

THE VALUE PROPOSITION OF PREVENTION: THE IMPACTS OF PURE NORTH S'ENERGY FOUNDATION'S PREVENTIVE CARE PROGRAM ON ACUTE CARE UTILIZATION IN ALBERTA[†]

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SUMMARY

This analysis of Pure North S'Energy Foundation's preventive health services shows that the acute health care cost savings of being pro-active, rather than reactive, and averting chronic disease, are significant, immediate and worth pursuing further.

Chronic disease, such as cardiovascular maladies, diabetes, cancer and other long-term illnesses, represents the leading cause of disability and death in Canada. An estimated 25 per cent of expenditures in the public health system go towards treating these frequently avoidable diseases. This health-care cost curve, which sees more money expended on fighting the increase of chronic disease, can be bent, so to speak, through prevention services that offer long-term benefits to people's health. Preventing disease is not just good for individuals, but for the health system in general, as prevention frees up acute care beds for more timely access by those who need them. The concern for health care decision makers struggling to find dollars to meet current health care needs is that investment in prevention is risky compared spending on medical treatment. It is often expressed that the health cost savings of prevention are too far off in the future and there is a lack of convincing evidence that preventive services and interventions will achieve the health gains expected.

Pure North offers participants in its eight-year-old program access to a variety of health-care practitioners, including doctors, naturopaths, nurses, nurse practitioners and dentists.

[†] The study of the Pure North program received approval from the University of Calgary's Conjoint Health Research Ethics Board (Ethics ID: 24890). Data linkage was performed by the Data Integration, Measurement and Reporting unit at Alberta Health Services, according to a research agreement designed to keep all health information confidential. The data used in this study are all unidentified and confidential. I thank Dan Dutton, Wei Zhao and Mubasiru Lamidi for research support and statistical analysis and Ken Fyie of the Pure North S'Energy Foundation for his work and support of integrating Pure North data into our research data set.

Participants receive lifestyle counselling and dietary supplements aimed at combating vitamin D insufficiency, obesity, insulin resistance and other problems that can lead to chronic disease.

Our study found that participants who stay with the program for two years demonstrate significant reductions in their number of visits to emergency rooms and hospitals. Indeed, after just one year in the program, the number of hospital visits was down 27 per cent and the number of visits for ambulatory care reduced by 14 per cent over a control group matched for age, sex and postal code, who did not participate in the Pure North program. In the second year after joining the program, hospital admissions dropped by 32 per cent for participants aged 55 and over. If these effects could be achieved in the population of Albertans aged 55 to 75, the hospital bed nights freed up per year would be equivalent to adding the acute care bed capacity of the Foothills Medical Centre in Calgary.

These figures translate into significant cost differences. The average cost of hospitals, ambulatory care and visits to general practitioners in the year prior to joining Pure North's program came to \$1,320 per individual. Cost reductions in annual health-care utilization among participants ranged from \$294 (22 per cent) per person who joined the program to \$600 (45 per cent) per person who stayed in the program for at least a year. Two years into the program, a participant could expect to avoid \$276 in hospitalization and emergency room costs.

The Pure North program is a cost-effective model for preventive health services, resulting in better health and labour productivity for individuals, and considerable savings in public money for the health-care system. Every dollar spent on a participant who stays with the program for at least a year represents a \$2.36 benefit in the avoidance of hospitalization and ambulatory care, as well as gains in personal health and productivity.

The public health-care system must shift its focus to preventive care if it wants to realize cost savings, efficiency and improved health for Albertans, rather than waiting to treat people until after they become ill with chronic diseases. Pure North offers an important model to help the public system understand how to make that transition to a prevention-oriented mindset.

INTRODUCTION

For over 30 years, Canadian government commissions and health policy researchers have identified the potential to “bend the cost curve” facing Canada’s iconic single-payer health-care system (Medicare) through upstream investment in health promotion and chronic disease prevention.¹ To date, the level of public investment in prevention represents a small portion of the total public expenditure on health care and initiatives implemented largely fall within the traditional domains of public health (vaccinations, screening for diseases, environmental regulation and information campaigns).² Policy makers are faced with determining which health prevention programs and interventions should be supported to improve the population’s health beyond traditional actions in the domain of public health, and what programs are actually feasible for public support and/or delivery. With neither clear evidence of the likely effectiveness of such programs and interventions, nor information regarding the returns to the public payer, decision makers may be hesitant to commit scarce resources to prevention rather than treatment.

Since 2012, we have studied the not-for-profit Pure North S’Energy Foundation’s (henceforth “Pure North” or PN) preventive and integrative health program. We see this as an opportunity to investigate the impact of preventive care services on health-care utilization offered on a large scale and on the same patient cost terms as hospitals’ and doctors’ services. Since 2007, Pure North and its founder, Allan Markin, have spent \$230 million to provide over 44,000 participants in Western Canada with personalized preventive health-care services through access to lifestyle counselling, health assessment, nutritional supplementation and dental services from a team of physicians, nurse practitioners, nurse naturopaths and dentists. Until January 2013, all participants bore no out-of-pocket costs for the program.

In this paper, we present the results of our analysis which advances the analysis published in Daniel J. Dutton, J. C. Herbert Emery, Thomas Mullie and Jennifer D. Zwicker, “Bending the Medicare Cost Curve in 12 Months or Less: How Preventive Health Care Can Yield Significant Near-Term Savings for Acute Care in Alberta,” *The School of Public Policy SPP Research Papers*, 8(2) January 2015. The 2015 published paper presented an analysis of a sample of Pure North S’Energy Foundation participants who had given consent for their Alberta personal health numbers to be linked to Alberta Health and Alberta Health Services databases allowing for an investigation of the impact of the PN preventive care program on hospital admissions, ambulatory care including emergency department visits, and use of general practitioners’ services. That analysis used data from fiscal year 2003/2004 to fiscal year 2013/2014. Each PN participant had one randomly selected control matched on age and sex. The Dutton et al. analysis showed significant and sizeable reductions in hospital admissions and use of ambulatory care by participants in the first year after joining, after accounting for the trends in health-care utilization of PN

¹ The need to prioritize efforts to improve the health of the Canadian population to promote the fiscal sustainability of Medicare dates back to at least the Lalonde report, published in 1974 by the Government of Canada, “A New Perspective on the Health of Canadians: A Working Document.” See footnote 1 of Dutton, Emery, Mullie and Zwicker (2015) for other calls for investment in health promotion and chronic disease prevention. <http://www.policyschool.ucalgary.ca/sites/default/files/research/preventive-health-care-emery-dutton-mullie-zwicker.pdf>

² Only 5.3 per cent of total health expenditure expected to be spent on public health in 2011 and 2012. Canadian Institute for Health Information, *National Health Expenditure Trends, 1975 to 2012* (Ottawa: CIHI, 2012).

participants and their matched controls in the five years prior to joining the PN program. The authors interpreted their results as showing that future returns to better health from chronic disease prevention are effectively funded out of the short-term medical treatment costs avoided by preventive care services.

We have had an opportunity to advance the Dutton et al. analysis of the PN program by adding fiscal year 2014/2015 to the Dutton et al. data set allowing us to see whether program effects persist beyond one year. We have drawn the control sample so that we have controls matched on age, sex and the first three digits of a program participant's postal code. The matching on postal code will control for some of the unobserved socio-economic influences on health-care utilization (including access to services) that the Dutton et al. control sample did not. Also, we drew five controls for each PN participant.

Our analysis confirms the previous findings in the 2015 Dutton et al. study that for program participants in the first year, there are statistically significant reductions of 27 per cent in the number of hospital visits and of 14 per cent in the number of ambulatory care visits, relative to what we observe in the age- and sex-matched controls. For the participants whom we can confirm persisted in the program at least one year, the effect sizes for the first year after joining are larger than what Dutton et al. report. There are 54 per cent fewer visits to hospital in the year after joining and 34 per cent fewer visits to emergency departments. Extending our study to the second year after joining the PN program, we find sustained, significant 32 per cent reductions in hospital admissions for participants aged 55 and over who persisted in the program. Reductions in emergency department visits in the second year in the program were 28 per cent for participants whom we could confirm persisted in the program. Overall, we find that for participants who persist in the program there are sustained reductions in health-care use to two years.

In terms of health-care costs attributable to the population represented by this sample, these reductions in annual health-care utilization attributable to the program are worth from \$294 per person who joined the program to \$600 per person who was known to have persisted in the program for at least one year. These represent reductions in annual health spending of 22 per cent and 45 per cent of the \$1,320 average cost of hospitals, ambulatory care and general practitioners use for the sample relative to the year prior to joining the program. For participants who persist to a second year in the program, hospitalization and emergency department costs avoided are \$276. For persisting participants, reductions in spending in the second year after joining PN are 21 per cent of the spending in the year prior to joining PN.

