Postoperative Coronary Artery Bypass Graft Hospital Readmissions in Rural, Remote and Northern Communities: A Retrospective Case-Control Study

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Abstract

Rural, remote, and northern communities (RRNC) have high rates of hospital readmissions post-coronary artery bypass graft (CABG). I performed a case-control study to understand the contributing factors associated with postoperative CABG readmissions in residents of RRNC, including the influence of the social determinants of health (SDOH). All patients readmitted within 30-days of CABG between 2021 and 2023 and a subset of non-readmitted patients, matched for age and sex, were included. Logistic regression showed that readmission was associated with myocardial infarction (OR 2.517; CI 1.493-4.242), surgical wait time (OR 1.016; CI 1.003-1.030), town of residence (OR 0.183; CI 0.066-0.512), distance from hospital (OR 1.010, CI 1.005 – 1.015), and need for community care (OR 14.968; CI 4.026-55.645). Factors for readmission were less associated with patient health factors but rather associated with SDOH, including, health services, physical environment, and community factors. Nursing implications include clinical practice, education, research, and health policy.

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List of Abbreviations

ANOVA	Analysis of Variance
APN	Advanced Practice Nursing
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CARRN	Canadian Association for Rural and Remote Nursing
CASN	Canadian Association of Schools of Nursing
CIHI	Canadian Institute of Health Information
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CVD	Cardiovascular Disease
HSN	Health Sciences North
ICD-11	International Classification of Disease, Eleventh Edition
NOSM	Northern Ontario School of Medicine
PIPOH	Population, Phenomena of Interest, Patients' Outcomes, and Health Setting
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
REB	Research Ethics Board
RNAO	Registered Nurses Association of Ontario
RRNC	Rural Remote and Northern Communities
SDOH	Social Determinants of Health
USA	United States of America

Chapter 1: Introduction

Research Problem

Over 800,000 people live in rural, remote, and northern communities (RRNC) in Ontario. These communities represent 88% of Ontario's land mass (Government of Ontario, 2023). Residents living in RRNC have the worst health statuses in Ontario, with cardiovascular disease (CVD) being the most prominent condition (Donio et al., 2019). Due to reduced access to specialized healthcare services and longer wait times, the cardiac health status of RRNC's residents often progresses to the point where invasive interventions are required, such as the minimally invasive percutaneous coronary intervention (PCI) or more invasive coronary artery bypass grafts (CABG) surgery (Donio et al., 2019).

Recovery from a CABG can be strenuous, especially for people living in RRNC compared to people living in urban areas for various reasons including disparities in the social determinants of health (SDOH) such as lower income status, and poor physical environment (Feng et al., 2018; Hale et al., 2021). In fact, 10.6% of CABG procedures performed in Northern Ontario result in hospital readmissions in comparison to average readmission rates of 7.9% in Southern Ontario (Canadian Institute for Health Information [CIHI], 2022). Hospital readmissions post-CABG are associated with increased patient morbidity and mortality, as well as healthcare burdens such as increased costs (Feng et al., 2018; Khoury et al., 2019). Yet, little is known about the factors associated with postoperative readmissions in residents of RRNC, in particular the influence of the SDOH alongside more standard sociodemographic and clinical variables. In this thesis, I identified the factors associated with hospital readmission post-CABG in patients living in RRNC, with a particular focus on SDOH, for a more holistic understanding of the health-related factors associated with their readmissions.

Background

Rural, Remote, and Northern Communities

Within Ontario, there is a rich diversity of people, systems, and environments given the variety of lands, cultures, languages, and traditions (Burnett et al., 2020). The province of Ontario has a population of over 14 million residents, occupying 917,741 square kilometres of Canada's land mass (Statistics Canada, 2021). Nearly 25% of Ontario's population live in RRNC (Health Quality Ontario, 2017). Based on the definition widely used by Statistics Canada (2021), a rural community is any community outside of a population center. Population centers are classified into three groups: small, having populations of 1,000 to 29,999, medium having populations of 30,000 to 99,999 and large having populations of 100,000 or more. Remote communities are defined as geographic areas only accessible by air or ice roads (Government of Ontario, 2023). Finally Northern Ontario communities are any areas within the districts of Algoma, Cochrane, Kenora, Manitoulin, Nipissing, Parry Sound, Rainy River, Sudbury, Thunder Bay, and Timiskaming. In total, there are 393 communities out of 444 total (88.5%) in Ontario that are considered rural, remote, and/or northern (Government of Ontario, 2023).

There is a multitude of cultures, languages, races, and ethnicities within these communities, with the most common being First Nations, Métis people, and francophones (Health Quality Ontario, 2017; Vodden & Cunsolo, 2021). Moreover, RRNCs have supported the postcolonial development of Ontario through agriculture, natural resources, business and building key transportation networks (Registered Nurses Association of Ontario [RNAO], 2015; Vodden & Cunsolo, 2021). Although they dominate the physical landscape of Ontario and support Ontario's development, residents in RRNC face precarious health environments and varying degrees of isolation (Vodden & Cunsolo, 2021). As such, challenges that continue to be encountered

include distance between medical centers, limited access to various methods of transportation, and population shifts tied to boom and bust economies (Vodden & Cunsolo, 2021).

Health disparities

People living in RRNC in Ontario have very different health experiences and poorer outcomes than those living in urban centers (Hale et al., 2021; Health Quality Ontario, 2017; Vodden & Cunsolo, 2021). In fact, they have a shorter life expectancy, of 78.6 years compared to 81.5 years, than people living in urban parts of the province, respectively (Health Quality Ontario, 2017). Health conditions commonly identified in RRNC are diabetes, respiratory disease, obesity, suicide and injury, and most prominently coronary artery disease (CAD) (Health Quality Ontario, 2017). People living in RRNC are more likely to die prematurely from suicide, cardiovascular disease, or other causes (Health Quality Ontario, 2017). Reasons for these differences may be linked to the unique health and social challenges that people living in RRNC experience, in comparison to those living in urban communities (Hale et al., 2021). Hale et al. (2021) have proposed potential contributors, including differences in socioeconomic status, education level, and health behaviours (Hale et al., 2021). For example, Smale and Holliday (2020) described that residents of RRNC are less likely to complete high school. The authors also noted that there was a higher incidence of smoking among this population. These findings are similar to Desmeules et al.'s (2006) report, that revealed a significantly higher proportion of rural Canadians smoke or are exposed consistently to second-hand smoke.

Health Services

Ontario's RRNC lag provincial averages in quality of health and health care access (Health Quality Ontario, 2017). Services with close proximity of these regions remain limited thus suggesting that health equity does not exist between urban and rural communities. Despite

generous government funding having been allocated to health practitioners' recruitment and retention in RRNC, limited social infrastructure and employment opportunities outside healthcare (i.e., for partners and family members of recruited health practitioners) have hindered progress (Cherba et al., 2019).

While general health services are available, there is a significant lack of specialised services (Health Quality Ontario, 2017). For example, in renal care, Northern Ontario has five regional renal centers with nine satellite dialysis providers (Ontario Renal Network, n.d.). Patients outside the regional or satellite centers, must travel to dialysis three to four times a week to receive life sustaining services. Likewise, only three regional hospitals in Northern Ontario perform diagnostic coronary angiograms, creating an immense waiting list for all the cardiac patients in Northeastern and Northwestern Ontario (CIHI, 2022). Residents living in RRNC report that their health care needs were not met with respect to access, equity and improved overall health (Health Quality Ontario, 2017; Smale & Holliday, 2020). The inability to access services has been associated with geographic distance, socioeconomic status, (lack of) availability of health human resources and community infrastructure (Registered Nurses Association of Ontario, 2015). These factors are subsumed within the SDOH through the means of income and social status, physical environment, and health behaviours (Hale et al., 2021).

The Social Determinants of Health

Public Health Agency of Canada's 12 Social Determinants of Health (SDOH) are main contributors to health disparities in RRNC (Hale et al., 2021). SDOH-related disparities are often shaped by the unequal distribution of resources and power rooted in social identity and location (Hale et al., 2021). Numerous authors have proposed that people living in RRNC often experience poor outcomes related to inequities related to SDOH (Hale et al., 2021; Smale &

Holliday, 2020). In Chapter 2, the 12 SDOH will be thoroughly described as they apply to this thesis.

Coronary Artery Disease Diagnosis, Treatment and Management

There are 2.4 million Canadians living with CVD, making it the second leading cause of death in the country (Public Health Agency of Canada, 2017). CVD rates are 50% higher in people residing in Ontario's Northeast and Northwest Local Health Integration Network, than people living in the Central area (Tu et al., 2017). According to Desmeules et al. (2006), and Donio et al. (2019), individuals living in RRNC are more likely to die from CVD.

CAD is caused by blockages of the coronary arteries in the heart and can eventually lead to a myocardial infarction (Shahjehan & Bhutta, 2021). When CAD is suspected, a diagnostic coronary angiogram is performed to determine the best course of treatment, whether medications, angioplasty, or CABG (Shahjehan & Bhutta, 2021). Compared to urban communities, RRNC residents with suspected CAD wait considerably longer for a consultation with a cardiologist and an angiogram than their urban counterparts leading to further disease progression and increasing the likelihood of need for CABG (Schultz et al., 2018).

Coronary Artery Bypass Grafts in Ontario

Over 6,000 CABG are performed annually in Ontario (CorHealth Ontario, 2018). In a systematic review of 53 studies aimed at quantifying and exploring the causes for readmission within 30-days post-CABG, Shawon et al. (2021) found that within 30 days of discharge after a CABG, 12.9% of patients were readmitted due to postoperative complications. The majority of included articles were conducted in the United States of America (USA) (n= 40), with two studies conducted in both the United Kingdom (n=2) and Canada (n=2). None of the included articles reported data from a RRNC perspective. The most frequently reported reasons for

readmissions were incision infections (6.9-28.6%), new onset atrial fibrillation (4.5-26.7%), new onset heart failure (5.8-15.7%), or respiratory complications (1–20%).

CIHI (2022) reported on readmissions post-CABG in Canadian hospitals between 2018-2021. Health Sciences North (HSN), the main hospital serving most of Northern Ontario, was among the top five hospitals with the highest readmission rates after a CABG, with a rate of 10.6% (CIHI, 2022). Patients who live in Northeastern Ontario and require a CABG, are referred to have it performed at HSN. Complex surgical interventions with higher risk of complications, such as a combined mitral clip and CABG, are most often performed at a hospital or surgical centre in southern Ontario. To compare, two urban hospitals, St. Mary's Hospital in Kitchener, Ontario and Trillium Health Partners in Toronto, Ontario had the lowest readmission rates, with rates of 7.1% and 7.0% respectively (CIHI, 2022). Readmissions to urban hospitals are lower, as patients have additional opportunities to access essential care, such as 24-hour clinics, rather than being limited to hospital care, like most patients living in RRNC (Schultz et al., 2018).

In summary, disparities between rural and urban communities result in poorer cardiac health outcomes for people living in RRNC. This has implications for patients living in RRNC undergoing CABG as they are at increased risk of readmissions due to complications. Until now, reasons for readmissions post CABG have been limited to demographic and clinical characteristics, primarily in urban settings. The role of SDOH, in addition to demographic and clinical characteristics, in RRNC warrant further investigation.

Overview of Thesis Chapters

This chapter went into depth about the background related to RRNC and hospital readmission post-CABG. Chapter 2 consists of a literature review of relevant studies that compares readmission rates and factors related to readmission post-CABG. Chapter 3 describes

the methods of the thesis, a case-control study. Chapter 4 is a manuscript of this case-control study formatted for submission to the *Canadian Journal of Cardiovascular Nursing.* Finally, Chapter 5 is an integrated discussion which offers implications for nursing practice, education, policy, and research.

Contributions

My thesis advisory committee was created with the inclusion of health practitioners, researchers, and university professors. My supervisor is Dr. Krystina Lewis who is an Assistant Professor at the University of Ottawa and an Affiliate Researcher at the University of Ottawa Heart Institute. Dr. Lewis' role was to supervise me during every step of the research process, particularly in guidance related to cardiovascular nursing and mixed method research. Dr. J. Craig Phillips is Full Professor at the University of Ottawa. Dr. Phillips' role on the committee was to provide guidance on the SDOH and ensure this framework and its considerations are embedded throughout this work. Dr. Chris Verschoor is a Scientist at the Health Sciences North Research Institute, and an Assistant Professor at the Northern Ontario School of Medicine. As an affiliate with HSN, Dr. Verschoor supported this research as a liaison with HSN. He also provided his expertise in clinical epidemiology. Dr. Davina Banner-Lukaris is Associate Professor at the University of Northern British Columbia School of Nursing and Northern Medical Program. Dr. Banner-Lukaris provided expertise related to rural and northern health care service delivery.

References

Burnett, K., Sanders, C., Halperin, D., & Halperin, S. (2020). Indigenous Peoples, settler Colonialism, and access to health care in rural and northern Ontario. *Health & Place*, *66*, 102445. https://doi.org/10.1016/j.healthplace.2020.102445

Canadian Institute for Health Information (CIHI). (2022). *Cardiac care quality indicators report*. Retrieved from: https://www.cihi.ca/en/indicators/30-day-all-cause-readmission-rate-after-isolated-coronary-artery-bypass-graft-cabg

Cherba, M., Healey Akearok, G. K., & MacDonald, W. A. (2019). Addressing provider turnover to improve health outcomes in Nunavut. *Canadian Medical Association Journal*, *191*(13), E361–E364. https://doi.org/10.1503/cmaj.180908

CorHealth Ontario. (2018). *Report on adult cardiac surgery: Isolated coronary artery bypass graft (CABG) surgery, isolated aortic valve replacement (AVR) surgery and combined CABG and AVR surgery October 2011 - March 2016*. Retrieved from: https://www.corhealthontario.ca/Report-on-Adult-Cardiac-Surgery-October-2011-March-2016-April-2018.pdf

DesMeules, M., Pong, R., Lagacé, C., Heng, D., Manuel, D., Pitblado, R., Bollman, R., Guernsey, J., Kazanjian, A., & Koren, I. (2006). *How healthy are rural Canadians? An assessment of their health status and health determinants*. Retrieved from: https://secure.cihi.ca/free_products/rural_canadians_2006_report_e.pdf

Donio, P., Freitas, C., Austin, P., Ross, H., Abdel-Qadir, H., Wijeysundera, H., Tu, K., Cram, P., Liu, P., Abrams, H., Udell, A., Mak, S., Farkouh, M., Tu, J., Wang, X., Tobe, X., & Lee D. (2019). Comparison of readmission and death among patients with cardiac disease in Northern vs Southern Ontario. *Canadian Journal of Cardiology*, *35*(3), 341

DOI: 10.1016/j.cjca.2019.01.004S

Feng, T. R., White, R. S., Gaber-Baylis, L. K., Turnbull, Z. A., & Rong, L. Q. (2018). Coronary artery bypass graft readmission rates and risk factors - A retrospective cohort study. *International Journal of Surgery (London, England)*, *54*(Pt A), 7–17. https://doi.org/10.1016/j.ijsu.2018.04.022

Government of Ontario. (2023). *Growth plan for northern Ontario*. Retrieved from: https://www.ontario.ca/document/growth-plan-northern-ontario/people

Khoury, H., Sanaiha, Y., Rudasill, S. E., Mardock, A. L., Sareh, S., & Benharash, P. (2019). Readmissions following isolated coronary artery bypass graft surgery in the United States (from the Nationwide Readmissions Database 2010 to 2014). *The American Journal of Cardiology*, *124*(2), 205–210. https://doi.org/10.1016/j.amjcard.2019.04.018

Hale, I., Grzybowski, S., & Ramdin, Z. (2021). What makes a healthy rural community?. *Canadian Journal of Rural Medicine, 26*(2), 61–68. https://doi.org/10.4103/CJRM

Health Quality Ontario. (2017). *Health in the North: A report on geography and the health of people in Ontario's two northern regions*. Retrieved from: http://www.hqontario.ca/portals/0/Documents/system-performance/health-in-the-north

Ontario Renal Network. (n.d.). *Local services*. Retrieved from: https://www.ontariorenalnetwork.ca/en/local-services

Public Health Agency of Canada. (2017). *Heart disease in Canada: Highlights from the Canadian chronic disease surveillance system*. Retrieved from: https://www.canada.ca/en/public-health/services/publications/diseases-conditions/heart-disease-canada-fact-sheet.html

Registered Nurses' Association of Ontario (RNAO). (2015). *Coming together, moving forward:*

Building the next chapter of Ontario's rural, remote and northern nursing workforce –report. Retrieved from: http://rnao.ca/sites/rnao-ca/ files/RR_May8.pdf

Schultz, A., Dahl, L., McGibbon, E., Brownlie, J., Cook, C., Elbarouni, B., Katz, A., Nguyen, T., Sawatzky, J. A., Sinclaire, M., Throndson, K., & Fransoo, R. (2018). Health outcome and follow-up care differences between First Nation and Non-First Nation Coronary Angiogram Patients: A retrospective cohort study. *Canadian Journal of Cardiology*, *34*(10), 1333–1340. https://doi.org/10.1016/j.cjca.2018.07.418

Shahjehan, R. D., & Bhutta B. S. (2021). Coronary artery disease. *StatPearls Publishing*. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK564304/

Shawon, M. S. R., Odutola, M., Falster, M. O., & Jorm, L. R. (2021). Patient and hospital factors associated with 30-day readmissions after coronary artery bypass graft (CABG) surgery: a systematic review and meta-analysis. *Journal of cardiothoracic surgery*, *16*(1), 172. https://doi.org/10.1186/s13019-021-01556-1

Smale, B., & Holliday, C. (2020). *A profile of wellbeing in rural Ontario: A report by the Canadian index of wellbeing prepared for the rural Ontario institute.* Retrieved from: https://uwaterloo.ca/canadian-index-wellbeing/sites/default/ files/uploads/documents/ruralontarioreport-ciw-accessible_final.pdf

Statistics Canada. (2021). *Population Centre (POPCTR).* Retrieved from: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?ID=geo049a

Tu, J. V., Chu, A., Maclagan, L., Austin, P. C., Johnston, S., Ko, D. T., Cheung, I., Atzema, C. L., Booth, G. L., Bhatia, R. S., Lee, D. S., Jackevicius, C. A., Kapral, M. K., Tu, K., Wijeysundera, H. C., Alter, D. A., Udell, J. A., Manuel, D. G., Mondal, P., Hogg, W.,

Cardiovascular Health in Ambulatory Care Research Team (CANHEART). (2017). Regional variations in ambulatory care and incidence of cardiovascular events. *Canadian Medical Association Journal, 189*(13), E494–E501. https://doi.org/10.1503/cmaj.160823

Vodden, K. and Cunsolo, A. (2021). Rural and Remote Communities. *Canada in a Changing Climate: National Issues Report.* Retrieved from: https://natural-resources.canada.ca/sites/nrcan/files/GNBC/Chapter%203_Rural%20and%20Remote%20Communities_Final_EN.pdf

Chapter 2 : Literature Review

Literature Review Methods

A focused literature review was conducted to explore and synthesize the recent available literature on postoperative CABG readmissions, in both urban and rural communities. In this literature review, I also identify the gaps in knowledge with attention to the SDOH.

Research Strategy

The search strategy was designed in consultation with a University of Ottawa academic librarian. I searched several electronic databases to identify peer-reviewed literature related to factors associated with postoperative CABG hospital readmissions for patients living in RRNC or urban communities. Databases included the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and the Joanna Briggs Institute as they were the primary health related databases accessible through the University of Ottawa network. I searched the following key words in various combinations: rural, urban, readmission, coronary artery bypass grafts, postoperative, and risk factors. I identified additional articles by hand searching reference lists of systematic reviews and meta-analyses. The PRISMA diagram, which includes the results of the database and hand searches, is included in Figure 1.

