PREDICTING HEALTH HUMAN RESOURCE NEEDS FOR AN EVOLVING POPULATION IN THE LABRADOR-GRENFELL REGIONAL HEALTH AUTHORITY

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REPORT PREPARED FOR THE LESLIE HARRIS CENTRE OF REGIONAL POLICY AND DEVELOPMENT, MEMORIAL UNIVERSITY
POPULATION PROJECT: *NEWFOUNDLAND AND LABRADOR IN TRANSITION*

THE HARRIS CENTRE
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The Population Project: Newfoundland and Labrador in Transition

In 2015, Newfoundland and Labrador had the most rapidly aging population in the country – which when combined with high rates of youth out-migration, declining birth rates, and an increasing number of people moving from rural parts of the province to more urban centres, means that the province is facing an unprecedented population challenge. Without intervention, this trend will have a drastic impact on the economy, governance, and the overall quality of life for the people of the province. Planning for this change and developing strategies to adjust and adapt to it is paramount.

The Harris Centre's Population Project has developed potential demographic scenarios for the province and its regions for the next 20 years and will explore a number of the issues arising. These include, but are not limited to, those concerning:

- Labour markets – how will future demands for labour be met given a shrinking labour supply?
- Service demands – what are the implications of an aging and a geographically shifting population on the demand for public, private and non-government sector services?
- Service provision – what are the implications of a declining rural population for the costs and delivery of services to an increasingly smaller and older, but still geographically dispersed population?
- Governance – how will local and senior levels of government respond to changing governance issues in the light of these demographic changes and challenges?

Utilizing expertise from both inside and outside the university, the project employs a combined research and debate approach to inform and contribute to government policy, as well as to develop strategies for the private and non-profit sectors to respond to the broad range of issues resulting from the anticipated population shifts.

This report, by Alvin Simms, Jamie Ward and Kris Aubrey-Bassler, Memorial University, forecasts health care demands associated with the next generation of seniors in Labrador, and frames the outcomes within the context of general strategies for the future delivery of health care services. Demand for care for the Province as a whole will increase because the province already has the oldest population in Canada, and by 2036 the proportion of those 65 years or older will have increased to 31% of the population compared with 16% in 2011. The changing demographic structure in the province will impact the types and numbers of health care professionals required to provide care. Health care costs, which currently represent approximately 40% of provincial expenditures, will continue to increase unless a variety of measures are taken to control them. This report demonstrates how future demands for health care human resources can be estimated, which represents an important input into the health care planning and cost management process.

Funded by the International Grenfell Association (IGA), this report is the seventh published through the Population Project. This and all other reports generated through the Population Project are available online at www.mun.ca/harriscentre/populationproject. More information about the project can be obtained by contacting the Project Director. Comments on the Project and reports generated are welcomed.

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EXECUTIVE SUMMARY

In 2017, Newfoundland and Labrador`s Auditor General`s report (Auditor General NL, 2017) suggested that from 2016 to 2036 health care cost could increase by approximately $900 million or $45 million per year. This increase is due solely to an aging population. If historical trends continue, there will be a steady decline of population in many regions because of increasing mortality, lower fertility rates and out-migration from rural areas. In other words, there will be fewer younger people to replace the retirees unless there is a policy or strategy to replace the population where existing industries require a specific size workforce to keep the economy functioning.

The objective of this project is to forecast health human resource (HHR) demands associated with the next generation of seniors in Labrador, and frame the outcomes within the context of general strategies for the future delivery of health care services. The projections are computed with an age specific demographic forecast model paired with surveyed health professional expert information linked to age cohort hospital morbidity for human resource requirements and health care setting type. The professionals considered in this report include registered nurses, licensed practical nurses, several specialties of physician, social workers, physiotherapists, and occupational therapists, and others for a total of 15 professional types. A panel of 15 experts were surveyed using the Delphi method, to estimate their "time-contributed to the care of Labradorian patients by age cohort". This information is used to allocate "weighted patient days" to the various health human resources.

Quantification of the impact of projected population changes on the 15 HHR positions required the calculation of a "demand factor" that reflects patient "weighted demand" by HHR class and age cohort at several points in time in the future. Patient days are used to measure this type of demand whereby hospital admissions are multiplied by average length of stay. Because the primary objective of this study is to examine the potential impacts on HHR needs of projected future populations, it requires that baseline values be compared to projected future requirements. Baseline "patient day" values are calculated using the 2016 census population, health care admission data as well as average length of stay (Auditor General NL 2017; Labrador Grenfell Regional Health Authority 2017)[1].

The population forecasts are based on the single age cohort survival model used to estimate the data generated in the Harris Centre's Population Project report on "Regional Population Projections for Newfoundland and Labrador, 2016-2036 (Simms and Ward 2017)[2].

[1] An assumption of the model is that hospital morbidity rates by age cohort do not change over the forecast period. To develop scenarios with varying morbidity rates over time would require a time series analysis to determine the annual rate of change in health outcomes or hospital admissions. The data was not available for this study and would require additional time and funding.

[2] The Labrador projections in the report do not include the Northern Peninsula (North) Region the population of which was 7,425 in 2016, but it is included in this study as it is part of the Labrador-Grenfell Health Authority region.

The data used in this study only apply to Labrador-Grenfell admissions associated with the 3 hospitals and 3 community health centres (Labrador Grenfell Regional Health Authority 2017). It is assumed that these data will provide some insight to the projected demand on health human resources (HHR) in the region. The outcomes are at a macro level and are not meant to be used to estimate specific staffing demands,[3] but rather provide information to demonstrate how various HHR class time contributed to patients is potentially impacted by an aging population.

A baseline "weighted patient days" by HHR class and age cohort were calculated for 2016. These baseline values are compared to predicted "weighted patient days" associated with the population models outcomes for 2016, 2021 and 2036. The 18-44 to 65+ age cohorts all have higher HHR demands than younger cohorts except for Pediatrics. The 2016 population is skewed towards the older age cohorts and the baseline assessment of "patient demand" in the region indicates that 65+ age cohort accounts for 40% of the average patient days in the Labrador-Grenfell Health Region.

Two population models, Historical Survival (HS) and Replacement Survival (RS) are used to estimate future demands in human health resources. Overall, the two population models agree in the direction of net change, but differ in the magnitude of change. The highest HS[4] model percent net demand change from the 2016 baseline is associated with Specialized Geriatrics where average patient days increase by 18.29%, 35.78% and 63.54% for 2021, 2026 and 2036, respectively. By 2036 average patient days for orthopedics is projected to increase by 26.60%, occupational therapist, 26.70%, outpatient family medicine 13.99%, registered nurses by 6.9% and nurse practitioners by19.23%.

Overall age cohort outcomes indicate that by 2021 the HS model predicts that patient day demand for 0-2 year olds will be 90% of the 2016 levels or a reduction of 10% while the 65+ demand is 122% larger than 2016 values. By 2036 the HS model predicts that the overall demand for 65+ will increase by 179% Both the HS and RS models predict similar and significant increases for the 65+ age cohort.

When outcomes are converted to "expected average number of patients" to be admitted daily to the Labrador- Grenfell hospital system the results suggest that declines in the 0-2 to 45-64 cohorts are offset by gains in the 65+ cohort. The HS model predicts that the patient daily census for the 65+ cohort will increase from 59 in 2016 to 106 by 2036. The net effect of the increase patient demand related to an aging population is that the expected average daily census will increase from 148 in 2016 to 158 in 2021, 164 in 2026 and 167 in 2036.

[3] Staffing demand models can be applied in this context but requires micro data on existing staffing level per patient, professional and support staff requirement, specific disease prevalence and services used as well as facility specific service characteristics etc.

[4] For discussion purposes only the HS model results are referenced because both the HS and RS models predict increases except the RS rates of increase are somewhat higher but the patterns remain the same.

For the Labrador-Grenfell Health region the HS population model used in this study estimates that the percent of the region's population 65 and over will increase from 14% in 2016 to 18% in 2021, 22% in 2026 and 30% by 2036. This represents more than a doubling of the 65 and over population from 2016 to 2036.

The outcomes from the analysis are summarized as follows:

(1) Anticipated population shifts for the period from 2016-2036 will result in growth of the 65+ cohort and ultimately stability or decline in the others, regardless of model. This will result in an overall increase in healthcare demands due to the higher morbidity rates in this cohort.

(2) The increase forecast in overall patient demand in the study area is currently ongoing and will increase relatively steadily for each time period, to an overall increase of between 13.9% and 25.9% by 2036.

(3) The increase in patient demand days due to aging will affect some HHR categories more acutely than others. HHR categories that serve seniors, such as geriatrics or orthopedics will experience increased demand, while those that serve younger people, such as pediatrics, will decline. However, within the health region, outpatient family medicine, registered nurses and nurse practitioners will have the highest absolute demand in positons because of the combination of their relatively high involvement in the care of aging populations

(4) The increase in patient demand days due to the rise in the number of seniors will occur whether population replacement goals are met or not.

Given the absence of information on patient loads by specialization calculation of staffing requirements was not possible in this study

The analysis in this report is based on the admission data from 3 hospitals and 3 community centres in the Labrador-Grenfell Health Region. Missing from the analysis are the 14 community clinics and the two long term care facilities in the region. Although data were requested for all facilities within the Health Authority, it was not made available. Therefore, the results of the demand analysis have to be interpreted within the context of hospitals and community health centres only.

The rationale for this particular study was to provide guidelines for a planning approach to the changing HHR needs and the outcomes indicate that overall there will be additional pressures on HHR staffing in the Labrador-Grenfell Health Region. Although the population will decline in some parts of the region, the growth in older age cohorts will offset the reduction in HHR demands associated with younger cohorts.

The integration of the surveyed "time contributed to patient care" and the 2016 admission and population data is a good measure of the existing demand on the HHR clinician categories analyzed in this study, while the projected outcomes provide an indication of the potential

demands on HHR. However, the absence of information on the specifics of diseases associated with the aging population, and associated care and staffing levels requirements prevents the calculation of future costs and staffing needs.

Specifically, more detailed information is required on activity work standards (e.g. acceptable patient loads by specialization) and staffing requirements. This is beyond the scope of this study, but guidelines for this type of analysis are presented by the Ozcan and Hornby [30] study on determining hospital workforce requirements by examining the linkage between health service utilization and human health resources. Specifically, this analysis requires databases that can link patient, disease, treatments, staffing, patient age and level of service within a health care facility as well as linkages between facilities. Combined with health care cost factors, this type of linkage analysis [31] would provide a more detailed impact of aging populations and their associated costs in terms of infrastructure and staffing. Furthermore, this type of analysis can also evaluate simultaneously the interactions between all health care facilities with the region and assess the impacts, while addressing capacity issues, of adding or removing services from one facility and transferring a "patient load" to another facility.

The findings from this report indicate that:

- The increased demand for various health professional types in 2026 is projected to range from 36% for geriatricians to 9% for obstetricians and gynecologists (reduced demand for obstetrical services are only partially offset by the increased demand for gynecological services) above 2016 levels. The only health professional type with reduced demand expected in 2036 are pediatricians.

- The increased demand for various health professional types in 2036 is projected to range from 64% for geriatricians to 15% for obstetricians and gynecologists (reduced demand for obstetrical services are only partially offset by the increased demand for gynecological services).

- Results for provider types that are heavily involved in the care of patients of younger ages are heavily dependent on the assumptions regarding birth rates and the degree of in-migration which are difficult to estimate

The recommendations from these findings are that:

- Policy makers will need to plan for the additional HHR needs in LGH by ensuring adequate enrollment in health professional training programs and by implementing effective recruitment and retention strategies.

- The current study estimates the needs for health care professionals only, but elder care is often shared by non-professional caregivers and family members. Strategies to maintain working age populations who are able to provide this care in LGH should be implemented.

- A forecasting model should be adopted by the Department of Health to help determine and plan for the impacts of an aging population on health infrastructure, human resources and their associated costs.

- Databases that can link patient, disease, treatments, staffing, patient age and level of service within and between health care facilities need to be made more readily available as inputs to the forecasting model.

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1.0 INTRODUCTION

In 2017 Newfoundland and Labrador`s Auditor General`s report suggested that for 2016 to 2036 health care costs could increase by approximately $900 million or $45 million per year (Auditor General NL, 2017). This increase is due solely to an aging population. The aging population factor has dynamics that suggest there will be a "peak aging" at some point in time where older cohorts dominate the age structure of a region's population. If historical trends continue there will be a steady decline in many regions because of increasing mortality, lower fertility rates and out-migration from rural areas. In other words, there will be fewer younger people to replace the retirees unless there is a policy or strategy to replace the population where existing industries require a specific size workforce to keep the economy functioning. This presents two possible approaches to examining how aging populations impact health human resource requirements (HHR) for health care in the Labrador-Grenfell Health Region: [1] What are the impacts of historical trends in fertility, migration and mortality and its related aging populations on human health resources? And, [2] If the shortfalls in the workforce are adjusted by replacing retiring workers via recruitment of younger workers is there an additional demand for health human resources?