While these health costs avoided do not fully offset the program cost of \$930 per participant in fiscal year 2014/2015, we find that the health gains to persisting participants are large enough that the PN program is cost effective. For every dollar expended on a persisting participant, there is \$2.36 through health-utilization costs avoided, the value of health gains and the indirect benefits of higher labour productivity from better health.³ These are only the immediate benefits of the program for the Alberta taxpayer as we also expect the program is reducing the risk of developing chronic diseases. The impact of prevention of

³ See Public Health Agency of Canada, "Investing in prevention the economic perspective: Key Findings from a Survey of the Recent Evidence," May 2009, 2.

future chronic disease burdens could be large, as it is estimated that 25 per cent of acute health-care spending in Canada is attributable to avoidable chronic conditions.⁴

THE PURE NORTH PROGRAM

Pure North's stated goal is to identify health needs, share that information with participants and support them in achieving lifestyle changes that will help them "feel better and live longer." The organization operates out of Calgary, Alberta, but has established clinics across Alberta, British Columbia and Saskatchewan.⁵

Pure North's origins are as a workplace-based program for Canadian Natural Resource Limited (CNRL) oil field workers in Alberta. Until May 2012, program participants were primarily associated with CNRL, but after that, the program expanded to provide access to its preventive health-care services to a broader population including seniors, aboriginals, those who are homeless, suffering from addiction, living in isolated areas, and/or with low income. These groups have had more limited access to health promotion and prevention services as the out-of-pocket costs for these services are a substantial barrier to access.⁶ Prior to January 2013, Pure North provided preventive health services to participants in the program at little to no direct cost to the participant. In 2013, the Pure North program asked participants with incomes over \$24,000 per year to pay \$1,200 for the first year in the program and \$700 per year for the following years. At the beginning of 2014, Pure North received a grant from the Alberta government to fund the delivery of the program to over 7,000 seniors for 18 months with no costs of participating required. To maintain its sustainability, Pure North has moved to a subsidized program model. Since 2015, non-vulnerable participants pay for the program at cost, which is \$900 per year.⁷

⁴ See Ibid., and Greg Finlayson, Oke Ekuma, Marina Yogendran, Elaine Burland, and Evelyn Forget, "The Additional Cost of Chronic Disease in Manitoba," Manitoba Centre for Health Policy, April 2010.

⁵ These locations include the Thorpe Recovery Centre for recovering addicts in Lloydminster, several homeless shelters in Calgary such as the Mustard Seed Street Ministry and the Drop-In Centre, the Alberta Adolescent Recovery Centre in Calgary, a satellite clinic in Fort St. John, vulnerable seniors clinics in Calgary, as well as a central clinic in Calgary that is accessible to the public. Pure North also flies teams of clinicians to sites not served by its traditional-style clinics to operate mobile clinics at sites including St. Albert, Medicine Hat, and in rural areas such as Taber, Wabasca, Spirit River, and Slave Lake. Pure North also works with over 40 dental clinics and operates two of its own dental centres, one in Calgary known as the Pure North Outreach Health and Dental Care Clinic at the Mustard Seed and one in Lloydminster at the Thorpe Recovery Centre.

⁶ Canadian Institute for Health Information, "Exploring the 70/30 Split: How Canada's Health-Care System is Financed," (Ottawa: CIHI, 2005). Nadeem Esmail, "Complementary and Alternative Medicine in Canada: Trends in Use and Public Attitudes, 1997-2006," *Public Policy Sources*, no. 87 (Vancouver: Fraser Institute, 2007). <http://www.fraserinstitute.org/uploadedFiles/fraser-ca/Content/research-news/research/publications/complementary-alternative-medicine-in-canada-2007.pdf> Susan J. Whiting, Hassanali Vatanparast, Jeff G. Taylor, and Jennifer L. Adolphe, "Barriers to Healthful Eating and Supplement Use in Lower-Income Adults," *Canadian Journal of Dietetic Practice and Research* 71(2), 2010, 70-76. In Calgary in 2012, the cost of private medicine for services through wellness clinics most comparable to the program charge clients \$3,200 to \$6,200 per year. It appears that the cost of dietary supplements is in addition to those amounts. See "Options: Your Guide to Private Medicine, Spring 2013," a special advertising supplement to the *Calgary Herald*, Feb. 23, 2013.

⁷ As per the Pure North S'Energy Foundation website, the Gold Program option for \$75 per month provides for two visits to the clinic per year, blood panel and toxic metal testing and one-year supply of Vitality Pack supplements. A Platinum Program option is available for \$175 per month which includes dental health services and pain management therapy. The Gold option aligns with what we considered the core of the program in our previous study. http://www.purenorth.ca/?page_id=1373

Pure North aims to prevent and address the most common health conditions and chronic diseases seen in the Canadian population including cardiovascular disease, diabetes, mental illness and cancers.⁸ All of these conditions have been shown to lead to premature death and are associated with alterable risk factors such as poor nutrition, inactivity, tobacco use and excessive alcohol consumption. The program focuses on primary prevention through a combination of screening/testing, lifestyle modification, nutrition education, identification of nutritional deficiencies and dietary supplementation. As in other health promotion programs, the Pure North program assesses health needs and monitors health changes through the use of questionnaires, laboratory tests and biometric measurements.⁹

Pure North's program provides participants with access to multidisciplinary teams of physicians, naturopathic doctors, nurses, nurse practitioners and dentists for diet and lifestyle counselling and education, treatment of acute conditions, navigation of Medicare services and other required services (e.g., addiction treatment). The organization provides participants with dietary supplements for health promotion, some of which are tailored to the individual's assessed needs. As with most preventive care, a participant undergoes a baseline health assessment based upon responses to a lifestyle questionnaire, physiological measurements, blood analysis and interviews with clinicians. Counselling for lifestyle recommendations is based on an individual's characteristics and personal circumstances identified through the baseline assessment. Recommendations include behaviour change, encouragements for weight loss, smoking cessation, nutrition interventions and physical activity. Lifestyle strategies are individualized based on a person's willingness to change and his/her commitment to the potential program.

The dietary supplements used in the program are selected by Pure North's clinical team to address common problems such as vitamin D insufficiency, insulin resistance, obesity and hypercholesterolemia. Dietary supplements available to participants include multivitamins, fish oil, vitamin D₃, probiotics, magnesium, vitamin B12, vitamin C, alpha lipoic acid and N-Acetyl cysteine. With the exception of vitamin D₃, all dietary supplements provided are within Health Canada's tolerable upper level of intake (UL) (See Appendix 1 of Dutton et al. 2015). According to Pure North's "Goals of the Foundation" special emphasis is given to the importance of vitamin D₃ supplementation to address vitamin D insufficiency in the Canadian population.¹⁰ Pure North recommends an intake of vitamin D₃ that is higher than Health Canada's upper tolerable limit for vitamin D₃ of 4,000 IUs per day, which requires

⁸ Pure North S'Energy Foundation, Goals of the Foundation http://www.purenorth.ca/?page_id=122; About Pure North http://www.purenorth.ca/?page_id=104

⁹ Health promotion and disease management programs vary greatly in scope and scale. Prevention programs typically concentrate on smoking cessation, physical fitness, nutrition, cholesterol levels, blood pressure, weight and stress management. "National Worksite Health Promotion Survey," Association for Worksite Health Promotion, U.S. Department of Health and Human Services, 1999 (Northbrook, IL: Association for Worksite Health Promotion and William M. Mercer, Inc., 2000). These programs often offer health and safety workshops, health assessment surveys, screening programs and incentives for participation. R. L. Bertera, "The Effects of Workplace Health Promotion on Absenteeism and Employment Costs in a Large Industrial Population," *American Journal of Public Health*, 80(9): 1990, 1,101-1,105. S. G. Aldana, R. M. Merrill, K. Price, A. Hardy, and R. Hager, "Financial Impact of a Comprehensive Multisite Workplace Health Promotion Program," *Preventive Medicine*, 40: 2005,131-137. E.g., A. I. Talvi, J. O. Jarvisalo, and L. R. Knuts, "A Health Promotion Programme for Oil Refinery Employees: Changes of Health Promotion Needs Observed at Three Years," *Occupational Medicine*, 49(2): 1999, 93-101.

¹⁰ Pure North S'Energy Foundation, Goals of the Foundation http://www.purenorth.ca/?page_id=122; About Pure North http://www.purenorth.ca/?page_id=104

that the organization must have medical oversight of the participants.¹¹ Blood tests are repeated yearly to monitor changes in participants' health and select measurements may be repeated more frequently if deemed necessary by clinical staff. Follow-up and program adherence are completely voluntary.

Defining a cost of the program for a given participant is not straightforward, given the variability over time in what the program has provided participants, how the care model has been organized, where the program is provided (e.g., mobile clinics travelling to remote communities), capital purchases (e.g., dental clinic), education and outreach, and efforts toward program evaluation and research.¹² The total operating costs have been higher in the past due to the extent of laboratory tests and supplements provided that reflected research interests like the evaluation of the program and the safety and effectiveness of vitamin D₃ for improving health.

Pure North reported to the authors that the per-participant cost of the parts of the program offered to all participants on an ongoing basis (dietary supplements, laboratory testing and health consultation) was \$2,300 in 2012/2013, two-thirds of which was accounted for by the cost of the dietary supplements. Over time, they have reduced these costs per participant to \$1,535 in 2013/2014 and projected an average cost of \$900 in 2015. This trend in per-participant costs of the program is attributed to changes in the content and delivery of the program reflecting the experience gained through eight years of operating, combined with the results of internal program evaluation and external research on the program. Changes in the quantity and mixture of dietary supplements have decreased costs as the program focuses on effectiveness and consistency in compliance. Health consultation costs have decreased as the program moved to fewer consultations per year, and shorter duration consultations within the scope of practice of registered nurses, nurse practitioners and naturopathic doctors rather than physicians. The costs associated with laboratory services have been significantly reduced due to completed research-related program inquiries for safety and efficacy. Pure North projects that the core of the program -- health consultations, laboratory services and dietary supplements -- can be delivered for \$500 per participant per year.