Screening and Sorting

The eligibility criteria were informed using the population, phenomena of interest, patients' outcomes, and health setting (PIPOH) framework: Population (P) included adults over 18 years who underwent a CABG; the Phenomena of interest (I) was hospital readmission post-CABG; Patient outcomes (PO): health-related and social factors associated with hospital readmission post-CABG; and Health setting (H): urban or rural, remote and northern. I included peer reviewed studies using quantitative, qualitative, and mixed methods designs including knowledge syntheses. I included articles published 2012 to the 2024 to include the most recent

and relevant literature in keeping with contemporary CABG approaches and management. (Pautasso, 2013). I excluded articles if they: 1) focused on children less than 18 years, 2) included findings related to the perspectives of families of cardiac surgery patients; 3) were related to other open-heart surgeries with or without CABG (e.g., valvular surgeries + CABG); 4) focused on emergency room visits only; 5) were editorials, commentaries, discussion papers, or case reports; and 6) were published in a language other than English.

Results of Literature Review

Out of 1787 citations identified from databases and hand searches, a total of 19 peer-reviewed studies met eligibility criteria. The following literature review will begin with a description of the characteristics of included studies. While reading and rereading each article, I wrote down critical pieces of information, and insights to synthesize the known contributing factors of hospital readmission post-CABG, with particular attention to the reporting of SDOH. Although no articles explicitly studied the SDOH in this context, multiple risk factors that have been linked with readmission align with certain determinants. Finally, the gaps in knowledge identified from this literature review will be discussed. The characteristics of included studies are listed in Table 1.

Characteristics of Included Studies

Most articles were based in the USA (n = 14). Other countries of publication included Australia (n = 1), Canada (n = 1), Korea (n = 1), Saudi Arabia (n = 1), and Lebanon (n = 1). Publication dates ranged from 2013 to 2021. This review included two systematic reviews, 13 cohort studies and four case-control studies. The systematic reviews primarily included retrospective quantitative studies. Shawon et al. (2021) included 53 studies in their review, while Son et al. (2021) included 14 studies. The retrospective case-control and cohort studies identified

factors related to readmissions in patients post-CABG and were conducted in a variety of settings characterized by hospital size (large, medium, and small) and location (large metropolitan, small metropolitan, and rural) (Deo et al., 2018; Feng et al., 2018; Shah et al., 2019). The number of participants in the studies included in this literature review ranged from 110 to 12,062,081.

Readmission Rates Post-Coronary Artery Bypass Graft

Eighteen articles reported a range of readmission rates between 9.1% and 23% within the 30-day postoperative period. Feng et al. (2018) suggested that the wide range in readmission rates is possibly due to the various sizes of hospitals available to patients living in the USA. Feng et al. (2018) explain that at time of initial admission and at readmission, patients may favor visiting larger hospitals with better resources and reputation, over smaller metropolitan hospitals, causing a skew in readmission rates per institution. This reflects the availability of health care resources in major urban centers, such as New York, including, large academic, tertiary care centres (Feng et al., 2018). Readmission rates in Saudi Arabia were 16.1% (Alghafees et al., 2020), Canada were 11.5% (Tam et al., 2018), and Lebanon were 9.1% (Saab et al., 2013). Systematic reviews by Son et al. (2021) and Shawon et al. (2021) reported ranges of readmission between 9.2% to 18.9% and 11.3% to 23.3%, respectively.

Factors Associated with Readmission

Authors of included articles reported numerous causes associated with readmission post-CABG, including at the level of the patient, procedure, and hospital. At the level of the patient, these included cardiac causes, non-cardiac causes, and demographic factors.

Cardiac Factors

Cardiac factors associated with readmission post CABG were identified in all included studies. The most common cardiac causes were congestive heart failure (7.8% – 19.9%; *n*=11)

and atrial fibrillation (5.7% – 26.8%; *n*=9) (Feng et al., 2018; Hirji et al., 2020; Iribarne et al., 2014; Khoury et al., 2019; Shah et al., 2019; Shawon et al., 2021; Son et al., 2021; Tam et al., 2019; Trooboof et al., 2019). Myocardial infarction post-CABG (13% – 19.9%; *n*=6) was also noted by many authors as a cause of readmission (Benuzillo et al., 2018; Case et al., 2020; Khoury et al., 2019; Shawon et al., 2021; Tam et al., 2019; Trooboof et al., 2019).

Non-Cardiac Factors

Non-cardiac factors associated with readmission post CABG were also identified in all included studies. In a cohort study, Case et al. (2020) noted that most readmissions (80%) were non-cardiac related. Similarly, Shawon et al. revealed in their systematic review that the majority of readmissions occurred for non-cardiac causes. Respiratory and infectious complications were the most common non-cardiac causes (Benuzillo et al., 2018; Case et al., 2020; Connolly et al., 2017; Deo et al., 2018; Fanari et al., 2017; Feng et al., 2018; Fox et al., 2016; Hirji et al., 2020; Iribarne et al., 2014; Khoury et al., 2019; Price et al., 2013; Rosenblum et al., 2019; Shah et al., 2019; Shawon et al., 2021; Son et al., 2021; Trooboof 2019; Tam et al., 2019). Respiratory complications most commonly included pleural effusions, which have been associated with the development and onset of heart failure (Feng et al., 2018; Iribarne et al., 2014; Price et al., 2013; Shawon et al., 2021; Son et al., 2021; Tam et al., 2019; Trooboof 2019). Fifteen studies reported that infectious complications were contributing factors to readmission. In a cohort study (n = 2218 patients), Trooboof et al. (2019) reported that infections accounted for 26% of readmissions, including pneumonia, incisional infections, and endocarditis.

Demographic Factors

Patient demographics are referred to as factors that are not associated with the procedure, but rather related to patient characteristics. The most common demographic factors associated

with readmission post-CABG included age over 70 years, female sex, non-white race, and body mass index over 30 kg/m^2 (Benuzillo et al., 2018; Case et al., 2020; Connolly et al., 2017; Deo et al., 2018; Fanari et al., 2017; Feng et al., 2018; Fox et al., 2016; Hirji et al., 2020; Iribarne et al., 2014; Khoury et al., 2019; Price et al., 2013; Rosenblum et al., 2019; Shah et al., 2019; Shawon et al., 2021; Son et al., 2021; Trooboof 2019; Tam et al., 2019). Many authors, specifically in the USA, focused on insurance status as an indicator for readmission. The four insurance status groups were private insurance, Medicaid, Medicare and self-pay or no charge (Feng et al., 2018). To clarify, Medicare is medical insurance for American citizens over 65 years or younger people with disabilities, whereas Medicaid is a medical assistance program for low-income patients (Feng et al., 2018). Readmission rates were highest for those receiving Medicaid (20.2%) and Medicare (18.4%), which is unsurprising given age over 70 and low income was also identified as a risk factor. As Medicaid is a program for low-income patients, we may consider it alongside the social determinant of "income and social status". Less income and more reliance on public insurance can increase vulnerability to postoperative complications (Feng et al., 2018; Khoury et al., 2019). Although the latter research was conducted within a USA context, other countries have different healthcare funding models that align with these approaches to paying for health care. For example, Canada provides universal healthcare for most essential healthcare costs like hospital admissions, and health care practitioner visits. However private insurance or disability insurance is required for pharmaceuticals, dentistry, and many other services. The need for funding for these healthcare services increase the financial burden on patients (Tam et al., 2018)

Procedure and Hospital-Related Factors

Procedure and hospital-related factors include those directly related to the CABG surgery, time in hospital, and size or location of the hospitals where surgery took place. The

procedure-related factors associated with readmission included mechanical ventilation time over 530 minutes, nonelective or emergent surgery, and length of stay over 10 days. Nonelective or emergent admission or surgery is defined as a patient who presented with unstable angina and underwent CABG within 24 hours. Emergent surgery was strongly associated with postoperative readmission (Case et al., 2020; Connolly et al., 2017; Deo et al., 2018; Feng et al., 2018; Fox et al., 2016; Iribarne et al., 2014; Khoury et al., 2019; Price et al., 2013; Rosenblum et al., 2019; Shah et al., 2019; Shawon et al., 2021; Son et al., 2021; Trooboof et al., 2019; Tam et al., 2019).

Hospital-related factors included the size or locations of hospitals. Shah et al. (2019) conducted a retrospective cohort study using USA-based data from the National Readmissions Database to evaluate the incidence, cost, and risk factors for readmission post-CABG. They revealed that hospital size was significantly different in readmitted and non-readmitted patient, stating: "Readmissions are more likely from hospitals in large metropolitan areas with at least 1 million residents (51.8% versus 48.9%) and less likely to come from hospitals in small metropolitan areas with less than 1 million residents (45.3% versus 48.4%)" (Shah et al., 2019, 1784). However, this USA-based article used data from a nationwide database where only 2.8% of their data was collected in non-urban hospitals. Whereas Hirji et al., also conducted a retrospective cohort study and researched the frequency, risk factors, and outcomes of nonindexed hospital readmission after cardiac surgery. They noted that living in rural or suburban areas (OR=1.22) was a significant factor associated with nonindexed hospital readmission. Similarly, in Tam's et al. (2018) retrospective cohort study, they sought to develop a predictive risk score for readmission after discharge from cardiac surgery in Ontario residents. Authors found that 16.8% of patient living in a rural town were readmitted (Tam et al., 2018).

Predicting Readmissions: Risk Scores for Readmission

Authors attempted to predict readmissions post-CABG with the use of risk scores. A risk score is a way of stratifying a patient for targeted screening using individualized data from pre-determined risk factors. Usually, a higher score reflects higher risk. In this context, risk scores aimed to predict a patient's chances of being readmitted to the hospital post-CABG (Fanari et al., 2017). It is preferably calculated prior to surgery but can be calculated at any time after the initial admission. Using patient-level and procedure-related characteristics, many CABG-related risk models used a logistic regression with a C-statistic to predict risk scores of readmissions post-CABG. In this literature review, I identified six risk models for post-CABG readmission. The risk models and the factors included within them are presented in Table 2.

Using risk models allow health care practitioners to prospectively identify high risk patients ahead of the CABG and ensure enhanced discharge planning and follow-up. However, Fanari et al. (2017) found that predicting risk required more complete clinical data than what is available in hospital databases, complicating their use in clinical practice. Similarly, Price et al. (2013) also reviewed existing risk models and concluded that they are not as comprehensive as they could be, and warrant revision. Based on previous risk models, Tam et al., (2018) developed and adapted a clinical risk model with 22 variables that delineated patients into one of five risk quintiles. Furthermore, three different groups of authors used the Nationwide Readmissions Database as their primary source of data (Deo et al., 2018; Khoury et al., 2019; Shah et al., 2019) and all identified prolonged length of stay, female sex, atrial fibrillation, and renal failure as risk factors. However, each article utilized this database during different years, thus possibly explaining the differences in other findings.

Gaps in the literature

In this literature review, the patient-related, procedure-related, and hospital-related factors associated with readmission post-CABG have been discussed. However, many gaps in the literature remain. First, there is a paucity of literature on how the SDOH influence a person's risk for readmission post-CABG. While some authors have reported that race, and income status are associated with readmissions post-CABG, a more fulsome look at their influence may provide opportunity to optimize patients' circumstances pre-operatively, which may translate into better health outcomes and fewer readmissions post-operatively. While insurance status was identified as a factor associated with readmission post-CABG in USA-based studies, this has not been investigated for patients living in Ontario's RRNC.

Second, few studies have been conducted in RRNCs in Canada. Much of the existing literature is USA-centric. Research is needed on this topic in Canada, there may be important differences in readmission based on the different health care systems.

Third, none of the articles went into depth on the impact of rurality on hospital readmissions post CABG. Hence, it is not yet understood what specific factors are unique to rural or remote communities and how they affect readmission after a CABG. On the other hand, a retrospective cohort study by Donio et al., (2019) analysed hospital readmission and death in Northern versus Southern Ontario in patients with cardiac diseases. The authors found that patients living and readmitted in RRNC were less likely to be consulted by a cardiologist for cardiac related readmissions and less likely to access post-discharge transitional resources. Donio et al., (2019) discuss the disparities in health care access more prominent in those living in Northern Ontario in comparison to those living in Southern Ontario, however, do not provide in-

depth risk factors for readmission in alignment with the SDOH. Thus, this study provides an initial basis for readmission risk factors for those in RRNC.

Considerations for Social Determinants of Health

In this literature review, there was limited reference to the SDOH as factors associated with readmission post CABG. The only determinants that were considered in select articles were race and income/social status, where non-white race, and insurance status were associated with readmission (Benuzillo et al., 2018; Case et al., 2020; Connolly et al., 2017; Deo et al., 2018; Fanari et al., 2017; Feng et al., 2018; Fox et al., 2016; Hirji et al., 2020; Iribarne et al., 2014; Khoury et al., 2019; Price et al., 2013; Rosenblum et al., 2019; Shah et al., 2019; Shawon et al., 2021; Son et al., 2021; Trooboof 2019; Tam et al., 2019). It is possible that if SDOH were incorporated in more of the articles, risk models to predict readmission would be more person-centered as opposed to disease-centered. The SDOH includes all aspects of a person's social, economic, and physical environment as well as their access to health services and healthy behaviours. Thus, each of these factors, along with those identified by the authors within this literature review would allow a comprehensive model to predict risk of readmission.

Theoretical Underpinnings

The theoretical perspectives underpinning this research are the *Rural Nursing Theory* (Winters & Lee, 2018) and the *Public Health Agency of Canada's Social Determinants of Health framework*. The Rural Nursing Theory is a middle range theory that 1) explains how people living in rural communities shape their lives, and 2) how nurses adapt their practice to tailor and enhance patient-centered care in these settings (Winters & Lee, 2018). The SDOH framework describes the elements that constitutes the environments in which people live, learn, work, and function (Government of Canada, 2020). The SDOH also impact the way people view health and

access services. Taken together, these complementary theories will form the basis of understanding the ways of life of RRNC residents and how they view health, how the SDOH are integrated in their everyday environment, and how nursing practice can be tailored based on individuals' and communities' unique needs, particularly for individuals preparing for or recovering from CABG.

Rural Nursing Theory

Rural Nursing Theory is a middle range theory that defines health as a way of life and state of mind, much like people living in rural environments do (Winters & Lee, 2018). The goal of this theory is to define nursing practice within a rural environment by understanding how rural residents view health and how it affects their everyday interactions. The two main assumptions in the Rural Nursing Theory are that rural residents have a sense of self-reliance and resilience. *Self-reliance* is defined as the approach of relying on one's own efforts and abilities to maintain health. *Resilience* is defined as the ability to remain strong during tough circumstances. Due to smaller population sizes, residents within RRNC have strong ties to each other that result in a sense of community togetherness (Rohatinsky et al., 2018). When confronted with health-related concerns, RRNC residents tend to ask each other for informal health advice rather than turning to formal healthcare services for answers (Stewart Fahs, 2017). Residents prefer to make decisions and seek care based on self-assessment and the resources they perceive they need (Rohatinsky et al., 2018). Most often, informal systems are relied upon as health care resources such as a neighbor or friend who has experienced a similar situation. A current example on the use of informal healthcare advice is the topic of vaccine hesitancy. Smale and Holliday, (2020) reported that those living in a rural community in Ontario were more likely to express COVID-19 vaccine

hesitancy. Community members were reported to be influenced and misinformed by each other as they supported each other through decision-making about the vaccine.

By understanding the concepts of self-reliance and resilience with the rural nursing theory, nurses learn to adapt their services to suit the culture and lifestyle of rural residents (Winters & Lee, 2018). A nurse working in a RRNC learns that their profession does not end after working hours or after leaving the health care facility. Residents may approach the nurse if seen in community, such as a grocery store, and seek health care advice. Residents often prefer this method of informal health care. Another important role of the nurse as described by this theory is being able to adjust practice based on the patient's pre-existing knowledge of health. The use of informal sources of health information from the community could be a facilitator or a barrier to health. For example, some informal health advice may come from a friend who has had a similar health situation. However, each individual has unique characteristics to their health in which one treatment plan may not be suitable for another person. This has implications in the context of CABG recovery. For example, to screen for potential heart failure, patients are instructed to report a weight gain of more than 3 to 5 pounds in one week (Garland et al., 2022). However, a patient with obesity must report weight gain of more than 2 to 3 pounds in one week (Garland et al., 2022). Thus, the nurse must be able to individualize recommendations to ensure patients seek formal health advice and services as required (Winters & Lee, 2018).

Social Determinants of Health Framework

The Public Health Agency of Canada's 12 Social Determinants of Health is a framework that depicts the social determinants as a series of personal, social, economic, and environmental factors that impact health, that can be considered by health care providers, politicians and major stakeholders when making healthcare policies and decisions to improve patient and population

health (Kolahdooz et al., 2015). The 12 determinants of health are 1) income and social status, 2) employment and working conditions, 3) education and literacy, 4) childhood experiences, 5) physical environments, 6) social supports and coping skills, 7) healthy behaviours, 8) access to health services, 9) biology and genetic endowment, 10) gender, 11) culture, and 12) race / racism (Government of Canada, 2020, para. 2). When one or more of the determinants favors urban communities, there becomes an unfair advantage to those living in rural or remote communities. For example, more opportunities for employment in urban communities result in better income and social status. In rural communities by comparison, residents may be faced with fewer opportunities for stable employment.

Each determinant of health contributes to a persons' health status, with synergistic effects. From a rural health context, the inequality of one or more determinants can create or contribute to a system of poor health status. In this section, I will outline the twelve SDOH as per the Government of Canada (2020) and describe its relevance to rural health.

To start, health status is commonly influenced by *income and social status* (Kreatsoulas & Anand, 2010). The greater the gap in income status, then the greater the divide in an individual's overall living conditions (Kreatsoulas & Anand, 2010). Low income and social status contribute to the lack of ability to afford nutritious foods, prescription medications, or access speciality health care like private clinics with shorter wait times (Kreatsoulas & Anand, 2010; Public Health Ontario, 2015). Compared to urban centres, there is a higher proportion of RRNC community members with low incomes (Desmeules et al., 2006). *Employment and working conditions* in RRNC are also great indicators for health status as they are related to income and social status (Desmeules et al., 2006). Poor working conditions and unemployment have been associated with worse health outcomes, including CVD (Kreatsoulas & Anand, 2010).

Education and literacy represent the level of education attainment earned. Just under 15% of residents of RRNC have completed university education in comparison to individuals in urban areas (40.1%) (Smale & Holliday, 2020). *Childhood experiences* refer to the upbringings of people and how they have defined their living situation and way of life. Formal early childhood education is less common in communities that are rural and remote (Registered Nurses Association of Ontario (RNAO), 2015). *Physical environments* are defined as the environment a person interacts with through housing, nutrition, air quality, and transportation systems. Studies showed that in RRNCs, there are deficits in safe air, water, and food quality (Bhatnagar, 2017; Public Health Ontario, 2015). *Social supports and coping skills* refer to the skills used to cope with everyday stressors and the support available. Due to their remote living environment, rural residents endure more social isolation (Desmeules et al., 2006). *Healthy behaviours* describe the actions taken to maintain health. As described above, rural residents seek nonformal health advice and engage in more self-reliant health behaviours (Rohatinsky et al., 2018). *Access to health services* is defined as the access available to essential and specialized health services. It is well known that there are less health services available in RRNC, making timely access difficult for residents (RNAO, 2015). *Biology and genetic endowment* are the genetic and hereditary risks for health issues. The impact of this determinant remains unknown in the literature with respect to how it affects people living in RRNC. *Gender* impacts health and by extension, sexual orientation, gender identity and gender expression, as the socially constructed roles of gender are associated with various risks for specific diseases. The literature reviewed focuses primarily on the impact of sex, a biological attribute for health, however it is important to distinguish the difference with self-identified genders, which are socially constructed roles. For example, rural residents who are transgender or identify as anything other than their sex assigned at birth often

face more health care adversities than those in urban communities (Vodden & Cunsolo, 2021). Finally, *culture* and *race* are the specific traditions that affect health behaviours. Residents of RRNC belong to various cultural groups which are associated with a variety of different health practices (Smale & Holliday, 2020).

