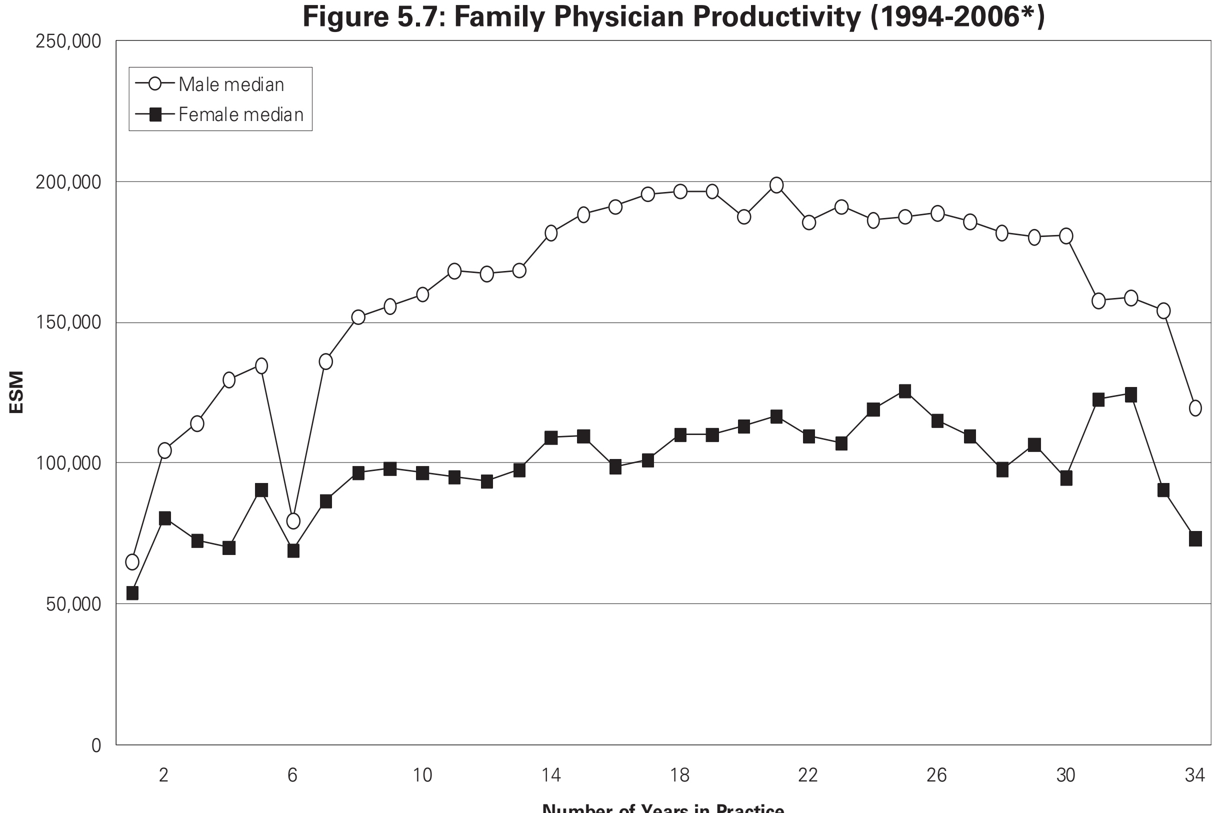
Our analyses identified a number of factors that influence physician productivity. Figure 5.7 depicts the effects of physician sex and length of time in practice, the two most significant factors in the measurement of productivity for family physicians. Physician age was represented by the 'years in practice' variable in our analyses.

Figure 5.6: Three Approaches to Describe Historical Services Use (ESM) for Family Physicians



Source: Manitoba Centre for Health Policy, 2009

Figure 5.7: Family Physician Productivity (1994-2006*)



* fiscal years

Source: Manitoba Centre for Health Policy, 2009

The only model we were able to build to describe the productivity of physicians over time was a linear model. Unfortunately, as this model does not adequately account for the changes in productivity in a meaningful way, the resulting projections are not reliable. We, therefore, based our productivity calculations on the most recent ESM (2005) produced by each physician group rather than on projected ESM based on past productivity.

We created a "productivity calculator" that incorporates the effect of sex and years in practice on current productivity. This tool can be used to calculate the number of physicians required to provide a certain amount of services (Table 5.1). A functional version of this calculator, which automatically adjusts the values based on changes to any one cell that the user may make, is available from the authors. For example, if the percentage of physicians with a characteristic is changed, the number of physicians needed to provide the predetermined amount of ESM is automatically updated to reflect the relative productivity of that group of physicians.

Table 5.1: Family Physician Productivity Calculator: Determining the Number of Physicians Required to Meet a Given Equivalent Services Measure (ESM)

Total ESM: 152,015,468[A]

Years in Practice	% ESM		% Physicians	
	Total	Female	Female	Male
1 – 5	27[B1]	25[C1]	6.75[D1]	20.25[E1]
6 – 10	14[B2]	29[C2]	4.06[D2]	9.94[E2]
11 – 15	15[B3]	27[C3]	4.05[D3]	10.95[E3]
16 – 20	15[B4]	18[C4]	2.70[D4]	12.30[E4]
21+	29[B5]	13[C5]	3.77[D5]	25.23[E5]
Total % =	100			

➡

Years in Practice	# Physicians Required[F]	
	Female	Male
1 – 5	104[F1]	206
6 – 10	48	94
11 – 15	48	92
16 – 20	33	98
21+	44	197

Total # Physicians Required: 965[G]

Note: Calculations exclude entities (i.e., billing numbers that are used by multiple physicians) and include only well-established physicians (i.e., those who are active one year prior and one year after the study year).

To project the # physicians needed to provide a required amount of service (ESM):

1. Determine the expected total ESM - Males and females (A)
2. Determine the % of total ESM that will be provided by total physicians (B1-B5) and the % provided by female physicians by years in practice (C1 to C5).
3. The % physicians by gender and # years in practice will be automatically updated (D1 to E5).
   Formula for D1: (B1/100)*(C1/100)*100
4. This will yield the # physicians required for each gender/years in practice group (F)
   This can be summed for a total (G).
   Formula for F1: (A*(D1/100)) /98,727 where the denominator is the average current ESM for that group

Source: Manitoba Centre for Health Policy, 2009

5.6 Summary

This chapter presented the results of the family physician models based on two different approaches. The utilization trend analysis resulted in lower projections of future service requirement for the projected population than the maximum level of service approach. The utilization trend approach may be underestimating the service needs because of supply constraints. We also provided a method for calculating the number of physicians needed to meet the projected ESM based on two key physician characteristics that affect productivity.