ALBERTA HEALTH SERVICES AND ALBERTA HEALTH UTILIZATION DATA

Beginning in 2012, upon entry to the program, participants were asked for their personal health number (PHN) and permission for their information to be used for research purposes. For participants who joined prior to 2012, Pure North collected PHNs and

¹¹ Pure North monitors 25(OH)D and calcium each six to 12 months to ensure that participants do not have increased calcium levels and other symptoms of toxicity. Pure North has protocols in place so that when high serum calcium results are obtained, a repeat serum calcium sample, PTH and urine calcium are collected. Analysis of program data showed that with supplementation levels of up to 20,000 IU per day, there were no substantial or statistically significant increases in serum calcium or in the risk for hypercalcemia. See J. P. Ekwaru, J. D. Zwicker, M. Holick, E. Giovannucci, and P. J. Veugelers, "The Importance of Body Weight for the Dose Response Relationship of Oral Vitamin D Supplementation and Serum 25-Hydroxyvitamin D in Healthy Volunteers," *PLoS ONE* 11; 9(11):e111265, 2014. DOI:10.1371/journal.pone.0111265.

¹² For example, select dental services have been a sizeable expense for Pure North, but they have been provided to only one-quarter of participants and for around half of those participants, the services have been for the removal of amalgam fillings. The Pure North program covers dental amalgam removal and replacement, with an average cost of \$1,600 per participant who opts in to amalgam removal. Regular dental maintenance is not part of the program.

permission at follow-up visits to a Pure North clinic or contacted the participants by phone and/or email to request PHNs and permission to use their PHNs and linked information for research purposes. For Alberta-based participants granting permission to use their PHNs, the organization provided those PHNs to Alberta Health Services (AHS) to link with provincially funded health-care utilization data from three different databases at the individual level. AHS successfully linked 11,985 program participants who joined the program prior to March 31, 2014.¹³

For these linked individuals, information from three databases, jointly referred to as the provincial registries, was available from the fiscal year starting April 1, 2003 until the fiscal year ending March 31, 2015. The first database is an inpatient one regarding hospital stays and hospital morbidity, called the *Discharge Abstract Database*. The second database, the *Ambulatory Care Database* (emergency departments and day surgery), provides us with information on visits to the emergency department. The third database, the *Practitioner Payments Database* provides information on fee-for-service payments made to Alberta physicians according to a pre-approved schedule of payments and billing codes, which we accessed for general practitioner billing.¹⁴

Along with PHNs, Pure North provided a participant's age, sex, postal code for their residence and program entry dates to AHS. Using this information, five random members of the Alberta population were drawn for each participant in the program to serve as a matched control.¹⁵ Each control was drawn from the pool of individuals with the same age and sex as the participant from the same three-digit postal code of the participant, from the registry for the fiscal year corresponding to the year the participant joined the program. For example, a 50-year-old man who joined the program in January 2010 would be matched with five men in the same three-digit postal code who were 50 years old in the 2009-2010 fiscal year. Individuals migrating to Alberta within the study period would be ineligible for matching, so our controls might under-represent in-migrants. Individuals who left Alberta and changed their PHNs after obtaining coverage under another provincial health-care plan were ineligible to provide a match for program participants. However, if an individual left Alberta and did not report their move to Alberta Health Services (i.e., they did not register for another provincial health card) they would falsely show up as using no health care. Thus, temporary out-migrants may be a source of downward bias in the level of health-care utilization in the AHS registries and an influence on our study if Pure North participants are more likely to temporarily reside out of Alberta than their matched controls.

After utilization data from the registries were compiled for the participants and their corresponding controls, that information was delivered to a data analyst at Pure North who removed all identifying information from the records and assigned randomized alpha-

¹³ A number of PHNs were not linked because they did not correspond with numbers in the AHS registry. This can occur when the health number provided is for another province, PHN is incorrectly reported by the participant, or the participant was not in the AHS database during the study time period. We do not include persons who started the Pure North Program after March 31, 2014 since we do not have a full fiscal year post-joining.

¹⁴ Information on physician utilization is only available until the fiscal year ending March 31, 2014, i.e., the physician billing database is one fiscal year behind the other two databases in terms of data availability.

¹⁵ While we are not able to increase the number of participants in our sample, the statistical efficiency of matched-pairs design of a case-control study improves by matching each case with several independent controls. Hans K. Ury, "Efficiency of case-control studies with multiple controls per case: Continuous or dichotomous data," *Biometrics* 31, September 1975, 643-649.

numeric identification labels to the participants and controls. For participants, information provided from Pure North was available for biological measures (e.g., vitamin D (25(OH)D) blood serum level), category of participant (based on clinic, clinic site or groups like the homeless).

Each entry in any of the registries represents one interaction with the health-care system for one most responsible diagnosis. This is straightforward for the majority of emergency department and general practitioner visits, since those are often one single contact with the health-care system. For longer stays in hospitals, one visit can count as multiple visits if the most responsible diagnosis changes. For example, if someone is treated for an injury, and then received four additional weeks of rehabilitation in a hospital, the treatment and the rehabilitation would count as two visits since their reason for being at the hospital and associated resource use changed. Separating long visits into multiple shorter visits is done by AHS to track resources associated with hospital use.

Not all of the 11,985 participants linked to AHS data were used in our analysis reported on in this paper. First, we focused on adults, age 25 to 75 at the time of joining the program.¹⁶ Second, following Dutton et al. (2015), we used the most common biomarker measurement, vitamin D blood serum level (25(OH)D in nmol/L), to determine whether a participant continued with the program, so 338 participants without a baseline measure of 25(OH)D were excluded. We also removed 359 homeless participants and their matched controls since we were not clear that the matching on the basis of postal code would be as useful as for the rest of the sample.

Finally, as our interest is in determining the robustness of Dutton et al. study findings to the new sample of controls, and to investigate the effects of the PN program on health-care utilization in the second year post-joining, we focus on the cohort of participants referred to as Vital 2.2 in the Dutton et al. study in reference to the name of the formulation of the multivitamin they received from Pure North. Members of this Pure North program cohort in our sample joined the program as early as April 1, 2012 and as late as March 31, 2013. For this cohort, we have two complete calendar years (365 days per calendar year) of observation after the date of joining. Vital 2.2 is a group of interest because the revision of the multivitamin formulation coincided with Pure North expanding its program from a workplace-specific program to being available to the general population (occurring May 2012). The earlier cohorts of joiners who were largely employed by CNRL likely faced poorer access to acute care services through hospitals and doctors due to the remoteness of the region of the province in which they reside and work. Reviewer comments on the Dutton et al. study also identified their concern that estimated program effects generated from a workplace-based sample are less likely to be generalizable to the Alberta population than the sample restricted to Vital 2.2 participants. For these reasons, we have a final sample size of 3,595 participants and 17,975 matched controls.

¹⁶ Some of the participants under the age of 25 in the program are elite athletes, including Olympic athletes, who are not likely to be representative of the general population with respect to health and health-care needs. In our data set, almost three-quarters of participants under age 25 do not persist in the program, compared to less than half in the sample aged 25 and over.

DATA ANALYSIS

The health-care utilization of the age-, sex- and postal code-matched control sample provides the counterfactual case for program participants – what would their health-care utilization have been on average if they had not joined the program? We compare the average change in utilization across time between participants and controls, pre- and post-joining the PN program. Any successful program that prevents health-system utilization would exhibit a lower rate of increase (which could include an absolute decrease) in utilization than the controls.

Since the sample of program participants consists of persons who joined over different calendar years and at different times in the calendar year, time in our models is defined relative to date of joining. Each 365-day period before the date of joining the program counts as a year prior to joining. Each individual in our sample provides two full years of post-joining utilization data. Each 365 days after the date of joining the program counts as a year post-joining.

We estimate two types of models with a difference-in-differences research design. The first type is analogous to the intention-to-treat (ITT) analysis employed in studies with randomized treatment assignment. We do not require individuals to adhere to the program to count as being treated -- we consider all participants as having access to the same treatment, though we acknowledge that individuals received access to the treatment and could elect not to participate. Throughout, we refer to the group who had access to the treatment regimen as the participants. This method has the advantage of providing estimates of effect mimicking real-life circumstances when offering a voluntary intervention; that is, individuals will participate with varying levels of intensity. Statistically significant ITT estimates are strong evidence of a program's effectiveness since they are still identified even if not all participants are adhering to the program. In contrast, statistically insignificant results are inconclusive evidence as to a program's effectiveness in the sense that it could be the case that the program is ineffective or that the program is effective for participants who adhere to it but the measured effect is diluted by the outcomes for non-adherents to the program.

We adopt a difference-in-differences research design to study the impact of the program. The effect of the program is the difference in utilization between the first year (and second year) after joining the program and the year prior to joining the program compared to the difference observed in matched controls across the same years. We estimate linear regression models that provide coefficients for the average utilization of the variable of interest in each year pre-joining (up to five years) and one and two years post-joining for participants and controls. The intention-to-treat model for health-care utilization of person i in year t is:

$$HC_{it} = \sum_{t=1}^2 (\beta_t^c \cdot Y_t + \beta_t^{pn} \cdot Y_t \cdot PN_i) + \sum_{t=0}^{-4} (\beta_t^c \cdot Y_t + \beta_t^{pn} \cdot Y_t \cdot PN_i) + u_{it}$$

u_{it} is the model's error term. Each year has its own average provided by the variables included in the model. " PN_i " is an indicator variable equal to one if an observation is for a

participant, and zero if the observation is for a control. Y_t is an indicator variable equal to one if the observed utilization is in a given year t , and zero otherwise. $t=1$ denotes one year after joining the program, $t=0$ denotes the first year prior to joining the program, $t=-1$ is two years prior to joining, $t=-2$ is three years prior to joining, and so on. While controls are never in the program, the period of time where their matched participant is in the program is still denoted $t=1$. Thus, the difference in utilization between the controls across the period of interest ($t=1, 2$ years after their matched PN participant joins the program) is $\beta_t^c - \beta_0^c$ and the difference in utilization for the participants is $(\beta_t^c + \beta_t^{pn}) - (\beta_0^c + \beta_0^{pn})$. The difference between these differences is $\beta_0^{pn} - \beta_t^{pn}$. If the difference-in-differences term is positive, it means the controls exhibited a larger increase, or less of a decrease, in utilization across the year the participants joined the program than the participants did.