In the light of the Rural Nursing Theory and the SDOH, health care practitioners tailor their consultations, care and treatments based on the patient's preferences, needs, and community access or availability of resources. Specifically, nurses can create a more holistic plan of care for their patients undergoing CABG to ensure a successful postop recovery and avoid readmission.

Summary

In summary, the literature revealed several patient, procedural, and hospital-related factors associated with post-operative CABG readmission. Authors of the research studies did not specifically focus on RRNC in Canada, nor any other nation. Further, little is known about the impact of SDOH on risk of readmission post-CABG for individuals living in RRNC. To narrow the gap of equity of access, and care for individuals living in RRNC in Ontario, further research is required to identify the predictive factors of readmission post-CABG.

Research Aims and Specific Objectives

The overall aim of this research was to identify the factors associated with readmission post-CABG in RRNC, including SDOH, to identify potential predictors for readmission.

Hypothesis

It was hypothesised that risk factors associated with postoperative complications and readmissions after a CABG will be different in patients that were readmitted versus those who were not readmitted. Acknowledging the complex health needs of RRNC residents, I

hypothesized that risk factors for readmission would be further associated with the disparities in the SDOH and the lack of accessible healthcare in these communities (Kolahdooz et al., 2015).

References

Alghafees, M. A., Alsubaie, N. A., Alsadoon, L. K., Aljafari, S. A., Alshehri, E. A., & Suliman, I. F. (2020). Thirty-day readmission rates and associated risk factors after coronary artery bypass grafting. *Journal of Taibah University Medical Sciences*, *15*(4), 292–297. https://doi.org/10.1016/j.jtumed.2020.05.004

Benuzillo, J., Caine, W., Evans, R. S., Roberts, C., Lappe, D., & Doty, J. (2018). Predicting readmission risk shortly after admission for CABG surgery. *Journal of Cardiac Surgery*, *33*(4), 163–170. https://doi.org/10.1111/jocs.13565

Case, R., George, J., Li, Q., Arnaoutakis, G. J., & Keeley, E. C. (2020). Unplanned 30-day readmission after coronary artery bypass in patients with acute myocardial infarction. *Cardiovascular Revascularization Medicine: Including Molecular Interventions*, *21*(4), 518–521. https://doi.org/10.1016/j.carrev.2019.08.005

Connolly, T. M., White, R. S., Sastow, D. L., Gaber-Baylis, L. K., Turnbull, Z. A., & Rong, L. Q. (2018). The disparities of coronary artery bypass grafting surgery outcomes by insurance status: A retrospective cohort study, 2007-2014. *World Journal of Surgery*, *42*(10), 3240–3249. https://doi.org/10.1007/s00268-018-4631-9

Deo, S. V., Raza, S., Altarabsheh, S. E., Deo, V. S., Elgudin, Y. E., Marsia, S., Mitchell, S., Chang, C., Kalra, A., Khera, S., Kolte, D., Costa, M., Simon, D., Markowitz, A. H., Park, S. J., & Sabik, J. F. (2019). Risk calculator to predict 30-day readmission after coronary artery bypass: A strategic decision support tool. *Heart, Lung & Circulation*, *28*(12), 1896–1903. https://doi.org/10.1016/j.hlc.2018.11.007

Fanari, Z., Elliott, D., Russo, C. A., Kolm, P., & Weintraub, W. S. (2017). Predicting readmission risk following coronary artery bypass surgery at the time of

admission. *Cardiovascular Revascularization Medicine: Including Molecular Interventions*, *18*(2), 95–99. 10.1016/j.carrev.2016.10.012

Feng, T. R., White, R. S., Gaber-Baylis, L. K., Turnbull, Z. A., & Rong, L. Q. (2018). Coronary artery bypass graft readmission rates and risk factors - A retrospective cohort study. *International Journal of Surgery (London, England)*, *54*(Pt A), 7–17. https://doi.org/10.1016/j.ijsu.2018.04.022

Fox, J. P., Suter, L. G., Wang, K., Wang, Y., Krumholz, H. M., & Ross, J. S. (2013). Hospital-based, acute care use among patients within 30 days of discharge after coronary artery bypass surgery. *The Annals of Thoracic Surgery*, *96*(1), 96–104. https://doi.org/10.1016/j.athoracsur.2013.03.091

Garland, R., Gagnon, M., & Lewis, K. B. (2022). Time to revisit heart failure self-care: A concept analysis. *Advances in Nursing Science*, *45*(4), 371–386. https://doi.org/10.1097/ANS.0000000000000430

Government of Canada. (2020). Social determinants of health and health inequalities. Retrieved from: https://www.canada.ca/en/public-health/services/health-promotion/population-health/what-determines-health.html

Hirji, S. A., Percy, E. D., Zogg, C. K., Vaduganathan, M., Kiehm, S., Pelletier, M., & Kaneko, T. (2020). Thirty-day nonindex readmissions and clinical outcomes after cardiac surgery. *The Annals of Thoracic Surgery*, *110*(2), 484–491. https://doi.org/10.1016/j.athoracsur.2019.11.042

Iribarne, A., Chang, H., Alexander, J. H., Gillinov, A. M., Moquete, E., Puskas, J. D., Bagiella, E., Acker, M. A., Mayer, M. L., Ferguson, T. B., Burks, S., Perrault, L. P., Welsh, S., Johnston, K. C., Murphy, M., DeRose, J. J., Neill, A., Dobrev, E., Baio, K. T., Taddei-

Peters, W., … O'Gara, P. T. (2014). Readmissions after cardiac surgery: experience of the National Institutes of Health/Canadian Institutes of Health research cardiothoracic surgical trials network. *The Annals of Thoracic Surgery*, *98*(4), 1274–1280. https://doi.org/10.1016/j.athoracsur.2014.06.059

Khoury, H., Sanaiha, Y., Rudasill, S. E., Mardock, A. L., Sareh, S., & Benharash, P. (2019). Readmissions Following Isolated Coronary Artery Bypass Graft Surgery in the United States (from the Nationwide Readmissions Database 2010 to 2014). *The American Journal of Cardiology*, *124*(2), 205–210. https://doi.org/10.1016/j.amjcard.2019.04.018

Kolahdooz, F., Nader, F., Yi, K., & Sharma, S. (2015). Understanding the social determinants of health among Indigenous Canadians: priorities for health promotion policies and actions. *Global Health Action, 8*(1). doi: 10.3402/gha.v8.27968

Pautasso, M. (2013). Ten simple rules for writing a literature review. *PLoS Computational Biology*, *9*(7), e1003149. https://doi.org/10.1371/journal.pcbi.1003149

Price, J. D., Romeiser, J. L., Gnerre, J. M., Shroyer, A. L., & Rosengart, T. K. (2013). Risk analysis for readmission after coronary artery bypass surgery: developing a strategy to reduce readmissions. *Journal of the American College of Surgeons*, *216*(3), 412–419. https://doi.org/10.1016/j.jamcollsurg.2012.11.009

Rohatinsky, N., Udod, S., Anonson, J., Rennie, D., & Jenkins, M. (2018). Rural Mentorships in Health Care: Factors Influencing Their Development and Sustainability. *Journal of Continuing Education in Nursing*, *49*(7), 322–328. https://doi-org.librweb.laurentian.ca/10.3928/00220124-20180613-08

Rosenblum, J. M., Lovasik, B. P., Hunting, J. C., Binongo, J., Halkos, M. E., Leshnower, B. G., Miller, J. S., Lattouf, O. M., Guyton, R. A., & Keeling, W. B. (2019). Predicted risk of mortality score predicts 30-day readmission after coronary artery bypass grafting.

General Thoracic and Cardiovascular Surgery, *67*(8), 661–668. https://doi.org/10.1007/s11748-019

Saab, S., Noureddine, S., & Dumit, N. Y. (2013). Readmission rates and emergency department visits after coronary artery bypass graft surgery and related factors. *The Lebanese Medical Journal*, *61*(3), 155–160. https://doi.org/10.12816/0001444

Shah, R. M., Zhang, Q., Chatterjee, S., Cheema, F., Loor, G., Lemaire, S. A., & Ghanta, R. K. (2019). Incidence, cost, and risk factors for readmission after coronary artery bypass grafting. *The Annals of Thoracic Surgery*, *107*(6), 1782-1789. https://doi.org/10.1016/j.athoracsur.2018.10.077

Shawon, M. S. R., Odutola, M., Falster, M. O., & Jorm, L. R. (2021). Patient and hospital factors associated with 30-day readmissions after coronary artery bypass graft (CABG) surgery: a systematic review and meta-analysis. *Journal of Cardiothoracic Surgery*, *16*(1), 172. https://doi.org/10.1186/s13019-021-01556-1

Smale, B., & Holliday, C. (2020). A Profile of Wellbeing in Rural Ontario. *Rural Ontario Institute.* Retrieved from: https://www.ruralontarioinstitute.ca/uploads/userfiles/files/CIW-ROI-ProfileWellbeingRuralOntario-March2020.pdf

Son, Y. J., Lee, H. J., Lim, S. H., Hong, J., & Seo, E. J. (2021). Predictors of unplanned 30-day readmissions after coronary artery bypass graft: a systematic review and meta-analysis of cohort studies. *European Journal of Cardiovascular Nursing*, *20*(7), 717–725. https://doi.org/10.1093/eurjcn/zvab023

Stewart Fahs, P. (2017). Leading-following in the context of rural nursing. *Nursing Science Quarterly*, *30*(2), 176–178. doi: 10.1177/0894318417693317

Tam, D. Y., Fang, J., Tran, A., Tu, J. V., Ko, D. T., Deb, S., & Fremes, S. E. (2018). A clinical risk scoring tool to predict readmission after cardiac surgery: An Ontario administrative and clinical population database study. *The Canadian Journal of Cardiology*, *34*(12), 1655–1664. https://doi.org/10.1016/j.cjca.2018.09.004

Trooboff, S. W., Magnus, P. C., Ross, C. S., Chaisson, K., Kramer, R. S., Helm, R. E., Desaulniers, H., De La Rosa, R. C., Westbrook, B. M., Duquette, D., Brown, J. R., Olmstead, E. M., Malenka, D. J., & Iribarne, A. (2019). A multi-center analysis of readmission after cardiac surgery: Experience of The Northern New England Cardiovascular Disease Study Group. *Journal of Cardiac Surgery*, *34*(8), 655–662. https://doi.org/10.1111/jocs.14086

Vodden, K. and Cunsolo, A. (2021). Rural and Remote Communities. *Canada in a Changing Climate: National Issues Report.* Retrieved from: https://natural-resources.canada.ca /sites/nrcan/files/GNBC/Chapter%203_Rural%20and%20Remote%20Communities_Fina l_EN.pdf

Winters, C. & Lee, H. J. (Eds.). (2018). Rural nursing: Concepts, theory and practice. (5th ed.). Springer Publishing Company.

Figure 1

PRISMA Diagram

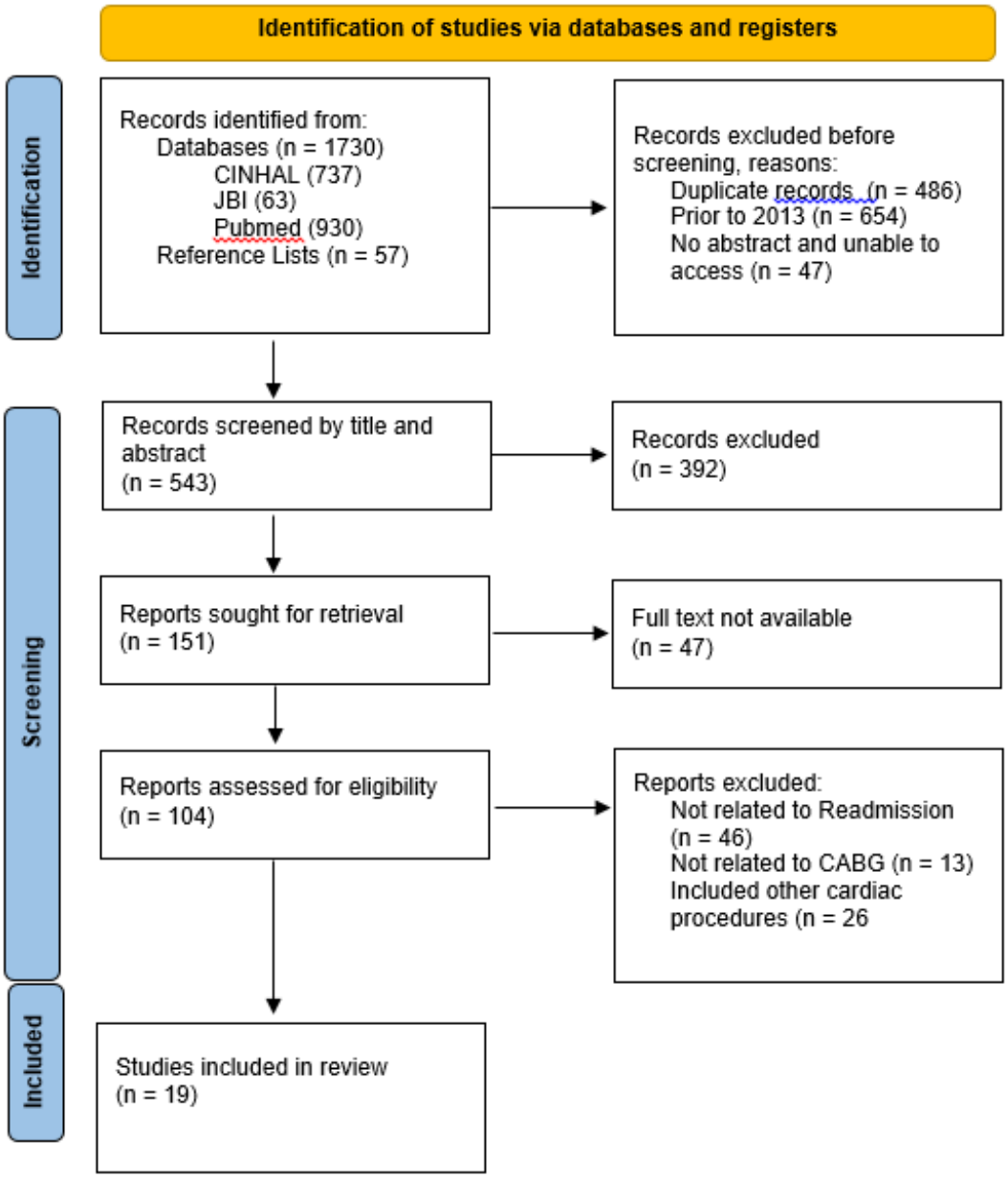

Table 1

Characteristics of included studies

Primary author, Year, Country	Purpose	Methods	Number of Participants	Data Source	Findings	Limitations
Alghafees et al., 2020 Saudi Arabia	Assess the rates and associated risk factors of 30-day readmissions for CABG patients.	Retrospective cohort study	534	Best-care system	30-day readmission rate was 16.1% Diabetes mellitus, amiodarone use, statin use, amlodipine use, asthma, and hyperlipidemia were significantly correlated with 30-day readmission.	Possibility of incomplete record due to use of retrospective secondary data. Selection bias with the retrospective data collection.
Benuzillo et al., 2018 USA	Develop a model to predict hospital readmission using data available soon after admission for isolated CABG surgery.	Retrospective case control study	2,589	STS Registry	30-day readmission rate was 9.15% Five risk factors were predictive of readmission: age, prior heart failure, total albumin prior to surgery, previous myocardial infarction, and history of diabetes.	Missing data values in database and could not contact individual patients. Some readmissions may have been missed.
Case et al., 2020 USA	Determine the unplanned 30-day readmission rate post-CABG	Retrospective case control study	150	University of Florida Integrated Data Repository	30-day readmission rate was 23%. Predictors were female sex, CABG less than 7 days after	Small single center study. Limited generalizability.

					myocardial infarction, post-operative atrial fibrillation.	Limited ethnic diversity (90% white). Unable to assess if patients were readmitted to another hospital.
Connolly et al., 2017 USA	Examine associations between insurance statuses on postoperative outcomes following isolated CABG.	Retrospective cohort study	312,018	Florida, California, New York, Maryland, and Kentucky State Inpatient Databases	Medicaid and uninsured has increased risks of readmission compared with private insurance	Data can be generalizable to an entire population but not a single institution
Deo et al., 2018 USA	Predict 30-day readmission after a CABG.	Retrospective cohort study	135,699	National Readmissions Database	30-day readmission rate was 14.3 %. Patients who were readmitted were older (>67), females, and had a higher Elixhauser comorbidity score.	Only use of administrative data therefore they could not obtain more specific data of patients preoperatively.
Fanari, et al., 2017 USA	Predict 30-day readmission at a specific institution in patient who underwent CABG.	Cohort study	1,277	STS Registry	Three researcher developed models are predictive for readmission risks.	Data derived from a single center (not representative of entire population, especially rural centers).

Feng et al., 2018 USA	Study readmissions at 30- and 90- day post discharge from CABG in relation to insurance and socioeconomic status.	Retrospective cohort study	177,229	California, Florida, and New York from the State Inpatient Databases	30-day readmission rate was 16.1%. Medicaid had the highest readmission, followed by Medicare and self-pay.	Administrative data set was used so clinical significance was difficult to determine.
Fox et al., 2016 USA	Describe the frequency of and diagnoses associated with emergency department visits and hospital readmissions within 30 days of discharge after CABG.	Retrospective cohort study	63,911	California State Inpatient and Emergency Department Databases,	30-day readmission rate was 15%. Most common causes of readmission were infection, arrhythmia, and volume overload. Baseline patient characteristics associated with readmission included female sex, diabetes mellitus, chronic obstructive pulmonary disease, elevated creatinine, lower hemoglobin, and longer operation time.	Potential forerrors during manual coding of CABG cases. Unable to exclude patients who died prior to 30 days post-op.
Hirji, et al., 2020 USA	Characterizes the frequency, risk factors, and outcomes of	Retrospective cohort study	1,070,073	National Readmission Database	30-day readmission rate was 12.8%.	Unable to distinguish numbers from index and

	nonindex hospital readmission after cardiac surgery.				Readmission were primarily noncardiac in etiology. Older age, higher income, and increased comorbidity burden were all independent predictors of readmission.	nonindex hospitals thus fragmentation of healthcare could not be assessed. Unable to assess the outcomes of patients who were discharged to rehabilitation facilities.
Iribarne et al., 2014 USA	Examine the frequency, timing, and associated risk factors for readmission after isolated CABG.	Retrospective cohort study	5,059	National Institutes of Health and the Canadian Institutes of Health Research	30-day readmission rate was 16.5%. Baseline patient characteristics associated with readmission included female sex, diabetes mellitus, chronic obstructive pulmonary disease, elevated creatinine, lower hemoglobin, and operation time.	Data was only collected from academic centers (excluded non-academic centers).
Khoury et al., 2019 USA	Identify risk factors for repeated admission to the intensive care unit for patients who underwent isolate CABG.	Retrospective case-control study	1,070,203	National Readmissions database	30-day readmission rate was 11.2%. Age over 70, body mass index, non-elective surgery patients, and surgery lasting more than 4 hours were associated	Unequal sample sizes for groups causing statistical difficulties. Only data from administration was used - they

					with 30-day readmission rates.	could not obtain more specific data of patients preoperatively.
Price et al., 2013 USA	Analyze quality improvement risk factors for readmissions after CABG.	Retrospective cohort study	1,205	New York Cardiac Surgery Reporting System	30-day readmission rate was 13%. The most frequent reasons for readmission were cardiac and pulmonary complications.	Several values missing from dataset causing difficulty with analysis of risk factors.
Rosenblum et al., 2019 USA	Determine whether STS Predicted Risk of Mortality scores predict 30-day readmission following CABG.	Retrospective cohort study	21,719	US academic institution	30-day readmission rate was 9.2%. STS Predicted Risk of Mortality was higher in the readmitted group.	Unable to gather data for patient who were readmitted to another hospital. Database only include preop variables and not postop variables.
Saab et al., 2013 Lebanon	Determine rates of readmissions and emergency department visits in CABG surgery patients within 30 days post-discharge.	Retrospective cohort study	110	Tertiary medical center	30-day readmission rate was 9.1%. The most frequent reasons for readmission were pleural effusion and dyspnea.	Several missing data points in the database used. Data from Lebanon could not be generalized to other populations.