Chapter 6: Services Provided to the Pediatric Population

6.1 Introduction

This chapter addresses two distinct approaches to service delivery. Because we are able to identify a specific population (Manitobans aged 18 or less), we can look at the services this population received from the population perspective or we can look at the services this population received from the perspective of the physicians who provide those services. This latter approach was used for the other specialist physician groups addressed in Chapters 7 and 8. For the pediatric population, the first approach is equally relevant because the services are provided in Manitoba by both pediatricians and family physicians. It is important to project both total services requirements of the pediatric population and how much ESM each physician group would supply to the pediatric population.

6.2 Generalist and Specialized Pediatricians

Pediatricians in Manitoba can be divided into two groups – specialists and generalists. "Specialized pediatricians" either limit their practices to a specific area of pediatric practice such as pediatric cardiology, neurology or endocrinology or spend the majority of their time working in a specific area of specialization. They generally see patients on referral from a family physician. There are a limited number of these pediatricians within each area of specialty, all almost exclusively in Winnipeg. Generalist pediatricians, in contrast, provide primary care to pediatric patients. They also provide **secondary care,** but the majority of the care they provide is not on referral from a family physician. They tend to provide the same types of services to their patients as do family physicians.

The number of specialized pediatricians needed for Manitoba is generally not dictated by the number of children in the province as much as by the need to have at least minimal coverage in all the required specialties. Specialties needing more urgent consultations will require sufficient numbers of practitioners to sustain a reasonable call roster to provide the necessary services. Within specialties, there are also staffing requirements for sub-specialty areas, such as the need for pediatric neurologists who specialize in epilepsy and electro-encephalography. The requirements for specific pediatric specialists are not included in this study.

Generalist pediatricians provide primary care "in competition" with family physicians. Pediatric patients may see either a pediatrician or a family physician as their "personal physician" for routine care and assessment of acute illnesses. We include the primary care provided to the pediatric population by both generalist pediatricians and family physicians in our projections for the pediatric population.

We used the **Concentration of Care Index (COCI)** developed by Watson et al. (2003) to determine which pediatricians to include as generalists for the purposes of this study. The COCI measures the similarity of the diagnoses used in a physician's billings. The more similar the diagnoses a pediatrician uses (i.e., the more limited the list is with regard to different organ systems), the higher the index score and the more likely the physician has a specialized area of practice. We thus removed pediatricians with a high COCI score. We also removed pediatricians who had a generalist scope but also a high level of consults as this indicates that they are not really providing primary care. Finally from generalist pediatricians who were included, we removed any counts for consultations (care provided on referral from another physician). Thus, our analyses are limited to the primary care of the pediatric population.

6.3 Pediatric Services

Our analyses included all primary care services provided to patients 18 years old and younger, by both family physicians and pediatricians. While Chapter 5 included the care provided by family physicians for all age groups, this chapter includes the projections for care provided by both pediatricians and family physicians to the pediatric age group.

It is important to note that there is no "correct" number of services required by the pediatric population. While there are recommended "well child visits" during the first two years of life when immunizations are provided, there is no standard number of visits beyond this. Children are less likely to suffer from chronic illness and their use of medical services for episodic acute illness is influenced by multiple factors.

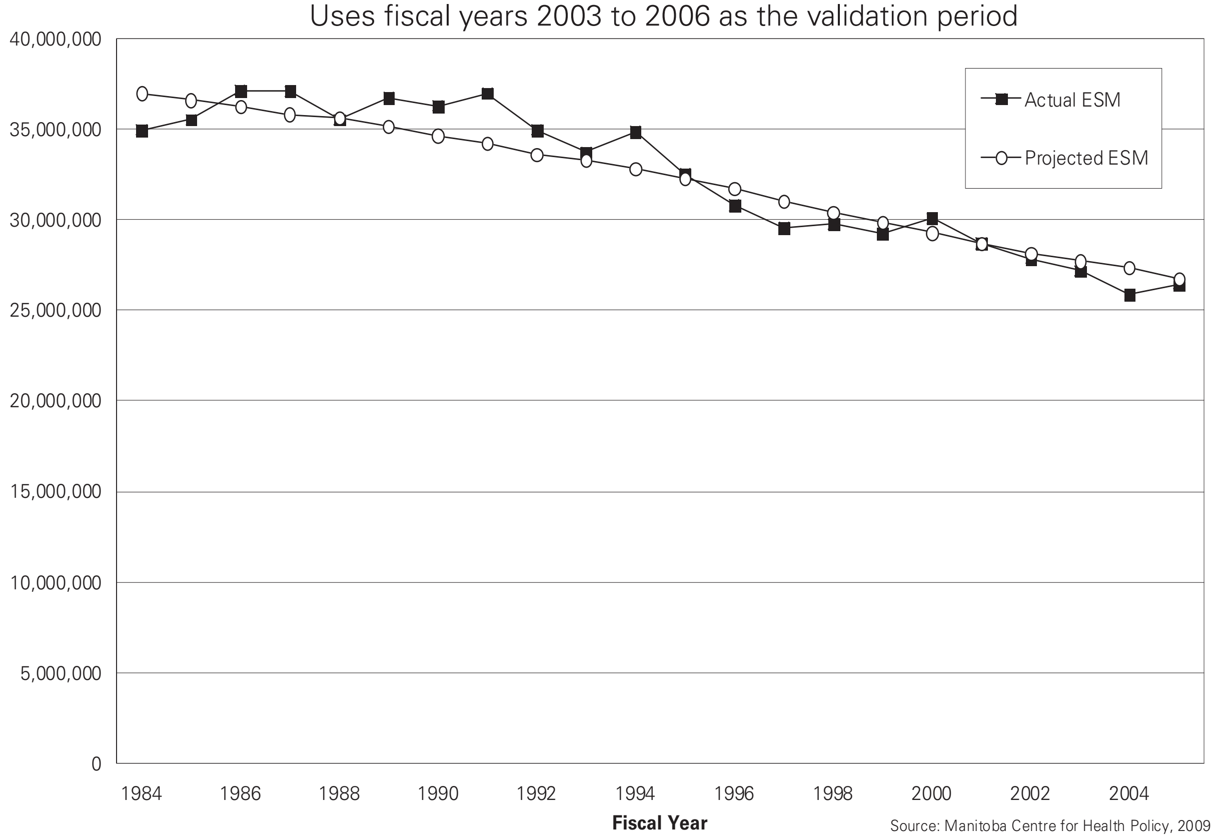
6.4 Projected ESM

The ESM for the pediatric population involves very similar tariffs to those used in the previous chapter. We validated our ESM models for services provided to this population by both family physicians and pediatricians using the 2003-2005 period. The results of this validation are presented in Figure 6.1. The total services provided to the pediatric population dropped due to the decrease in services from family physicians, as noted in Chapter 5. This is in contrast to the projected increase in services provided by pediatricians (see Table 6.1); this increase, however, is not sufficient to compensate for the reduction in Family Physician services. If this trend were to continue, it would potentially create a shortage of pediatric services that could place pressure on one or both of the disciplines.