We extend the preceding model to account for the fact that some individuals in the program may have stopped participating, or are not adhering to the program. Since the program is voluntary, we can only observe contact with the program rather than conclusive evidence of adherence to it. Thus, we define persisting in the program with respect to the reporting of vitamin D levels measured by blood serum 25(OH)D (nmol/L). Participants in our data set have a 25(OH)D measure at baseline which includes measures taken up to 90 days after an individual enters the program as baseline, since individuals might register in the database some time before actually beginning the program. If a participant has a second measure of 25(OH)D six to 18 months after joining, we define them as persisting in the program for one year post-joining. If they do not have a second measure, then they are classified as non-persisting, which we interpret as meaning they are not participating in the program.¹⁷ We also extend the persistence measure to a third 25(OH)D measure 18 months to 30 months after joining to identify program persistence to two years post-joining. We recognize that the decision to persist or not persist in the Pure North program is not necessarily exogenous to the program's impact on a joiner's health. The samples of persisting and non-persisting joiners are selected rather than randomly assigned, which introduces a potential bias into the model's coefficient estimates. For example, the reduction in health-care use suggested by the coefficient estimates may overstate the true causal effect of access to the program if the persisting versus non-persisting members reflects a sorting of the participant sample into healthy and less healthy persons.

When we account for persisting versus not persisting in the program, we augment the preceding model to:

$$HC_{it} = \sum_{t=1}^2 (\beta_t^c \cdot Y_t + \beta_t^{pn} Y_t \cdot PN_{it} + \beta_t^{pn-np} Y_t \cdot PN_i \cdot NP_{it}) + \sum_{t=0}^{-4} (\beta_t^c \cdot Y_t + \beta_t^{pn} \cdot Y_t \cdot PN_i) + u_{it}$$

NP_{it} is an indicator equal to one if the individual has a baseline measure upon entry to the program but no follow-up measure in year t , and zero for a persisting program participant. β_t^{pn} is the difference in mean utilization between participants known to persist in the

¹⁷ We do not know whether the individual has truly stopped following the program protocol. Individuals do not have to contact Pure North to cancel their program participation; they can simply stop returning. It is also possible for individuals to participate without having a follow-up 25(OH)D measurement. However, our results indicate that the proxy for participation seems reasonable. We have chosen to use the term "persisting" over "adhering" since even if participants have a baseline and follow-up measure of 25(OH)D, we still do not know the degree to which they are following the program.

program at least $t=1, 2$ years over that of the matched controls.¹⁸ Note that coefficient estimates in this model for the pre-joining period will be identical to those in the ITT model.¹⁹

Now we have three difference terms: the difference in the controls $\beta_1^c - \beta_0^c$, the difference in those who persist in the program for at least t years $(\beta_t^c + \beta_t^{pn}) - (\beta_0^c + \beta_0^{pn})$, and the difference in those who do not persist in the program at least t years $(\beta_t^c + \beta_t^{pn} + \beta_t^{pn-np}) - (\beta_0^c + \beta_0^{pn})$. The difference-in-differences for those who persist is $\beta_0^{pn} - \beta_t^{pn}$ and the difference-in-differences for those who quit is $\beta_0^{pn} - \beta_t^{pn} - \beta_t^{pn-np}$.

We estimated all models with the Ordinary Least Squares estimator, using standard errors clustered by individual and bootstrapped 1,000 times to address the non-normal distribution of health-care utilization variables.²⁰

RESULTS

The summary statistics in Table 1 show that program participants in our Vital 2.2 sample have a mean age of 54 years. Sixty-two per cent of participants are female. In terms of health-care utilization, for hospitals, program participants prior to joining the program overall had comparable frequency of use and statistically insignificantly lower mean nights in hospital per year to the matched controls. With respect to emergency department visits, in the year prior to joining, program participants had higher average use than the matched controls but the difference is not statistically significant. PN participants had significantly higher use of physician (GP) services than their matched controls in the year prior to joining PN.

¹⁸ We also estimate models for the stratified samples of persisting program participants and their matched controls and non-persisting program participants and their matched controls. The point estimates of the models' coefficients are statistically equivalent to the model described above, but there is a loss of statistical power due to the larger number of model parameters.

¹⁹ We also estimate models akin to the ITT specifications for three subsamples of participants and their matched controls. We use the sample of participants with only a baseline measure of 25(OH)D, a baseline measure and one year measure of 25(OH)D and a sample of participants with baseline, one-year and two-year measures of 25(OH)D. This allows us to have the pre-joining coefficients differ across persisting and non-persisting members.

²⁰ We have also calculated standard errors clustered by postal code and we have bootstrapped 999 times at the advice of an anonymous reviewer. The results we present are robust to these alternative calculations of standard errors.

TABLE 1 MEAN VALUES OF DEMOGRAPHIC AND HEALTH-CARE UTILIZATION MEASURES FOR PROGRAM PARTICIPANTS AND MATCHED CONTROLS IN YEAR PRIOR TO JOINING PURE NORTH

	Vital 2.2		Vital 2.2 aged 55-75	
	Participants	Controls	Participants	Controls
Average age	54		63	
Proportion female	62%		63%	
Proportion user (DAD)	6.2%	6.1%	6.7%	6.9%
Average use (DAD)	0.084	0.082	0.092	0.092
Average nights (DAD)	0.26	0.43	0.311	0.58
Proportion user (ED)	26% [†]	21%	24%	20%
Average use (ED)	0.53	0.45	0.47	0.41
Proportion user (GP)	90% [†]	80%	93% [†]	85%
Average use (GP)	6.1 [*]	4.9	6.8 [*]	5.7
Proportion of participants persisting 1 year (DAD & ED)	0.54		0.70	
Proportion of Participants persisting 2 years (DAD & ED)	0.38		0.52	
N (DAD & ED)	3595	17595	2055	10275

NOTES: * indicates difference between participants and controls is statistically significant (Mann-Whitney U test, $p < 0.05$). † indicates difference between participants and controls is statistically significant (Z test of proportions, $p < 0.05$). DAD (discharge abstract database) is hospital visits or nights, ED is ambulatory care/emergency department visits, and GP is general practitioner visits.

Some assumptions have to hold for difference-in-differences estimates to be interpreted as causal effects of access to the PN program on health-care utilization. One condition necessary for difference-in-differences is that the participants and controls satisfy the common support assumption. The principle is that based on observables in the treatment group, suitable matches can be drawn. Suitability can be questioned if controls are drawn from a separate population than the one generating the participants. Matching the control sample with the participants' postal codes improves the odds that this assumption holds at least in comparison to the sample used by Dutton et al. (2015). There is still the issue that there are systematic unobservable differences between participants and controls as there is a possibility that participants are more health-conscious than the general population. So long as these unobservable changes are stable over time and uncorrelated with participation in the program, then these unobserved fixed effects are addressed in our modelling strategy. Second, to support a causal interpretation of a difference-in-differences estimate, the treatment and control groups must have parallel or common trends across time before the intervention. Finally, there must be no pre-treatment, or anticipation, effects of the program. With a voluntary program, individuals self-select into the program rather than being exogenously assigned to it. If agents self-select by the outcome variables that the program is designed to affect, then the construction of counter-factual outcomes for what would have happened in the absence of the program becomes complicated. Anticipation effects make the difference-in-differences estimator sensitive to the specific periods over which pre and post are defined, and may confound temporary changes prior to the program due to anticipation of starting the program with causal effects of participating in it.²¹

²¹ James J. Heckman and Jeffrey A. Smith, "The Pre-Programme Earnings Dip and the Determinants of Participation in a Social Programme: Implications for Simple Programme Evaluation Strategies," *The Economic Journal*, 109, July 1999, 313-348.

TABLE 2 MEAN VISITS TO HOSPITAL, EMERGENCY DEPARTMENTS AND GENERAL PRACTITIONERS IN THE 5 YEARS PRIOR AND 2 YEARS AFTER JOINING PURE NORTH

Years relative to joining	Hospital Visits (number per 100 persons)		Emergency Department Visits (number per 100 persons)		GP Visits (per persons)	
	Participants	Controls	Participants	Controls	Participants	Controls
Pre 5	6.4	6.7	32.9*	34.2	5.2*	4.4
Pre 4	6	6.8	33.4	34.8	5.4*	4.6
Pre 3	6.3	7.2	38.2	38.4	5.4*	4.6
Pre 2	8.8*	7.8	47.3*	41.7	5.7*	4.7
Pre 1	8.4	8.2	53.4*	44.8	6.1*	4.9
Post 1	7.5*	9.6	47.7*	46.5	6.1*	5.1
Post 2	9.8	9.4	51.1*	46.3		
N	3595	17975				

NOTES: * indicates difference between participants and controls is statistically significant (Mann-Whitney U test, $p < 0.05$).