Shah et al., 2019 USA	Evaluate incidence, costs, and predictors for 30-day readmission following a CABG.	Retrospective cohort study	288,059	National readmission database	30-day readmission rate was 12.24%. Postoperative infection or sepsis, heart failure, and arrhythmia were associated with 30-day readmission rates.	National database was missing multiple demographics.
Shawon et al., 2021 Australia	Quantify rates and explore causes of readmission within 30 days of CABG surgery.	Systematic review	53 studies including 8,937,457 patients	N/A	30-day readmission rate was 12.9%. Age, female sex, non-White, not having private insurance and various comorbidities were strongly associated with 30-day readmission rates.	Database may include missing data and authors could not access individual medical records. Database may not exclude planned readmission or follow-up.
Son et al., 2021 Korea	Identify and synthesize the perioperative risk factors for 30-day unplanned readmission after CABG.	Systematic review	14 studies including 2,805,242 participants	N/A	30-day readmission rate ranged from 9.2% to 18.9%. Postoperative complications, prolonged length of hospital stay, and mechanical ventilation were revealed as the risk factors for 30-day readmission.	No socio-economic data available in the literature. Data could not be generalized globally as all articles were based in the United States.
Tam et al., 2018	Develop a predictive risk	Retrospective cohort study	63,336	Canadian Institute of	30-day readmission rate was 11.5%.	Does not list hospitals

Canada	score for readmission after discharge in cardiac surgery.			Health Information Discharge Abstract Database	Significant risk factors for readmission from the final model were prolonged length of stay, sepsis, acute myocardial infarction.	included in study. Unable to assess if rurality included in study. Did not assess immediate post-op outcomes.
Trooboof et al., 2019 USA	Explore causes of readmission following cardiac surgery.	Retrospective case control study	2,218	Northern New England Cardiovascular Disease Study Group	30-day readmission rate was 12.3%. Infection, pleural or pericardial effusion, arrhythmia, and CHF were the most common causes for readmission.	Unable to distinguish numbers from index and nonindex hospitals thus fragmentation of healthcare could not be assessed. Data from New England cannot be generalized to all populations

Abbreviations: CABG: Coronary Artery Bypass Graft; CHF: Congestive Heart Failure; STS: Society of Thoracic Surgeon

Table 2

Risk Scores for Readmission

Author, Year, Country	Data sources	Predictors of risk score	C-statistic
Deo et al., (2018) USA	Nationwide Readmissions Database	End-stage renal disease, prolonged length of stay, atrial fibrillation, female sex and weight loss, and Medicaid.	0.65
Fanari et al., (2017) USA	Christiana Care Health System	Increasing age, female sex, African American race, higher body mass index, numerous comorbidities, 2 post-operative complications (renal failure and unplanned cardiac reoperation), Medicare or Medicaid insurance, discharges to a skilled nursing facility, saphenous vein grafts, and longer initial lengths of stay.	0.67
Feng et al., (2018) USA	California, Florida, and New York from the State Inpatient Databases	Age, sex, insurance status, race, median income, hospital volume, comorbidities (heart failure, valvular disease, atrial fibrillation, renal failure, lymphoma, HIV, alcohol abuse, fluid and electrolyte disorders, depression), postoperative complications (cardiovascular, pulmonary, infectious, gastrointestinal) hospital length of stay, discharge destination.	0.66
Khoury et al., (2019) USA	Nationwide Readmissions Database	Female sex, age over 75 years, length of stay greater than 14 days, emergent admission, and Medicare and Medicaid insurance, atrial fibrillation, fluid and electrolyte disorders, renal disorders, neurological disorders, obesity, and discharge destination.	0.65
Price et al., (2013) USA	New York Cardiac Surgery Reporting System	Age, sex, race, body mass index, cerebrovascular disease, shock, congestive heart failure, diabetes, prior stent, ejection	0.65

		fraction less than 30%, renal failure, insurance status, postoperative complications (cardiac reoperation, renal failure), discharge destination, length of stay.	
Shah et al., (2019) USA	Nationwide Readmissions Database	Length of stay of at least 10 days Medicaid status female sex, renal failure, in-hospital atrial fibrillation, chronic pulmonary disease, pneumonia, and nonelective admission.	0.70
Tam et al., (2018) Canada	CorHealth Ontario Cardiac Registry	Prolonged length of stay, isolated valve surgery, in-hospital complications of sepsis, and acute myocardial infarction.	0.63

Chapter 3: Methods

Methods

Please note, the original design for this study was a mixed methods sequential explanatory design consisting of this case-control chart review (quantitative) and patient interviews (qualitative). I encountered difficulties with recruitment for the patient interviews. Given the time constraints of this master's level thesis, in collaboration with my thesis advisory committee, we decided to suspend the interview portion of the thesis.

Design

A quantitative retrospective case-control design was used for this thesis to identify sociodemographic, clinical, procedural, and social factors associated with hospital readmission within 30 days of discharge after a CABG for patients living in RRNC. A case control study was well suited to answer this research question because it allowed for the comparison between patients readmitted to hospital within 30-days of CABG (cases) and patients not readmitted to hospital post-CABG (controls) to identify factors associated with readmission post-CABG. This study is reported in accordance with the STROBE reporting guidelines included in Appendix F (von Elm et al., 2007).

Setting and Population

The study was conducted at HSN in Northern Ontario, Canada. Its main site, located in Sudbury, Ontario, is the regional tertiary care center for Northeastern Ontario and an academic teaching facility for health care practitioners including, nurses, physiotherapists, medical learners, ect. HSN has 25 other sites (including hospitals, outpatient centers, dialysis centers, addiction centers, etc.) across Ontario providing critical, inpatient care and outpatient care for more than 500,000 people. An estimate of 520 cardiac surgeries are performed each year at HSN,

with a reported readmission rate for isolated CABG surgeries of 10.6% in 2021 (CorHealth Ontario, 2018).

Eligible participants included: 1) Patients 18 years or older who underwent an isolated CABG at HSN between January 1, 2021, to December 31, 2023; 2) Patients living in an RRNC in northeastern or northwestern Ontario based on postal code, including large population centers with over 100,000 residents. A three-year time frame was selected for feasibility given the scope of a master's thesis, and the anticipation that it would offer sufficient data to answer the research questions as evidenced by similar studies (Khoury et al., 2019) The International Classification of Disease, Eleventh Edition (ICD-11) codes were used to identify diagnoses for the study population. Coronary Artery Bypass Graft was defined by code PK80.14: other cardiac procedure associated with injury or harm, open approach. ICD-11 codes were also used to identify other diagnoses.

As cases, I included all patients who were readmitted to HSN within 30 days post-CABG between 2021 and 2023. An equal number of controls were randomly selected and matched (1:1) by age and sex. Informed consent from eligible participants was not required, as this phase of the research was considered minimal risk and relied exclusively on the secondary use of non-identifiable information (Sheri Webb, HSN Research Ethics Board [REB], Personal communication, November 13th, 2022). Hence, a waiver to informed consent could be used in this case (Government of Canada, 2018; HSN, 2018).

Sample Size and Sampling Methods

The case group included all patients readmitted within the stated time frame above. For the control group, an equal number of non-readmitted patients was chosen using simple random sampling. This sampling technique ensured each sample had an equal probability of being

chosen creating an unbiased representation of the total population (Shen, 2020). The sample size was dependent on the number of readmitted patients in the selected time frame.

Data collection

Data were collected from the Meditech Electronic Medical Record database (SUG/SUG.LIVE/N01/LIVE), used at HSN and other Northern Ontario hospitals. In Meditech, medical data from HSN is documented including data from every patient visit (ambulatory and admissions), and clinical practice resources such as pre-printed orders. At the time that this study was being conducted, nursing notes and interdisciplinary health practitioner's notes were charted on paper, hence were not accessible

In August 2022, I had several exchanges with a member of the HSN Health Records department to determine what data were available in the Meditech database including potential proxies for SDOH factors not routinely captured. In consultation with my Thesis Advisory Committee and HSN Health Records department, the following data were collected (Table 3):

Clinical and Demographic Data

Age, sex, and cardiac and non-cardiac health histories.

Procedure-Related Data

Length of stay preoperatively and postoperatively, wait time for surgery post coronary angiogram, emergency level of surgery, postoperative complications and discharge destination. For the subset of patients who were readmitted, I also captured their date of readmission, readmission diagnosis, length of stay of readmission, complications within readmission stay, and readmission to the Intensive Care Unit (ICU), if applicable.

Social Determinants of Health Data

Employment and working conditions (reported as employment group and private insurance), physical environments (reported as size of town or residence, distance from HSN and need for community care), social supports (reported as marital status, and discharge location), access to health services (reported as if patient had a family health practitioners), and culture (reported as Indigenous insurance status). Indigenous insurance status was identified in the charts as Non-Insured Health Benefits provided to residents who identify as Indigenous, under the Indian Act. Indigenous status, also referred to as Status Indian under the Indian Act, includes those who identify as Aboriginal, First Nation and/or Metis (Government of Canada, 2019). The following SDOH could not be collected as they are not routinely collected in the Meditech database: income and social status, education and literacy, childhood experiences, healthy behaviours, biology and genetics, self-identified gender, and race.

Only data within the electronic medical records relevant to admissions for CABG surgery and readmissions post-CABG were considered for extraction, including admission histories, discharge summaries, and consultations. By reviewing these narrative notes, it may have been possible to reveal variables that are not routinely collected during the initial admission history. For example, employment type, social support systems, education levels, and household types.

Analysis

Descriptive and inferential statistical analyses were conducted using the IBM SPSS statistical software (Version 29.0.1.0). A full list of variables with an analysis plan for each is available in Table 3. Categorical variables were analyzed using frequencies, an approach used in most retrospective database reviews (Feng et al., 2018; Khoury et al., 2019; Shah et al., 2019; Son et al., 2021). Continuous variables were analyzed using measures of central tendency

including mean, standard deviation and range, similar to Hirji et al., (2020). A 1-way Analysis of Variance (ANOVA) and a chi-squared test was conducted to determine the variance and significance of each continuous variable and categorical variable, respectively, similar to Shah et al., (2019). A binary logistic regression analysis was conducted to estimate odds ratios with 95% confidence intervals, similar to Shah et al. (2019). The regression model was used to investigate the relationship between 30-day readmission post-CABG and the independent variables. The odds of each factor predicting readmission were determined as a result of this test. The p-values were two-sided, with statistical significance evaluated at an alpha level of .05.

To mitigate missing data, a pairwise deletion method was used. This is where missing values from a case are removed from the analysis (Kang, 2013). Pairwise deletion was the preferable approach as it preserved more data and information than, for example, listwise deletion, which removes the whole case. As with any research, missing data was almost always inevitable (Kang, 2013). Missing data could lead to biased evidence and mislead conclusions.

Data management

In December 2023, I connected with a member of HSN Research Institute, the HSN privacy team and an information technology expert to confirm a data management plan. As I am also an employee at HSN, I was given access to the HSN network to extract data collected from Meditech through special secondary researcher access. The data was collated and saved in password-protected files on an HSN server (Citrixin) on a password-protected personal computer that only I could access. Data was reviewed only with my supervisor, Dr. Krystina Lewis, the Principal Investigator, through screen sharing on Microsoft Teams meeting video calls.

Ethics

This research involved human participants in an observational study design. Ethical approval was sought from the HSN REB (File #: 23-002) in October 2023. An administrative approval from the University of Ottawa was also received (File #: H-03-23-9038). A modification to Ethics approval was submitted to expand the inclusion criteria (originally excluded large population centers) and increase sample size, approved in January 2024. A renewal was submitted to maintain REB approval during the writing phase of this thesis in September 2024. The REB approval documents are included in Appendix D and E.

As this research was non-experimental, and used secondary non-identifiable data, it was anticipated that the level of review from the REB would be completed at a minimal risk level. Minimal risk research involves risks no greater than those ordinarily encountered in daily life or during routine tests or procedures (Canadian Institutes of Health Research, 2018). The HSN REB also confirmed that participants' informed consent was not required. The research study followed the approaches and conducts outlined in the Tri-Council Policy Statements, including Articles 1.1, 3.1-3.5, 3.7A, 4.1, 5.1-5.4, 5.5B, 6.12, and 8.2 (Canadian Institutes of Health Research, 2018). Finally, I had no conflicts of interest to declare prior to engaging in this research.

References

CorHealth Ontario. (2018). *Report on Adult Cardiac Surgery: Isolated Coronary Artery Bypass Graft (CABG) Surgery, Isolated Aortic Valve Replacement (AVR) Surgery and Combined CABG and AVR Surgery October 2011 - March 2016*. Retrieved from: https://www.corhealthontario.ca/Report-on-Adult-Cardiac-Surgery-October-2011-March-2016-April-2018.pdf

Canadian Institute of Health Research. (2018). *Tri-council policy statement: ethical conduct for research involving humans.* Retrieved from: https://ethics.gc.ca/eng/documents/tcps2-2018-en-interactive-final.pdf

Feng, T. R., White, R. S., Gaber-Baylis, L. K., Turnbull, Z. A., & Rong, L. Q. (2018). Coronary artery bypass graft readmission rates and risk factors - A retrospective cohort study. *International Journal of Surgery (London, England)*, *54*(Pt A), 7–17. https://doi.org/10.1016/j.ijsu.2018.04.022

Government of Canada. (2019). Indian Act. (R.S.C., 1985, c. I-5) https://laws-lois.justice.gc.ca/eng/acts/i-5/

Health Sciences North. (2018). Requests for waiver or alteration of the informed consent process. *HSN REB Guidance Document.* Retrieved from: https://hsnsudbury.ca/Portals/1/Research/REB/Guidance_Documents/Waivers_Alterations_Informed_Consent_Process_Guidance%20.pdf?ver=xrrhhqr60SNuvBDMvFBOdA

Hirji, S. A., Percy, E. D., Zogg, C. K., Vaduganathan, M., Kiehm, S., Pelletier, M., & Kaneko, T. (2020). Thirty-day nonindex readmissions and clinical outcomes after cardiac surgery. *The Annals of Thoracic Surgery*, *110*(2), 484–491. https://doi.org/10.1016/j.athoracsur.2019.11.042

Kang, H. (2013). The prevention and handling of the missing data. *Korean journal of anesthesiology*, *64*(5), 402–406. https://doi.org/10.4097/kjae.2013.64.5.402

Khoury, H., Sanaiha, Y., Rudasill, S. E., Mardock, A. L., Sareh, S., & Benharash, P. (2019). Readmissions following isolated coronary artery bypass graft surgery in the United States (from the Nationwide Readmissions Database 2010 to 2014). *The American Journal of Cardiology*, *124*(2), 205–210. https://doi.org/10.1016/j.amjcard.2019.04.018

Shah, R. M., Zhang, Q., Chatterjee, S., Cheema, F., Loor, G., Lemaire, S. A., & Ghanta, R. K. (2019). Incidence, cost, and risk factors for readmission after coronary artery bypass grafting. *The Annals of Thoracic Surgery*, *107*(6), 1782-1789. https://doi.org/10.1016/j.athoracsur.2018.10.077

Shen, E. (2020). On the Use of Sampling Weights for Retrospective Medical Record Reviews. *The Permanente Journal*, *24*(1). https://doi.org/10.7812/TPP/18.308

Son, Y. J., Lee, H. J., Lim, S. H., Hong, J., & Seo, E. J. (2021). Predictors of unplanned 30-day readmissions after coronary artery bypass graft: A systematic review and meta-analysis of cohort studies. *European Journal of Cardiovascular Nursing*, *20*(7), 717–725. https://doi.org/10.1093/eurjcn/zvab023

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & STROBE Initiative (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet (London, England)*, *370*(9596), 1453–1457. https://doi.org/10.1016/S0140-6736(07)61602-X

Table 3

Quantitative Variables suggested by Health Sciences North Health Records Department

Variable	ICD-11 Code	Available in Meditech	Variable Type	Analysis Method
Age Number of years		Yes	Continuous	Central tendency, ANOVA
Sex at birth		Yes	Categorical	Frequency, chi-squared test
Length of hospital stay		Yes	Continuous	Central tendency, range, ANOVA
Comorbidities		Yes	Categorical	Frequency, chi-squared test
Hypertension	BA00.Y			
Heart failure	BD10			
Previous myocardial infarction	BA42			
Stroke	8B20			
Chronic Kidney Disease	GB61			
Chronic Obstructive Pulmonary Disease	CA22.Z			
Cirrhosis	XT8W			
Cancer (all types)	2D4Z			
Obesity	5B81			
Anorexia	6B80			
Smoking	6C4A.1			
Atrial Fibrillation	BC81.3			
Recreational or illicit drug use	6C4Z			
Diabetes (Type 1 or 2)	5A10 5A11			
Reason for readmission/ diagnosis		Yes	Categorical	Frequency, chi-squared test
Immediate post-operative complications (prior to discharge)		Maybe – if included in medical record e.g. notes	Categorical	Frequency, chi-squared test

Acute kidney injury	GB60.Z			
Bleeding	NE81.0Z			
Infection,	NE81.2Z			
Heart failure	BE11			
New-onset atrial fibrillation	BC81.30			
Pneumonia	CA40			
Emergency level of surgery		Maybe – if included in medical record e.g. notes	Categorical	Frequency, chi-squared test
Emergent				
Non-emergent				
Discharge location E.g. home; nursing home; rehabilitation facility; respite care; other		Maybe – if included in medical record e.g. notes	Categorical	Frequency, chi-squared test
Income and social status		No	N/A	N/A
Median household income				
Employment and working conditions		Maybe – if included in medical record e.g. notes	Categorical	Frequency, chi-squared test
Employment status				
Private insurance data				
Education and literacy		No	N/A	N/A
Highest level of education				
Childhood experiences		No	N/A	N/A
Physical environments		Yes	Categorical	Frequency, chi-squared test
Town of residence				
Social supports and coping skills		Yes	Categorical	Frequency, chi-squared test
Marital status				
Healthy behaviours		Maybe – if included in medical record e.g. notes	Categorical	Frequency, chi-squared test

Access to health services Distance from Hospital Patient has family health practitioner	Yes	Continuous (Distance) and Categorical (family health practitioner)	Central tendency, range, ANOVA Frequency, chi-squared test
Biology and genetic endowment Family history	Maybe – if included in medical record e.g. notes	Categorical	Frequency, chi-squared test
Self- Identified Gender	No	N/A	N/A
Culture	No	N/A	N/A
Race	No	N/A	N/A

Abbreviations: ANOVA: 1-way Analysis of Variance, N/A: not applicable

Chapter 4: Manuscript

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Postoperative Coronary Artery Bypass Graft Readmissions in Rural, Remote and Northern Communities: Case Control Study focused on the Social Determinants of Health

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Abstract

Background: People living in rural, remote and Northern communities (RRNC) are at greater risk for hospital readmissions post-coronary artery bypass graft (CABG). We aimed to identify the factors, including social determinants of health (SDOH), associated with hospital readmission post-CABG in RRNC.

Methods: In case-control study from one Northern Ontario hospital, we reviewed 44 patients' charts, all of whom were readmitted within 30-days of CABG between 2021 and 2023. The control group included 44 patients matched by age and sex.