The objective of this project is to forecast health care demands of future populations in Labrador and frame the outcomes within the context of general strategies for the future delivery of health care services. The projections are computed with an age specific demographic forecast model paired with expert information linked to an age cohort utilization factor for human resource requirements and health care setting type. In this case, human resources include practitioners such as nurses, physicians, social workers, therapists, etc.

2.0 LITERATURE REVIEW

The purpose of this selected literature review is to provide insight into the potential impacts that aging populations may have on health care delivery and to highlight some of the strategies that have been proposed in other jurisdictions. Issues around rural health care are specifically examined in the review.

2.1 National Perspectives

The aging of industrialized countries has been a topic of debate and research for the last three decades, and the first recommendations for policy direction were presented in the 1982 UN Vienna Plan of Action (United Nations 1983), followed by the 2002 Second World Assembly on Aging (United Nations, 2002). By 2012 each country participating was required to evaluate their progress and Canada contributed a report indicating "various policies and programs had been put in place for seniors" (Canada 2012). This report included an analysis of the potential increase on demands for healthcare.

In Canada, the UN initiatives from 1982 to 2012 included a series of studies and reports by organizations such as the Canadian Health Services Research Foundation (CHSRF), Canadian Medical Association (CMA), The College of Family Physicians and various federal government agencies such as the Canadian Institute for Health Information (CIHI), Public Health Canada (PHAC), Human Resources and Skills Development, etc.

CHSRF published a background paper on "Better With Age: Health Systems Planning for the Aging Population" (CHSRF 2010) which was a pre-cursor to their 2010 roundtable series held on the subject across Canada, which in turn resulted in the publication of a series of regional reports that included the Report on the Atlantic Regional Roundtable (CHRSF 2011). This particular report suggested that aging had accounted for 0.8% increase per year in health care costs over the previous 10 years (i.e. 2000 to 2010) and would increase to 1.0% per year over the next 25 years. However, the rate of health care cost increases varies by provinces and regions. Furthermore, aging is only one factor contributing to those increases in costs. Other factors include increased utilization of the health care system by all age groups (CHRSF 2010). In Atlantic Canada provinces between 42 and 55% of the population live in rural areas, compared to an average of 20% for the rest of Canada. This combined with a high out-migration of young people and returning retirees, will present additional stresses on the health care system in rural areas in the region (CHRSF 2010, 2011).

The PHAC (2014) report on the state of public health in Canada highlights not only aging issues, but also the life-style trends among younger age groups that impact their health status later in life. Of interest for demands on health care systems and its practitioners is that in 2012 "85% of the seniors aged 65-79 years and 90% of seniors reported having at least one chronic condition". In addition, about 24% of seniors have more than three chronic diseases and account for 40% of health service utilization amongst seniors (PHAC 2014). For this particular

study on forecasting health care demands in rural areas as the population ages, it is important to recognize the fact that areas with First Nation, Inuit, and Innu populations who are younger than the general population have higher rates of diabetes, heart disease, tuberculosis, HIV and AIDs. In addition, the "relative size" of the senior cohorts in indigenous groups is increasing, and the onset of chronic diseases is earlier. For example, in 2008/2010 approximately 90% of First Nations people aged 60 or older reported having one or more chronic conditions while 47% report having 4 or more chronic conditions (PHAC 2014).

A CMA (2016) report suggests that in areas where aging and associated diseases are a factor a shift in services, as well as an increase in expenditures, may be required. For example, aging may create a 40% increase in cancer cases by 2030, dementia cases are expected to increase by 66% in the next 15 years and, most notably the number of seniors requiring a family caregiver will probably double in the next 30 years (CMA 2016). This could be problematic in many rural areas where the population is aging faster than in urban centres and the out-migration of youth will probably leave a noticeable gap in "familial care givers" thus potentially shifting these demands to the health care system. Health care costs currently increase dramatically as people age: in 2013 persons aged 65-69 on average cost $6,298 per year, age 70-74 $8,384, 75-79 $11,557 and for age 80 plus the cost was $20,917, or 3.3 times the cost of the 65-69 cohort" (CMA 2016).

In terms of action plans, the CMA (2016) report recommends that: [a] a pan-Canadian strategy is required to address the health need of seniors, [b] there is a need for agreement on how seniors care is measured and delivered, and [c] health system performance evaluations be conducted. Also included are recommendations to improve integration of health and social services and provide support for home caregivers.

The earlier literature does not specifically identify rural health care issues and policies, however a 2002 "Rural Health in Rural Hands" report (Ministerial Advisory Council on Rural Health 2002) provides a framework for improving the inequalities between rural and urban health care by addressing the following issues:

a) Building Healthy Communities
b) Infrastructure for Community Capacity-building
c) Intersectoral Collaboration
d) Rural Health Research
e) Health Information Technology
f) Health Human Resources
g) Aboriginal Health

Within the report there is no specific information on how aging will potentially shift health care services and demands on practitioners in rural and remote areas, but it does examine policy and strategies for improving health care services and well-being of the population. Of note, the report indicates that rural and remote health professionals need to be "highly skilled generalists as opposed to specialists", and that recruitment and retention in rural areas is of utmost importance. These recommendations are re-enforced by the College of Family Physicians of Canada (2017) report on Steps to Improving Rural Health Care in Canada, which

highlights the retention of health professionals as an ongoing problem in rural Canada. This project analyzes how practitioners allocate their time with different population cohorts and provides insight into how health human resources (HHR) requirements shift as the population ages.

2.2 Other Perspectives

Layte (2009) offers one of the most comprehensive reports on projecting the impact of demographic change on the demand and delivery of health care. Although this study of the parallel public/private Irish health care system differs from the Canadian universal coverage system, the analysis provides relevant guidelines for this study. The study examines the capacity to shift from an acute care dominated model to a primary care community-based model, whereby teams of GPs, nurses/midwifes, home care workers, physiotherapists, occupational therapists, social workers, receptionists, clerical officers and administrators would provide services at the community level. These teams would serve populations of 3,000-7,000 from a single location. This type of model is considered more cost-effective than multiple acute care facilities serving smaller populations. This concept of reconfiguration to provide higher quality care, cost efficiencies and appropriate trade-offs between acute and primary care is somewhat similar to a Newfoundland and Labrador Medical Association (NMLA) proposal released in January 2017 (NLMA 2017).

Layte (2009) also demonstrates that with appropriate data, one can forecast future changes in health care demands and services. For example, the integration of population forecast models with average annual number of visits by age cohorts (e.g. male and female cohorts aged 16-20 had on average 1.4 and 2.2 visits annually, while males and females in the 82+ cohort averaged 7.2 and 7.8 visits) are used as inputs to the forecast models. The use of this information, used in conjunction with a population projection model, indicated that from 2006 to 2010 the demographic change factor would result in a 9.4% increase in consultations. However, the projected demographic impact from 2006 to 2021 is 32.5%. Layte (2009) also raises the issue of impacts related to changing medical technologies, which may be more important drivers of cost than the age structure of a population. Finally, the age composition of a population that is skewed towards older cohorts is more likely to increase the number of visits to a particular health care facility or service and costs.

Whereas Layte's (2009) study focused on the reconfiguration of health care delivery and increased demands, Ha *et al.* (2014) had a much narrower focus on the "impact of population aging on the cost of hospitalisation for cardiovascular disease". From an Australian perspective, the authors note that healthcare cost for those aged 65+ is 4 times higher than those younger than 65. However, the study does not assess how much time/effort is spent on each cohort by type of service. An important finding is that the increased incidence of cardiovascular disease and other chronic diseases related to an increase in the population aged 65+ was the main driver of the rise in the cost of hospitalizations. The study indicates that increasing incidences contributed to a 20% increase in costs for cardio vascular disease, but the

authors note that additional research is required to determine the impact of new technologies on hospital costs (Ha *et al*. 2014).

The previous two reports indicate that there will likely be an increase in health care demands and costs in the coming years. A 2015 US report (Trocaire College 2015) attempts to quantify the potential increase in human resource requirements for aging populations. For example, by 2022 the expected increase in positions requiring to be filled, related to aging, was for: [a] registered nurses 19%, [b] licensed practical nurses 25%, [c] medical assistants 29%, [d] massage therapists 23%, [e] surgical technologists 30% and [f] health information technicians 22%. Although these US national averages are not directly transferable to the Newfoundland and Labrador setting, one can expect either an increased demand for personnel and/or re-assignment of existing human resources to deal with a shift related to decreasing demands in the younger age cohorts or increasing demand in older cohorts.

Increasing demand for health services is a global issue. For example, an Australian report on aging and the health systems indicated that in 2011-2012 98% of people aged 65+ had visited at least one health professional in the previous year, while those under 65 had a visitation rate of 82% (Australian Institute of Health and Welfare 2014). Of note, 57% of those 65+ had visited a specialist within a year versus 28% for those under 65. Furthermore, 20% of the older population had been admitted to hospital, versus 11% for the younger cohorts. The report acknowledges that with increased demands on health care there is a corresponding need to have an adequate workforce in terms of numbers and requisite skills sets to meet the various demands of an aging population. The literature (see, for example, Onnis 2016; Savy *et al.* 2017) identifies factors that should be considered when analyzing potential impacts related to aging and corresponding strategies for delivery of health care such as:

a) There will be "pockets of pressure" whereby demands for health care will vary by location and service type. This is especially relevant in rural and rural remote areas with rapidly aging populations.

b) Indigenous populations are relatively young, but develop age-related chronic diseases earlier and require particular attention.

c) There will be a need to promote good health across an individual's lifespan because studies have demonstrated that many chronic conditions can be prevented or postponed.

d) Enabling healthy aging where the health and quality of life of present older cohorts is improved by better management of existing chronic conditions.

e) The focus should be on the "efficient coordination of care" for older cohorts given the high rates of chronic disease and multiple medications.

Thus, when estimating human resource demands and potential strategies it must be evaluated within the context of local information and how it varies by geography. To address this requirement the clinicians surveyed in this study were asked to consider how their rural situation and patients influenced the demand for their "patient care time" by age cohort.

The previous studies referenced in this section focused on how the demands for healthcare resources will change with an aging population. Although there were passing references to the fact that that life choices (e.g. food, activity levels, obesity) of younger cohorts will also have an impact on the healthcare system as this population ages, there was no specific discussion on the impact, but noted that chronic diseases may appear earlier in life and this may put additional pressure on health care resources in the future. In addition, the outcomes highlighted the potential differences based on geography, cultural differences and the setting (e.g. hospitals, emergency department, family medicine clinics etc.), in which healthcare is delivered. Thus, the problem becomes complex and multi-dimensional whereby human resources, setting, patient age cohorts, changes in chronic diseases, lifestyle changes, and medical technologies (e.g. advanced disease treatments, tele-medicine etc.), as well as geography, need to be considered in examining the interrelationships between aging and the subsequent demand on health care resources. Essentially this becomes "a problem of resource allocation" in terms of health care and facility resources. What is required for the analysis these types of problems is a method that has the capacity to integrate both qualitative and quantitative information provided by a health care practitioners (Saaty 1996; Schmidt *et al.* 2015).

In this study the method is a hierarchical process, whereby values assigned by health practitioners to different levels of health care, human resources, settings and age cohorts are analyzed through a pairwise comparison function. This function computes weights and probabilities that can be used in an integrated population forecast model to estimate future health human resource demands. This type of analytic process for decision-making also permits the analysis of the consistency in the judgment of the "expert responses" and provides information on whether or not the responses are stable enough to be included in the analysis. This is especially important when the "patient care time" depends on the role of various clinicians involved in a patient's care and how health resources are allocated and utilized. In this case the consistency factor permits the analyst to determine if the responses reflect a random or a structured understanding of the process being measured (Saaty 1996; Schmidt *et al.* 2015).

Of interest for this study is the Kwak *et al.* (1997) paper on human resource planning for hospital laboratory personnel, in which factors associated with different supply and demand models were evaluated by ten experts via the Delphi process (i.e. participants assign a ranked preference for particular models through an iterative decision process). Subsequently, the preference rankings assigned by the participants for the different models were pairwise compared to assess the different alternatives for the purpose of estimating the degree of change required in the demand and supply of laboratory personnel to implement the different models. From this process, the authors were able to prioritize the different models, estimate impact on demand or supply and estimate the net effect on the system as a whole (Kwak *et al.* 1997). This particular approach provides a framework for the model used in this study. In addition, Lee and Kwak (1999) used a similar approach to Kwak *et al.* (1997) to estimate various demands for informatics services for a hospital. The human resource requirement for each department was identified and linked to a demand for various types of digital informatics

services. The model was developed to reflect the needs of the facility's decision-makers who are both users and owners of the information system. This study adopts a similar approach whereby the health practitioners were asked to provide estimates of time spent with patients as this relates to the demand for human resources, but adds another dimension related to the age cohort of the patient within a specified healthcare setting (Kwak *et al*. 1997; Lee and Kwak 1999; and Padilla-Garrido *et al*. 2014).