This trend is clearly not sustainable. While there is no defined minimum number of services that the pediatric population may require, there is a limit to the amount of ESM that generalist pediatricians can supply to compensate for the reduction in family physician services. Furthermore, newly qualified pediatricians are moving away from generalist pediatrics towards specialized practice. This will leave a gap in pediatric service provision; either more generalist pediatricians will need to be trained or family physicians will need to provide more services to the pediatric population.

Figure 6.1: Model Validation for Pediatric Work Done by both Family Physicians and Pediatricians

Uses fiscal years 2003 to 2006 as the validation period



Source: Manitoba Centre for Health Policy, 2009

Table 6.1: Projected Equivalent Services Measures (ESM) for Pediatric Work*

	Base and Change in Projected Population	Base and Change in Projected ESM		
		FPs** and Pediatricians	FPs only	Pediatricians only
2005/06 (base)	**300,411**	**26,288,219**	**16,560,723**	**9,894,706**
2010	-0.13 %	-6.14%	-8.93 %	+0.04 %
2015	+0.24 %	-10.34%	-16.11 %	+2.91 %
2020	+2.77 %	-13.38%	-21.40 %	+5.34 %

* Uses the medium population projections

Source: Manitoba Centre for Health Policy, 2009

CHAPTER 7: SERVICES PROVIDED BY ORTHOPEDIC SURGEONS

7.1 Introduction

There is no definable target population for orthopedic services; therefore, we focussed on all the services orthopedic surgeons provide. These services vary from complex surgical procedures, which are clearly orthopedic in nature (e.g., joint replacements), to office consultations, which are difficult to differentiate from other office visits as being specifically "orthopedic". Due to this fact, we included all services provided by orthopedic surgeons in the analyses for this chapter. In addition, we included orthopedic surgeries that were performed by other physicians. This latter addition represents a minimal contribution to the total ESM for orthopedic surgery.

7.2 The ESM for Orthopedic Surgeons

The ESM for orthopedic surgeons was calculated using the most frequently occurring fee in the most recent year. This mode fee was then applied backwards in time. That is, if a tariff appeared in 1991, 1992, 2000 and 2005, then we assigned the 2005 mode value to it. We used the mode instead of mean values because the distribution of the fees for orthopedic surgeries was skewed. For a skewed distribution, the mode is a better measure of the centre. It is also more intuitive to assume that the most frequent fee (mode) is a better representation of the actual tariff fee in a system where it is difficult to ascertain the actual fee. The actual fees vary because some services are provided more than once to the same patient on the same visit. Had we known the actual tariff fee, then the ESM would have been defined by the most recent fee. As with the family physician ESM, fees related to telephone and conference calls were excluded from the ESM used in the orthopedic models. The distribution of the total ESM and the number of tariffs used by orthopedic surgeons in the entire study period is shown in Table 7.1.

Table 7.1: Changes in the Total Equivalent Services Measure (ESM) and the Number of Tariffs Used by Orthopedic Surgeons Between Fiscal Years 1991 and 2005

Duration of Tariffs in Study Period	# of Tariffs (%)	Total ESM (%)
Whole Period	227 (30)	114,185,054 (85)
New	75 (10)	9,385,441 (7)
Retired	37 (5)	8,839,084 (7)
Intermittent	422 (55)	1,276,121 (1)
Total	**762**	**133,685,699**

Source: Manitoba Centre for Health Policy, 2009

The model projections for the ESM required in order to maintain the past pattern of orthopedic surgery service use is presented in Table 7.2.

Table 7.2: Projected Changes in the Population* and the Projected Equivalent Services Measure (ESM) for Orthopedic Surgeons

	Base and Change in Projected Population	Base and Change in Projected ESM
2005/06 (base)	**1,175,360**	**11,199,008**
2010	+4.93 %	+25.64 %
2015	+9.29 %	+53.75 %
2020	+13.37 %	+87.82 %

* Medium projections

Source: Manitoba Centre for Health Policy, 2009

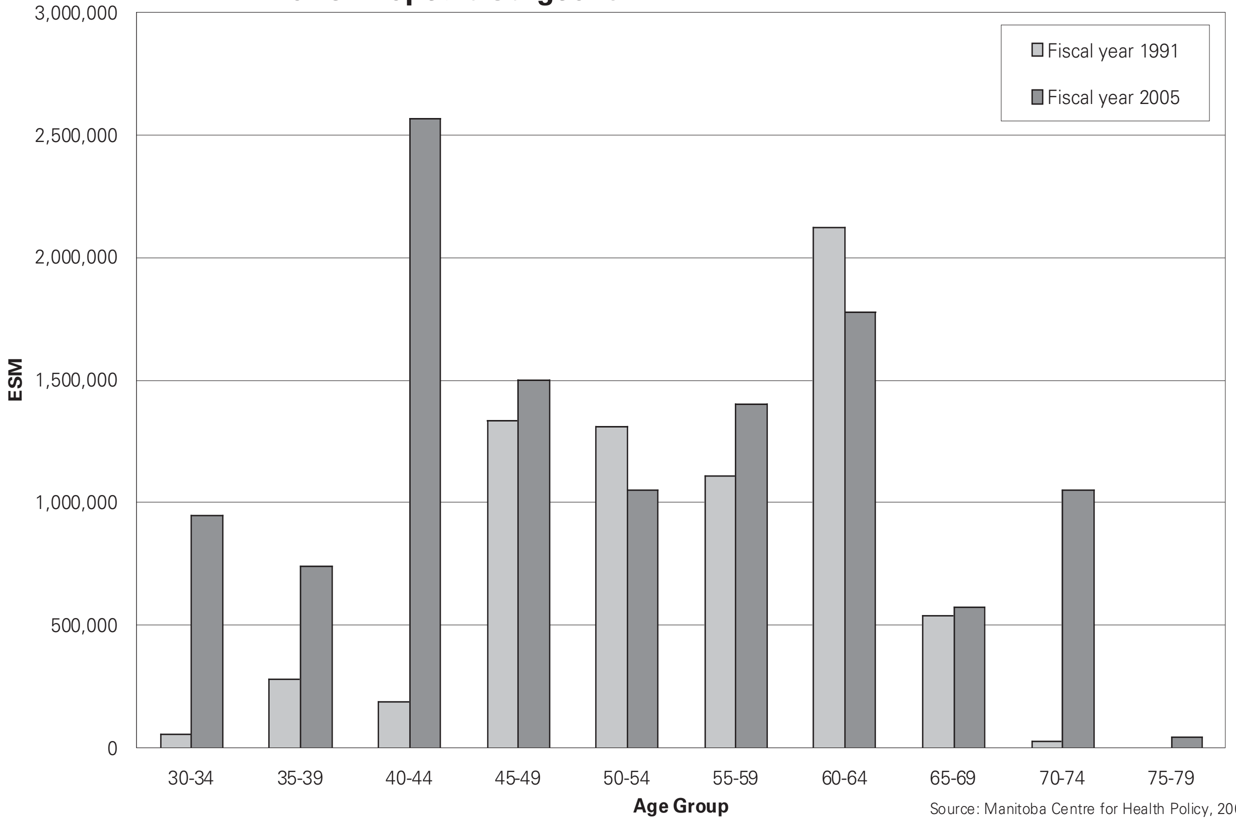
7.3 Orthopedic Surgeons Needed to Provide the ESM