Results: Logistic regression analysis revealed that readmission was associated with previous myocardial infarction (OR 2.517; CI 1.493-4.242), wait time for surgery (OR 1.016; CI 1.003-1.030), town of residence (OR 0.183; CI 0.066-0.512), distance from hospital (OR 1.010, CI 1.005 – 1.015), and need for community care upon discharge (OR 14.968; CI 4.026-55.645).

Conclusion: Readmission post-CABG correlated with access to healthcare and community-related factors, notable within the SDOH.

Key words: Rural, remote, and northern communities, Social determinants of health, coronary artery bypass graft, post-operative readmissions

Introduction

Access to healthcare for people living in rural, remote, and northern communities (RRNC) in Canada is different than for people living in urban areas. Geographic differences result in different health outcomes and health experiences (Hale et al., 2021; Health Quality Ontario, 2017). This is true for people with coronary artery disease (CAD) and particularly for people necessitating a coronary artery bypass graft (CABG) to treat advanced CAD (Health Quality Ontario, 2017). Recovery from CABG can be strenuous, often requiring numerous physical and social supports, with an inherent risk of readmission to hospital for various post-surgical complications. Recent data from a pan-Canadian study on cardiac centres reported an average post-CABG readmission rate in one Northern Ontario hospital of 10.6%, while the readmission rate averaged 7.9% across all Southern Ontario hospitals (Canadian Institute of Health Information [CIHI], 2022). These differences in readmission rates demonstrate significant disparities in outcomes for those residing in RRNC.

Rural, Remote, and Northern Communities and the Social Determinants of Health

Statistics Canada (2021) defines RRNC as any community outside a population centre. Population centers are classified into three groups: small (1,000 to 29,999 residents), medium (30,000 to 99,999 residents), and large (100,000 residents or more). People living in RRNC are known to have worse health outcomes, linked to socioeconomic status, education level, and health behaviours, in comparison to people living in urban communities (Hale et al., 2021). Specifically related to cardiovascular status, Ontario's RRNC have 50% higher rates of cardiovascular disease (CIHI, 2022). Within Northern Ontario, only three hospitals perform diagnostic coronary angiograms (CIHI, 2022), creating a lengthy wait list for patients with or suspected to have CAD in Northeastern and Northwestern Ontario, allowing disease to critically

progress to the point of requiring intervention (Vervoort et al., 2024). As a result, a greater proportion of residents living in RRNC present with progressive CAD and require surgical interventions. In addition, more patients living in RRNCs who undergo CABG are readmitted to hospital within 30-days (CIHI, 2022). This could be explained, in part, by the differences in SDOH of people living in RRNC, impacting their health and health experiences.

Until now, much of the focus on readmissions post-CABG has centred on demographic and clinical factors, including age over 70 years (Benuzillo et al., 2018; Khoury et al., 2019; Shawon et al., 2021), female sex (Case et al., 2020; Shawon et al., 2021), congestive heart failure (Benuzillo et al., 2018; Shah et al., 2019; Trooboof et al., 2019), atrial fibrillation (Case et al., 2020; Shah et al., 2019; Trooboof et al., 2019), diabetes mellitus (Benuzillo et al., 2018; Shawon et al., 2021), myocardial infarction (Benuzillo et al., 2018; Tam et al., 2019), incisional infections (Shah et al., 2019; Tam et al., 2019), insurance status (Fanari et al., 2017; Feng et al., 2018; Shawon et al., 2021), size of the hospitals where surgery took place (Fanari et al., 2017, Tam et al., 2018), and length of stay post-op (Fanari et al., 2017; Feng et al., 2018; Shah et al., 2019; Son et al., 2021; Tam et al., 2019). No authors have specifically studied the social determinants of health (SDOH) as factors associated with hospital readmission post-CABG.

The Government of Canada (2020) recognizes 12 SDOH: 1) income and social status, 2) employment and working conditions, 3) education and literacy, 4) childhood experiences, 5) physical environments, 6) social supports and coping skills, 7) healthy behaviours, 8) access to health services, 9) biology and genetic endowment, 10) gender, 11) culture, and 12) race / racism. The SDOH play a key role in achieving and maintaining cardiovascular health, particularly for people living in RRNC (Smale & Holliday, 2020). People living in RRNC often report that their health care needs are not met in relation to accessing to health practitioners,

compounded with long wait times for health services, and having limited education related to health, all impacting health equity (Smale & Holliday, 2020). By identifying the factors associated with hospital readmission post-CABG in patients living in RRNC, including the SDOH, we can gain a holistic understanding of the health-related factors associated with readmissions. Yet, little is known about the impact of SDOH amongst other personal and clinical factors on 30-day post-CABG readmission rates. The overall aim of this research was to identify the social, demographic, and clinical factors associated with 30-day hospital readmission post-CABG in RRNC, with principal attention to the SDOH.

Methods

Design

We conducted a retrospective case-control study. Ethical approval was sought from the Health Sciences North Research Ethics Board (File #: 23-002). An administrative approval from the University of Ottawa was also received (File #: H-03-23-9038). This study is reported in accordance with the STROBE reporting guidelines (von Elm et al., 2007).

Theoretical Framework

The Rural Nursing Theory provides the theoretical underpinning for this research (Winters & Lee, 2018). The Rural Nursing Theory defines health as a way of life and a holistic state of mind for those living in rural environments (Winters & Lee, 2018). This theory explains the characteristics of rural patients' health outlook and how nurses can adapt their practices and everyday interactions with patients. There are two main assumptions: rural residents have a sense of self-reliance and resilience (Winters & Lee, 2018), defined as the approach of relying on one's own efforts to maintain health (self-reliance) and remain strong during tough circumstances (resilience).

Setting and Population

This study was conducted in Sudbury, Ontario at the Health Sciences North (HSN) which is the regional tertiary care center for Northeastern Ontario and an academic teaching facility. HSN has 25 other sites (including hospitals, outpatient centres, dialysis centres, addiction centres, etc.) across Ontario providing critical, inpatient care and outpatient care for more than half a million people. Over 500 cardiac surgeries are performed each year at HSN, with a reported readmission rate for isolated CABG surgeries of 10.6% (CIHI, 2022).

Eligible participants included: 1) Patients aged 18 years or older who underwent an isolated CABG at HSN between January 1, 2021, to December 31, 2023. 2) Patients living in an RRNC in northeastern or northwestern Ontario based on postal code started with P, including centres with populations greater than 100,000 residents (large). Patients who met the eligibility criteria were classified as readmitted to HSN (case) or not readmitted (control), 30-days post-CABG. A similar study that compared readmission factors between patients readmitted at 30-days or 90-days post-CABG saw no significant differences between the groups (Feng et al., 2018). Thus, a 30-day post-CABG timeline was chosen for this study. Patients in the readmitted group had to be readmitted to HSN so their data could be accessed through the Meditech electronic medical records database. The International Classification of Disease, Eleventh Edition (ICD-11) codes were used to identify diagnoses for the study population. According to the ICD-11, Coronary Artery Bypass Graft is defined by code PK80.14: other cardiac procedure associated with injury or harm, open approach.

Sample Size and Sampling Methods

The case group included all patients readmitted within the stated time frame above. For the control group, the HSN health records department provided a random selection with the same

number of non-readmitted patients (1:1), matched by age and sex. The sample size was confirmed once the number of readmitted patients was identified.

Data collection

Data were extracted from the Meditech Electronic Medical Record database (SUG/SUG.LIVE/N01/LIVE), used at HSN and other Northern Ontario hospitals. We gathered data from admission histories, discharge summaries, and consultation notes from Meditech. We retrieved patients' clinical and demographic data including, age, sex, comorbidities, medical histories and indigenous status (proxy as indigenous insurance status), from their admission(s) for coronary angiogram and/or CABG surgeries. Indigenous insurance status was identified in the charts as Non-Insured Health Benefits provided to residents who identify as Indigenous, under the Indian Act. Indigenous status, also referred to as Status Indian under the Indian Act, includes those who identify as Aboriginal, First Nation and/or Metis (Government of Canada, 2019). Procedure-related data included length of stay preoperatively and postoperatively, wait time for surgery post coronary angiogram, emergency level of surgery, postoperative complications and discharge destination. For the subset of patients who were readmitted, data was also captured regarding their date of readmission, reason for readmission, length of stay of readmission, and complications within readmission stay, if applicable. Nurses' charting and interdisciplinary health practitioner's notes are charted on paper and not uploaded to the Meditech database; thus, were not accessed.

We also aimed to collect data related to the 12 SDOH. The HSN health records department confirmed that only five of the twelve SDOH were routinely collected, including employment and working conditions, physical environments, social supports, access to health services, and culture. Those that were not routinely captured were income and social status,

education and literacy, childhood experiences, self-identified gender, healthy behaviours, biology and genetic endowment, and race. If collected, these SDOH would be captured in the practitioners' notes and patient summaries entered into the electronic medical records.

Analysis

Descriptive and inferential statistical analyses were conducted using the IBM SPSS statistical software (Version 29.0.1.0). A full list of variables with an analysis plan for each is available in Table 3. Categorical variables were analyzed using frequencies, an approach used in most retrospective database reviews. Continuous variables were analyzed using measures of central tendency including mean, standard deviation and range. A 1-way Analysis of Variance (ANOVA) and a chi-squared test was conducted to determine the variance and significance of each continuous variable and categorical variable, respectively. A binary logistic regression analysis was conducted to estimate odds ratios with 95% confidence intervals. A regression model was used to investigate the relationship between readmission status (yes/no) and the independent variables. The odds of each variable becoming a factor for readmission were determined as a result of this test. The *p*-values were two-sided, with statistical significance evaluated at an alpha level of .05. Missing data was managed with a pairwise deletion method, ultimately removing missing values from the analysis (Kang, 2013). Given the small number of cases per group, we opted to avoid removing whole cases.

Results

Of 1021 patients who had an isolated CABG at HSN between 2021 to 2023, 44 patients (4%) were readmitted within 30-days of their surgery (cases). For the case-control study, we reviewed an additional 44 charts of patients who were not readmitted post-CABG (controls), matched (1:1) by age and sex, for a total of 88 patient charts.

Patient and Procedure-Related Characteristics

As shown in Table 4, patients' mean age was 67.8 years (range 40 to 85 years old) in the readmitted group and 67.0 years (range 52 to 79 years old) in the non-readmitted group. Male patients made up 68.2% of the readmitted group and 72.7% of the non-readmitted group. Aside from CAD, hypertension was the most common cardiac comorbidity, followed by hyperlipidemia, and myocardial infarction. Myocardial infarction (chi-squared 13.410; *p*-value <0.001) and hyperlipidemia (chi-squared 5.301; *p*-value 0.021) were the two cardiac factors that showed statistically significant differences between the two groups. Ten (25%) patients had pleural effusion as a postoperative complication in the readmitted group (chi-squared 12.571, *p*-value <0.001) with none in the non-readmitted group.

The readmitted group experienced longer wait time for surgery after coronary angiogram averaging 49.8 days versus 35.1 days (*F*-value 7.001; *p*-value 0.010) and longer post-operative length of stay (7.4 days, *F*-value 5.276; *p*-value 0.024), showing a statistically significant difference from the non-readmitted group. Two patients in the readmitted group, and seven patients in the non-readmitted group did not have angiogram dates noted in their charts, thus their wait time could not be calculated. These patients had their angiograms performed at another hospital; thus, full details could not be obtained.

As shown in Table 5, we found the most common readmission diagnosis was congestive heart failure (*n*=9; 20.5%) and wound infection (*n*=7; 15.9%). Most patients (*n*=20; 45.5%) did not experience additional complications during their readmission stay; however, six (13.6%) other patients did have a wound infection that complicated their readmission stay.

Social Determinants of Health

Of the 12 SDOH, we were able to obtain data points for five determinants, namely: employment and working conditions, physical environments, access to health services, culture – including Indigenous status, and social supports (Table 6). No data was available in any charts for income and social status, education and literacy, childhood experiences, healthy behaviours, biology and genetic endowment, self-identified gender, and race.

Most patients (*n*=30, 68.2%) in the readmitted group were from a large population center and lived an average 57.8km away from HSN. Patients in the non-readmitted group lived an average 182.0km away from HSN. Of the patients who were readmitted, 72.7% (*n*=32) were discharged home while the others were discharged to another health care facility 13.6% (*n*=6) or a family member's home 13.6% (*n*=6). All patients who were not readmitted were discharged to their own home. With respect to social support, 59.1% (*n*= 26) of patients who were readmitted were married and 18.2% (*n*=8) were single; 77.3% (*n*=34) of patients who were not readmitted were married. None were single.

Variance testing on categorical and continuous SDOH variables showed that statistically significant differences were noted with employment groups (chi-squared = 44.091, *p*-value=0.007) and the three dimensions of physical environment including distance from HSN (F=19.731, *p*-value<0.001), size of population center (chi-squared = 26.799, *p*-value<0.001) and need for community care post-discharge (chi-squared = 21.836, *p*-value<0.001). Discharge location (chi-squared = 11.855, *p*-value=0.003) and access to a family health practitioner (chi-squared = 3.880, *p*-value=0.049) were also statistically significant.

Comparisons Between Readmitted and Non-Readmitted Groups

Logistic regression showed that readmission was associated with myocardial infarction (OR 2.517; CI 1.493-4.242), wait time for surgery (OR 1.016; CI 1.003-1.030), town of residence (OR 0.183; CI 0.066-0.512), distance from HSN (OR 1.010, CI 1.005 – 1.015), and need for community care post-discharge (OR 14.968; CI 4.026-55.645) (Table 5). No associations were found for the other factors noted in Table 7.

Discussion

In this case-control study, we identified patient, procedure, and social-related factors associated with readmission post-CABG in one RRNC hospital in Ontario. We found statistically significant differences between readmission status and the following patient and procedure-related factors: myocardial infarction, hyperlipidemia, arthritis, wait time post coronary angiogram, and length of stay postoperatively. To our knowledge, this is the first study to explore the associations between the SDOH and post-CABG readmissions. There were statistically significant differences between readmission status and the following SDOH: employment and social status (employment groups), physical environment (distance from HSN, size of population center, and need for community care post-discharge), social support (discharge location), and access to health services (if patient had family practitioner). We also found five factors through logistic regression that are associated with readmission 30 days post-CABG: 1) myocardial infarction, 2) wait time for surgery, 3) population size of town of residence, 4) distance from HSN, and 5) need for community care post-discharge.

Patient-Related and Procedure-Related Factors for Readmission

We identified similar patient-related and procedure-related factors as described in the existing literature. These included myocardial infarction (Benuzillo et al., 2018; Tam et al.,

2019), wait time for surgery (Fanari et al., 2017; Feng et al., 2018; Shah et al., 2019; Tam et al., 2019), and discharge to a destination other than the patient's home (Fanari et al., 2017; Feng et al., 2018; Khoury et al., 2019). Tam et al., (2018), one of the only studies conducted in Canada on this topic, revealed other reasons for readmission at 30-days post-CABG included congestive heart failure (12.6%), arrhythmia (11.5%), pleural effusion (10.0%), surgical site infection (9.8%), angina (8.1%), and pneumonia (4.5%), many of which were revealed in our study.

Social determinants of health and readmission post-CABG

To our knowledge, our study is the first to reveal associations between 30-day readmissions post-CABG with factors related to SDOH. We found that access to health services, distance from hospital where the CABG took place, the population size of town of residence, and need for community home care post-discharge were associated with readmission.

In our study, we found that the non-readmitted group mostly consisted of patients who live in small (45.45%) and medium (31.82%) population centres, while the readmitted group consisted of patients who live in larger population centres (68.2%). The patients who resided in small and medium population centres, were in an area that is approximately 300km away from the hospital. In this area, the main hospital serves 100 smaller surrounding communities, yet does not offer specialized cardiac care such as coronary angiograms and cardiac surgeries. Hence, patients must transfer to HSN for these specialised cardiac services.

Those in the readmitted group were readmitted to HSN only and resided approximately 57km from the hospital. While those in the non-readmitted group resided approximately 180km from the hospital. While at first glance this may be surprising, it is possible that a proportion of patients in the non-readmitted group may have been readmitted to a hospital closer to their town of residence, in facilities outside HSN where we did not have access to patient charts.

We found that in RRNC, wait times for surgery were on average 35 days for readmitted patients and 49.7 days for non-readmitted patients. Waitlists for cardiac surgery often result in unplanned re-hospitalization and an increased risk of death (Sun et al., 2021). Although, the non-readmitted group waited longer for cardiac surgery, again, we are uncertain if this subset of patients was readmitted elsewhere. Nevertheless, the wait for cardiac consultation and surgical waitlists are an ongoing challenge for publicly funded systems globally (Vervoort et al., 2024).

Despite our best efforts to obtain SDOH data, we found that overall, there were few references to them in patients' electronic medical records. The SDOH were not systematically collected on every patient, and when found, they were most often located in the physician dictated notes and the registered patient summaries. At the present time, it is at the discretion of the health practitioner to make reference to SDOH in their notes. There is a paucity of literature on the influence of SDOH on readmissions post-CABG. The only SDOH that have been found to be associated with readmission include income status, non-white race, and insurance status (Benuzillo et al., 2018; Case et al., 2020; Fanari et al., 2017; Feng et al., 2018; Khoury et al., 2019; Shah et al., 2019; Shawon et al., 2021; Son et al., 2021; Trooboof 2019). We were unable to analyze these SDOH as they were not available in the patient charts we reviewed.

Ko et al. (2021) has highlighted that Canada lacks population data regarding race and ethnicity in health care settings. This has impeded progress in understanding the influence of race and ethnicity on health inequality. There was limited reference to Indigenous status in the Meditech database. In three instances it was referenced, yet only with respect to insurance status, including those who carry a valid federally-funded Non-Insured Health Benefits, as outlined in the Indian Act (Government of Canada, 2019). By relying on Indigenous insurance status to determine a person's Indigenous identify, there is a greater possibility of not being able to

identify all Indigenous patients with their charts. The Rural Nursing Theory acknowledges the severe institutional racism towards Indigenous people who end up deliberately avoiding public hospitals and favour clinics managed and staffed by Indigenous people (Tsuji et al., 2023).

Indigenous peoples have significantly higher rates of cardiovascular risk factors (Smale & Holliday, 2020). Knowledge of a patient's Indigeneity can assist in the cultural tailoring of their care. For example, post-operative cardiac rehabilitation can be culturally adapted to benefit Indigenous communities (Ko et al., 2021) which may in turn reduce readmission rates.

Implications for Nursing Practice

The findings from this study allows nurses caring for people living in RRNC, as well as other members of the health care team, to be more aware of the association between patient, procedure and social determinants-related factors. By being aware of the risk factors associated with readmission, nurses can work to enhance pre- and post-operative teaching and care based on the needs, locations, and lifestyles of each patient. Eliciting and documenting the SDOH in patients' charts is vital to obtain a more holistic view of the patient and the environment in which they live, and what may help or hinder their recovery (Etowa & Hyman, 2022). The 12 determinants of health, especially physical environments and access to health services, can be integrated into the admissions documentation process. Access to this information can inform discharge planning and ongoing treatment (Etowa & Hyman, 2022). Nurses can also advocate for more specialized services, such as coronary angiograms, closer to each community in RRNC.

Guidance could be adopted from the Registered Nurses Association of Ontario (2015), who outlined 23 recommendations to help the Government of Ontario recruit and retain nurses in RRNC, including increased access to nursing education, infrastructure renewal for community

growth, and strategies to address compensation and benefit inequities for nurses in both primary and acute care sectors (Scaini & Alacon, 2023)

At the very core of this subject area, with direct relation to the SDOH, is that of health equity. Health equity seeks to increase access to health care opportunities and conditions conducive to fair health for all (Government of Canada, 2020). Nurses and all health care practitioners must focus on ways to detect, understand, and reduce inequities (Thompson et al., 2023). With an understanding of the influence of SDOH on outcomes of people living in RRNC, nurses can tailor their care to reflect their patient's culture and lifestyle (Winters & Lee, 2018). Health equity is crucial in the context of CABG recovery. Nurses should be able to identify patients at higher risk of readmission, so that they can receive tailored postoperative teaching, and be referred to appropriate community care and support systems available.