2.3 A Rural Perspective

To provide context on rural health care a review of strategies proposed in different jurisdictions is presented. This review informs on how the definition of "rural" may influence the perspective on health care requirements and delivery.

Setting the context for rural health strategies in Australia, its College of Rural and Remote Medicine recognizes not only the difference between urban versus rural health care, but also the differences within rural in which rural and rural remote are identified as requiring separate, but complementary, strategies. Wakerman *et al*. (2017) suggests that although there is a general assumption that rural and remote are synonymous with each other, rural and remote health professionals in Australia may have different goals, training and practices. In this situation, remote is typically defined by distance to other communities, degree of isolation and access to health care. However, some authors view the geographical aspect of rural and remote as not a key factor, rather they suggest that socioeconomic and social determinants are more important. The review by Wakerman *et al.* (2017) indicates that rural remote "is characterized by relatively higher mortality and morbidity, a higher proportion of indigenous people and there is a more dispersed population than in non-remote rural areas". Furthermore, remote areas generally lack access to services and while the shortage of health care professionals tends to be greater, multidisciplinary teams with overlapping roles practicing in a visiting service model are more common. From a human resources perspective Australian remote health care is one of General Practitioner substitution, with nurses becoming the point of contact for primary care. In summary, the characteristics of remote medical practice are one of cultural diversity, telehealth, a need for skilled clinical diagnostics, a multidisciplinary approach, and public health (Wakerman *et al*. 2017).

To provide evidence of how practitioners view remote versus rural Wakerman *et al*. (2017) surveyed 48 people who worked or had worked in a rural and/or remote health practices for at least 5 years. The outcome from this analysis indicated that all respondents agreed that isolation, access to services, requirements for visiting services and the role of general practitioners, differentiate remote from the concept of rural. Approximately half of the respondents indicated that "procedural practices, or how teams work in a health service and the role of public health in practice" in remote health were different from rural health. Of note is that those practitioners working in remote places, especially in Aboriginal communities, generally indicated there were greater differences in "the need for visiting services, the types of populations that live there, the relative roles of general practitioners, nurses and Aboriginal health workers, culturally, in political power, mortality and morbidity". This would suggest that

experience in remote practices is important in highlighting these geographical differences. From an analysis perspective the Wakerman *et al*. (2017) study reinforces the fact that when estimating the human resources demands for aging populations, geography (degree of remoteness), cultural, and socioeconomic differences must be considered when discussing outcomes and making general recommendations.

To provide background on the type of strategies under consideration Lavis and Boyko's (2010) report on developing a rural health strategy for Saskatchewan provides both a background on rural conditions as well as strategies. This report is augmented by a detailed literature review of available evidence regarding the effectiveness of proposed rural health care strategies including those for aging. Generally, rural communities in Saskatchewan have a higher proportion of First Nations peoples than the provincial average, with poorer physical health, an increased sedentary lifestyle, more chronic illness, access to fewer health care services and less access to public transportation. Lavis and Boyko (2010) suggest that rural Saskatchewan is "conceptualized as being underserviced, sparsely populated and geographically dispersed". Rural health issues from 1995 to 2005 included a 54% prevalence rate for diabetes amongst adults and during the same period a relative 54% change in prevalence of hypertension. Chronic disease is a significant and growing challenge in rural areas. Chronic disease is the leading cause of death in all of Canada, including Saskatchewan. From an analysis perspective, the demand for human resources as related to health setting is linked to the strategies implemented by a jurisdiction. Lavis and Boyko (2010) completed a systematic review of the proposed rural health strategies together with available evidence from other studies: The strategies included[5]:

a) Option 1: Support for self-management (aging in place) such as telehealth/e-health and specialist outreach services. This includes supports for rural residents who have to travel to receive care (includes financial assistance, accommodations and linguistically and culturally appropriate supports) while engaging patients and their families in decisions about how to support self-management, aging in place and healthcare travel.

b) Option 2: Increase the breadth and accessibility of chronic disease management programs. This is focused on the issues related to the growing burden of chronic disease and may involve approaches to chronic disease management that are linked to available resources (e.g. nursing stations) and to the needs of communities (e.g. improved coordination of care). Implementation of some variant of a Chronic Care Model that could be applied across a range of conditions or in relation to self-management supports, decision support, delivery systems design, clinical information systems, health systems changes and community resources is considered.

c) Option 3: Optimize the use of healthcare professionals and of inter-professional teams. This option deals with the rural healthcare provider workforce and the requisite skill sets. This includes the potential for a role extension for existing healthcare workers (e.g. expanded role for nurses). This option proposes the utilization of inter-professional

[5] The options list is a combination of direct quotes from the authors and in some instances paraphrased from the original document.

health care teams and a consideration of whether they should be electronic, mobile or stationary. It addresses the issue of recruitment and retention of healthcare professionals and the need to expand the participation of the indigenous population in the health profession. The need to provide support for health providers that includes continuing professional development, decision support, as well as engagement in quality improvement initiatives such as collaborations are considered.

Lavis and Boyko's (2010) review of the literature suggests that there is very little evidence to support the effectiveness of the options for people living with two or more chronic diseases, but did note several difficulties to implementing the options. For example, for Option 1, which promotes self-management, the ability of patients with multiple chronic diseases to self-manage is limited. Furthermore, the professional development and training as well as organizational requirements to implement and facilitate self-management programs may not be viable in many rural communities. These programs would require additional financial commitments from a provincial government that may be unwilling or unable to afford those costs.

In the case of Option 2, which promotes the accessibility of chronic disease management programs, the health care providers would have to determine if the chronic disease management program can be incorporated or exist along with a model for acute disease management, or whether the programs are viable within a rural community setting. Again, cost of implementation is an important factor.

Finally, under Option 3, which focuses on the use of inter-professional teams, patients may prefer to obtain care with their physician. For rural communities with a small population, team-based care may not be financially viable. For example, the Irish study cited earlier (Layte 2009) suggested that for primary care teams to operate efficiently a population of 3,000 to 7,000 people was required.

The Saskatchewan challenge for health care delivery in rural areas is "to reduce repeated travel over long distances and reduce the time to access diagnostic services". Solutions include "patient and family-centered health care" and adoption of remote patient monitoring, whereby a patient's chronic condition (e.g. diabetes and hypertension) is monitored by a health professional remotely using varying combinations of medical diagnostic devices (e.g. glucometer, blood pressure meter) that may be linked to a computer, symptom surveys and videoconference connections (Lavis and Boyko 2010).

2.4 Newfoundland and Labrador

In 2015 the NL Government Department of Health and Communities released a report highlighting a healthier place and a framework for primary care (Newfoundland and Labrador 2015). Of particular note is the stated requirement for reform and evaluation of the current system. This is similar to conclusions reached in other countries, including Australia and Ireland, as well as in other parts of Canada. The support for change is linked to a number of provincial

health issues that are already putting pressure on the health care system. Demand for care for the aged will increase because of the fact that:

a) The province has the oldest population in Canada and by 2036 31% of the population will be 65 years or older versus 16% in 2011.

b) Health care in the province currently costs $5,087 per person and is approximately 22.15% higher than the Canadian average.

c) 63% of the population over the age of 12 have at least 1 chronic disease while 88% of seniors (65+) have one or more chronic diseases (the top 4 chronic diseases are arthritis (22.1%), chronic pain (21.2%), diabetes (9.5%) and heart disease (6.3%)).

d) 70% of the population is obese or overweight and 76% have poor eating habits.

e) Approximately 20% of the population smoke.

Health care practitioner retention issues, especially in rural and remote NL, a rapidly aging population, together with high health care costs are the government's motivation for primary health reform where access to care, continuity (long term relationships with individuals), person-focused (individual health care plans), multidisciplinary teams and community engagement are the guiding principles for policy (Newfoundland and Labrador 2015). These strategies generally align with Lavis and Boyko's (2010) recommendations for rural Saskatchewan, however these authors suggest that multidisciplinary teams may only be suitable for larger communities and may not be viable in rural/remote areas. In addition, the NL government report indicates that social determinants of health such as income, education, employment, working conditions, food security, health services, and aboriginal status are also important factors when considering the health and the well-being of a population (Newfoundland and Labrador 2015).

As with other studies and reports, analysis and reporting of outcomes must consider the geography, culture and socioeconomic characteristics of a community or region. The Newfoundland and Labrador Medical Association's (NLMA) fact sheet on rural health emphasizes the importance of geographical determinants of health and disproportionate access as major factors in the health and well-being of the population in rural and remote areas (NLMA 2010). Thus, people living in rural and remote places have poorer health outcomes along with poor socio-economic conditions, less healthy lifestyles and higher mortality rates than those living in larger centres. Small rural communities are geographically dispersed and disability and accident rates are higher in those areas (NLMA 2010). In terms of disproportionate access to health care in rural and remote areas, this means that although rural places exhibit a poorer health status and have a relatively higher demand for services than urban areas their populations are generally not well served. According to the NLMA (2010) fact sheet, the deficiency in health care services is directly related to acute shortages of health care professionals, which is linked to retention and recruitment issues, which in turn increases the burden on rural physicians, nurses and administrators. The geographical issue of dispersed and low-density populations associated with rural communities is also associated with the difficulty of providing "acute intervention in the 'golden hour' of trauma, the 30 minutes for caesarean

and other time-based standards that save lives" whereby proximity to health services is a necessity and not an option. Although in some instances delays in accessing health care will not significantly affect outcomes, there are cases where delays will increase the risk of complications and negatively affect outcomes (NLMA 2010). Again the geographical factor must be accounted for and in this study the location of the respondents (health care practitioners) and proximity to services is included as a part of the analysis.

In January 2017, the NLMA released a document titled "Rebuilding NL Health and Community Services: Proposal by the NLMA to the Minister of Health and Community Services" (NLMA 2017), which stated that in order to provide "higher quality care, greater financial sustainability, improved recruitment and retention of providers, and a better balance between community care and acute institutional care, the health care system requires the reconfiguring of the roles of the health care facilities and the distribution of services. One facet of this reconfiguration strategy is "a health human resource plan". Given that this study is examining population aging and human resource demands for mostly rural and remote areas in Newfoundland and Labrador, it will contribute information on how aging may affect demands on existing human health resources in a rural setting.

Evidence supporting disparities in accessing health services in rural areas is highlighted by Montevecchi's (2012) study on those factors that influence access to health care services in Labrador. This study included a survey of community members, administrators and health care providers in Labrador. The research was completed within the context of social determinants, rural considerations, and aboriginal considerations. The findings support previous studies on rural health care where environmental factors such as distance to services, weather and geography (in many cases rural remoteness), culture and jurisdictional difference, gender as well as continuity and comprehensive care are identified as key issues. The outcomes suggest that health care strategies that may help to overcome these challenges included tele-health, mobile services, recruitment/retention and the medical travel assistance program. These were seen as useful in addressing issues related to [a] physical environment (e.g. distance, weather and geography); [b] socio-cultural and political environment (e.g. cultural/jurisdiction differences etc.); [c] gender (e.g. travel stresses, absence from families, caring for children etc.), and; [d] continuity and comprehensiveness of care (e.g. consistency and predictable access to health care). For example, it is recommended that patient navigation tools, which reduce socio-cultural and political barriers to health, should include "a systemic, technological and human resource" that helps residents navigate the health care system" (Montevecchi 2012). For example, "Two Aboriginal Patient Navigators, employed by Eastern Health, provide navigation assistance in the health care system, hospital, the city, and finding accommodations, meals and social support services for Aboriginal individuals accessing health care in St. John's." Physical environment, continuity and comprehensiveness of care challenges can also be mitigated by an on-demand medical evacuation system (Medevac). Finally, a Schedevac system, in which a scheduled flight was arranged for three days a week to transport patients with appointments from remote communities to the hospital in Happy Valley-Goose Bay, was a proposed as strategy to address the physical environment factor. Montevecchi's (2012) study suggests strategies that can reduce the challenges associated with providing health care services in rural

and remote areas of Labrador; however, it does not provide estimates for the effort and resources required to sustain these services. This study aims to provide estimates on the human resources required to provide selected services in the Labrador-Grenfell Health region as the population ages. Information from the literature cited above is used to inform the researchers when formulating the forecast model and in producing general strategies for delivery.