We also attempted to determine the number of orthopedic surgeons that would meet the required ESM as projected by the model. This was done as much to demonstrate the challenges and limitations of our ability to perform this task as to provide valid projections.

Any attempt to quantify the number of surgeons needed to provide a particular volume of ESM must include a measure of surgeon productivity. This can be as simple as the average productivity of surgeons currently providing services or an attempt can be made to develop more complex models of individual productivity. The challenge is not in developing these more complex models, but in acquiring the data to use in the projections. For example, if we knew that surgeons provided different levels of service based on their sex (as we do for family physicians), we would need projections of the percentage of female and male surgeons in order use the model to project the numbers of providers needed. This was not relevant here since the vast majority of orthopedic surgeons in Manitoba are male.

Another potential factor that influences productivity is physician age; we therefore, plotted the relative productivity of orthopedic surgeons by age (Figure 7.1). For this data to be useful, however, we need to be able to project the ages of orthopedic surgeons in practice at any particular time.
We used the simpler "average productivity" approach for orthopedic surgeons in Table 7.3. While we know that the productivity of orthopedic surgeons varies considerably depending on their age and how long they have been in practice, we have no reliable way of predicting the age distribution of the orthopedic surgery workforce in the future. Our average productivity approach has significant limitations and any attempts to predict actual numbers of physicians should not be made without the availability of additional information.

Figure 7.1: Distribution of Median Equivalent Services Measure (ESM) of Orthopedic Surgeons



Source: Manitoba Centre for Health Policy, 2009

We project that 83 orthopedic surgeons will be needed to meet the projected ESM for 2020. This is based on the pattern of orthopedic surgeon utilization over the last 14 years, demographics of the current workforce, and population projections. This projection should however be viewed with caution. One encouraging aspect of our findings is that the productivity of orthopedic surgeons is increasing, as the orthopedic surgeons present in Manitoba in recent years have been more productive than those who have been here longer. The reasons for this should be explored in further studies to determine its impact on the long term supply of orthopedic services.

Table 7.3: Number of Orthopedic Surgeons Needed to Meet the Projected Equivalent Services Measure (ESM)

	Projected ESM	% Increase in Projected ESM	Projected Median Workload (ESM)	Projected # of Surgeons
2005 †	11,199,008	--	226,744	49
2010	14,070,106	26	251,009	56
2015	17,218,288	54	252,024	68
2020	21,034,420	88	252,438	83

† Fiscal year

Source: Manitoba Centre for Health Policy, 2009

Chapter 8: Services Provided by General Surgeons

8.1 Introduction

As we did for orthopedic surgeons, our analyses for this group included all services—surgical and non–surgical—provided by all the general surgeons listed in the Physician Resource Database. We also included physicians who were not formally registered as general surgeons, but whose work included services that were essentially the same as those provided by registered general surgeons. Most of these physicians worked in rural areas.

Some general surgeons, who are mainly outside of Winnipeg and most of whom trained outside of Canada, also do more specialized surgical procedures. These are procedures that would be done by a sub–specialist surgeon (e.g., thoracic, orthopedic or plastic surgeon) were one available. It is unlikely that this group, when they are no longer in practice, will be replaced with surgeons with a similar broad range of skills as Canadian surgery training programs do not provide this breadth of training. Thus, we decided to include this group and their work in the ESM based on the following criteria:

i. If their specialized surgery work was 10% of their total ESM, keep them and their work.
ii. If their specialized work was >10%, keep the person as they will likely need to be replaced with somebody doing similar work, but delete the specialized surgery part of their work as it is not general surgery and should not be included in the projection model.

8.2 The ESM for General Surgery

The next step was to develop the ESM for general surgical services. Thirty percent of the tariff codes were present throughout the whole study period and most of the work was accounted for by these tariff codes. The ESM was then modelled and validated. The model validation is presented in Figure 8.1.

The model projections for the amount of ESM required in order to maintain the past pattern of population general surgery service use is presented in Table 8.1.