Limitations

This study addressed previous gaps in the literature as it explored the association between SDOH, amongst other personal and clinical factors, and 30-day post-CABG readmission status of patients living in RRNC. We must consider two main limitations when interpreting the study's findings. Our study is an observational study, and we cannot identify the causes of the revealed differences. In terms of the SDOH, we observed that readmitted patients were part of different employment groups, lived closer to the hospital in which the surgery occurred, lived in a larger population center, were discharged to a location other than their own home, required more community care services and had less access to family practitioners. We can only make assumptions as to why these differences exist. For instance, readmission rate at HSN between 2021 and 2023 was 4%, lower than rates reported by other authors (CIHI, 2021; Son et al., 2021; Shawon et al., 2021). It is possible that patients documented as non-readmitted were in fact

readmitted to community hospitals closer to their home. We were limited to HSN's database, and unable to access the medical records of smaller community hospitals in the RRNC. Second, we obtained all available data points of interest, but it remains that some data were missing from the patient's charts, a common limitation of retrospective database studies (Talari & Goyal, 2020). While we were able to access physician's notes, nursing and allied health practitioner's notes are not routinely uploaded to Meditech and thus could not be accessed. We did consider all forms of documentation in the electronic charts but were limited to what data was available in Meditech.

Conclusion

Factors for readmission post-CABG were less associated with patient health related factors but rather more access to health services, physical environment, and community related factors, all notable within the SDOH. The findings of this study are an important step towards improving health infrastructure within RRNC. The SDOH are a great tool to embed within nursing practice in order to create holistic plans of care for patients and create a healthy environment for patients to succeed post-CABG.

Key Highlights

1. Factors for readmission post-CABG were more so associated with access to health services, physical environment, and community.
2. Seven of the twelve SDOH are not routinely documented in patient charts.
3. Factors for readmission 30 days post-CABG were: 1) myocardial infarction, 2) wait time for surgery, 3) population size of town of residence, 4) distance from HSN, and 5) need for community care.

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Conflicts of Interest: None

References

Benuzillo, J., Caine, W., Evans, R. S., Roberts, C., Lappe, D., & Doty, J. (2018). Predicting readmission risk shortly after admission for CABG surgery. *Journal of Cardiac Surgery*, *33*(4), 163–170. https://doi.org/10.1111/jocs.13565

Case, R., George, J., Li, Q., Arnaoutakis, G. J., & Keeley, E. C. (2020). Unplanned 30-day readmission after coronary artery bypass in patients with acute myocardial infarction. *Cardiovascular Revascularization Medicine: Including Molecular Interventions*, *21*(4), 518–521. https://doi.org/10.1016/j.carrev.2019.08.005

Canadian Institute for Health Information (CIHI). (2022). *Cardiac Care Quality Indicators Report*. Retrieved from: https://www.cihi.ca/en/indicators/30-day-all-cause-readmission-rate-after-isolated-coronary-artery-bypass-graft-cabg

Etowa, J., & Hyman, I. (2022). Leadership and system transformation: Advancing the role of community health nursing. *Witness: The Canadian Journal of Critical Nursing Discourse*, *4*(2), 5–16. https://doi.org/10.25071/2291-5796.101

Fanari, Z., Elliott, D., Russo, C. A., Kolm, P., & Weintraub, W. S. (2017). Predicting readmission risk following coronary artery bypass surgery at the time of admission. *Cardiovascular Revascularization Medicine: Including Molecular Interventions*, *18*(2), 95–99. https://doi.org/10.1016/j.carrev.2016.10.012

Feng, T. R., White, R. S., Gaber-Baylis, L. K., Turnbull, Z. A., & Rong, L. Q. (2018). Coronary artery bypass graft readmission rates and risk factors - A retrospective cohort study. *International Journal of Surgery (London, England)*, *54*(Pt A), 7–17. https://doi.org/10.1016/j.ijsu.2018.04.022

Government of Canada. (2019). Indian Act. (R.S.C., 1985, c. I-5). Retrieved from:

https://laws-lois.justice.gc.ca/eng/acts/i-5/

Government of Canada. (2020). *Social determinants of health and health inequalities*. Retrieved from: https://www.canada.ca/en/public-health/services/health-promotion/population-health/what-determines-health.html

Hale, I., Grzybowski, S., & Ramdin, Z. (2021). What makes a healthy rural community?. *Canadian Journal of Rural Medicine, 26*(2), 61–68. https://doi.org/10.4103/CJRM

Health Quality Ontario. (2017). *Health in the North: A report on geography and the health of people in Ontario's two northern regions*. Retrieved from: http://www.hqontario.ca/portals/0/Documents/system-performance/health-in-the-north

Khoury, H., Sanaiha, Y., Rudasill, S. E., Mardock, A. L., Sareh, S., & Benharash, P. (2019). Readmissions following isolated coronary artery bypass graft surgery in the United States (from the nationwide readmissions database 2010 to 2014). *The American Journal of Cardiology*, *124*(2), 205–210. https://doi.org/10.1016/j.amjcard.2019.04.018.

Ko, D. T., Brophy, J. M., Mamas, M. A., McCrindle, B. W., & Wijeysundera, H. C. (2024). Social determinants of health in cardiovascular disease: A call to action. *Canadian Journal of Cardiology, 40*(6), P969-972. https://doi.org/10.1016/j.cjca.2024.04.011

Registered Nurses' Association of Ontario. (2015). *Coming together, moving forward: Building the next chapter of Ontario's rural, remote and northern nursing workforce –report*. Retrieved from: http://rnao.ca/sites/rnao-ca/ files/RR_May8.pdf.

Scaini, M., & Alacon, V. (2023). RNAO has the strategy for government to adopt in wake of auditor general report. *Registered Nurses' Association of Ontario*. Retrieved from: https://rnao.ca/news/media-releases/rnao-has-the-strategy-for-government-to-adopt-in-wake-of-auditor-general-report.

Shah, R. M., Zhang, Q., Chatterjee, S., Cheema, F., Loor, G., Lemaire, S. A., & Ghanta, R. K. (2019). Incidence, cost, and risk factors for readmission after coronary artery bypass grafting. *The Annals of Thoracic Surgery*, *107*(6), 1782-1789. https://doi.org/10.1016/j.athoracsur.2018.10.077

Shawon, M. S. R., Odutola, M., Falster, M. O., & Jorm, L. R. (2021). Patient and hospital factors associated with 30-day readmissions after coronary artery bypass graft (CABG) surgery: a systematic review and meta-analysis. *Journal of cardiothoracic surgery*, *16*(1), 172. https://doi.org/10.1186/s13019-021-01556-1

Smale, B., & Holliday, C. (2020). A profile of wellbeing in rural Ontario. *Rural Ontario Institute*. Retrieved from: https://www.ruralontarioinstitute.ca/uploads/userfiles/files/CIW-ROI-ProfileWellbeingRuralOntario-March2020.pdf

Son, Y. J., Lee, H. J., Lim, S. H., Hong, J., & Seo, E. J. (2021). Predictors of unplanned 30-day readmissions after coronary artery bypass graft: a systematic review and meta-analysis of cohort studies. *European Journal of Cardiovascular Nursing*, *20*(7), 717–725. https://doi.org/10.1093/eurjcn/zvab023

Statistics Canada. (2021). *Population Centre (POPCTR).* Retrieved from: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng

Sun, L., Bader Eddeen, A., Wijeysundera, H.C., Mamas, A., Tam., D and Mesan. T. (2021). Derivation and validation of a clinical model to predict death or cardiac hospitalizations while on the cardiac surgery waitlist. *Canadian Medical Association Journal, 193*(34), E1333-E1340. https://doi.org/10.1503/cmaj.210170

Talari, K., & Goyal, M. (2020). Retrospective studies - utility and caveats. *The Journal of the Royal College of Physicians of Edinburgh*, *50*(4), 398–402.

https://doi.org/10.4997/JRCPE.2020.

Tam, D. Y., Fang, J., Tran, A., Tu, J. V., Ko, D. T., Deb, S., & Fremes, S. E. (2018). A clinical risk scoring tool to predict readmission after cardiac surgery: An Ontario administrative and clinical population database study. *The Canadian Journal of Cardiology*, *34*(12), 1655–1664. https://doi.org/10.1016/j.cjca.2018.09.004

Thompson, D. R., Ski, C. F., & Clark, A. M. (2023). Advancing health equity in cardiovascular care. *European Journal of Cardiovascular Nursing, 23*(3), e23–e25. https://doi.org/10.1093/eurjcn/zvad131

Trooboff, S. W., Magnus, P. C., Ross, C. S., Chaisson, K., Kramer, R. S., Helm, R. E., Desaulniers, H., De La Rosa, R. C., Westbrook, B. M., Brown, J. R., Olmstead, E. M., Malenka, D. J., & Iribarne, A. (2019). A multi-center analysis of readmission after cardiac surgery: Experience of The Northern New England Cardiovascular Disease study group. *Journal of Cardiac Surgery*, *34*(8), 655–662. https://doi.org/10.1111/jocs.14086

Vervoort, D., Afzal, A. M., Ruiz, G. Z., Mutema, C., Wijeysundera, H. C., Ouzounian, M., & Fremes, S. E. (2024). Barriers to access to cardiac surgery: Canadian situation and global context. *Canadian Journal of Cardiology*, *40*(6), 1110–1122. https://doi.org/10.1016/j.cjca.2023.11.011

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2008). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Journal of Clinical Epidemiology*, *61*(4), 344–349. https://doi.org/10.1016/j.jclinepi.2007.11.008

Winters, C. & Lee, H. J. (Eds.). (2018). Rural nursing: Concepts, theory and practice. (5th ed.). Springer Publishing Company.

Table 4

Participants' characteristics for those readmitted vs non-readmitted

	Case Readmitted	Control Non-readmitted	Chi-Squared/ANOVA	*p*-value
	n= 44	*n*= 44		
Age, mean (*SD*)	67.8 (10.4)	67.0 (6.8)		
Sex, male, *n* (%)	30 (68.2%)	32 (72.7%)		
Cardiac health history, *n* (%)				
Coronary artery disease	42 (95.5%)	44 (100.0%)	2.047	0.153
Hypertension	41 (93.2%)	43 (97.7%)	1.048	0.306
Hyperlipidemia	39 (88.6%)	44 (100.0%)	5.301	0.021
Myocardial infarction	22 (50.0%)	5 (11.4%)	13.410	<0.001
Atrial fibrillation	12 (27.3%)	5 (11.4%)	3.572	0.059
Heart failure	6 (13.6%)	10 (22.7%)	1.222	0.269
Peripheral artery disease	5 (11.4%)	9 (20.5%)	1.359	0.244
Non-cardiac health history, *n* (%)				
Diabetes	21 (47.7%)	23 (52.3%)	0.182	0.670
Obesity	16 (36.4%)	14 (31.8%)	0.202	0.653
Arthritis	14 (31.8%)	6 (13.6%)	4.141	0.042
Smoking	6 (20.5%)	12 (27.3%)	0.850	0.654
COPD	8 (18.2%)	3 (6.8%)	2.597	0.107
Cancer	7 (15.8%)	5 (11.4%)	1.144	0.565
Chronic kidney disease	6 (13.6%)	6 (13.6%)	2.200	0.138
GERD	6 (13.6%)	5 (11.4%)	0.104	0.747
Anxiety	5 (11.4%)	1 (2.3%)	2.862	0.091
Obstructive sleep apnea	5 (11.4%)	7 (15.9%)	0.386	0.534
Recreational drug use[‡]	3 (6.8%)	1 (2.3%)	1.048	0.306
CABG-related factor, mean (*SD*)				
LOS preoperative (days)	8.0 (8.9)	5.2 (7.2)	2.704	0.104
LOS postoperative (days)	7.4 (10.2)	4.9 (2.7)	5.276	0.024
Wait time for surgery post-coronary angiogram[*](days)	35.1 (28.2)	49.7 (9.2)	7.001	0.010
Emergency level of surgery, *n* (%)			2.391	0.303
Emergent	27 (61.4%)	21 (47.7%)		
Non emergent	17 (38.6%)	23 (52.3%)		
Postoperative complications, *n* (%)				
Pleural effusion	11 (25.0%)	0 (0.0%)	12.571	<0.001
Atrial fibrillation[¤]	10 (22.7%)	10 (22.7%)	0.000	1.000
Weakness	4 (9.1%)	1 (2.3%)	1.908	0.167
Infection (all types)	4 (9.1%)	5 (11.4%)	0.124	0.725

Blood transfusion	2 (4.5%)	2 (4.5%)	0.000	1.000

Abbreviations: COPD: Chronic obstructive pulmonary disease; GERD: Gastroesophageal reflux disease; HSN: Health Sciences North; LOS: Length of stay

[ǂ]Recreational drug use includes marijuana use.

[¤]Post-operative atrial fibrillation was defined as new onset and heart rate >110 beats per minute

[*]Two patients in the readmitted group and seven patients in the non-readmitted group did not have angiogram dates noted in their charts thus wait time could not be calculated.

Table 5

Readmission characteristics

	Case Readmitted
	***n*=44**
Days to readmission from discharge, mean (*SD*)	18.9 (17.1)
Readmission diagnosis, *n* (%)	
Congestive heart failure	9 (20.5%)
Wound infection	7 (15.9%)
Atrial fibrillation	5 (11.4%)
Gastrointestinal bleeding	3 (6.8%)
Acute coronary syndrome	3 (6.8%)
COPD	2 (4.5%)
Failure to cope	2 (4.5%)
Pneumonia	2 (4.5%)
Syncope	2 (4.5%)
Acute kidney disease	1 (2.3%)
Cardiac arrest	1 (2.3%)
Cellulitis	1 (2.3%)
Hematuria	1 (2.3%)
Palpitations	1 (2.3%)
Pericardial effusion	1 (2.3%)
Pleural Effusion	1 (2.3%)
Sepsis	1 (2.3%)
Stroke	1 (2.3%)
Readmission complication, *n* (%)	
Wound infection	7 (15.9%)
Atrial fibrillation	4 (9.1%)
Pleural effusion	4 (9.1%)
Pneumonia	2 (4.5%)
Acute kidney disease	2 (4.5%)

Congestive heart failure	1 (2.3%)
Pericardial effusion	1 (2.3%)
Blood Transfusion	1 (2.3%)
Ventricular tachycardia	1 (2.3%)
Weakness	1 (2.3%)
None	20 (45.5%)
LOS of readmission, (days) mean (*SD*)	6.8 (5.7)
Intensive care unit stay required, yes, *n* (%)	8 (18.2%)

Abbreviations: COPD: Chronic obstructive pulmonary disease; LOS: Length of stay

Table 6

Social determinants of health

	Case Readmitted	Control Non-readmitted	Chi-Squared/ANOVA	*p*-value
	n= 44	*n*= 44		
Income and social status	Data not accessible	Data not accessible		
Employment and working conditions			44.091	0.007
Employment group *n* (%)				
Mining	6 (13.6%)	4 (9.1%)		
Administration	3 (6.8%)	3 (6.8%)		
Engineer	2 (4.5%)	1 (2.3%)		
Firefighter	1 (2.5%)	0		
Food services	1 (2.3%)	1 (2.3%)		
Landscaping	1 (2.3%)	2 (4.5%)		
Motor transport laborer	3 (6.8%)	2 (4.5%)		
Nursing	1 (2.3%)	1 (2.3%)		
Postal services	1 (2.3%)	1 (2.3%)		
Teacher	4 (9.1%)	5 (11.2%)		
Not reported	21 (47.7%)	24 (54.5%)		
Private insurance, yes, *n* (%)	24 (54.5%)	33 (75.0%)	4.086	0.130
Education and literacy	Data not accessible	Data not accessible		
Childhood experiences	Data not accessible	Data not accessible		
Physical environment				
Size of town of residence				
Large population center	30 (68.2%)	10 (22.7%)		

Medium population center	3 (6.8%)	14 (31.82%)		
Small population center	11 (25.0%)	20 (45.45%)	19.731	<0.001
Distance from HSN	57.8 (80.3)	181.9 (137.3)	26.799	<0.001
Community care required post discharge	23 (52.3%)	3 (6.8%)	21.836	<0.001
Social supports				
Marital status (*n, %*)			6.844	0.144
Married	26 (59.1%)	34 (77.3%)		
Separated	7 (15.9%)	2 (4.5%)		
Single	8 (18.2%)	0		
Windowed	2 (4.5%)	8 (18.2%)		
Common law	1 (2.3%)	0		
Social support postoperatively	Data not accessible	Data not accessible		
Discharge location			11.855	0.003
Home	32 (72.7%)	44 (100%)		
Other health care facility	6 (13.6%)	0 (0%)		
Family support	6 (13.6%)	0 (0%)		
Healthy behaviours	Data not accessible	Data not accessible		
Access to Health Services				
Patient has family health practitioner, yes *n*(%)	38 (86.4%)	43 (97.7%)	3.880	0.049
Biology and Genetics	Data not accessible	Data not accessible		
Gender	Data not accessible	Data not accessible		
Culture				
Indigenous insurance status	3 (6.8%)	0 (0%)	3.106	0.078
Race	Data not accessible	Data not accessible		

Abbreviations: HSN: Health Sciences North

Table 7

Logistic regression with odds ratio for readmission predictors

	Odds Ratio	*p* value	95% Confidence Interval	
			Lower	Upper
Coronary artery disease	0.000	0.999	0.000	0.000
Hypertension	0.318	0.141	0.032	3.180
Hyperlipidemia	0.886	0.999	0.797	0.985

Myocardial infarction	2.517	<0.001	1.493	4.242
Atrial fibrillation	2.925	0.017	0.932	9.175
Heart failure	0.537	0.112	0.176	1.634
Peripheral artery disease	0.499	0.464	0.152	1.630
Diabetes	0.834	0.872	0.361	1.924
Obesity	1.224	0.050	0.506	2.961
Arthritis	2.956	0.274	1.014	8.612
Smoking	0	0.999	0.000	0.000
COPD	3.037	0.039	0.749	12.320
Cancer	0	0.999	0.000	0.000
Chronic kidney disease	3.316	0.021	0.631	17.428
GERD	1.232	0.197	0.347	4.377
Anxiety	5.513	0.120	0.617	49.275
Obstructive sleep apnea	0.678	0.148	0.198	2.325
Recreational drug use[ǂ]	3.146	0.094	0.314	31.484
CABG-related factors	0.956	0.109	0.905	1.010
LOS Preoperatively				
LOS postoperative	0.918	0.242	0.796	1.059
Wait time for surgery post-angiogram	1.016	0.016	1.003	1.030
Emergency level of surgery	1.810	0.155	0.799	4.100
Pleural effusion	0.750	0.997	0.632	0.890
Atrial fibrillation[¤]	1.000	0.668	0.396	2.710
Weakness	4.300	0.121	0.461	40.118
Infection (all types)	0.780	0.734	0.195	3.122
Blood transfusion	1.000	0.214	0.135	7.434
Social determinants of health				
Employment group	1.095	0.763	0	0
NOC teer	1	0.522	0.999	1.001
Employment status	0.878	0.284	0.693	1.114
Insurance status	1.718	0.079	0.940	3.140
Size of town of residence	0.183	<0.001	0.066	0.512
Distance from HSN	1.010	<0.001	1.005	1.015
Community care required	14.968	<0.001	4.026	55.645
Marital status	0.815	0.256	0.573	1.160
Discharge disposition	1.375	0.170	0	0
Access to family health practitioner	0.147	0.082	0.017	1.279

Abbreviations: COPD: Chronic obstructive pulmonary disease; GERD: Gastroesophageal reflux disease; HSN: Health Sciences North; LOS: Length of stay; NOC: National Occupational Classification

[ǂ]Recreational drug use includes marijuana use.