3.0 LITERATURE REVIEW SUMMARY

The literature suggests that aging populations will have an impact on the type of health care services as well as the required resources to deliver these services. In some cases the focus of clinicians and practitioners will have to shift to delivering care from a younger to an older population. It is evident that geography, socio-economic conditions, cultural differences and jurisdictional issues add to the complexity of formulating strategies for the delivery of health care or providing the human resources for a comprehensive delivery of services. Findings from this review of selected literature suggest that:

a) For aging-in-place strategies it is important to note that 30% of Canadians are caregivers and the number of seniors is likely to double within the next 20 years (CMA 2016).

b) With reference to item [a], the availability of "community based care givers" in rural and remote areas, where population decline together with a rapidly aging population, will be problematic in terms of who will be available to look after the seniors (CMA 2016).

c) Early estimates of increasing health care costs associated with aging populations are somewhat modest, with costs due to aging expected, on average, to increase 0.9% annually. But cost per patient increases by a factor of 3.3 times when comparing the 65-69 age cohort to the 80+ cohorts. This is associated with increasing number of visits to health practitioners (CMA 2016; Layte 2009).

d) Given increasing health care costs, what is the capacity of a health care system to shift from an acute care system to primary community-based multi-disciplinary health care model to reduce costs?

e) When examining health costs due to aging, attention to the cost of new technology for diagnostics and treatment should be considered. It has been suggested that use of technology for health care across all age cohorts may be a bigger factor in increasing costs than aging itself (Layte 2009).

f) Evidence-based studies have established associations between specific age cohorts and increased use of health care services (Layte 2009; Ha et al. 2014; Trocaire College 2015); Australian Institute of Health and Welfare 2014).

g) Where increased demands on health services are related to geography (rural and remote) disparities in level of service, attraction/retention issues, differences and variations in rates of aging, and out migration will create "pockets of pressure" on an already strained system (Australian Institute of Health and Welfare 2014).

h) There is a significant difference in rural versus rural remote health care delivery models. For example, remote communities with small populations are more likely to have a high

degree of General Practitioner substitution, whereby nurse practitioners become the first point of primary care contact (Wakerman *et al*. 2017).

i) In rural and remote areas, people with multiple chronic diseases have a limited capacity for self-management. Community multidisciplinary health care teams may not be viable in smaller remote communities. For example, in Ireland the efficiencies are gained when these teams serve populations of 3,000 to 7,000 people from a fixed location [10], although we believe that teams can be used effectively with smaller populations than this. Conceptually, the potential inefficiencies can be mitigated by a combination of mobile health practitioner teams and telemedicine (Montevecchi 2012).

j) In NL the geographical determinants of health and disproportionate access to health care are significant issues related to population wellbeing, health care delivery, patient outcomes, and health practitioner retention/and recruitment (Australian Institute of Health and Welfare 2014; Wakerman *et al*. 2017; Lavis and Boyko 2010; Newfoundland and Labrador 2015; Montevecchi 2012).

k) Demands on human resources in health care need to be evaluated (NLMA 2017).

4.0 DATA AND METHODS

The objective of this study is to project future demands on "health human resources" (HHR) for the Labrador-Grenfell Health Region (Figure 1). These projections are based on a "time demand" model where surveyed health care professionals were required to estimate the percentage of time each type of clinician contributes to the care of the population within a specific age cohort. In this study, health care professionals constituted a panel of experts with experience in providing health care to rural and remote areas in Newfoundland and Labrador (NL). The panel of 15 experts included Medical Doctors, Registered Nurses, Nurse Practitioners, Licensed Practical Nurses, Physiotherapists and Social Workers. The approach is similar to that adopted by Lee and Kwak (1999) in which health professionals assessed health human resources (HHR) in each health department of a hospital and as a panel re-evaluated scores that provided both a consensus and validation of the assigned scores.

The selection of a panel of experts to provide primary information on a stated problem is the first step in the Delphi approach (Hassson *et al*. 2000; Hsu and Sandford 2007; Heiko 2012)). Healthcare professionals were recruited to participate in the Delphi panel using an email sent to all providers practicing in the Labrador Grenfell Health Region. The investigators reserved the right to limit both the size of the panel and the proportion of the panel that represented a particular provider type, but it was not necessary to do so. Targeted recruitment of certain provider types that were underrepresented was not successful.

The implementation of the survey (see Appendix I) was through an interactive PDF form where panelists individually estimated the percentage of time each health care professional contributed to the care of a population within specified age cohorts.

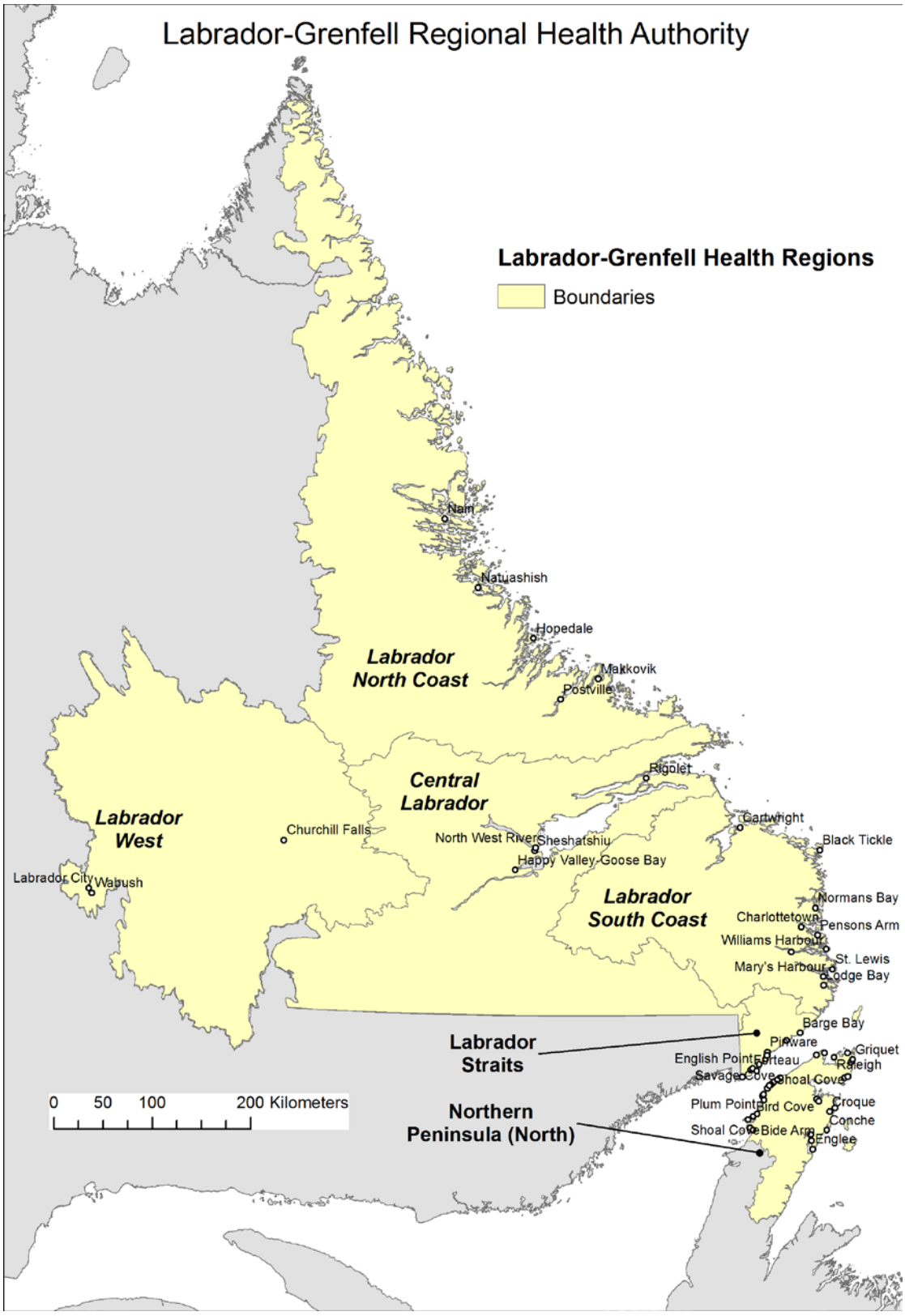

Figure 1: Labrador-Grenfell Regional Health Authority Boundaries

The first survey responses from each panelist were compared and if the time demand outcomes were not within 10% of each other, the panellists were provided feedback about how their responses compared to the group mean and they were re-surveyed on those items (see Table 1). During the review process, individual panellists were provided with the opportunity to clarify or comment on their responses. This process is repeated until there is a consensus (e.g. agreement to within 10% amongst the panellists) for all age cohorts. For this study, three rounds were required to achieve consensus. The Primary Healthcare Research Unit (PHRU), Faculty of Medicine, Memorial University managed the administration of the surveys and feedback reports.

Table 1: Survey Feedback Form

HHR Class	Specialization	Age Cohort		
		Your Answer	Group Response	New Response
Nurses	Licensed Practical Nurse			
	Registered Nurse			
	Nurse Practitioner			
Other Professional	Social Worker			
	Occupational Therapist			
	Physiotherapist			
Physicians	Family Medicine			
	Non-specialized inpatient FM or IM			
	Internal Medicine and Sub-specialties			
	Obstetrics and Gynecology			
	General Surgery			
	Specialized Geriatrics			
	Pediatrics			
	Orthopedics			
	Psychiatry			

The final surveyed average outcomes by HHR class and age cohort are presented in Table 2[6] where the "percentage time contributed to each age cohort" refers to the average amount of effort or time commitment required by each clinician to care for a patient in a specified age cohort. The assigned percent time contributed has to be interpreted by age cohort (columns) where each column sums to 100%, or the total effort to care for a patient(s). For example, for 0-2 year olds, the three highest time contributions to care for a patient are Registered Nurses (29%), Outpatient Family Medicine (21%) and Pediatrics (18%). However, the 65+-age cohort requires less time for Registered Nurses (14%), but a greater time commitment for Nurse Practitioners (12%), slightly more time for Outpatient Family Medicine (24%) and Specialized Geriatrics (5%). In the case of Registered Nurses, their time contribution to the care of 65+ patients is approximately half of that required to care for 0-2 year olds, while the effort for Nurse Practitioners to care for the 65+ age cohort is 3 times higher than that for 0-2 year olds (Table 2).

[6] Outpatient Family Medicine refers to Physicians who practice family medicine in an acute care hospital or community health centre. For Non-Specialized inpatient FM and IM, FM refers to Family Medicine and IM refers to Internal Medicine.

The time-contributed values from the survey are used to apportion patient days to the various health human resources. Note that the age cohorts used in the survey are those cohorts that best reflect the distribution of patient requirements within a clinical environment.

Table 2: Expert Health Professional Survey Outcomes: Aggregated Percent Time Contributed to Each Cohort

HHR Class	Percentage Time Contributed to Each Age Cohort					
	0-2 Years	3-6 Years	7-17 Years	18-44 Years	45-64 Years	65+ Years
Licensed Practical Nurse	4%	4%	3%	4%	5%	6%
Registered Nurse	29%	27%	22%	16%	17%	14%
Nurse Practitioner	4%	6%	6%	9%	14%	12%
Social Worker	4%	4%	11%	11%	7%	5%
Occupational Therapist	3%	4%	3%	3%	3%	5%
Physiotherapist	4%	4%	4%	4%	5%	5%
Family Medicine	21%	20%	20%	25%	23%	24%
Non-specialized inpatient FM or IM	4%	4%	3%	4%	4%	6%
Internal Medicine and Sub-specialties	2%	2%	3%	3%	3%	3%
Obstetrics and Gynecology	1%	0%	2%	7%	5%	3%
General Surgery	2%	3%	3%	4%	5%	4%
Specialized Geriatrics	0%	0%	0%	0%	1%	5%
Pediatrics	18%	17%	11%	0%	0%	0%
Orthopedics	2%	2%	3%	3%	3%	5%
Psychiatry	1%	3%	6%	6%	6%	3%

Note: The colour gradient in this and subsequent tables is scaled from dark blue for the lowest values (e.g. 0) to red for the highest values (e.g. 29). The purpose of this is to highlight both the low, intermediate and high values in the table.

Quantification of the impact of projected population changes on the 15 HHR positions listed in Table 2 requires the calculation of a "demand factor" that reflects patient "weighted demand" by HHR class and age cohort at a point in time. Generally, patient days are used to measure this type of demand whereby hospital admissions are multiplied by average length of stay. Because of constraints on data availability in this study, hospital admissions are used as an indicator of potential demand on health human resources.

Because the primary objective of this study is to examine the potential impacts of projected future populations on HHR needs, it requires that present baseline values be compared to projected future requirements. The 2016 Statistics Canada Census population and 2016 patient admission data for the Labrador-Grenfell Regional Health Authority area (Tables 3 and 4) and estimated adjusted average length of stay (Table 5) are used to calculate baseline patient hospital admission days for the region. Data on number of hospital admissions is from 2001 provincial hospital admission data for the Labrador-Grenfell Health Region, but it is adjusted to reflect the average length of stay of 6.2 days for 2016[7]. For example, the 2001 average length of stay days was 7.2 and for the 0-2 age cohort "average length of stay" was 10.2 days. After calculating the 2016 adjustment, the length of stay was reduced to 8.9 days and the overall average for length of stay is reduced to 6.2 days. The length of stay by age cohort is used to provide insight on how variation in length of stay influences patient days and the subsequent potential demand on HHR.