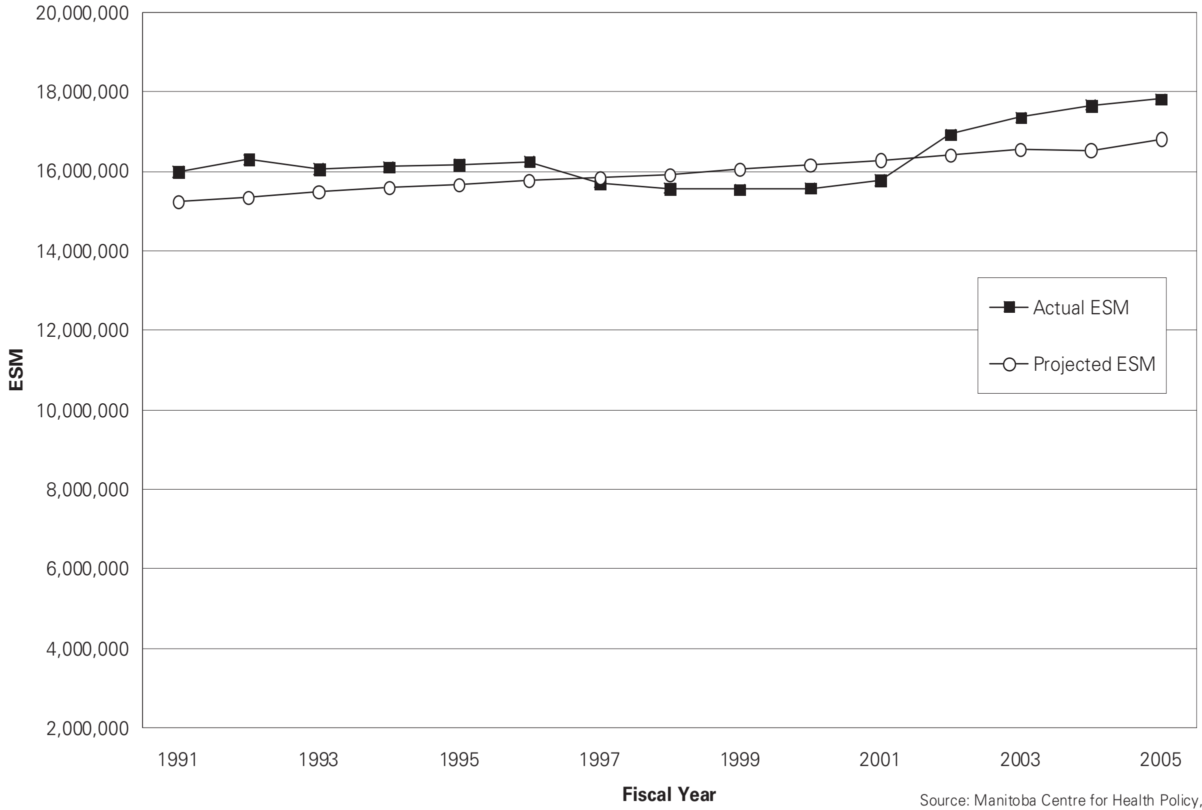
Table 8.1: Projected Changes in the Population* and the Projected Equivalent Services Measure (ESM) for General Surgeons

	Base and Change in Projected Population	Base Change in Projected ESM
2005/06 (base)	**1,175,360**	**17,417,227**
2010	+4.93 %	+9.32 %
2015	+9.29 %	+17.87 %
2020	+13.37%	+27.08 %

*Note: Medium projections

Source: Manitoba Centre for Health Policy, 2009

Figure 8.1: Model Validation for General Surgeries
Uses fiscal years 2003 to 2006 as the validation period



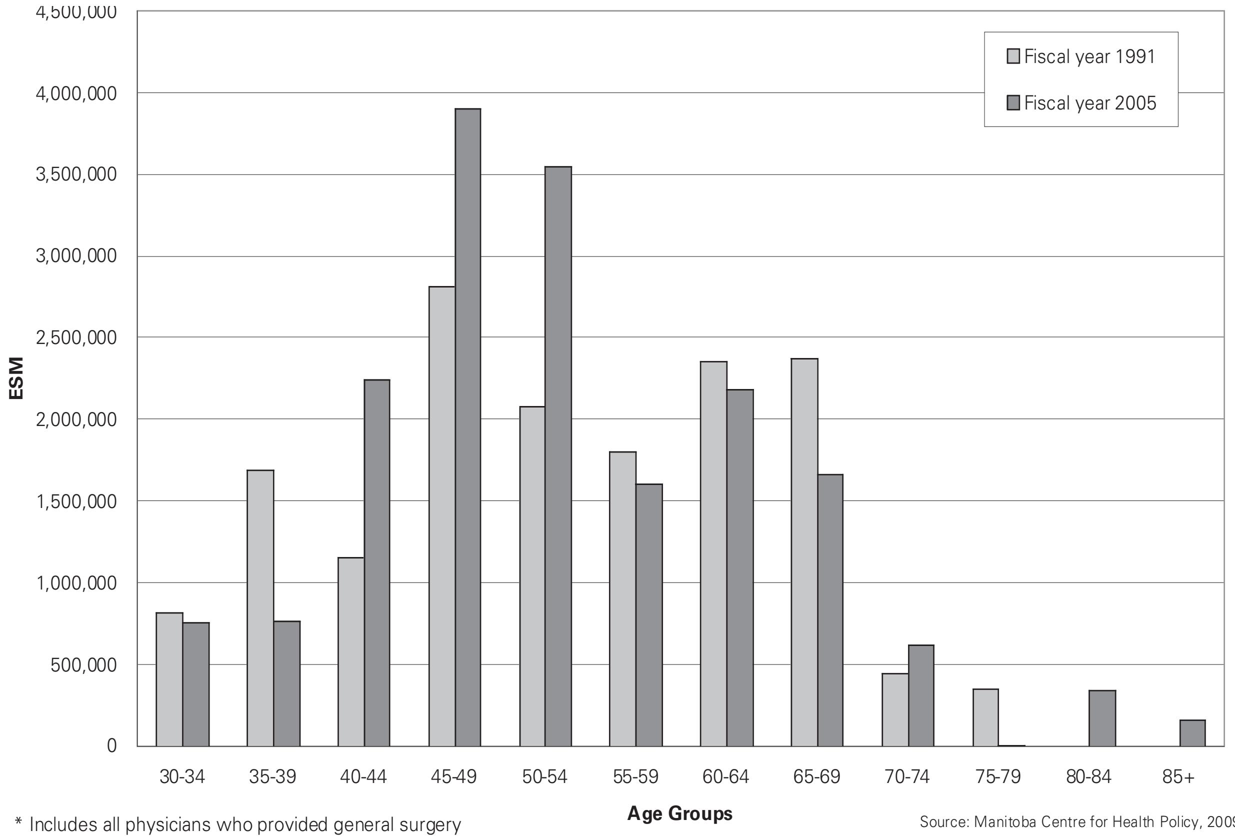
Source: Manitoba Centre for Health Policy, 2009

8.3 Surgeons Needed to Provide the ESM

We faced the same limitations in our ability to reflect the productivity of general surgeons in our projections as we did for orthopedic surgeons in Chapter 7. While the distribution of productivity across ages of surgeons is quite varied, the reasons for this are not known. This also limited our ability to use estimates of productivity in our projections.