[¤]Post-operative atrial fibrillation was defined as new onset and heart rate >110 beats per minute

Chapter 5: Integrated discussion

Integrated Discussion

The purpose of this chapter is three-fold. First, to summarize the findings of the thesis including the literature review (Chapter 2), the theoretical underpinnings (Chapter 2) and the case-control study (Chapter 4). Second, to discuss three important considerations that have arisen from this work. Finally, to discuss the implications from this thesis for nursing practice, education, research, and policy.

Summary of Thesis Findings

The overall purpose of this thesis was to identify the factors associated with hospital readmission post-CABG in Ontario's RRNC with consideration of the SDOH as potential predictors of hospital readmission. The literature review (Chapter 2) revealed that the evidence on this topic was primarily focused on the clinical and patient-related factors associated with hospital readmission post-CABG. The literature is limited on aspects related to the SDOH that may play a role in a person's risk of readmission post-CABG. To narrow this gap, I used the Rural Nursing Theory and the Government of Canada's (2020) SDOH framework (Chapter 2) to guide the design and conduct of a case-control study of patients readmitted within 30 days of CABG in comparison to those who had not been readmitted in one Northern Ontario hospital. Using the Meditech electronic record database at HSN as the source of data, I revealed five factors associated with readmission post-CABG, including 1) prior myocardial infarction, 2) length of time awaiting surgery, 3) population size of town of residence, 4) distance from the HSN, and 5) need for community care (Chapter 4). I concluded that factors for readmission post-CABG were less associated with patient health-related factors and rather factors related to access to health services, physical environment, and community factors. There are implications of this thesis for clinical practice, nursing education, research, and health policy, which I will discuss.

Integrated Discussion

The findings from this thesis as a whole highlight three important considerations. First, patients who live in RRNC and undergo CABG face health inequities throughout their care trajectory. Second, there was complementary value of using both the Rural Nursing Theory and SDOH's framework to explore this research problem. Third, there is a pressing need to focus on SDOH to enhance health equity in acute cardiovascular nursing care.

Patient Needs in Rural, Remote and Northern Communities

The findings from this thesis suggest that patients who live in RRNC and require CABG experience health inequities within their journey of care. Taken together, the literature review and the findings from the case-control study viewed through the lens of the selected theoretical frameworks highlighted the differences and inequities that patients living in RRNCs experience throughout the health care system (in comparison to urban settings) from seeking diagnosis and treatment, surgical stay in hospital, and transitioning back to the community upon discharge.

Seeking Diagnosis and Treatment. As stipulated in the Rural Nursing Theory, patients living in RRNCs are challenged in finding access to adequate and reliable primary health care to address their health concerns (Winters & Lee, 2018). At present, there is a lengthy waitlist of patients looking for family health practitioners all over Ontario and communities (Vervoort et al., 2024). In 2023, over 6.5 million residents in Canada were without a family health practitioner; a dramatic increase from 2019 when statistics Canada estimated 4.5 million residents were without a family health practitioner (Duong & Vogel, 2023). As of 2022, only 8% of physicians were concentrated in rural areas in Canada (CIHI, 2022). The Ontario College of Family Physicians (2023) reported that three Northern Ontario communities (Greater Sudbury, Manitoulin Island, and Parry Sound) have nearly 32,000 people that do not have a family health practitioner and this

number could nearly double in the next two years. As revealed in Chapter 2, the lack of family health practitioners makes it even more difficult for patients to be referred to a cardiologist. Donio et al. (2019) have stated that in the context of CAD, longer wait times for health services lead to delayed diagnosis and worsening disease, ultimately making it more likely that a referral to a cardiac surgeon will be needed. In fact, 13.6% of patients who were readmitted in the case-control study did not have access to family health practitioners, while patients in the non-readmitted group all had access to family health practitioners. This further suggests that lack of primary care access not only leads to worsened disease but also impacts recovery (Chapter 4).

Delays in receiving treatment can also be explained by suppositions of the Rural Nursing Theory. Rural residents tend to seek informal health advice from their own personal networks, and resist seeking help from their cardiologist or cardiac surgeon who are often considered "community outsiders" (Winter and Lee, 2018). Further, the mere awareness of the challenges of even accessing a cardiologist or cardiac surgeon may further discourage residents from seeking health advice for cardiac related symptoms. The delays even persist after diagnosis. In my case-control study, 45.5% of patients who were not readmitted (control) lived in a smaller population center (Chapter 4). This patient population waited over 49 days for their surgery post-coronary angiogram and CAD diagnosis. In comparison, at one Southern Ontario hospital, the average wait times for CABG post-coronary angiogram and CAD diagnosis was 19 days (Ontario Health, 2024). Law et al., (2022) conducted a retrospective analysis using a comprehensive provincial surgical wait time database in Ontario to study surgical wait times and socioeconomic status in provincially funded health care. The authors looked at all types of surgery and included 4,873,269 patient records that contained wait times within the database from 2006–2015. The authors noted that patients in rural towns waited longest for surgeries (mean 74.1 days); in

comparison to the overall mean waiting time for surgery of the population (mean 62.3 days). Further, De Jager's et al. (2023) cross sectional study assessed patients' timely access to nonurgent inguinal hernia repairs, cholecystectomies, hip arthroplasties, knee arthroplasties, arthroscopies, benign uterine surgeries and cataract surgeries in Ontario from April 2013 to December 2019. They revealed that 14% of surgeries performed in RRNC exceeded the Health Quality Ontario wait time targets in comparison to urban areas (10.6%). These authors further noted the importance of timely access to limit disease progression, improve patient outcomes, and reduce readmission, yet they concluded that research into SDOH was required to understand the health and geographic disparities affecting the surgical wait times in Ontario.

Surgical Stay in Hospital. When admitted to hospital in preparation for surgery, many patients living in RRNCs require culturally appropriate healthcare, including pre- and post-operative teaching and discharge planning tailored to RRNC living (Fox et al., 2019). Often this is not received, leaving these patients uncomfortable and ill equipped for preparation and recovery, and ultimately unsatisfied with the care received (Fox et al., 2019; Kusno & Duff, 2023). Patients perceive that health practitioners involved in their care during their hospital and operative stay do not understand their rural/remote lifestyle needs (Fox et al., 2019). For example, they are often provided with educational material that they perceive do not apply to their lifestyle (Winter & Lee, 2018). There is evidence suggesting that this lack of tailoring leads to some patients living in RRNC being more resistant to health teaching (Coombs et al., 2022). Some patients seem to favor seeking accounts from their family, friends, or acquaintances' experiences with CABG (Scheckel et al., 2020; Winters & Lee, 2018). In the case of CABG, an important nursing role is to provide evidence-based preoperative teachings: 1) to set realistic expectations of the surgery and the recovery, 2) to recognize and respond to signs and symptoms

of potential postoperative complications, and 3) to avoid readmissions. For patients in hospital, whether awaiting their CABG or post-CABG, there is much learning required to be able to self-manage at home once discharged.

Consequences of inadequate post-operative teaching and learning includes postoperative respiratory complications such as pleural effusions; this has been directly linked to incorrect incentive spirometry use (Franklin & Anjum, 2023; Su et al., 2022). My thesis findings revealed that the most common postoperative diagnosis was pleural effusion (25%) in the readmitted group while the patients in the non-readmitted group had zero pleural effusion complications postoperatively (Chapter 4). Su et al., (2022) studied patients who received pre and postoperative nurse-guided incentive spirometry and its effect on hospital length of stay post-cardiac surgeries in a rural hospital in China. The authors stated that respiratory complications postoperatively occur most commonly in patients who do not use the incentive spirometry properly. Reasons for incorrect use may be multi-faceted, yet part of it may be explained by some patients' challenges in comprehending and applying correct incentive spirometer usage. In a multimethod descriptive study, Fox et al. (2019) adapted a hospital-to-home transitional care intervention to the rural healthcare context in Ontario, Canada. They found that many caregivers within RRNC, the vast majority without a health care background, were capable of supporting their loved ones through the postoperative period when equipped with knowledge and skills acquired through teaching from nurses prior to hospital discharge. Yet, caregivers reported feeling unprepared to detect and respond to sinister signs and symptoms of worsening health (Fox et al., 2019). Scheckel et al. (2020) also recognized the likely benefit of involving patient and families in learning plans to manage postoperative care at home. Without a solid grasp of post-operative instructions for discharge, patients may be vulnerable for complications and hospital readmission.

Risk scores for readmission post-CABG can be a useful tool for nurses and members of the interprofessional team to remain aware of factors that would increase their patients' risk of readmission. From the literature review (Chapter 2), many authors proposed individualising discharge teaching based on patients' risk factors for readmission, as identified from existing clinically based risk scores (Deo et al., 2018; Fanari et al., 2021; Feng et al., 2018; Khoury et al., 2019; Price et al., 2013; Shah et al., 2019). For example, if a patient risk score showed higher risk for readmission based on their planned discharge destination, discharge teaching can focus on the community resources available in that area. In my literature review (Chapter 2), I identified that SDOH are virtually absent in existing CABG risk scores. The predictors used to determine risk varied throughout the literature but were mostly based on clinical variables, mainly age, sex, body mass index, cerebrovascular disease, shock, congestive heart failure, renal failure, postoperative complications (cardiac reoperation, renal failure), discharge destination, and length of stay (Deo et al., 2018; Fanari et al., 2021; Feng et al., 2018; Khoury et al., 2019; Price et al., 2013; Shah et al., 2019). Insurance status was identified, the only SDOH to be included within these risk scores (Fanari et al., 2021; Feng et al., 2018; Khoury et al., 2019; Price et al., 2013). My thesis findings offer a first step in recognizing that SDOH are associated with readmission post-CABG, and more research ought to be done to investigate which ones could be included in risk scores. The integration of SDOH and risk scores would permit a more well-rounded and individualised care plan, and shift nursing perspective to recognize that the responsibility to avoid readmission does not fall on patients alone, but how the health practitioner set the patients up for transitioning back into the community.

Findings from the literature review (Chapter 2) and my thesis findings (Chapter 4) concur that efforts to avoid readmission is an important consideration for discharge planning especially

in patients living in RRNC. In our current health care system, patients play an important role in avoiding readmission. Prior to discharge, they are instructed to recognize the signs and symptoms of a potential infection or other sinister complications, and when to seek help. The current system also relies on patients to individually take on the responsibility of engaging in heart healthy choices such as heart healthy diet, smoking cessation, and coping strategies for stress (Gaudel et al., 2022). Nevertheless, the responsibility does not fall on the patient and families alone to be able to be successful in self-management of their condition and avoid hospital readmission (Garland et al., 2022). Nurses and other health practitioners during the surgical stay should also be aware of factors that put their patients at risk for readmission post-CABG. They can work collaboratively as a team to address the inequities in RRNC, such as lack of cardiac clinics, increased cost for patients who must travel for appointments, and higher readmission rates within 30 days of initial hospitalization than for patients living in urban areas. Interprofessional approaches to care can help reduce risk for complications, improve access and overall improve better health outcomes for this patient population (Kusno & Duff, 2023).

Discharge destination. Finally, there are also inequities to consider related to patients' discharge destination. My thesis findings revealed that patients who were readmitted to hospital within 30 days of discharge were most often discharged to another health care facility or required community home care (Chapter 4). This is in keeping with the literature as others have also identified being discharged to a skilled health care facility or requiring community care was a factor for readmission (Fanari et al., 2021; Feng et al., 2018; Khoury et al., 2019; Price et al., 2013). Post-discharge follow-up with the cardiac surgeon is normally scheduled three to six weeks after discharge. In the meantime, patients are advised to follow-up with their family health practitioners, as needed. Yet, my findings revealed that 13.6% of readmitted patients did not

have immediate access to health care services other than the emergency department or walk-in clinics if in need, while the non-readmitted group all had access (100%) to family health practitioners. However, in both the emergency department and walk in clinics, it can be difficult to plan care and treatments for patients during the early post-operative period without access to their personal and surgical history, and discharge summary (Marshall et al., 2022). Some authors have proposed that this limited, fragmented access can lead to a higher risk for hospital readmission post-CABG (Donio et al., 2019; Shawon et al., 2021; Tam et al., 2018) (Chapter 2). Patients in Canada who are not followed by primary care in the community experienced a burden of care related to managing their own health, lack of continuity between health practitioners, and falling through the cracks of the health systems (Marshall et al., 2022).

In summary, the inequities that patients living in RRNC in comparison to their urban counterparts heighten their risk of readmission post-CABG. These inequities can be understood linearly throughout their care trajectory– and may have cumulative impact –from seeking care from initial signs and symptoms of CAD through to discharge into the community post-CABG. There are opportunities to focus on SDOH in surgical care, aiming to reduce hospital readmission post-CABG and improve patient outcomes. This can include improving access to family health practitioners and community resources post-discharge, tailoring pre- and post-operative teachings, and integrating risk scores to care plans and treatments.

Rural Nursing Theory and Social Determinants of Health

The Rural Nursing Theory and the Government of Canada's SDOH framework offered complementary theoretical perspectives for patients undergoing CABG in RRNC. According to the Rural Nursing Theory, health is defined as a way of life and a state of mind (Winter & Lee, 2018). Health represents the ability to function and work. People living in rural areas are self-

reliant, generally resist help from outsiders/strangers, and make decisions based on their own personal assessment of the severity of their health condition (Winter & Lee, 2018). The Rural Nursing Theory describes how rural residents' state of mind guide their health seeking behaviors. In comparison, the SDOH permitted a focus on the specific determinants of the person and the environment in which people are born, grow, and work that affect health and quality of life (Lathrop, 2020). Many residents of RRNCs are deprived of such SDOH like access to healthcare services (Kreatsoulas & Anand, 2010; Lanthrop, 2020). In my case-control study, I found that patients travelled over 180km on average for their CABG (Chapter 4). These findings align with what is known about access to specialized cardiac services in RRNC in Ontario. In Northeastern Ontario, there is one cardiac center that performs coronary angiograms and CABG (CorHealth Ontario, 2018). Yet, in Southern Ontario, there are 10 centers that perform coronary angiograms and CABG (CorHealth Ontario, 2018). Thus, residents of rural populations must travel further for cardiac care and wait longer to get it. With greater geographical distance from acute care and specialised care, causing more difficulty accessing care, rural residents may be more prone to dismissing early signs of postoperative complications and symptoms. Patients who live farther from health care services are challenged with the ability to travel and costs of missing work (Health Quality Ontario, 2017; Johnsan et al., 2023). This may be especially true if the patient has returned to work and returned to a degree of a daily routine, as health – as defined in the Rural Nursing Theory – represents the ability to function and work (Winters & Lee, 2018). Thus, patients believe they are "healthy" as they are able, to a certain extent, to work and function.

In my case-control study, wait time for surgery, population size of town of residence, distance from HSN, and need for community care were all identified as factors for readmission, all notable within the SDOH (Chapter 4). Hence, healthcare practitioners should be mindful of

their patients' SDOH profiles. Coupling the understanding of health in rural living, and health seeking behaviors as stipulated in the Rural Nursing Theory, together with the SDOH that may influence a patient's risk of readmission may offer health practitioners opportunities to prioritize and tailor care to minimize those risks. Yet, as discovered through the conduct of my case-control study, there was minimal documentation of SDOH in the electronic medical charts. When they were documented, it was at the cardiologist and cardiac surgeon's discretion to capture and document them themselves in their narrative notes. Yet, as noted earlier in this integration discussion, health practitioners from urban towns are often considered "outsiders" by people living in RRNC, making it less likely for the patient to disclose such information.

The SDOH that were captured in the Meditech database were employment and working conditions, physical environments, access to health services, social supports and culture (to little extent). The SDOH that were missing from the electronic charts were income and social status, education and literacy, childhood experiences, healthy behaviours, biology and genetic endowment, self-identified gender, and race.

I had hoped to explore these determinants in my thesis by way of semi-structured interviews with patients who had been readmitted to hospital within 30-days post-CABG. Despite multiple strategies tried over six months of recruitment, only one patient had consented. This is not unusual for research conducted in RRNC. Many scholars have experienced difficulty with recruitment for health-based research studies in RRNC (Dion et al., 2020). One potential reason may be that research about RRNC, including research with Indigenous people, is often conducted by people that do not have the lived experiences that are being sought (Dion et al., 2020). People who are then approached and invited to participate do not feel like the researchers truly understand them, and therefore decline participation (Dion et al., 2020). If we view this

through the lens of the SDOH, this may be explained by potential participants' perception of lack of social support from the researchers and health practitioners themselves. Alternatively, this apprehension to participate may also be explained by patients' distrust in the health care system, as proposed by the Rural Nursing Theory. In summary, the Rural Nursing Theory and the SDOH offered complementary theoretical underpinnings to investigate non-clinical factors associated with readmission to hospital post-CABG in RRNC.

A Focus on Social Determinants of Health to Enhance Health Equity in Cardiovascular Nursing Care

A deliberate focus on the SDOH for patients facing and recovering from CABG has the potential to enhance health equity. The Public Health Agency of Canada (2024) defines health equity as creating a fair health environment for all groups of people and being able to access health services without barriers, such as distance or income. Health equality, although similar, is defined as having the same level of health services and access across the region (Public Health Agency of Canada, 2024). Health equity has increasingly become a central focus in health research in Canada and globally (Public Health Agency of Canada, 2024). The United Nations Educational, Scientific and Cultural Organization (UNESCO) have presented a 2030 Agenda with 17 Sustainable Development with the main focus of health equity across the world. Many authors have reported that people of lower socioeconomic status, rural populations, and communities of color will at some point in their life experience a higher burden of poor health, whether in a cardiac context or otherwise (Donio et al., 2019; Health Quality Ontario, 2017; Lanthrop, 2020; Tam et al., 2018).

People living in RRNC experience more disparate health outcomes in comparison to people living in urban areas. This can be attributed to 1) issues of access to health care due to

lengthy wait times and geography (distance), 2) inattention to culture and race including Indigeneity, and 3) poverty. The results of this case-control study showed that people living in smaller population centers experience longer wait times for CABG (mean 49.7 days), while urban hospitals in Southern Ontario have an average wait time for CABG of 26.5 days (Ontario Health, 2024). In the non-readmitted group, which primarily consisted of patients from small (45.45%) and medium (31.82%) population centers, travel distance to hospital where surgery took place was over 180km. While in the readmitted group, mostly consisted of patients living in larger population centers (68.2%), the average distance to hospital was 57 km. While this may be surprising, it is important to note that I did not have access to patient charts outside of the HSN Meditech database, so patients who were not readmitted in this study, may have been readmitted to a hospital closer to their town of residence. This is further explained in the limitation section.

Culture, race, including Indigeneity, and socio-economic statuses were minimally captured in patients' charts (Chapter 4). Cultural groups in RRNC have different health practices and lifestyles (Canadian Association for Rural and Remote Nursing [CARRN], 2020). Culture and race are the basis for traditions and behaviors that affect health behaviours in residents of RRNC (CARRN, 2020). Statistics Canada (2021), found that the Northern Ontario population was made up of mostly French (23.8%), English (20.1%), Irish (19.1%), Canadian (17.4%), and Scottish (17.1%) with some racial groups overlapping. Statistics Canada (2021), also noted 26.6% of the population was of Indigenous identity in Northwestern Ontario and 14% in Northeastern Ontario. The cultural practices of the aforementioned racial groups may influence how patients define and understand health concepts, how they take care of their health, and how they make health decisions. For example, patients of Indigenous ancestry have more complex health issues than other cultural groups in Ontario (Sehgal et al., 2024; Tsuji et al., 2023). Tsuji

et al., (2023) conducted interviews with nine community elders of the Fort Albany First Nation of Northern Ontario. Participants discussed viewing their wellbeing and physical health holistically with an emphasis on their family's and community's health as well (Tsuji et al., 2023). Ensuring that the person is adequately supported by their community and recognizing the freedom to practice health traditions may set up the patient to be more inclined to succeed in the postoperative period. Sehgal et al., (2024) reviewed the literature and interviewed Indigenous people to develop an Indigenous-centered patient complexity assessment framework for urban Indigenous patients in Canada. The authors found that factors that contributed to health complexities among Indigenous patients are rooted in a legacy of colonization, which often go unnoticed in clinical settings. This creates discordance between Indigenous patients, and their health practitioners. Health systems in Canada are set up in ways that tend to dismiss the colonial history and its impacts on Indigenous peoples' health (Sehgal et al., 2024; Tsuji et al., 2023).