[7] The Labrador-Grenfell Health Region average length of stay days for 2016-2017 was obtained from the Labrador-Grenfell Regional Health Authority 2016-2017 Annual performance Report

Table 3: Labrador-Grenfell Regional Health Authority 2016 Population by Specified Age Cohorts

Geography	0 -2 Years	3 - 6 Years	7 -17 Years	18 - 44 Years	45 - 64 Years	65+ Years	Row Total
Northern Peninsula North	165	260	930	2125	3460	2345	**9285**
Labrador North Coast	160	295	560	1300	720	185	**3220**
Labrador West	375	545	1350	4070	2725	805	**9870**
Central Labrador	460	600	1490	3925	2945	1060	**10480**
Labrador South Coast	40	45	250	575	720	325	**1955**
Labrador Straits	20	35	170	360	585	410	**1580**
Total	**1220**	**1780**	**4750**	**12355**	**11155**	**5130**	**36390**

Source: Statistics Canada 2016 Census Single Age Population Table 98-400-X2016003

Table 4: 2016 Labrador-Grenfell Regional Health Authority 2016 Hospital Admission by Facility, Geography and Age Cohort

Facility	Geography	0 - 2 Years	3 - 6 Years	7 -17 Years	18 - 44 Years	45 - 64 Years	65+ Years	Row Total
Charles S. Curtis Memorial Hospital	Northern Peninsula North	100	73	125	493	1225	1066	**3082**
Labrador Health Centre	Central Labrador	289	80	134	774	802	526	**2605**
Labrador South Health Centre	Labrador Straits	0	0	8	18	34	101	**161**
Labrador West Health Centre	Labrador West	122	14	80	608	517	316	**1657**
Strait of Belle Isle Health Centre	Northern Peninsula North	0	0	0	5	25	33	**63**
White Bay Central Health Centre	Northern Peninsula North	0	0	0	0	11	62	**73**
Labrador- Grenfell Health Region Total Admissions		**511**	**167**	**347**	**1898**	**2614**	**2104**	**7641**

Source: Compiled by the Health Analytics and Evaluation Services Department, NL Centre for Health Information using data from the Provincial Discharge Abstract Database (PDAD) 2016/17

Notes:

1. Includes both acute care and surgical day care hospitalizations to residents of Newfoundland and Labrador

2. '0'indicates that primary data suppression was used where cell counts are less than five or secondary data suppression to avoid inadvertent disclosure through subtraction, in accordance with privacy guidelines

Table 5: Average Length of Stay (Days) Labrador - Grenfell Regional Health Authority

Average Length of Stay Days versus Age Cohort	0 -2 Years	3 - 6 Years	7 -17 Years	18 - 44 Years	45 - 64 Years	65+ Years	Overall Average Length of Stay
2001 Average Length of Stay	10.2	3.0	4.9	5.6	7.4	11.7	**7.2**
2016-17 Average Length of Stay	--	--	--	--	--	--	**6.2**
Adjusted Average Length of Stay	**8.9**	**2.6**	**4.3**	**4.9**	**6.5**	**10.2**	**6.2**

Present and future admission rates are based on hospital morbidity for each age cohort and are calculated by dividing the admission data by its corresponding population. The outcomes are presented in Table 6 where the three highest morbidity age cohorts are 0-2 (41.89%), 54-64 (23.43%) and 65+ (41.01%). These hospital morbidity values are used to estimate the admission rates for the projected populations.[8]

Table 6: Labrador-Grenfell Health Region 2016 Hospital Morbidity by Age Cohort

Age Cohorts	% Total Population	% of Total Admissions	% of Population Admitted to Hospital*
0-2 Years	3.35%	6.69%	41.89%
3-6 Years	4.89%	2.19%	9.38%
7-17 Years	13.05%	4.54%	7.31%
18-44 Years	33.95%	24.84%	15.36%
45-64 Years	30.65%	34.21%	23.43%
65+ Years	14.10%	27.54%	41.01%

*% of population admitted to hospital is generally referred to as “hospital morbidity”

[8] An assumption of the model is that hospital morbidity rates by age cohort do not change over the forecast period. To develop scenarios with varying morbidity rates over time would require a time series analysis to determine the annual rate of change in health outcomes or hospital admissions. The necessary data were not available for this study and would require additional time and funding for their collection and analysis.

The population forecasts are based on the single age cohort survival model[9] used to estimate the data generated in the Harris Centre's Population Project report on "Regional Population Projections for Newfoundland and Labrador, 2016-2036 (Simms and Ward 2017). The base year is the 2016 Statistics Canada Census population, and projected years used for the impact analysis are for 2021, 2026 and 2036. Specifically, two models are used to estimate future populations:

1) The **Historical (Cyclic) Survival Model (HS)** assumes that existing age specific birth and death rates will continue into the future and migration rates are set to cycle through periods of high and low growth, continuing the cyclic pattern of population changes experienced during the last 10-15 years. The migration component of population change is decomposed into intra-provincial, interprovincial, international in-migration, and total out-migration. In addition, the migration calculation utilizes a "migration propensity" for each age group/migration type combination, which ensures that migration volumes remain sensitive to shifts in population demographics over time. The cyclic models represent two different migration trend analyses in which:

    i) the *medium cycle* model represents a scenario where 2001 to 2006 (lower rate) and 2006 to 2011 (higher rate) migration trends alternate on 5 year cycles whereby 2012 to 2016 reflect the lower rate forecast and 2017 to 2021 forecast is based on the higher rate. This alternating of lower and higher trends is repeated for the forecast period.

    ii) the *high cycle* model starts with the lower rate trend for 2012 to 2016 and uses the higher rate trend for the remaining forecast period.[10]

2) The **Replacement Survival Model (RS)** where net migration levels are calculated based on forecast replacement demands due to workforce aging. First, retirements, worker deaths, and young workforce entrants over time are estimated using historical rates. Second, these values are combined to estimate the net in-migrants required to maintain the workforce population for each region, given historical trends of out-migration. The medium cycle migration trends are used in the RS model.

The RS projections are based on the integration of different worker replacement rates with a replacement success factor and are used to estimate low, medium, and high growth scenarios. For this model, values of 50% for low, 70% for medium, and 100% for high are assigned as constants for the required workforce replacement factor. Conceptually, replacement rates of less than 100% could still allow an existing economy to be sustained by increasing the

[9] The cohort survival method accounts for differences in rates of fertility, mortality and migration by using age specific rates

[10] The high cycle model is based on assumptions used by some provincial governments whereby the first five years of the forecast is based on a five-year low migration trend and the remaining 15 years are based on a high five-year trend. Note that in the model migration is decomposed into inter/intra provincial and international migration factors. In all cases out-migration trends are a single factor and cannot be decomposed by destination.

productivity of the remaining workforce and/or the hiring of currently unemployed people if their skillsets matched industry requirements.

The RS model estimates what replacement levels are required to maintain the workforce population. It says nothing about how these replacement levels might be achieved. In regions characterized by high levels of out-migration, reversing that process and encouraging in-migration may be very difficult and policies that encourage retention of working age members of the population may have more chance of success, but this too should not be expected to be an easily achievable solution.

However, given mining activities in Labrador West and Voisey's Bay, and the relatively stable regional centre-type economy of Happy Valley-Goose Bay in Central Labrador, replacement strategies for the workforce may be feasible in some areas of the region. In reality, the replacement practice is already evident in Labrador West's mining economy whereby younger workers generally replace retiring workers.

Estimates of potential impacts on health human resources (HHR) are dependent on population forecast models. Figures 2 and 3 present the single age population distribution for the base census year (2016) and the forecasted populations for the HS and RS medium models, while Figures 4 and 5 display the difference between the baseline 2016 population counts and the forecasted HS and RS model population counts. The main difference between the HS and RS models is that the HS model permits historic trends related to fertility, mortality and migration to continue without any intervention. If those trends continue, the outcomes indicate that from 2021 to 2036 younger age cohorts (e.g. 0-19 and 20-45) generally, will experience a decline and the 65+ cohort will increase over the projection period (Figures 2 and 4). The RS medium model has the same properties as the HS model, but evaluates the capacity of the population to replace retirees in the workforce. In this instance, the retirees are replaced by a combination of younger residents and migrants. This RS model replaces 70% of the retirees and the effect is that on average the 2016 population numbers are maintained in the younger age cohorts, but growth in the 65+ cohort population remains unaltered and there are significant increases (Figures 3 and 5).

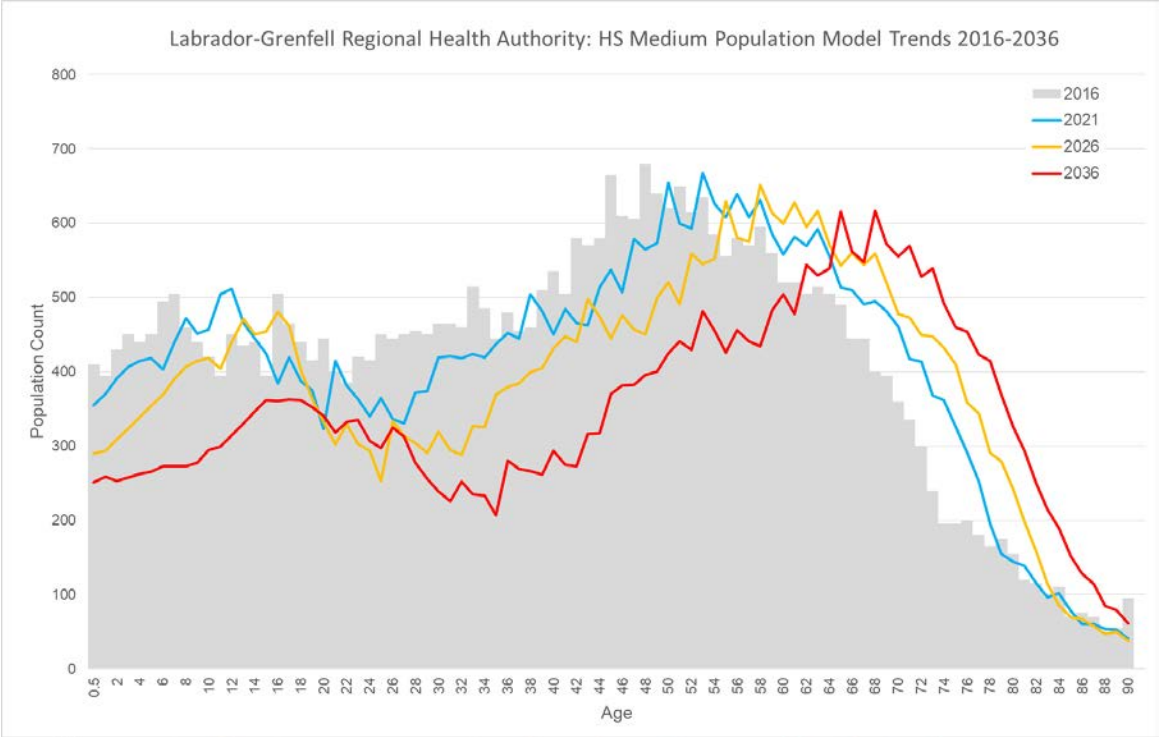

Figure 2: Labrador-Grenfell Regional Health Authority 2016 Statistics Canada Census Age Distribution versus Medium HS Projections 2021 to 2036

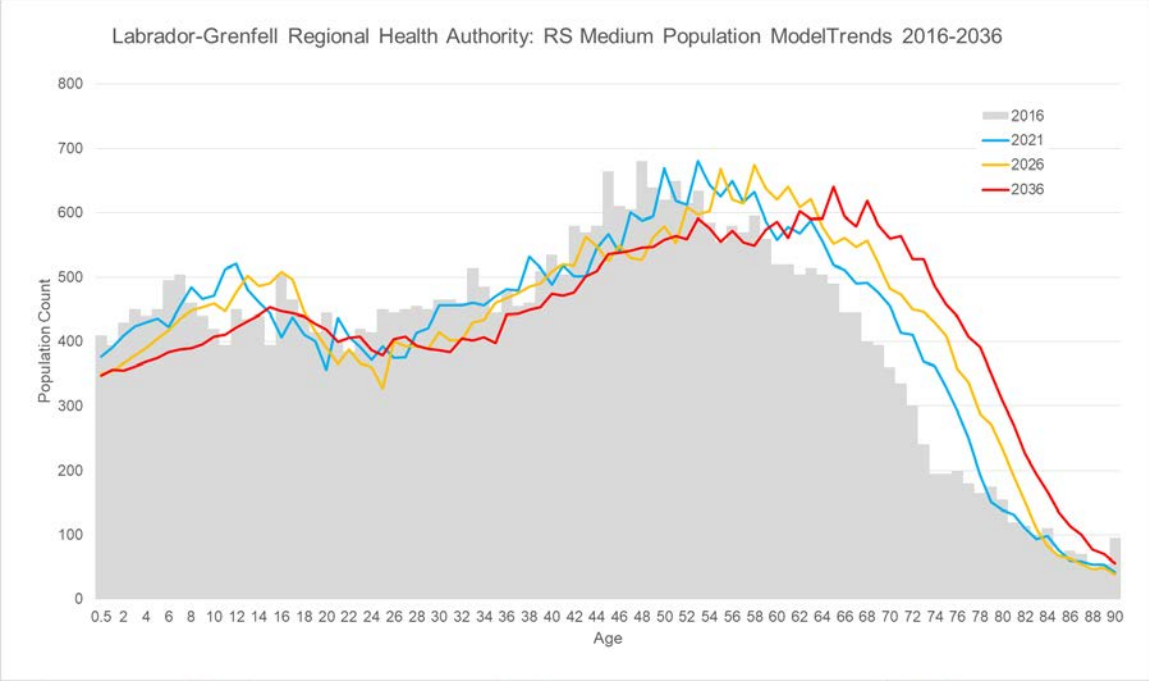

Figure 3: Labrador-Grenfell Regional Health Authority 2016 Statistics Canada Census Age Distribution versus Medium RS Projections 2021 to 2036