The pattern of productivity for general surgeons is related to the amount of time the surgeon has been working in Manitoba, as is the case with orthopedic surgeons. This means that the average productivity we would have used to calculate the number of surgeons required to supply the projected ESM for any particular year would vary depending on which surgeons we included in the calculations. This is reflected in Table 8.2. If all 33 surgeons present between 1991 and 2005 are included in calculating the average productivity, fewer surgeons would be required than the same calculation with the 55 surgeons who were present in the most recent seven years.

Figure 8.2: Distribution of Median Equivalent Services Measure (ESM) by Age of General Surgeon*



* Includes all physicians who provided general surgery

Source: Manitoba Centre for Health Policy, 2009

Table 8.2: Number of Physicians Needed to Meet the Projected Equivalent Services Measure (ESM) for General Surgery

	Projected ESM	% Increase in Projected ESM	Projected Median Workload (ESM)		Projected # of Surgeons	
			*n=33**	*n=55***	*n=33**	*n=55***
2005 †	17,417,227	--	255,029	252,289	68	69
2010	19,040,688	9	308,708	269,834	62	71
2015	20,528,829	18	329,757	273,448	62	75
2020	22,133,424	27	352,159	276,998	63	80

* Number of surgeons practicing throughout the entire study period (fiscal years 1991 – 2005).

** Number of surgeons in practice in the most recent seven years of the study period (i.e., from fiscal years 1999 – 2005).

† Fiscal year

Source: Manitoba Centre for Health Policy, 2009

Chapter 9: Conclusion

Planning physician resource needs is an in-exact science. Many different approaches have been used in the past with little success in making meaningful projections. While the most commonly used measure of physician supply is the physician-to-population ratio, this measure is fraught with inherent inaccuracies. It is also of very limited value in developing projections of future need.

This study demonstrates a new approach to projecting physician supply requirements; it takes advantage of the unique data available in the Repository and addresses many of the limitations of previously used methods. However, like methods previously developed, our method, is limited by data availability. It is critical to recognize that mathematical projections are based on the available data and cannot predict changes to the system. The health system is a dynamic system that is continually in a state of change. Financial pressures, ideological challenges, public dissatisfaction and research evidence continue to drive change within the delivery system. The resulting changes will undoubtedly impact the way physicians work and the services they supply. For some specialties, this may result in the use of new technologies to introduce efficiencies; while for others, the workforce is likely to be expanded to include other professionals. None of these changes can be included in our models and projections. Our results need to be interpreted in this context.

The mandate given to us recognized this reality; our task was therefore to develop models which could be used to update the projections repeatedly over time. As patterns in care delivery change, they will affect the utilization patterns included in the models which will, thereby, alter the projections. Similarly, population projections need to be updated regularly to reflect changes in migration, birth rates and mortality. This dynamic process will address some of the limitations inherent in projecting supply needs.

The differences in the four groups of physicians we studied, in terms of the types of service provided and the different sizes in the workforce, resulted in different approaches being taken. While this may make our choice of models more difficult to follow, in reality, a strength of our study is that we have been able to be flexible in addressing each group differently. We have projected physician service requirements based on past patterns of use for each group up to 2020. We have also provided guidance on how to calculate the number of physicians needed to provide the projected service needs based on the factors known to influence physician productivity. Unfortunately, this was not possible for all the physician groups due to the small numbers within the specialty in Manitoba.

This project has developed a new methodology for capturing physician workload that can be used in similar studies of other physician groups. Furthermore, we recommend that these projections be updated regularly to capture changes in the patterns of service provisions.

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GLOSSARY

Acronyms used in this report:

APP	Alternate payment plan
COCI	Concentration of Care Index
DPIN	Drug Programs Information Network
ESM	Equivalent Services Measure
FFS	Fee-for-service
FTE	Full-time Equivalent
MCHP	Manitoba Centre for Health Policy
MBS	Manitoba Bureau of Statistics
SAS®	Statistical Analysis Software

Alternate Payment Plan (APP)

Type of compensation for physicians who are not paid on a **fee-for-service** basis but are either salaried, sessional, or hired on contract. These physicians submit claims (**shadow billings**) for administrative purposes only.

Capitation System

A per capita method of compensation for physicians. The amount of revenue a practice receives is based on an amount paid per patient (capitation fee) times the number of patients the practice treats (practice population) regardless of the number of visits.

Comorbidity

Presence of one or more medical conditions known to increase risk of death, that exist in addition to the most significant condition (usually recorded as the “most responsible diagnosis” on **hospital discharge abstracts**) that causes a patient’s stay in the hospital.

Concentration of Care Index (COCI)

An index to measure the extent to which a physician’s patients with at least two visits (to that physician) see them versus one or more other physicians over a specified period of time. It is the average of the patient’s continuity of care and can range from just greater than zero to one.

Drug Programs Information Network (DPIN) Database

A database containing prescription drug claims from the Drug Programs Information Network (DPIN), an electronic, on-line, point-of-sale prescription drug database. Initiated in 1994, it connects Manitoba Health and Healthy Living and all pharmacies in Manitoba to a central database maintained by Manitoba Health and Healthy Living. Information about pharmaceutical dispensations is captured in real time for all Manitoba residents (including Registered First Nations), regardless of insurance coverage or final payer. DPIN facilitates payment administration for eligible drug costs, incorporating functions such as real-time adjudication, and collects high-quality data on all prescriptions issued to Manitobans, such as drug, dosage, and prescription date. Note that the prescription's indication (the physician's prescribing intent) is not collected and must be inferred from other data.

Equivalent Services Measure (ESM)

A standardized measure of service provision that enables researchers to use **tariff codes** over time regardless of any changes in the fee associated with them. The ESM is a numerical value standardized based on the dollar value of a tariff in 2004 or the most recent year that it was used if this was prior to 2004. The ESM accounts for the effects of inflation and reflects the intensity of the service.

Family Physician

A generalist physician who provides and coordinates personal, continuing, comprehensive primary care to individuals and families. Such physicians are identified by a code in MCHP's physician data.

Fee-for-Service (FFS)

A method of payment whereby physicians bill for each service rendered, according to a pre-arranged schedule of fees and services. Physicians who are paid on a FFS basis file a claim for each service rendered and are responsible for their operating costs. Other physicians are compensated under an **alternate payment plan**.