The necessary conditions for difference-in-differences estimation are not obviously satisfied for all of the utilization measures which we recognize as a limitation of our analysis. Table 2 provides information on the trends in health-care use for the Vital 2.2 participant sample and matched controls for the five years prior to joining. Table 2 presents mean values of numbers of visits to hospitals, emergency departments and general practitioners for the Vital 2.2 sample. For hospital use and ambulatory care, the participants had insignificantly lower use than the matched controls three to five years prior to joining. Two years prior to joining the Pure North program, participants had an increase in utilization of hospitals and ambulatory care/emergency departments. For visits to general practitioners, the participants have higher mean visits in the five years prior to joining than the matched controls. The increase in participant health-care utilization two years prior to joining the PN program suggests that a negative shock to health, or declining health, may have been a motivating factor for joining the PN program. This would pose a problem for the assumption of common support for the case and control samples and the issue of no pre-treatment effects. The increase in utilization two years prior to joining the program also affects the common trend assumption.

Table 3 presents the ITT difference-in-differences estimates derived from the OLS regression models.²² These estimates show the changes in utilization over what was observed in the matched controls for all participants. For example, a positive number indicates that the difference over time in the controls is larger than the difference over time for the participants. We compare utilization one and two years after joining PN to the observed utilization in the year prior to joining the program.

Table 3 shows that PN participants have a statistically significant reduction in the number of visits to hospital of 2.3 per 100 participants per year ($p=0.007$) in the first year after joining the program. Relative to the year prior to joining PN, this is a 27 per cent reduction in the number of hospital visits per person per year. In the first year after joining, Vital 2.2 participants show a statistically significant reduction in emergency department visits of 7.3 per 100 participants per year, 14 per cent of the mean number of visits in the year prior to

²² Full results of coefficient estimates for all regression models are provided in an Appendix available from the author upon request.

joining (p=0.021). The ITT results show significant reductions in general practitioner visits of 23.9 visits per year per 100 persons (p=0.037), 40 per cent of the mean number of visits in the year prior to joining.

TABLE 3 ITT ESTIMATES OF MEAN REDUCTIONS IN HEALTH-CARE UTILIZATION OF PROGRAM PARTICIPANTS VERSUS THAT OF AGE-, SEX- AND POSTAL CODE-MATCHED CONTROLS

Sample (N)		Hospital Number of Admissions per 100 Persons per Year	Emergency Department Number of Visits Per 100 Persons per Year	General Practitioner Number of Visits per 100 Persons per Year
Vital 2.2 (3,595)	1 year post	2.3* (0.01)	7.3* (0.02)	23.9* (0.04)
	2 years post	-0.2 (0.85)	3.7 (0.22)	
Vital 2.2 Aged 55-74 (2,055)	1 year post	2.5* (0.04)	2.2 (0.58)	25.9^ (0.09)
	2 years post	0.6 (0.65)	3.1 (0.41)	

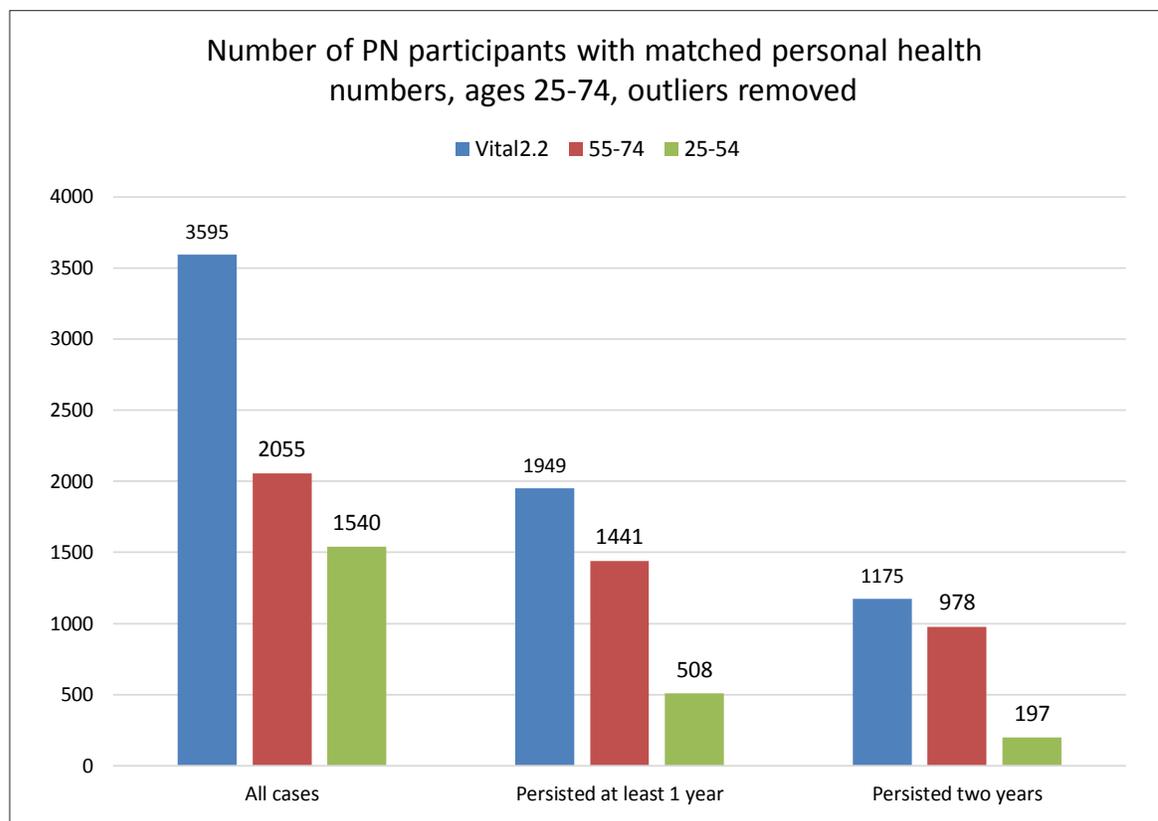
NOTES: p-values in parentheses. * indicates the estimate is statistically significantly different from zero (p < 0.05). ^ indicates the estimate is statistically significant different from zero (p<0.10). Based on bootstrapped standard errors (1,000 replications). GP visits not available for two years post-joining year for Vital 2.2 sample.

In the second year after joining, Table 3 shows that there is no statistically significant ITT difference in the participants' use of hospitals and emergency departments compared to the matched controls. We do not have the fiscal year of data for GP visits to evaluate the second year after joining. Table 3 shows that for the seniors in Vital 2.2 the ITT effects for hospitalization are statistically significant and as large as for the full Vital 2.2 sample in the first year after joining but statistically insignificant and one-quarter of the magnitude in the second year after joining. Seniors showed no significant reductions in emergency department use in the ITT estimates in the first or second year after joining. For GP use, seniors have a larger ITT reduction than the full sample, but the estimate is not statistically significant

As discussed earlier, statistically significant ITT estimates are strong suggestive evidence of a program's effectiveness since they are still identified even if not all participants are adhering to the program. In contrast, statistically insignificant results are inconclusive evidence as to a program's effectiveness in the sense that the program could be ineffective or that the program is effective for participants who adhere to it, but the measured effect is diluted by the outcomes for non-adherents. Figure 1 shows that a large percentage of participants in the Vital 2.2 were not persisting to the second year in the program. To define persistence in the program, we use information as to whether a participant had a vitamin D test (25(OH)D level) at baseline, one year after joining and two years after joining. For the Vital 2.2 sample, 3,595 participants had a 25(OH)D level at baseline, 1,949 one year after joining and only 1,175 two years after joining. Thus, one reason for the diminishing ITT estimate for the program effect to two years is that the majority of joiners were not in the program by two years. When we stratified the sample in Figure 1 by age group, non-seniors aged 25-54 and seniors aged 55-74, we determined that non-senior participants had high levels of non-persistence in the program at one year and especially two years after joining. Of 1,540 non-senior joiners in PN in the Vital 2.2 sample, only 197 had a recorded vitamin D level two years after joining. In contrast, senior joiners in the Vital 2.2 sample showed

greater persistence in the PN program as 70 per cent had a vitamin D level recorded one year after joining and 48 per cent two years after joining.

FIGURE 1



Persisting participants have 4.5 fewer hospital admissions per 100 persons in the first year after joining the program and 1.3 fewer admissions per 100 persons in the second year after joining. For persisting participants aged 55 to 74, the reductions in hospital admissions in the first year after joining are 5.4 per 100 persons and 2.9 per 100 persons in the second year after joining. These reductions represent a 55 per cent decrease from the year prior to joining for the full Vital 2.2 year sample in the first year after joining and 15 per cent in the second year after joining. For participants aged 55 to 74, the reductions represent decreases of 59 per cent in the first year after joining and 32 per cent in the second year after joining. For persisting participants, the reductions in ambulatory care/emergency department visits are 17.9 per 100 persons in the first year after joining and 15 visits per 100 persons in the second year. For the seniors' sample, the reductions are 12.4 and 11.3 fewer visits per 100 persons in the first and second years after joining. These reductions represent a 40 per cent decrease from the year prior to joining for the full Vital 2.2 sample and 30 per cent reductions for the Vital 2.2 seniors' sample. Non-persisting seniors show large and sizeable increases in emergency department utilization in the first year after joining. Again, this could signal that a health shock was the reason for not persisting in the program.