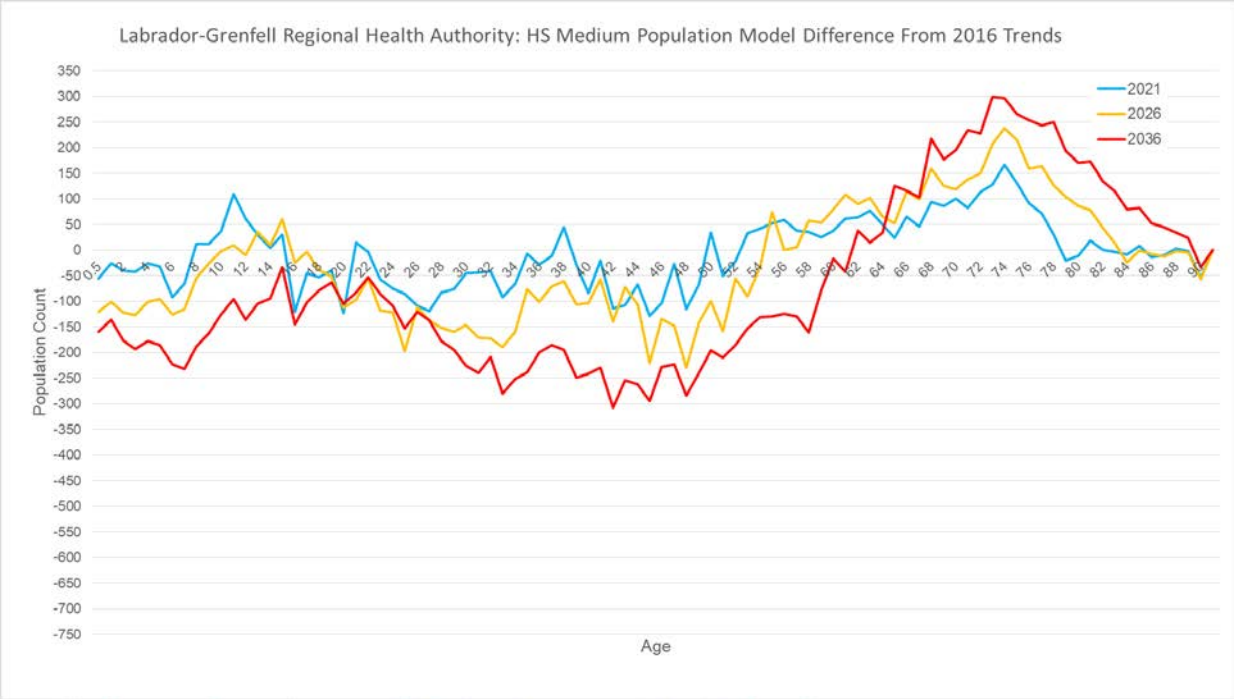

Figure 4: Labrador-Grenfell Regional Health Authority Difference Between 2016 Census Population Counts and HS Medium Population Projections 2021 to 2036

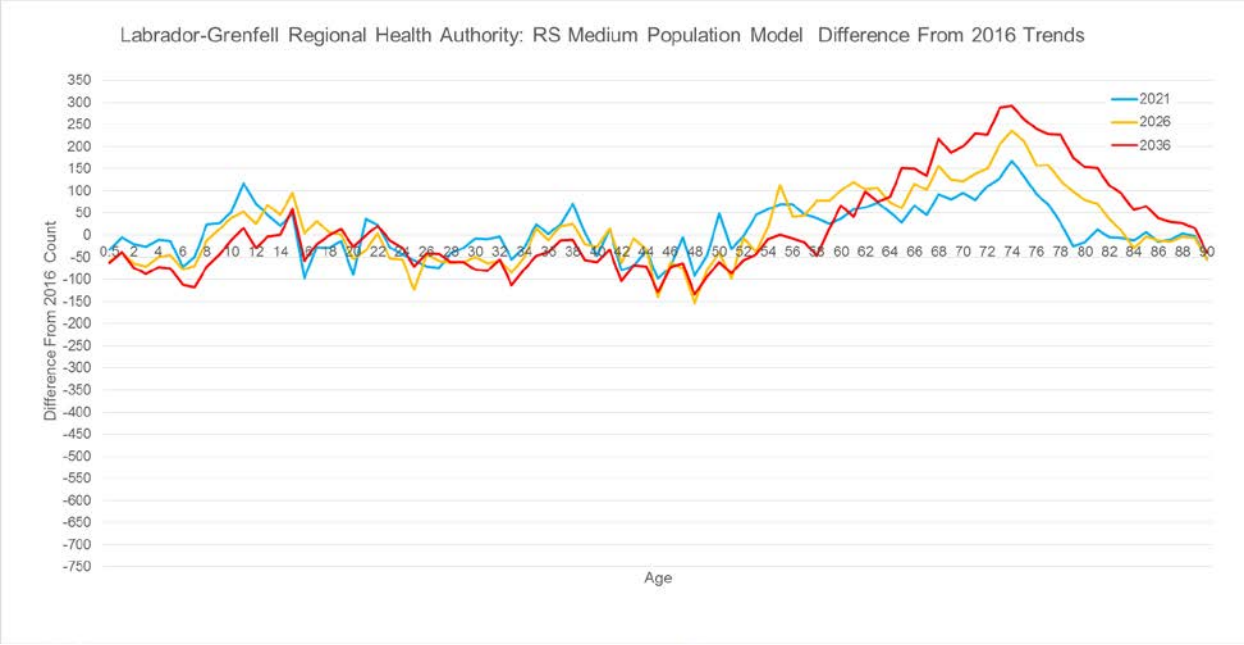

Figure 5: Labrador-Grenfell Regional Health Authority Difference Between 2016 Census Population Counts and RS Medium Population Projections 2021 to 2036

The patterns of decline and growth predicted by the different models for each age cohort are compared in Table 7. In the HS and RS models the 0-2 cohort exhibits a decline; however, for the HS model this cohort declines by 9.98% from 2016-2021 and 20.27% between 2021 and 2026. In the same periods, the RS model predicts declines of 5.46% and 9.58%, respectively. In both models age cohorts 7-17 and 45-64 are predicted to increase from 2016 to 2021. For example, the outcome from the HS model indicates a potential 1.65% increase for the 7-17 cohort while the RS model predicts a 4.75% increase (Table 7). Thus the main difference between the two models is that in general declines are higher for the HS model while the growth values are lower than those predicted by the RS model. However, both models predict growth for the 65+ age cohort and the increases are similar for each time period. For example, between 2016 and 2021 the HS model predicts an increase of 21.54% for the 65+ cohort and the RS model predicted an increase of 20.81% (Table 7). According to the Statistics Canada 2016 Census, the population of the Labrador-Grenfell Regional Health Authority was 36,390. According the HS model the population will decline by 1.03% between 2016 and 2021, with the greatest decline (11.47% between 2026 and 2036. For the same time periods, the RS model predicts a growth of 2.46% and 0.28%, respectively.

The health human resource (HHR) demand analysis uses the HS and RS medium trend models to evaluate how different future population projection scenarios impact HHR. For example, the HS model assumes historical trends of fertility, mortality and migration will continue over time while the RS model assesses the shortfalls caused by retiring workers and replaces them with younger cohorts in the population or through in-migration.

Table 7: Labrador-Grenfell Regional Health Authority 2016 to 2036 Predicted Population Percent Change by Model Type and Age Cohort

Population Model	Year Range	0 - 2 Years	3 - 6 Years	7 -17 Years	18 - 44 Years	45 - 64 Years	65+ Years	Total % Change
HS Medium Cycle	2016 - 2021	-9.98%	-8.89%	1.65%	-11.79%	1.61%	21.54%	-1.03%
HS Medium Cycle	2021 - 2026	-20.27%	-15.75%	-2.91%	-13.82%	-5.81%	17.98%	-4.62%
HS Medium Cycle	2026 - 2036	-17.09%	-31.69%	-36.16%	-23.48%	-21.46%	20.00%	-11.47%
RS Medium	2016 - 2021	-5.46%	-5.50%	4.75%	-5.11%	3.58%	20.81%	2.46%
RS Medium	2021 - 2026	-9.58%	-7.61%	1.58%	-2.95%	-0.76%	18.01%	1.40%
RS Medium	2026 - 2036	-1.58%	-7.25%	-11.13%	-2.89%	-4.99%	23.21%	0.28%

To examine the impact of an aging population on future human health resources (HHR) a "weighted patient days" variable is calculated for the Labrador-Grenfell Regional Health Authority for the 2016 population and the forecast populations for 2021, 2026 and 2036. The baseline patient days for the 2016 population of the study area and associated hospital admission data and average length of stay for each age cohort and can be expressed as follows:

$$\mathbf{BPD_{ij} = (AdjLSD_i * HA_i) * THHR_{ij}} \text{ where:}$$

BPD_{ij} = baseline (2016 estimated weighted patient days by HHR class and age cohort)

$AdjLSD_i$ = 2016 adjusted average length of stay by age cohort (Table 5)

HA_i = Hospital admissions by age cohort for 2016 (Table 4)

$THHR_{ij}$ = Matrix of surveyed percent time HHR specializations contributed to each patient age cohort (Table 2)

The values of BPD_{ij} are subtracted from the predicted patient days (PPD_{ij}) where:

$$PPD_{ij} = (HM_i * PPOP_i) * AdjLSD_i * THHR_{ij}$$

PPD_{ij} = predicted patient days by HHR class and age cohort for 2021, 2026 and 2036

HM_i = hospital morbidity for each age cohort (HA_i / 2016 population by age cohort; Tables 4, 5 & 6)

$PPOP_i$ = predicted population counts by age cohort (2021, 2026, 2036; data from Figures 2 and 3)

$THHR_{ij}$ = Matrix of surveyed percent time HHR specializations contributed to each patient age cohort (Table 2)

The impact of an aging population on future health human resources for the Labrador-Grenfell region is stated as PPD_{ij} - BPD_{ij} where the differences in estimated patient days are used as a metric for demands on human resources in the system. In addition, for overall impacts and shifts by age cohort an "average daily census" is calculated by dividing BPD_{ij} and PPD_{ij} by 365 where the outcomes are the average number of patients per day.

The HHR demand analysis is based on the following data and conditions:

1) Statistics Canada 2016 single age population tables and the 2016 hospital admission data for the Labrador-Grenfell Regional Health Authority are used to calculate age cohort hospital morbidity (e.g. hospital admissions/population). This morbidity rate is used to calculate future admissions for predicted populations.

2) Surveyed health professionals estimated "percentage of time contributed to patients" for specified age cohorts and these estimates are used to estimate the "patient load" change for each clinician category.

3) In this study age cohort 'patient days' are used to measure change in HHR demand. This metric is calculated by average (hospital) stay days by age cohort * admission totals by age cohort.

4) Patient days contribute to the magnitude of impact, however forecast populations contribute to both magnitude and direction of impact. For example, a decrease in population of one age cohort and an increase in another will decrease patient days in one while shifting a higher demand to the growing cohort.

5) For these models, hospital morbidity and average length of stay by age cohort are assumed not to change over the forecast time frame.

6) Fertility, mortality and migration rates follow historic trends

5.0 RESULTS

The Labrador-Grenfell Health Authority operates 22 facilities that includes 3 hospitals, 3 community health centres, 14 community clinics and 2 long term care facilities (Labrador-Grenfell Health Association 2017) and employs 1,501 people of which there are approximately 811 support staff, 390 nurses,105 health professionals, 60 management personnel and 45 physicians. As noted above, the data used in this study only apply to admissions associated with the 3 hospitals and 3 community health centres. As a consequence, the results provide some, but not a comprehensive insight into the projected demand on health human resources (HHR) in the region. The outcomes are for the macro level and are not meant to be used to estimate specific staffing demands,[11] rather, they provide information to demonstrate how various HHR class time contributed to patients is potentially impacted by an aging population.

The baseline "weighted patient days" by HHR class and age cohort for 2016 is presented in Table 8. These baseline values are compared to predicted "weighted patient days" associated with the HS and RS medium population model outcomes for 2021, 2016 and 2036. Registered nurses, outpatient family medicine and pediatrics have the highest demands for the 0-2 and 7-17 cohorts. However, for the 18-44 to 65+ cohorts all HHR classes have higher demands than younger cohorts except for Pediatrics (Table 8).