Fiscal Year

For most businesses, healthcare institutions included, the fiscal year is defined as starting April 1 and ending the following year at March 31. For example, the 2005/06 fiscal year would be April 1, 2005 to March 31, 2006, inclusive. In this report, for simplicity we have only used the year (i.e., 2005)

Full-Time Equivalent (FTE)

Standard measure of physician workload established by Health Canada that uses **physician claims** to quantify their practice relative to what is considered a full load and results in a single value for each physician. "Full-time" physicians (FTE=1) are those whose earnings fall between the 40th and the 60th percentile of billings. A physician with an average workload above this "normal" level would have an FTE value greater than one and a physician whose workload is below "normal" would have an FTE value of less than one.

Gamma Distribution
A two-parameter family of probability distributions. It is used to model continuous variables, such as money or tariff fees, that are always positive and have skewed distributions (i.e., are not normally distributed). The probability density function for a gamma distribution can be given as:

$$f(x,\alpha,\theta) = x^{\alpha-1}\frac{e^{-\frac{x}{\theta}}}{\theta^{\alpha}\Gamma(\alpha)} \quad \text{for } x > 0 \text{ and } \alpha,\theta > 0.$$

General Surgery
A branch of surgery that deals with a broad spectrum of surgical conditions on almost any area of the body.

Generalized Linear Models
A unified class of models for regression analysis of independent observations of a discrete or continuous response. A characteristic feature of generalized linear models is that a suitable non-linear transformation of the mean response is a linear function of the covariates. These models also provide a unified method for analyzing diverse types of univariate responses (e.g., continuous, binary, counts). Generalized linear models are actually a collection of regression models and they include as special cases the standard linear regression for normally distributed continuous outcomes, logistic regression models for a binary outcome, or Poisson regression models for counts.

Goodness of Fit
How well a statistical model fits the actual data. Summary measures of goodness-of-fit are commonly known as test statistics and typically summarize the differences between the observed values and the values expected under the model equation.

Hospital Discharge Abstract
A computerized record containing information taken from a person's medical chart that is created at the time the person is discharged from an acute care hospital.

Lognormal Distribution
A continuous probability distribution of any random variable whose logarithm is normally distributed. For example, if X is a random variable with a normal distribution, then $Y = exp(X)$ is log-normally distributed. The probability density function of a log-normal distribution can be written as:

$$f(x,\mu,\sigma) = \frac{1}{x\sigma\sqrt{2\pi}}\exp\left(-\frac{(\ln(x)-\mu)^2}{2\sigma^2}\right);\ x > 0, -\infty < \mu < \infty,\ \sigma > 0.$$

Maximum Likelihood

A method used for estimating the parameters of a mathematical model. Given the set of observed data and a probability distribution, it aims at obtaining the most "likely" values of the parameters that maximizes the likelihood function (or the likelihood that a particular population would produce the observed data).

Non-Discretionary

Procedures for which there is little controversy over its indications; such procedures are generally the only treatments available or are the treatments of choice (e.g., colectomy for colon cancer, severe colitis or polyposis and thyroidectomy for hyperthyroid goitre); there is less controversy over the indications for these procedures.

Nurse Practitioners

Registered nurses with advanced training that allows them to provide a full range of primary care services to patients. "They work in partnership with physicians and other health care professionals to provide care in a variety of health care settings" (Nurse Practitioner Association of Manitoba, 2006).

Ordinary Least Squares Regression

The process of determining a regression or prediction equation to predict Y from X. In the resulting regression line, "the sum of the squared discrepancies between the actual dependent values and the corresponding values predicted by the line are as small as possible, hence the name "least squares" (Hassard, 1991).

Orthopedic Surgery

A branch of surgery that deals with injuries and other disorders of the musculoskeletal system. Orthopedic surgeons also address most musculoskeletal ailments including arthritis, trauma and congenital deformities using both surgical and non-surgical means.

Physician Assistant

In Manitoba, "a health care professional, licensed to practice medicine under the supervision of a licensed medical practitioner" (Physician Assistant Education Program (PAEP), 2008).

Physician Claims

Claims (billings) that are submitted to the provincial government by individual physicians for services they provide. **Fee-for-service** physicians receive payment based on these claims, while those submitted by physicians on **alternate payment plans** are for administrative purposes only. The physician claims data file is part of the **Population Health Research Data Repository**.

Physician Resource Database

An elaboration of the basic physician information available to the **Population Health Research Data Repository** (**Repository**) from Manitoba Health and Healthy Living. It contains physicians' demographic data and information derived from analysis of their practice patterns. These data can be used to analyze other components of the Repository from the perspective of physicians.

Population Health Research Data Repository (Repository)

A comprehensive collection of administrative, registry, survey and other databases primarily comprising residents of Manitoba housed at the **Manitoba Centre for Health Policy** (**MCHP**). It was developed to describe and explain patterns of healthcare and profiles of health and illness, facilitating inter-sectoral research in areas such as healthcare, education, and social services. The administrative health database, for example, holds records for virtually all contacts with the provincial healthcare system, the Manitoba Health Services Insurance Plan (including physicians, hospitals, personal care homes, home care, and pharmaceutical prescriptions) of all registered individuals. MCHP acts as a steward of the information in the Repository for agencies such as Manitoba Health and Healthy Living.

Primary Care

"…Includes assessment, diagnosis, and treatment of common illnesses generally provided by family physicians and nurses" (Manitoba Health, 2006).

Salaried Physicians

Physicians who are paid on an annual or sessional salary [rather than **fee-for-service**]. The claims they submit are for administrative purposes only.

Secondary Care

Care provided by a specialist healthcare professional usually after referral from a **primary care** physician.

Sentinel Services (Physician)

For physicians, services that represents a significant proportion of the workload for a particular specialty. They are "determined by true patient need and not likely to be heavily influenced by physician discretion" (Expert Panel on Health Professional Human Resources, 2001).

Shadow Billings

Claims submitted to the provincial government by physicians on **alternate payment plans** including **salaried physicians** for services they provide. Unlike **physician claims** submitted by **fee-for-service** physicians for payment, these claims are for administrative purposes only (i.e., as a record of services provided).

Socioeconomic Status

Characteristics of economic, social and physical environments in which individuals live and work, as well as demographic characteristics. Measures of socioeconomic status include: Income and Education quartiles/quartiles and Socioeconomic Risk Index or Socioeconomic Factor Index scores. It is often ranked from 1 (poor) to 5 (wealthy), based on income quintiles that measure mean household income, and grouped into five income quintiles, each quintile assigned to 20% of the population.