TABLE 4 ESTIMATES OF MEAN REDUCTIONS IN HEALTH-CARE UTILIZATION OF PERSISTING AND NON-PERSISTING PROGRAM PARTICIPANTS VERSUS THAT OF AGE-, SEX- AND POSTAL CODE-MATCHED CONTROLS

Sample (N)			Hospital	Emergency Department	General Practitioner
			Number of Admissions per 100 Persons per Year	Number of Visits Per 100 Persons per Year	Number of Visits per 100 Persons per Year
Vital 2.2 (3,595)	Persisters	1 year post (1,549)	4.5*	17.9*	9.9
		2 years post (1,175)	1.3	15*	
	Non-Persisters	1 year post (2,046)	-0.2	-5.3	40.4*
		2 years post (2,420)	-1.0	-9.4	
Vital 2.2 Aged 55-74 (2055)	Persisters	1 year post (1,441)	5.4*	12.4*	36.9*
		2 years post (978)	2.9*	10.8*	
	Non-Persisters	1 year post (614)	-4.2*	-21.8*	0.3
		2 years post (1,077)	-0.7	-15.0	

NOTES: * indicates the estimate is statistically significantly different from zero ($p < 0.05$). Based on bootstrapped standard errors (1,000 replications). GP visits not available for post-joining year for Vital 2.2 sample. GP is general practitioner visits.

The results for GP visits for the Vital 2.2 sample are only calculated for the first year post-joining and they show a surprising result that non-persisting members have a significant eight per cent decrease in GP visits. For the Vital 2.2 seniors, however, persisting participants have a significant 6.4 per cent decrease in GP visits while the non-persisting seniors show no differences from the matched control sample.

From these models, we know that PN participants who persist in the program have significant avoidance of hospital admissions and ambulatory care/emergency department use in the first year in the program, but smaller magnitudes of health-care use avoided in the second year after joining. We investigated several potential explanations for non-persistence in the PN program. We explored whether the attrition in PN participation after the first year in the program for non-senior participants could have been due to the introduction of a payment requirement in January 2013. We did not find that non-persistence rates in the sample differed between program joiners during non-payment period May to December 2012 and those who joined January to August 2013. Seniors show higher rates of persistence in the program. For the full Vital 2.2 cohort, 33 per cent of the sample persisted for two years in the program, but 48 per cent of senior participants persisted two years versus only 13 per cent of joiners aged 25-54.

MAGNITUDES AND VALUES OF THE HEALTH CHANGES

Table 5 presents *ex ante* estimates of expected hospital and ambulatory care (emergency department) costs avoided for participants in the first and second year in the PN program based on the estimates in Tables 3 (ITT) and Table 4 (Persisting Participants). For baseline purposes, we use the average hospital visits per year, and ambulatory care visits per year per person for the control samples in the year prior to participants joining PN. For the length of stay in hospital, we use the mean nights for controls who were admitted to hospital in the year prior to joining the PN program. For the Vital 2.2 control sample, that

was 7.1 nights per hospitalization and 8.6 nights for the Vital 2.2 seniors control sample. For costs of utilization, we use Dutton et al.'s (2015) \$1,414 per night in hospital based on the billing rate for a night in hospital in Calgary, Alberta, and \$840 per emergency department visit. Based on the mean frequencies of use in the year prior to joining the program, average health-care costs for the public payer in Alberta would have been \$1,320 per participant, and \$1,509 per senior participant.²³

For the Vital 2.2 cohort, the ITT reductions in hospital and emergency department utilization represent \$294 in health-care costs avoided, due to the program representing 22 per cent of health-care costs in the year prior to joining. For program participants who persisted at least one year in the program, costs avoided are \$600, representing 45 per cent of health-care costs of hospital, and emergency department use. In the second year after joining, there are no further costs avoided based on the ITT estimates, \$276 (or 20 per cent of baseline) in health spending avoiding for persisting participants.

TABLE 5 BASELINE HEALTH-CARE UTILIZATION AND COST AND COSTS AVOIDED FOR VITAL 2.2 PN PARTICIPANTS

		Pooled Average visits per year	Average nights per visit	Cost per visit (1 night)	Total Annual Expenditure	Costs Avoided --ITT estimate	Costs Avoided -- Persisting estimate
First year, All (n=3595)	Hospital	0.087	7.1	\$1,414	\$873	\$233	\$449
	ED	0.532		\$840	\$447	\$61	\$151
	TOTAL				\$1320	\$294	\$600
	Proportion of total cost				0.22	0.45	
First Year Seniors (n=2055)	Hospital	0.092	8.6	\$1414	\$1119	\$303	\$652
	ED	0.465		\$840	\$391	\$18	\$104
	TOTAL				\$1509	\$321	\$756
	Proportion of total cost				0.21	0.50	
Second year, All (n=3595)	Hospital	0.087	7.1	\$1,414	\$873	-\$18	\$133
	ED	0.532		\$840	\$447	\$31	\$143
	TOTAL				\$1320	\$13	\$276
	Proportion of total cost				0.01	0.21	
Second Year Seniors (n=2055)	Hospital	0.092	8.6	\$1414	\$1119	\$73	\$353
	ED	0.465		\$840	\$391	\$27	\$95
	TOTAL				\$1509	\$100	\$448
	Proportion of total cost				0.07	0.30	

NOTES: The average visits are for controls in the year prior to joining.

²³ The health-care utilization of the Vital 2.2 participants is around half of the per capita cost of hospitals and doctors for Alberta in 2013 (\$3,365) reported by the Canadian Institute for Health Information. From Table 6, Chapter 4, "Health Expenditure in the Provinces and Territories," by the Canadian Institute for Health Information, *National Health Expenditure Trends, 1975 to 2013* https://secure.cihi.ca/free_products/4.0_TotalHealthExpenditureProvTerrEN.pdf. The lower costs implied for the participant's health-care utilization could reflect that the reductions in utilization are being generated from the relatively healthy persons, that the per capita Alberta figure includes visits to specialist physicians, and that our assumed costs of nights in hospital or visits to the emergency department are low compared to actual costs. It also appears to be the case that our sample does not represent the small portion of the population with multiple chronic conditions who account for a large share of total health-care costs in the province.

For senior participants, the first year post-joining health-care costs avoided are \$321 (ITT), 21 per cent of baseline costs, and \$756 (persisting), 50 per cent of baseline health-care costs. In the second year after joining, however, senior participants have \$100 in health spending avoided (seven per cent of baseline costs) using the ITT estimates and \$448 in health spending avoided (30 per cent of baseline costs) of persisting senior participants.

For illustrative purposes, we can project the immediate health-care system level impacts of preventive services, recognizing that the selected nature of the Pure North participant sample does not guarantee that the program effects we report will generalize for the adult population in Alberta and ignoring any logistical challenges with scaling up the program. Dutton et al. (2015) have previously projected the effects of the PN program from the first year after joining the program on the Alberta health-care system, assuming that the first-year effects were sustained. Here, we are going to project the system-level impacts of the PN program on acute-care utilization based on the effect sizes for persisting senior participants.

In 2015, the Alberta population aged 55 to 75 is 783,049. Applying the estimates for the persisting seniors from the second year in program of 2.9 admissions avoided per 100 persons, and using 8.6 nights in hospital per admission, then there would be 195,292 fewer nights in hospital for the population aged 55 to 75 in the province.²⁴ These nights in hospital avoided represent 7.4 per cent of the 2,640,201 Total Hospital Days in Alberta in 2012-2013. On an annualized basis (total nights avoided divided by 365 days), the hospital nights avoided represent the equivalent of 535 more beds available per year in the province, which is around 6.5 per cent of Alberta's 2013 capacity of 8,230 acute care beds. In terms of bed capacity, the beds freed up through improved health in the population are equivalent to adding close to the acute care bed capacity of a Foothills Medical Centre (Calgary). Put another way, this freed-up bed capacity is roughly the number of acute care beds occupied each day in Alberta by patients awaiting placement in a facility with an alternative level of care (e.g., nursing home).²⁵ As the issue of the "bed blockers" has been prominently discussed in Alberta for backing up emergency departments, delaying surgeries and generating lengthy wait times for the emergency departments and surgeries, the Pure North program effect could be projected to provide considerable benefit for freeing up beds and reducing emergency department wait times.

The program effect in Vital 2.2 seniors for emergency department use shows the potential for preventive care to directly reduce pressure on the province's over-burdened emergency departments. Applying the estimate for emergency department visits avoided in the second year after joining to the Alberta population aged 55 to 75, we project that 88,485 emergency department visits could have been avoided in fiscal year 2014-2015. This would represent a four per cent reduction in the 2,116,474 emergency department visits in Alberta in fiscal year 2012-2013.

²⁴ According to Alberta Health Services, the average nights in hospital for the entire Alberta population, which includes children in 2012-2013 were 6.8. Using this value results in 450,132 fewer nights spent in hospital in Alberta in fiscal year 2013-2014.

²⁵ Matt McClure, "Surgery waits lengthen despite hike in hospital spending," *Calgary Herald*, Nov. 25, 2014, A7, reports that a median of 632 hospital beds were clogged each day with patients waiting an average of 32 weeks — nearly a month longer than a year earlier — for a less expensive bed in the community.

The gains to the public payer in terms of health-care costs avoided need to be considered in terms of the costs of the intervention that generate the benefits. Pure North identified three categories of service that it sees as the core of the program, which are services provided to all participants. The costs shown in Table 6 provided to us by Pure North are what it defines as representative of the costs associated with the delivery of the program for the fiscal years 2012/2013 to 2015/2016.