Table 8: 2016 Baseline Health Human Resources Demands in "Weighted Patient Days"

HHR Class	0 - 2 Years	3 - 6 Years	7 - 17 Years	18 - 44 Years	45 - 64 Years	65+ Years	Row Total	Percent of Total
Licensed Practical Nurse	193	16	47	359	823	1351	2790	5%
Registered Nurse	1312	118	331	1501	2808	3106	9176	17%
Nurse Practitioner	193	26	94	872	2288	2667	6141	11%
Social Worker	176	18	170	1015	1116	1162	3656	7%
Occupational Therapist	155	19	49	269	548	1102	2143	4%
Physiotherapist	161	15	53	396	813	1067	2506	5%
Family Medicine	952	88	294	2357	3962	5062	12715	23%
Non-specialized inpatient FM or IM	176	16	49	354	690	1328	2613	5%
Internal Medicine and Sub-specialties	80	9	41	280	548	640	1599	3%
Obstetrics and Gynecology	48	2	27	682	870	557	2185	4%
General Surgery	107	12	39	343	785	853	2141	4%
Specialized Geriatrics	0	0	0	16	161	972	1149	2%
Pediatrics	842	76	163	0	0	0	1081	2%
Orthopedics	110	10	38	259	548	1008	1974	4%
Psychiatry	51	12	89	587	946	640	2324	4%
AverageTotal Patient Days	**4555**	**438**	**1486**	**9290**	**16906**	**21515**	**54190**	**100%**
Percent of Total Age Cohort Patients Days	**8%**	**1%**	**3%**	**17%**	**31%**	**40%**	**100.00%**	
Average Census Days	**12**	**1**	**4**	**25**	**46**	**59**	**148**	

[11] Staffing demand models can be applied in this context but requires micro data on existing staffing level per patient, professional and support staff requirement, specific disease prevalence and services used as well as facility specific service characteristics etc.

Although the 0-2 age cohort has a high hospital morbidity, its smaller population and admission counts, compared to the 45+ cohorts, produces a smaller demand on HHR (Tables 3, 4, 6 and 8). The aging factor in the 2016 population is evident in the estimated 2016 patient days where only 12% of the demand is associated with the 0-2 to 7-17 cohorts, while 71% of the demand is created by the 45+ cohorts. According to the 2016 estimates the daily patient census for the 45+ cohorts is 6.2 times higher than the 0-2 to 7-17 cohorts. The skew of the 2016 population towards the older age cohorts (Table 2) and the baseline assessment of "patient demand" in the region (Table 8), where 40% of the average patient days in the Labrador-Grenfell Health region are linked to the 65+ age cohort, suggests that the region is already experiencing the impacts of aging in its health care system.

Predicted "average weighted patient days"[12] for 2021, 2026 and 2036 are based on the HS and RS population forecast models, the 2016 hospital morbidity, and adjusted average length of stay by age cohort (Tables 5 and 6). Impact on HHR is the predicted minus the baseline average patient days. Table 9 provides an example of this calculation for the HS 2021 model outcomes. It is notable that average patient days are increasing for the 45-64 and 65+ cohorts while the demand in the younger cohorts has decreased. The highest increases are for registered nurses (669), nurse practitioners (574) and outpatient family medicine (1,090) in the 65+ cohort. The net shift in average patient days by age and ranked in ascending order are 18-44 (-1095), 0-2 (-455), 3-6 (-39), 7-17 (+24), 45-64 (+272) and 65+ (+4634).

Table 9: Average Patient Days: "2021 Predicted" Minus "2016 Baseline"

HHR Class	0 - 2 Years	3 - 6 Years	7 - 17 Years	18 - 44 Years	45 - 64 Years	65+ Years
Licensed Practical Nurse	-19	-1	1	-42	13	291
Registered Nurse	-131	-10	5	-177	45	669
Nurse Practitioner	-19	-2	2	-103	37	574
Social Worker	-18	-2	3	-120	18	250
Occupational Therapist	-15	-2	1	-32	9	237
Physiotherapist	-16	-1	1	-47	13	230
Family Medicine	-95	-8	5	-278	64	1090
Non-specialized inpatient FM or IM	-18	-1	1	-42	11	286
Internal Medicine and Sub-specialties	-8	-1	1	-33	9	138
Obstetrics and Gynecology	-5	0	0	-80	14	120
General Surgery	-11	-1	1	-40	13	184
Specialized Geriatrics	0	0	0	-2	3	209
Pediatrics	-84	-7	3	0	0	0
Orthopedics	-11	-1	1	-31	9	217
Psychiatry	-5	-1	1	-69	15	138

[12] Weight in this case refers a HHR class's portion of time contributed to each age cohort where "average patient days" are multiplied by time contributed and the sum of the weighted patient days sum to the estimated total average patient days.

Despite the decreases in the younger cohorts due to a combination of low fertility and out-migration of youth, there was, because of the increase demand created by the 65+ cohort, a net increase in average patient days of 3,341, or an average of 9 additional patients per day for a total of 157[13] (Tables 8.0 and 9.0).

The information in Table 8 is generated for the HS and RS model outcomes and summarized in net percent changes, ranked highest to lowest, for each HHR class (Figure 10). Overall, the two population models agree in the direction of net change, but differ in the magnitude of change.

Table 10: Percent Net Change from 2016 Baseline versus Predicted 2021 to 2036 Estimated Average Patient Days by HHR Class and Population Model

HHR Class	HS Model			RS Model		
	2021 % Change	2026 % Change	2036 % Change	2021 % Change	2026 % Change	2036 % Change
Specialized Geriatrics	18.29%	35.78%	63.54%	18.04%	36.30%	63.55%
Orthopedics	9.32%	16.09%	26.60%	10.71%	20.72%	35.50%
Occupational Therapist	9.25%	15.93%	26.69%	10.64%	20.60%	35.55%
Non-specialized inpatient FM or IM	9.08%	15.59%	26.07%	10.52%	20.36%	35.10%
Licensed Practical Nurse	8.67%	14.54%	23.78%	10.15%	19.45%	33.29%
Nurse Practitioner	7.95%	12.83%	19.23%	9.52%	17.99%	29.82%
Physiotherapist	7.17%	11.30%	17.45%	8.93%	16.90%	28.53%
General Surgery	6.76%	10.30%	14.96%	8.57%	16.04%	26.61%
Internal Medicine and Sub-specialties	6.60%	10.11%	14.82%	8.48%	15.98%	26.59%
Family Medicine	6.12%	9.18%	13.98%	8.12%	15.32%	25.98%
Registered Nurse	4.37%	5.06%	6.97%	6.62%	11.96%	20.45%
Psychiatry	3.62%	4.29%	4.69%	6.22%	11.72%	19.28%
Social Worker	3.41%	3.36%	1.37%	5.93%	10.72%	16.56%
Obstetrics and Gynecology	2.25%	1.22%	-1.46%	5.07%	9.25%	14.63%
Pediatrics	-8.15%	-23.83%	-37.23%	-3.92%	-11.24%	-14.52%
Overall Demand Change	**6.17%**	**9.18%**	**13.90%**	**8.13%**	**15.27%**	**25.86%**

The highest HS[14] model percent net change from the 2016 baseline is associated with Specialized Geriatrics where average patient days increase by 18.29%, 35.78% and 63.54% for 2021, 2026 and 2036, respectively. These values are similar to the predicted values for the RS model (Table 10). Pediatrics is the only HHR class to decline from 2021 to 2036 with average decline in demand ranging from -8.15% to -37.23%, respectively. Family medicine[15], registered nurses and nurse practitioners had the highest percent of patient days in 2016 with 23.46%, 16.93% and 11.22% respectively (Table 8). By 2036, average patient days for outpatient family medicine is projected to increase by 13.99%, registered nurses by 6.9% and nurse practitioners by19.23%. These predicted increases would require that HHR classes that currently service

[13] On average, this means that an additional 9 patients would be admitted daily (i.e. 365/3,341) in the regions acute care or daily surgical hospitalizations.

[14] For discussion purposes only the HS model results are referenced because both the HS and RS models predict increases except the RS rates of increase are somewhat higher but the patterns remain the same.

[15] Family medicine demands may be under estimated because of low response from physicians.

younger cohorts would need to be retrained or, if retraining is not appropriate, there would need to be new hiring of appropriately skilled HHR personnel to meet the demand for the older cohorts[16].The overall average change in average patient days increases from 6.17% in 2021 to 13.9%, suggesting that as the younger age cohorts in the population decline over time, the region's health care system will still have to maintain at least the 2016 level of care, but with a transition to a system of care where the dominant age cohort is 45+ years.

The outcomes presented in Table 10 identify the relative increase in average patient days over the forecast periods by HHR class. However, it does not inform on the patient day load distribution for each HHR class. Table 11 presents the estimated 2016 and 2036 predicted average patient days by HHR class as well as the percent change from 2016-2036. For the 2036 HS model, results indicate that the top three average patient day demands are associated with outpatient family medicine (14,492), registered nurses (9,816) and nurse practitioners (7,322). The percent change from 2016-2036 for each of these categories is13.98%, 6.97% and 19.23%, respectively.

Although a percent change of 63.54% in specialized geriatrics is quite high, the relatively low involvement of geriatricians in patient care means that this percent change corresponds to a relatively modest increase from 1,149 to 1,879 patient days attributed to this provider type between 2016 and2036. However, NL has struggled to recruit and retain specialized geriatricians. As a result, other providers such as internal medicine and family physicians take on many of the tasks that are completed by geriatricians in other jurisdictions. Thus, the 2016 estimate of care delivered by geriatricians presented here is almost certainly an overestimate. Further evaluation is required to determine if the existing staffing in this specialization can accommodate the projected increase in demand, or if existing strategies to deliver specialized geriatric services will continue.

Unfortunately, the absence of information on the specifics of diseases associated with the aging population, and associated care and staffing levels requirements, prevents the calculation of future costs and staffing needs as part of this study. However, the outcomes do indicate there will be an increase demand for health human resources in the Labrador-Grenfell Health region, but that the nature and level of these resource requirements requires further analysis. Specifically, more detailed information is required on activity work standards (e.g. acceptable patient loads by specialization) and staffing requirements. This is beyond the scope of this study but guidelines for this type of analysis are presented by the Ozcan and Hornby (1999) study on determining hospital workforce requirements by examining the linkage between health service utilization and human health resources.

[16] This requires further investigation by appropriate health care professionals who are familiar with the HHR skill sets required to care for older cohort patients as well as the acceptable level of patient days for each specialization.

Table 11: Comparison of 2016 and Predicted HS Model 2036 Average Patient Days by HHR Class

HHR Class	Average Patient Days 2016	Average Patient Days 2036	% Change 2016 - 2036
Family Medicine	12715	14492	13.98%
Registered Nurse	9176	9816	6.97%
Nurse Practitioner	6141	7322	19.23%
Social Worker	3656	3827	4.69%
Licensed Practical Nurse	2790	3453	23.78%
Non-specialized inpatient FM or IM	2613	3294	26.07%
Physiotherapist	2506	2943	17.45%
Psychiatry	2324	2356	1.37%
Obstetrics and Gynecology	2185	2154	-1.46%
Occupational Therapist	2143	2715	26.69%
General Surgery	2141	2461	14.96%
Orthopedics	1974	2499	26.60%
Internal Medicine and Sub-specialties	1599	1836	14.82%
Specialized Geriatrics	1149	1879	63.54%
Pediatrics	1081	678	-37.23%

Note: The predicted 2016 – 2036 Change in Staffing values are rounded and and numbers less than 0.5 equals 0.

The dominance of the older age cohorts in predicted future populations is evident when comparing the ratio of predicted average patient day demands versus the 2016 levels (Table 12). For example, by 2021 the HS model predicts that patient day demand for 0-2 year olds will be 90% of the 2016 levels, or a reduction of 10%, while the 65+ demand is 122% larger than 2016 values. By 2021 patient day demand for cohorts 7-17 and 45-64 is 102% larger than 2016 levels, but declines through 2036 (Table 11). Both the HS and RS models predict similar and significant increases for the 65+ age cohort. For example, from 2026 to 2036 the HS model predicts that the 65+ cohort demand will increase by 143% and 179% respectively, while the RS model predicts a 143% and 176% increase for the same years.