Specialist Physicians

Physicians whose practices are limited to a specific area of medicine in which they have undergone additional training. They were identified by a code in the **Physician Resource Database**.

Tariff

The fee schedule for each service provided by a physician.

Tariff Code

A specific code used to identify each service provided by a physician or a **nurse practitioner** as defined in the Tariff Manual.

Appendix: Models for Orthopedic Surgery, General Surgery, and Pediatric Work

The utilization approach for forecasting the number of needed physicians often models the 'per capita' utilization rate. These rates could be expenditure per capita (Byrick, Craig, & Carli, 2002) or billings or claims per capita (Greenberg & Cultice, 1997). In epidemiology and health services research, the modeling of per capita rather than actual utilization is usually done to emphasize the idea that the frequency with which an event (disease) occurs can be expected to be higher in larger populations. Also, in a projection study such as the one discussed in this report, modeling the per capita utilization rate simplifies the projection process; the projected resources for any given age and sex stratum are obtained by multiplying the estimated regression parameters by the projected population for that age and sex stratum for the target year of projection.

The regression equation for modeling the per capita Equivalent Services Measure (ESM) as a function of age, sex, and year is given by

$$Y = (\text{ESM/pop}) = b_0 + b_1(\text{age}) + b_2(\text{sex}) + b_3(\text{year}) \qquad (1)$$

.If the distribution of Y = (esm/pop) in equation (1) above is normal, then one can use **Ordinary Least Squares (OLS)** Regression to estimate the betas. Estimating the projected ESM simplifies to multiplying the projected population estimates by the regression coefficients. If the distribution of Y is not normal, as is usually the case with expenditure or cost data which are positively skewed, then the modeling process becomes more complex and challenging. Traditionally, this problem is alleviated by transforming Y using the natural logarithmic transformation. This transformation makes it possible to apply the normal distribution theory and consequently use OLS to estimate the parameters. One drawback of modeling the natural logarithmic transformed data is that re-transformation to obtain predicted values in its original scale is more complex (Blough & Ramsey, 2000; Manning & Mullahy, 2001). Furthermore, the transformed data may still not be normal.

Generalized linear models, with appropriate link functions, enable one to model the expected value of Y given the independent variables (McCulloch & Searle, 2001; Blough & Ramsey, 2000; Briggs & Gray, 1998; Manning & Mullahy, 2001). They also alleviate the above mentioned drawbacks. For instance instead of modeling the ln(Y) in equation (1) using the normal theory and OLS, we model ln (E(Y)) using the appropriate distribution of Y. The E(Y) is then obtained by applying the inverse link function to the regression coefficients; which in this case is exponentiation.

Since the number of claims and the amount of claims independently affect health care utilization, we modelled them separately in this study. For the number of claims, we modelled the rate at which these claims occur. Thus, the regression equation is given by

$$\ln\left(E\left(\#\text{ of claims}\right)\right) = b_0 + b_1\left(\text{age}\right) + b_2\left(\text{sex}\right) + b_3\left(\text{year}\right) + \text{offset} \qquad (2)$$

where, offset=ln(pop).

We used the negative binomial distribution in the modeling of equation (2) above. In modeling the amount of claims, we used the following regression equation:

$$\ln\left(E\left(\text{esm}\right)\right) = b_0 + b_1\left(\text{age}\right) + b_2\left(\text{sex}\right) + b_3\left(\text{year}\right) \qquad (3)$$

The distribution used in equation (3) is gamma.

From equation (2), we obtain the rate at which claims are made for any age, sex, and year stratum. Consequently, the number of claims for any age, sex, and year stratum is obtained by multiplying the beta coefficients from equation (2) by the population value for that stratum. Equation (3) gives the expected ESM for any age, sex, and year stratum. Thus, total ESM for any age, sex, and year stratum is equal to the number of claims multiplied by the mean ESM for that stratum. Mathematically, we have

$$\text{E}\left(i,j,k\right) = \text{N}\left(i,j,k\right) * \bar{\text{E}}\left(i,j,k\right) \qquad (4)$$

where

$\text{E}\left(i,j,k\right) =$ the total ESM in age group i, sex j, and year k.

This quantity measures the volume of services administered to the population by any physician specialty (e.g., orthopedic surgery, general surgery).

N(*i,j,k*)= the number of claims made in age group *i*, sex *j*, and year *k*. This quantity can be obtained as:

$$\text{N}\left(i,j,k\right) = \text{Rate}\left(i,j,k\right) * \text{Pop}\left(i,j,k\right) \qquad (5)$$

where

Rate (*i,j,k*) = the rate at which claims are made in age group *i*, sex *j*, and year *k* and is obtained from equation (2).

$\text{Pop}\left(i,j,k\right) =$ the population value for age i, sex j, and year k stratum.

$\bar{\text{E}}\left(i,j,k\right) =$ the average or mean ESM in age group i, sex j, and year k and is obtained from equation (3).

The total number of physicians needed in any year is equal to the total ESM for that year divided by the mean physician workload or productivity for that year. Mathematically, this is represented as:

$$P(k) = \frac{E(k)}{\bar{W}(k)} \qquad (6)$$

where

$P(k) =$ the total number of physicians in year k.

$E(k) = \sum_i \sum_j E(i, j, k) =$ the total ESM in year k.

$\bar{W}(k) =$ the mean physician workload or productivity in year k.

Defining this variable is a challenge. In this study, we define it as follows:

$$\bar{W}(k) = \frac{E_p(k)}{N_p(k)} \qquad (7)$$

where

$E_p(k) =$ the total ESM in year k based on p physicians.

These *p* physicians can be those who practiced throughout the entire study period or those who practiced in the most recent seven years (1998/99 to 2004/05).

$N_p(k) =$ the total number of physicians in year k

It is worth noting that the distinction between E(*k*) and EP (*k*) is that E(*k*) is the ESM in year *k* for all the physicians in the entire study period while EP (*k*) is the ESM in year k only for those physicians used in defining the physician workload or productivity.

Model Implementation and Goodness of Fit

All models were implemented using PROC GENMOD in **SAS®**9.1. The **goodness of fit** statistic was assessed by the value of the deviance statistic divided by the degrees of freedom. The model with the deviance statistic divided by the degrees of freedom value between 0.9 and 1.3 was accepted to be a good fit to the data.

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Aboriginal Health Research and Policy: First Nations-University Collaboration in Manitoba, Canadian Journal of Public Health, Volume 96, Supplement 1, January/February 2005.

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