TABLE 6 SUMMARY OF COSTS PER PERSON PER YEAR ASSOCIATED WITH DELIVERY OF THE PROGRAM 2012/2013 TO 2015/2016

Fiscal Year	Health Consultation	Laboratory Services	Dietary Supplements	Total
2012/13	\$240	\$460	\$1,600	\$2,300
2013/14	\$200	\$435	\$900	\$1,535
2014/15	\$130	\$360	\$440	\$930
2015/2016	\$120	\$340	\$440	\$900
Projected feasible cost	\$70	\$100	\$330	\$500

NOTES: These costs are provided by the Pure North S'Energy Foundation in response to an author query.

The trend reduction in costs of the program in Table 6 is driven by changes in the content and delivery of the program reflecting the experience gained by Pure North through eight years of operating the program, combined with the results of internal program evaluation and external research on the program. The quantity, mixture and costs of dietary supplements have decreased as the program focuses on consistency in compliance and effectiveness of the program. Health-consultation costs have decreased as the program moved to delivery with fewer consultations per year, and through shorter duration consultations within the scope of practice of registered nurses, nurse practitioners and naturopathic doctors rather than physicians. Laboratory service costs to date have reflected costs incurred for purposes of program evaluation and research interests of the foundation. Laboratory costs for the subset of biometric measures that the organization sees as necessary for the preventive health-care program are one-quarter of the laboratory costs per participant incurred to date. Pure North has projected that its program can be delivered for \$500 per year.

The health-care costs avoided for hospitals and emergency department visits for the Vital 2.2 cohort are attributable to the program in the fiscal years 2013/2014 and 2014/2015. Using the 2014/2015 fiscal year cost of \$930 from Table 6, health-care costs avoided for a persisting program participant represent 67 per cent (Vital 2.2) and 81 per cent (Vital 2.2 seniors) of total program costs in the first year after joining, and 30 per cent (Vital 2.2) and 48 per cent (Vital 2.2 seniors) in the second year. These costs are not necessarily the minimum costs for delivering the program. If the benefits in terms of health-care costs avoided can be achieved with the projected program cost of \$500 per participant, then the health costs avoided in the first year for persisting participants would more than recoup the program cost, but only cover a little over half of the cost (Vital 2.2 persisting) to 90 per cent of the cost for persisting seniors.

As Dutton et al. (2015) argue, an appropriate perspective for valuing the immediate benefit of the program on health costs avoided when the objective of the program is the prevention of chronic diseases to reduce health-care costs in future, is that of the net price

of preventive care – the cost of preventive services net of reduced health-care costs in the immediate term. That is, the PN program cost \$930 per participant in 2014/2015. The last fiscal year for our AHS data is offset by \$756 in hospitalization and ambulatory costs that were avoided for persisting senior participants, meaning the net cost of the PN program for improving health and avoiding future chronic disease burdens is \$174 per participant. As this cost would still represent a net increase in expenditure for a payer, the question as to the value proposition of this prevention program remains. To address this issue, we consider the size of the immediate improvement in participant health as measured by Quality Adjusted Life Years (QALYs) and we calculate Incremental Cost Effectiveness Ratios (ICERs) for the program to determine if the PN program is cost effective, hence good value for money.

Pure North participants complete questionnaires as part of the program at baseline and at follow-up visits. On the questionnaire are the components of the EQ5D which can be used to evaluate participant health in terms of Quality Adjusted Life Years (QALYs).²⁶ The change in QALYs between baseline and follow-up represents health change measured in terms of years in full health. Comparing the cost of an intervention to the QALY gain, we can interpret the value of the PN program in terms of the cost of purchasing a year in full health. Interventions are considered to be cost effective, hence good value for money, when the cost of purchasing a year in full health is less than a chosen benchmark like \$50,000. Among our Vital 2.2 senior sample, 874 participants had baseline and one-year EQ5D questionnaire responses. Of those, 601 had EQ5D responses two years after joining. This means that for 601 of 978 senior two-year persisters, we have QALY values for baseline, at one year in the program and two years in the program.

The mean value of the QALY for the Vital 2.2 seniors who persist for two years in the program is 0.798 at baseline, 0.824 at one year in the program and 0.825 at two years in the program. That is, the program generates an improvement in health of 0.026 years (9.5 extra days) in full health in the first year and that improvement over baseline is sustained into the second year. For the 273 senior participants who completed the EQ5D questionnaire at baseline and at one year, but did not persist in the program to a second year, the baseline QALY is 0.781 and the value at one year is 0.812. This suggests that non-persisters entered the program in poorer health, but have a larger gain in health than the two-year persisters of 0.031 years in full health (11.3 extra days in full health).

²⁶ These questionnaire data for the EQ5D instrument are described in Y. S. Chao, J. P. Ekwaru, A. Ohinmaa, G. Griener, and P. J. Veugelers, "Vitamin D and Health-Related Quality of Life in a Community Sample of Older Canadians," *Quality of Life Research*, August 2015; DOI:10.1007/s11136-015-1103-7. J. P. Ekwaru, A. Ohinmaa, and Paul J. Veugelers, "The Effectiveness of a Preventive Health Program and Vitamin D Status in Improving Health-Related Quality of Life of Older Canadians," *Quality of Life Research*, August 2015, 1-8 <http://link.springer.com/article/10.1007/s11136-015-1103-7/fulltext.html>

TABLE 7 COSTS AND INCREMENTAL COST-EFFECTIVENESS RATIOS (ICER) FOR SAMPLE OF PN SENIOR PARTICIPANTS PERSISTING TWO YEARS IN THE PROGRAM

Year	Program Cost	Health costs avoided 1st year	ICER - Gross Program Cost	ICER - Net program cost	Health Costs Avoided 2 nd year	ICER - Gross Program Cost	ICER - Net Program Cost
2012/13	\$2,300	\$756	\$88,462	\$59,385	\$448	\$85,185	\$68,593
2013/14	\$1,535	\$756	\$59,038	\$29,962	\$448	\$56,852	\$40,259
2014/15	\$930	\$756	\$35,769	\$6,692	\$448	\$34,444	\$17,852
2015/16	\$900	\$756	\$34,615	\$5,538	\$448	\$33,333	\$16,741
Projected feasible cost	\$500	\$756	\$19,231	-\$9,846	\$448	\$18,519	\$1,926

The incremental cost effectiveness ratio (ICER) is a statistic used in cost effectiveness analysis to summarize the cost effectiveness of a health-care intervention. It is defined by the difference in cost between two possible interventions, divided by the difference in their effect. Since our alternative intervention to the PN intervention is to do nothing, the PN program cost is the difference in cost, and the change in QALYs for participants in the program is the difference in program effect, assuming that controls in our sample and non-participants would see no improvement in health. We lack direct information on QALYs for the controls and non-participants, but we do note that our difference-in-differences estimates for health-utilization changes for cases and controls support our assumption. We also note that in the absence of an intervention, QALY scores are expected to decrease as an individual ages. The changes in HrQOL that we present likely underestimate the effect of the program, as natural aging is not taken into account.²⁷

Table 7 shows the program costs from Table 6, the health-care costs avoided for participating senior participants and ICERs calculated using the program costs from Table 6 and the same annual program costs net of health costs avoided. Using a benchmark cost per QALY of \$50,000 and the gross program costs, the PN program would not have been considered cost effective for purchasing improved health until 2014/2015. The cost effectiveness of the PN program at an annual cost of \$900 to \$1,200 has previously been assessed by Ekwaru et al. using a different sample of PN participants. Those authors assessed that at a QALY gain of 0.012, with the higher program costs in Table 6, the program would be considered cost effective at a threshold cost per QALY of \$80,000, which they cite the Canadian Common Drug Review as identifying as the threshold at which new drugs were accepted.²⁸ Accounting for the health costs avoided, however, shows that the PN program has been cost effective since 2013/2014 using health costs avoided from either the first or second year in the program even at the lower threshold of \$50,000 per QALY. The impact of PN reducing its program costs has been to improve the cost effectiveness of the program, hence improving the value for money achieved by its preventive care services.

²⁷ QALYs are one way to value health-related quality of life (HrQOL). A study of patients at two British general practice clinics found that HrQOL declined by 0.005 per year when controlling for various other factors. M. L. Hazell, J. A. Morris, M. F. Linehan, and T. L. Frank, "Temporal Change in Health-Related Quality of Life: A Longitudinal Study in General Practice 1999-2004," *British Journal of General Practice*, 59: 2009, 839-843. Ekwaru, Ohinmaa and Veugelers translate the Hazell et al. change in HrQOL into a reduction of 0.0025 QALYs per person per year. J. P. Ekwaru, A. Ohinmaa, and Paul J. Veugelers, "The Effectiveness of a Preventive Health Program and Vitamin D Status in Improving Health-Related Quality of Life of Older Canadians," *Quality of Life Research*, August 2015, 1-8 (<http://link.springer.com/article/10.1007/s11136-015-1103-7/fulltext.html>)

²⁸ Ibid.

Consider an alternative perspective for the economic evaluation of the PN program. For the persisting senior participants, we have found that \$448 of hospitalization and ambulatory care costs are avoided in the second year in the program. These are often referred to as the direct benefits of an intervention. The indirect benefits reflecting improved workplace productivity are typically considered equal in size to the direct benefits of an intervention.²⁹ If that is the case, then the PN program generates \$448 in indirect benefits. If the value of a year in full health is \$50,000 as per the ICER discussion above, then the value of the improved health as measured by the increases in QALYs is \$1,300. The sum of these values generated by the PN program is \$2,196 which compared to the 2014/2015 program cost of \$938 yields \$2.36 in benefit for each dollar of program cost.