Table 12: Ratio of Predicted Average Patient Day Demands versus 2016 Levels

Population Model	Year	0 - 2 Years	3 - 6 Years	7 -17 Years	18 - 44 Years	45 - 64 Years	65+ Years
HS Medium Cycle	2021	90%	91%	102%	88%	102%	122%
HS Medium Cycle	2026	72%	77%	99%	76%	96%	143%
HS Medium Cycle	2036	61%	58%	72%	62%	79%	179%
RS Medium Replacement	2021	95%	95%	105%	95%	104%	121%
RS Medium Replacement	2026	85%	87%	106%	92%	103%	143%
RS Medium Replacement	2036	84%	81%	95%	89%	98%	176%

The ratios presented in Table 12 and the associated average patient days by population model predicted year outcomes, can be put into an average patient daily census framework. This is a potential metric that is best described as the "expected average number of patients" to be admitted daily to the Labrador-Grenfell hospital system (Table 13). Of note is the decrease in the HS predicted daily census values for the 0-2 cohort of 13 in 2016 to 8 by 2036. The values for the 3-6 and 7-17 cohorts remain stable from 2016 to 2036. For the 18-44 cohort there is a decline of 10 census days from 2016 to 2036 while the 45-64 cohort declines by 12 (Table 13). Declines in the 0-2 to 45-64 cohorts are offset by gains in the 65+ cohort, where the HS model predicts that the patient daily census will increase from 59 in 2016 to 106 by 2036. The net effect of the increase patient demand related to an aging population is that the expected average daily census will increase from 148 in 2016 to 158 in 2021, 164 in 2026 and 167 in 2036. Further interpretation of these outcomes requires more detailed staffing and service data, as well as facility capacity factors (bed availability) to estimate the impact in terms of cost, staffing and services requirements for hospitals dealing with a predominantly aged population. If these data were available a more detailed impact analysis could be performed.

Table 13: Patient Average Daily Census by Population Model, Year and Age Cohort

Population Model	Year	0 - 2 Years	3 - 6 Years	7 -17 Years	18 - 44 Years	45 - 64 Years	65+ Years	Total
HS Medium Cycle	2016	13	1	4	25	46	59	**148**
HS Medium Cycle	2021	12	1	4	22	47	72	**158**
HS Medium Cycle	2026	11	1	4	19	44	85	**164**
HS Medium Cycle	2036	8	1	3	15	34	106	**167**
RS Medium Replacement	2016	13	1	4	25	46	59	**148**
RS Medium Replacement	2021	12	1	4	24	48	71	**160**
RS Medium Replacement	2026	11	1	4	23	47	84	**170**
RS Medium Replacement	2036	11	1	4	22	45	104	**187**

5.1 Summary

The objective of this study was to predict health human resources (HHR) needs for the aging population in the Labrador-Grenfell Health region. A 2015 report [23] by the Newfoundland and Labrador Provincial Government indicated that the province was the oldest in Canada, and by 2036 31% of the population would be 65 years or over (Newfoundland and Labrador 2015). For the Labrador-Grenfell Health region, the HS population model used in this study estimates that the percent of the region's population 65 and over will increase from 14% in 2016 to 18% in 2021, 22% in 2026 and 30% by 2036. This represents more than a doubling of the 65 and over population from 2016 to 2036. This increase is similar to that projected for the province as a whole. The report [23] also highlights that fact that 88% of the seniors in the province have at least 1 chronic disease. If this trend is similar in the Labrador-Grenfell region then it will undoubtedly put pressure on the existing health care services in the region. The 2016 hospital admission data for the region indicated that the 65+ age cohort accounts for 14.1% of the population and 27.54% of the admissions (Table 6). With a high hospitalization rate, the doubling of the 65+ cohort population will offset any declines in HHR demand forecast for the younger cohorts (Tables 7, 12 and 13).

The outcomes from the analysis are summarized as follows:

1) Anticipated population shifts for the period from 2016-2036 will result in growth of the 65+ cohort and ultimately stability or decline in the others, regardless of the projection model used. This will result in an overall increase in healthcare demands due to the higher morbidity rates in this cohort.

2) The increased forecast in overall patient demand for the study area is ongoing and will increase relatively steadily for each time period, to an overall increase of between 13.9% and 25.9% by 2036.

3) The increase in patient demand days due to aging will affect some HHR categories more acutely than others. HHR categories that serve seniors, such as geriatrics or orthopedics will experience increased demand, while those that serve younger people, such as pediatrics, will decline. However, outpatient family medicine, registered nurses and nurse practitioners will have the highest increased demand factors associated with aging (Tables 10 and 11).

4) The increase in patient demand days due to the rise in the number of seniors will occur whether population replacement goals are met or not.

5) Given the absence of information on patient loads by specialization calculation of staffing requirements was not possible.

The analysis in this report is based on the admission data from three hospitals and three community centres in the Labrador-Grenfell Health Region. Although data were requested for all facilities within the Health Authority data for 14 community clinics and the two long term care facilities in the region are missing from this analysis. Therefore, the results of the demand

analysis have to be interpreted within the context of hospitals and community health centres only. Admissions to the two long-term care facilities would be expected to be almost entirely attributable to the 65+ cohort, which suggests that increased HHR demand for the region as a whole is likely under-estimated.That said, we feel that the analyses here are more than adequate for their intended purpose. If detailed data on disease type, treatments, services utilized, required staffing etc. were available, a more comprehensive analysis could be completed where the interaction of patients, clinicians and support staff within the region's health care system of hospitals, community health centres and long term care facilities are evaluated in terms of specific demands for human health care resources. This type of linkage analysis (see Uzsoy 2005) would provide a more detailed impact of aging populations and its associated costs in terms of infrastructure and staffing.

6.0 RECOMMENDATIONS

The rationale for this particular study was to provide guidelines for a planning approach to changing HHR needs and the analyses indicate that there will be additional pressures on HHR staffing in the Labrador-Grenfell Health Region over the next 20 years. Although the population is expected to decline in some parts of the region, the growth in older age cohorts will offset the reduction in HHR demands associated with younger cohorts.

The integration of the surveyed "time contributed to patient care" and the 2016 admission and population data provide a good measure of the existing demand on the HHR clinician categories analyzed in this study, while the projected outcomes provide an indication of the potential demands on HHR. However, the absence of information on the specifics of diseases associated with the aging population, and associated care and staffing levels requirements prevent a more thorough estimation of future costs and staffing needs.

Specifically, more detailed information is required on activity work standards (e.g. acceptable patient loads by specialization) and staffing requirements. This is beyond the scope of this study but guidelines for this type of analysis are presented by the Ozcan and Hornby (1999) study on determining hospital workforce requirements by examining the linkage between health service utilization and human health resources. This analysis requires databases that can link patient, disease, treatments, staffing, patient age and level of service within a health care facility as well as linkages between facilities. Combined with health care cost factors this type of linkage analysis (see Usoy 2005) would provide a more detailed impact of aging populations and its associated costs in terms of infrastructure and staffing. Furthermore, this type of analysis can also evaluate simultaneously, the interactions between all health care facilities with the region and assess the impacts, while addressing capacity issues, of adding or removing services from one facility and transferring a "patient load" to another facility.

Recommendations:

- Policy makers will need to plan for the additional HHR needs in LGH by ensuring adequate enrollment in health professional training programs and by implementing effective recruitment and retention strategies.
- The current study estimates the needs for health care professionals only, but elder care is often shared by non-professional caregivers and family members. Strategies to maintain working age populations who are able to provide this care in LGH should be implemented.
- A forecasting model should be adopted by the Department of Health to help determine and plan for the impacts of an aging population on health infrastructure, human resources and their associated costs.
- Databases that can link patient, disease, treatments, staffing, patient age and level of service within and between health care facilities need to be developed as inputs to the forecasting model.

7.0 REFERENCES

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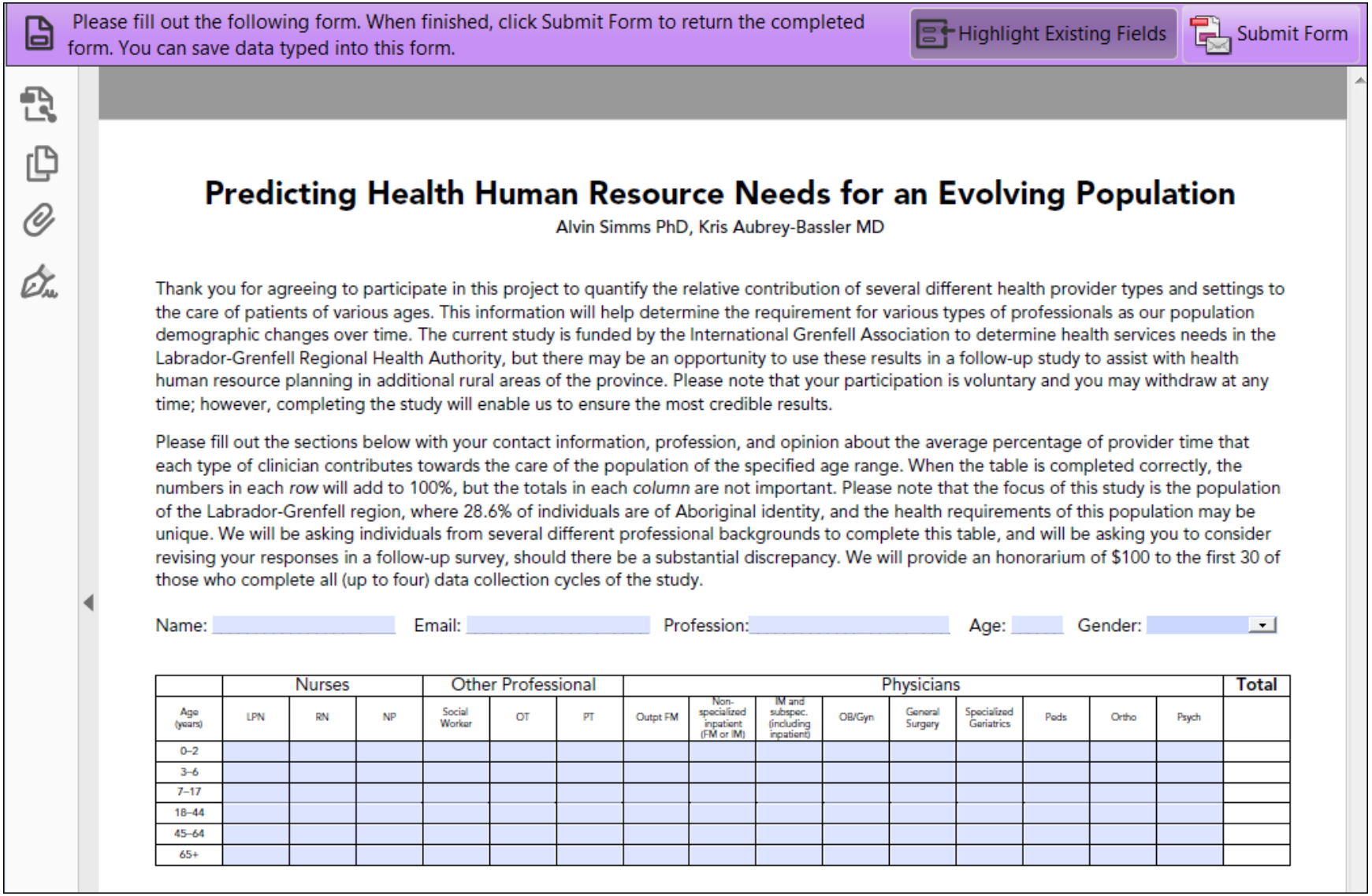
APPENDIX 1: INTERACTIVE SURVEY FORM



Please fill out the following form. When finished, click Submit Form to return the completed form. You can save data typed into this form.

Highlight Existing Fields | Submit Form

Predicting Health Human Resource Needs for an Evolving Population

Alvin Simms PhD, Kris Aubrey-Bassler MD

Thank you for agreeing to participate in this project to quantify the relative contribution of several different health provider types and settings to the care of patients of various ages. This information will help determine the requirement for various types of professionals as our population demographic changes over time. The current study is funded by the International Grenfell Association to determine health services needs in the Labrador-Grenfell Regional Health Authority, but there may be an opportunity to use these results in a follow-up study to assist with health human resource planning in additional rural areas of the province. Please note that your participation is voluntary and you may withdraw at any time; however, completing the study will enable us to ensure the most credible results.

Please fill out the sections below with your contact information, profession, and opinion about the average percentage of provider time that each type of clinician contributes towards the care of the population of the specified age range. When the table is completed correctly, the numbers in each *row* will add to 100%, but the totals in each *column* are not important. Please note that the focus of this study is the population of the Labrador-Grenfell region, where 28.6% of individuals are of Aboriginal identity, and the health requirements of this population may be unique. We will be asking individuals from several different professional backgrounds to complete this table, and will be asking you to consider revising your responses in a follow-up survey, should there be a substantial discrepancy. We will provide an honorarium of $100 to the first 30 of those who complete all (up to four) data collection cycles of the study.

Name: Email: Profession: Age: Gender:

	Nurses			Other Professional			Physicians									Total
Age (years)	LPN	RN	NP	Social Worker	OT	PT	Outpt FM	Non-specialized inpatient (FM or IM)	IM and subspec. (including inpatient)	OB/Gyn	General Surgery	Specialized Geriatrics	Peds	Ortho	Psych	
0–2																
3–6																
7–17																
18–44																
45–64																
65+																