Note that our calculations of cost effectiveness and return on investment are conservative, meaning that they are biased against finding that this program is good value for money. We have not accounted for the additional values of health-care costs avoided in future due to lower chronic disease prevalence which are estimated to be as much as 25 per cent of acute care treatment costs in Canada. These direct returns to chronic disease prevention could be large. Frank Denton and Byron Spencer (2010) show that “the savings from even a modest reduction in the prevalence of chronic conditions would be substantial,” on the magnitude of about a 16 per cent reduction in nights in hospital and a 10 per cent reduction in consultations with family physicians.³⁰ An Alberta Health projection in 2013 showed that if the prevalence of diabetes between 2012 and 2020 could be held at 2011 levels, \$1.9 billion in health-care costs could be avoided over that period of time.³¹ Whatever these magnitudes are, our study suggests that as the costs of preventive care are recouped through hospitalization and ambulatory care services avoided, improved health and improved productivity, chronic disease burden reductions are pure return to preventive care.

The returns to preventive care are immediate and large and the intuition for why that is the case is obvious when you compare the evaluation of prevention to the economic evaluation of medical treatment. The methods of economic evaluation applied to medical treatment, drugs and medical devices have been relatively straightforward as the benefits of a therapy or intervention occur close in time to the application of the intervention, and the benefits, often measured by improvement in a surrogate health endpoint, are distinct to the intervention. That is, a single drug will have an impact on a single outcome like blood pressure or blood cholesterol. Prevention interventions, in contrast, could have benefits in the immediate term but also benefits accruing over time. An intervention will not impact on only one outcome but can generate many benefits which are additive. That is, the same intervention will have preventive effects on several chronic disease risks. With preventive care, benefits from the care are additive and are more likely to generate positive side-effects

²⁹ See Public Health Agency of Canada, “Investing in Prevention - The Economic Perspective: Key Findings from a Survey of the Recent Evidence,” May 2009, 2.

³⁰ Frank Denton and Byron Spencer, “Chronic Health Conditions: Changing Prevalence in an Aging Population and Some Implications for the Delivery of Health Care Services,” *Canadian Journal on Aging / La Revue canadienne du vieillissement*, vol. 29, special issue 01, March 2010 (18), 11-21.

³¹ Surveillance and Assessment Branch, Alberta Health, “Health Care System Cost of People with Diabetes,” *Public Health Surveillance Bulletin* no. 3, June 2013. That estimate was based on the costs of inpatient hospitalizations, ambulatory care and physician services. Ohinmaa et al (2004, 119) estimate the per capita health-care system costs of a diabetic person to be \$3,834 (\$3,203 in 2004 purchasing power) per year. A. Ohinmaa, P. Jacobs, S. Simpson, and J. A. Johnson, “The Projection of Prevalence and Cost of Diabetes in Canada: 2000 to 2016,” *Canadian Journal of Diabetes*, 28: 2004, 116-123.

which contrasts with pharma and medical treatments that are typically aimed at specific outcomes and can come with increased risks and negative side-effects.

LIMITATIONS

We recognize several limitations of our analysis. First, the PN program was organized to deliver services and was not structured to be an intentional prospective research study. Consequently, the degree of personalization of services provided to participants, and the changes in what the program does over time, mean that the intervention that we investigate is not clearly defined. Nor are we able to attribute outcomes to any one aspect of the program. The specific aspects of the program are not modular, all individuals are given the baseline program and minor adjustments are made on an individual basis by Pure North clinicians.

We lack direct measures of program adherence and we rely on a proxy of adherence represented by persistence in the program, and conditional on persisting in the program -- the level of serum 25(OH)D (nmol/L) to indicate compliance/adherence with supplementation. While that proxy measure has face validity, a more direct measure of persistence is preferable.

Finally, we are studying a program which has voluntary participation. The potential for sample selection of who chooses to join, those who provided valid PHNs, and who chooses to persist in the program, means that there may be systematic, but unobserved, differences in health that influence levels and trajectories of health-care utilization between the participant and control groups which undermine a causal interpretation of our estimates as program effects on health. Further, whether an individual persists could be endogenous with change in health utilization: If someone experiences improvement, they could be more likely to persist, and vice versa. That said, as an anonymous reviewer noted, if a public payer were to fund a program like PN, the choice to access the program would be voluntary as it is unlikely universal participation could be mandated. In that context, an understanding of the causal effects of access to a program such as PN would be relevant for understanding the potential benefits and costs of lower barriers to accessing preventive care.

To address these limitations with our current study, one could pursue a prospective study with individuals randomly assigned to different defined treatment groups. Prospective studies could also trial the treatment approaches in alternative community settings to determine if the results of this study generalize to the broader population.

CONCLUSIONS

Our analysis confirms the previous findings in the Dutton et al. (2015) study that for PN program participants in the first year of the program, there are statistically significant reductions of 27 per cent in the number of hospital visits and of 14 per cent in the number of emergency department visits, relative to what we observe in the age- and sex-matched controls. For the participants whom we can confirm persisted in the program at least one

year, the effect sizes for the first year after joining are larger than Dutton et al. previously found. There are 54 per cent fewer visits to hospital in the year after joining and 34 per cent fewer visits to emergency departments. Extending our study to the second year after joining the PN program, we found sustained, statistically significant reductions in hospital admissions for participants aged 55 to 74. Reductions in emergency department visits in the second year in the program were 28 per cent for participants whom we could confirm persisted in the program. Overall, we find that for participants who persist in the program there are sustained reductions in health-care use to two years.

In terms of health-care costs attributable to the population represented by this sample, these reductions in annual health-care utilization attributable to the program are worth from \$294 per person who joined the program to \$600 per person who was known to have persisted in the program for at least one year. For participants who persist to a second year in the program, hospitalization and emergency department costs avoided are \$276. These represent reductions in annual health spending of 22 per cent and 45 per cent of the \$1,320 average cost of hospitals, emergency departments and use of general practitioners for the sample relative to the year prior to joining the program. For persisting participants, reductions in spending are 21 per cent of the spending in the year prior to joining PN.

Given the program costs in 2014/2015, the value proposition of this prevention strategy cannot be made solely on the basis of the immediate impact on health-care utilization. We show that the gain in health as measured by QALYs is sufficiently large that the PN program represents a cost-effective health intervention. For every dollar spent on a persisting PN participant, \$2.36 in benefit results through hospitalization and ambulatory care services avoided, health gains and improved productivity. The value proposition of preventive care is also likely better than we can show as there will also be future costs avoided when the better health and lower chronic disease risks of the population are considered. This means that the gains to the system from future reductions in health-care spending for treating and managing chronic diseases are pure return for the public payer.

Why should decision makers take notice of these reductions in health-care utilization through investment in preventive services for healthy members of the population? Chronic disease is now the leading cause of death and disability in Canada, resulting in great and rising expense through Canada's publicly funded medical treatment system -- Medicare. Twenty-five per cent of Medicare expenditures are attributable to avoidable chronic diseases and conditions. The reductions in health-care utilization generated by the PN program demonstrate that prevention is an effective approach for "bending the health-care cost curve" that can begin in the immediate term, not just years out. Preventive care delivered to the Alberta population has the potential to free up acute care bed capacity that is equivalent to the addition of the bed capacity of one of Alberta's larger hospitals. In other words, investing in health promotion eliminates the need to build more acute care bed capacity with the positive side-effects that come with the improved health and well-being of Albertans.

Our analysis lends support to policy commentators who call for greater emphasis in the health-care system on chronic disease prevention and health improvement to address the sustainability of Canada's publicly funded health-care systems. Don Drummond suggests that "a broader perspective would consider the cost savings possible through

improving various lifestyle patterns that have health implications. For example, education interventions may be more effective in lowering future health-care costs than investments in hospitals today.”³² Steven Lewis and Terrence Sullivan argue “that bending the needs curve is the best way to bend the cost curve. Every structure and incentive should be aimed at preventing or postponing avoidable health breakdown.”³³ In 2013, Dr. Louis Hugo Francescutti, president of the Canadian Medical Association, argued that “policy makers should start looking at the health system beyond disease treatment and think about prevention. Prevention can pay a fiscal dividend.”³⁴ Stephen Duckett recommends that provincial governments address the upstream causes of acute care health spending through an expansion of the scope of public payment for health care to include cost-effective services for health promotion and disease prevention.³⁵

³² Don Drummond, “Benefactor’s Lecture, 2011: Therapy or Surgery? A Prescription for Canada’s Health System,” (Toronto: C.D. Howe Institute, 2011, 4-5). Accessed at http://www.cdhowe.org/pdf/Benefactors_Lecture_2011.pdf April 17, 2013.

³³ Lewis and Sullivan see the actual role of the health-care system as being one of “secondary prevention,” preventing conditions from getting worse through better management of chronic disease. This is because they believe that primary prevention, avoidance of conditions in the first place, is the product of social and economic conditions that are beyond the purview of health care to change.

³⁴ “So can improved social and economic conditions,” says Dr. Louis Hugo Francescutti, president, Canadian Medical Association. Francescutti, “Here is Another Reason to Improve CPP - Your Health,” *Canadian Newswire*, Dec. 20, 2013, (accessed at: <http://www.newswire.ca/en/story/1283341/here-is-another-reason-to-improve-cpp-your-health-by-dr-louis-hugo-francescutti-president-canadian-medical-association>)

³⁵ Stephen Duckett, *Where to from Here? Keeping Medicare Sustainable* (Kingston and Montreal: McGill-Queen’s University Press, 2012).

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