In particular, the only reference to race/culture within patient charts was Indigenous insurance status, limited to people who carry a valid federally-funded Non-Insured Health Benefits, as outlined in the Indian Act (Government of Canada, 2019). However, not all people who identify as Indigenous register with the Government under the Indian Act. In these instances, patients' Indigeneity would not have been captured in this study. Solely relying on Indigenous insurance status to determine a person's Indigenous identify creates a multitude of complexities as health care practitioners may not be aware of their patients' status, thus missing key information to offer tailored strategies for building a trusting relationship and offering tailored patient centered resources. The Rural Nursing Theory acknowledges the severe institutional racism towards Indigenous people who deliberately avoid public hospitals whenever possible in favour of clinics managed and staffed by Indigenous people (Tsuji et al., 2023).

Increasing rates of poverty also contribute to the disparate health outcomes of people living in RRNC. Poverty is one of the main stressors on health (Kreatsoulas & Anand, 2010; Lanthrop, 2020), yet income and social statuses were not located in the patient charts accessed in my case-control study. Even with Canada's medical system being free, patients with lower socioeconomic status have worse health outcomes due to nutritious foods and prescription medications being unaffordable, and specialized health services, such as cardiac services, being inaccessible (Kreatsoulas & Anand, 2010; Lanthrop, 2020). The chronic stress caused by inequitable societal structures such as poverty, racism, inadequate housing, unemployment, and food insecurity damages body systems and is linked to chronic disease and premature aging (Kreatsoulas & Anand, 2010; Lanthrop, 2020).

Nurses have a responsibility to uphold health equity. The Canadian Nurses Association has recognized that all nurses have "a professional and ethical responsibility to promote health equity" and "must include the social determinants of health in their assessments and interventions with individuals, families, and communities" (CARRN, 2020, pp.10). The first way to uphold health equity is by understanding patients as a whole, by eliciting and documenting their SDOH in their charts (CARRN, 2020). The PRAPARE tool is an example of a screening tool that aims to capture SDOH: Protocol for Responding to and Assessing Patient Assets, Risks, and Experiences, developed by the National Association of Community Health Centers (2016). This tool consists of 21 questions assessing SDOH including race/ethnicity, language, housing status, education, employment, transportation, and social integration, among others. Howell et al., (2023) conducted a cohort study testing the PRAPARE tool in a USA tertiary health care environment on over 6,000 patients. They stated this tool was often used in primary care and community clinics, yet the tool was set up to be easily adaptable to different settings, such as the

emergency department. The tool facilitated the collection of SDOH, but nurses expressed difficulty with fully completing the tool and embedding the results into their patient's care. The author suggested further research into strategies to improve the use of the data collected by the tool. I also believe with further research, this tool can be validated in a cardiac surgery context. The tool can be downloaded free in paper form in several languages at https://prapare.org/the-prapare-screening-tool/. There are also templates that have been developed to be incorporated into electronic health records (National Association of Community Health Centers, 2016).

Integrating the SDOH is key to shifting the focus in nursing practice on health equity. To achieve health equity, we must first tackle the unjust, modifiable factors such as ensuring those living in RRNC can easily access health services, be able to afford nutritious foods and medications, despite their geography, race or socioeconomic status (Health Quality Ontario, 2017). Several tools and frameworks, such as the PRAPARE tool, encourage accountability in nurses to be best prepared to care for patients from RRNC facing CABG and readmission.

Implications for Nursing

The findings of this thesis have implications for nursing clinical practice, education, research, and health policy.

Nursing Clinical Practice

Nurses are well positioned to adjust their clinical practice to incorporate the SDOH and principles of the Rural Nursing Theory to reduce readmissions post-CABG for patients living in RRNC. In addition to implementing risk scores discussed in Chapter 2, nurses can improve discharge planning by understanding, applying, and documenting the clinical and SDOH risk factors associated with readmission within patients' charts. For example, nurses should ensure an adequate support system is in place post discharge, implement referrals for community resources

available to the patient, and work with the patient to provide postoperative care practices that align with their culture and lifestyle. It is also important for nurses to understand how to tailor health teachings to the individual person and include family members and/or close social supports in the discharge process to allow patients to succeed during the postoperative period. A suggested strategy to include families in discharge teaching is assigning explicit roles and responsibilities to help the patient postoperatively (Fox et al., 2019).

Interprofessional approaches to care including the involvement of a physiotherapist, occupational therapist, nurses, physician, social workers, etc., allows for a more in-depth, comprehensive plan for patients to ensure successful recovery in the postoperative period. Interprofessional approaches to care offer promising avenues to achieve effective discharge planning and teachings, as it offers tailored support for various aspects of their recovery (e.g. deep breathing, diet, smoking cessation, physical movement) to determine what best fits their life circumstances, literacy levels, physical environments in which they live, and SDOH (Gaudel et al., 2022). Despite higher readmission rates in rural areas, Haj-Ali et al. (2020) concluded that integrating interprofessional care with other enablers of a strong primary care system such as access to health services and continuity of care could improve health services utilization and in turn reduce health inequities in RRNC.

Nursing Education

Education is a critical component of sensitizing future health practitioners to enter the workforce equipped to advocate for and enable health equity. There is an opportunity for nursing curriculums across Canada to enhance their focus on rural health, SDOH and health equity. Located in Sudbury, ON, Laurentian University's undergraduate and postgraduate nursing programs highlight the priority of increasing competences in nurses' scope practicing in RRNC

(Laurentian University, 2023). The Canadian Association of Schools of Nursing (2023) released a new strategic plan for 2023-2028, identifying the need to advance Indigeneity and health equity by improving education programs and promoting continuing education. Medical students will also need to integrate this as a stepping-stone towards their independent practice. The Northern Ontario School of Medicine (NOSM) University has a dedicated rural and northern health curriculum that includes a clinical practicum within a RRNC (NOSM University, n.d).

Continuing professional education and mentorship can also be offered to new licensed nurses practicing in cardiac settings who will be caring for a patient living in RRNC before and after CABG. When entering the workforce, new graduate nurses starting their practice in a cardiovascular surgical context, require further mentorship to ensure greater understanding of the CABG processes and teachings for their patients. Master's level nurses learn to integrate patient findings, as taught in their undergraduate education, with a unique perspective and critical thinking to care for more complex health issues to take on the role of Advance Practice Nurses (APN) (Canadian Nurses Association, 2019). APNs, who are most often located in urban hospital settings, can support staff nurses with current, evidence-based knowledge to integrate within their practice and can also help provide follow-up with patients postoperatively (Canadian Nurses Association, 2019). The funding and implementation of APN roles within Northern Ontario hospitals will help new nursing graduates working in RRNCs bridge the gap between being a nursing student and being a licensed registered nurse.

Nursing Research

While I was able to identify SDOH that are associated with readmission post-CABG, I was unable to explore the reasons why these factors in particular contributed to readmission. Next steps could include qualitative investigations of patients who have and have not been readmitted

to hospital post-CABG to further explore their journey through the surgical experience and gain an understanding of how they perceive SDOH playing a role in their journey and recovery. This was the initial intention of the qualitative portion of this thesis but due to recruitment and time constraint, this piece of the project was suspended. Examples of topic areas for interviews with patients could include exploring 1) the patient's awareness of the SDOH and how they influence their lives, 2) the patient's understanding about their CABG preoperatively and their impression of the health teaching and resources provided postoperatively, and 3) the nurses' perspective in caring for patients who live in RRNC and what barriers they experienced when trying to provide patient care pre- and post-CABG.

Furthermore, while my thesis was guided by the Rural Nurses Theory and the Government of Canada's 12 SDOH, other theoretical frameworks could be considered in future work to ensure a focus on health equity in nursing and health research. For example, the PROGRESS-plus framework is an acronym used to identify characteristics and outcomes that contribute (or limit) health equity (O'Neill et al., 2014). PROGRESS stands for Place, Race (ethnicity, culture, language), Occupation (out of work), Gender and sex, Religion, Education, Socioeconomic status, Social capital, (O'Neill et al., 2014). The "plus" considers personal characteristics associated with discrimination, features of relationships, and time-dependent relationships (O'Neill et al., 2014). Alternatively, the Integrated Health Equity Framework, developed by the Hamilton Family Health Team in Ontario, promotes inclusive and accessible care, and motivates patients to be engaged in their health journey (Upadhya-O'Brien & Janssen, 2023). Finally, more recently, intersectionality is increasingly used in rural health research to emphasize the role of power and structural oppression in reinforcing social inequities (Guan et al., 2021; Public Health Agency of Canada, 2022). Similar to the SDOH and the previously stated frameworks,

intersectionality would facilitate an enhanced understanding of the multiple, overlapping factors that influence patients' health from historical, social, economic, and political perspectives. Public Health Agency of Canada (2022) suggests combining universal health policies with targeted interventions in disadvantaged populations. When intersectionality and the SDOH are used in the context of hospital readmission post-CABG, they can offer unique perspectives in shifting the individual's roles and responsibilities of a successful recovery to revealing the structural and societal inadequacies that lead to and perpetuate inequities.

Nursing Policy

Lastly, policy changes within Ontario are a direct way to help reduce inequities for people living in RRNC. Efforts and recommendations to decrease readmissions after a CABG in RRNC require collaborative action from primary and tertiary health care systems. This can start with building capacity in existing health centres, to in turn build capacity and support additional cardiac services within Northern Ontario. Some cardiologists and surgeons have implemented virtual care as an option for initial consultations. However, such an approach risks loss of interpersonal relationships between the practitioner and the patient, which many patients in RRNC have rated important when seeking health advice (Marshall et al., 2022). It also does not solve the issue of long cardiac testing waitlists in RRNC, and patients' need to travel long distances to receive diagnostic testing and care. Thus, Northern Ontario requires more sites that perform cardiac angiograms and CABG to serve their long wait list of patients.

With cardiac testing centers, comes the additional need for more human resources; thus, more funding needs to be allocated into recruitment and retention of nurses, nurse practitioners, and other health practitioners. In 2015, the Registered Nurses Association of Ontario (RNAO) (2015), recognized and advocated for this need with the release of their report, *Coming Together,*

Moving Forward: Building the Next Chapter of Ontario's Rural, Remote and Northern Nursing Workforce. In this report, the RNAO outlined 23 recommendations to help the Government of Ontario with recruitment and retention, including increased access to nursing education, infrastructure renewal for growth in RRNC, and strategies to address compensation and benefit inequities for nurses in community (including primary care) and hospital sectors (Scaini & Alacon, 2023). The Government of Ontario (2022) introduced the Learn and Stay Grant to incentivise nursing staff to complete their nursing education in a particular setting, and remain there to practice in underserved Northern, Southwestern and Eastern Ontario.

Furthermore, greater emphasis needs to be placed on community care services to support healthy recoveries once discharged from hospital. There is a need for home care organizations to service more communities in Northern Ontario and aid patients in the post-operative period. RNAO (2015) suggested that homecare service could include the integration of virtual visits for consultation and educational purposes, augmented with occasional in person visits as needed.

Key stakeholders that need to be called to action are the Government of Ontario, the Ministry of Health and Long-Term Care, the Ministry of Research and Innovation, members of provincial parliament (MPP) and other Northern health care organizations to advocate for the integration of residents' voices when developing new provincial initiatives, to create more effective nurse retention strategies, and to increase accessibility to health services in RRNC. The latter initiatives will presumably benefit nurses and RRNC residents to improve utilization of health services pre- and post-CABG to reduce hospital readmission.

Strength and Limitations

This thesis is novel in that it explored the association between SDOH and 30-day post-CABG readmission status of patients living in RRNC from one Northern Ontario hospital, the

first of its kind to do so. Second, it viewed the problem from a nursing perspective offered by the Rural Nursing Theory, seeing the patient as a whole person who is shaped by the environment in which they live. Third, the use of a case-control study resulted in being able to focus on both clinical and SDOH as factors influencing readmission post CABG. As with any research study, there are limitations to consider. First, it was apparent in the literature review that attention to SDOH in the CABG-context is limited. The only determinants that were considered in the selected articles were race and income/social status, where non-white race and insurance status were associated with readmission. Therefore, there may be other factors that are missing and could influence pre- and post-CABG care in clinical practice. The choice of the Rural Nursing Theory for the content of this thesis offered a lens from which to view rural nursing care. However, a theory that specifically focused on self-care needs and recovery from surgery may have been helpful in delving deeper into the post-surgical care required to avoid readmission. However, investigating the influence of SDOH on rural and remote care was of most importance to this thesis, and the Rural Nursing Theory aligned best with my original intent for this project.

Second, I was limited in capturing patients who had post-CABG readmissions to the HSN hospital database only; I was unable to access readmissions to other rural Northern Ontario hospitals. This raises the possibility that the readmission rate may have been higher than actually reported in my results, as some patients may have sought care in a hospital closer to their town of residence. During the course of conducting this research study, 23 Northeastern Ontario hospitals, including HSN, introduced a new electronic health charting database, enhancing continuity of care and communication between hospitals and health centres across Northern Ontario regions. This progress offers a promising avenue for more accurate data collection and reporting for others wishing to conduct future research in these regions.

Conclusion

There are many factors influencing readmission post-CABG. In this thesis, I investigated the factors associated with readmission post-CABG in Ontario's RRNC, with particular attention to SDOH. According to my findings, readmission was associated with myocardial infarction, wait time for surgery, town of residence, distance from HSN, and need for community care. Therefore, factors for readmission were less associated with patient health related factors but rather related to health services, physical environment, and community related factors, which all consist within the SDOH. These factors should be considered in the care planning and management of patients undergoing CABG throughout their cardiac health journey from diagnosis to treatment, and to discharge into the community.

References

Canadian Association for Rural and Remote Nursing [CARRN]. (2020). Knowing the rural community: A framework for nursing practice in rural and remote Canada. CARRN: Unpublished document. Retrieved from: https://www.carrn.com/images/pdf/CARRN_RR_framework_doc_final_LR-2_1.pdf

Canadian Association of Schools of Nursing. (2023). *CASN strategic plan 2023-2028*. Retrieved from: https://www.casn.ca/about-casn/casn-strategic-plan-2023-2028/

Canadian Institute for Health Information. (2022). *A profile of physicians in Canada.* Retrieved from: https://www.cihi.ca/en/a-profile-of-physicians-in-canada

Canadian Institute for Health Information. (2023). *All patients readmitted to hospital.* Retrieved from: https://www.cihi.ca/en/indicators/all-patients-readmitted-to-hospital.

Canadian Nurses Association. (2019). *Advanced practice nursing: A pan-Canadian framework.* Retrieved from: https://www.cna-aiic.ca/-/media/cna/page-content/pdf-en/apn-a-pan-canadian-framework.pdf

Coombs, N. C., Campbell, D. G., & Caringi, J. (2022). A qualitative study of rural healthcare providers' views of social, cultural, and programmatic barriers to healthcare access. *BMC Health Services Research*, *22*(1), 438. https://doi.org/10.1186/s12913-022-07829-2

CorHealth Ontario. (2018). *Report on adult cardiac surgery October 2011 - March 2016.* Retrieved from: https://www.corhealthontario.ca/Report-on-Adult-Cardiac-Surgery-October-2011-March-2016-April-2018.pdf

de Jager, P., Aleman, D., Baxter, N., Bell, C., Bodur, M., Calzavara, A., Campbell, R., Carter, M., Emerson, S., Gagliardi, A., Irish, J., Martin, D., Lee, S., Saxe-Braithwaite, M., Seyedi, P., Takata, J., Yang, S., Zanchetta, C., & Urbach, D. (2023). Social determinants

of access to timely elective surgery in Ontario, Canada: Across-sectional population level study. *Canadian Medical Association Journal open*, *11*(6), E1164–E1180. https://doi.org/10.9778/cmajo.20230001

Dion, M. L., Díaz Ríos, C., Leonard, K., & Gabel, C. (2020). Research methodology and community participation: A decade of Indigenous social science research in Canada. *Canadian Review of Sociology, 57*(1), 122–146. https://doi.org/10.1111/cars.12270

Donio, P., Freitas, C., Austin, P., Ross, H., Abdel-Qadir, H., Wijeysundera, H., Tu, K., Cram, P., Liu, P., Abrams, H., Udell, A., Mak, S., Farkouh, M., Tu, J., Wang, X., Tobe, X., & Lee D. (2019). Comparison of readmission and death among patients with cardiac disease in Northern vs Southern Ontario. *Canadian Journal of Cardiology*, *35*(3), 341. doi: 10.1016/j.cjca.2019.01.004S

Duong, D., & Vogel, L. (2023). National survey highlights worsening primary care access. *Canadian Medical Association Journal, 19*(16). https://doi.org/10.1503/cmaj.1096049

Fanari, Z., Elliott, D., Russo, C. A., Kolm, P., & Weintraub, W. S. (2017). Predicting readmission risk following coronary artery bypass surgery at the time of admission. *Cardiovascular Revascularization Medicine: Including Molecular Interventions*, *18*(2), 95–99. 10.1016/j.carrev.2016.10.012

Feng, T. R., White, R. S., Gaber-Baylis, L. K., Turnbull, Z. A., & Rong, L. Q. (2018). Coronary artery bypass graft readmission rates and risk factors - A retrospective cohort study. *International Journal of Surgery (London, England)*, *54*(Pt A), 7–17. https://doi.org/10.1016/j.ijsu.2018.04.022

Fox, M.T., Sidani, S., Butler, J., Skinnner, M., & Alzhoul, M. (2019). Protocol of a

multimethod descriptive study: adapting hospital-to-home transitional care interventions to the rural healthcare context in Ontario, Canada. *BMJ Open, 9*(5). doi:10.1136/ bmjopen-2018-028050

Franklin, E., & Anjum, F. (2024). *Incentive Spirometer and Inspiratory Muscle Training.* Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK572114/

Gaudel, P., Neupane, S., Koivisto, A. M., Kaunonen, M., & Rantanen, A. (2022). Effects of intervention on lifestyle changes among coronary artery disease patients: A 6-month follow-up study. *Nursing open*, *9*(4), 2024–2036. https://doi.org/10.1002/nop2.1212

Garland, R., Gagnon, M., & Lewis, K. B. (2022). Time to revisit heart failure self-care: A concept analysis. *Advances in Nursing Science*, *45*(4), 371–386. https://doi.org/10.1097/ANS.0000000000000430

Government of Ontario. (2022). *Ontario learn and stay grant*. https://www.ontario.ca/page/ontario-learn-and-stay-grant

Government of Canada. (2019). Indian Act. (R.S.C., 1985, c. I-5). Retrieved from: https://laws-lois.justice.gc.ca/eng/acts/i-5/

Guan, A., Thomas, M., Vittinghoff, E., Bowleg, L., Mangurian, C., & Wesson, P. (2021). An investigation of quantitative methods for assessing intersectionality in health research: A systematic review. *SSM - Population Health*, *16*, 100977. https://doi.org/10.1016/j.ssmph.2021.100977

Haj-Ali, W., Moineddin, R., Hutchison, B., Wodchis., W & Glazier., R. (2020). Role of interprofessional primary care teams in preventing avoidable hospitalizations and hospital readmissions in Ontario, Canada: A retrospective cohort study. *BMC Health Services Research, 20*(782). https://doi.org/10.1186/s12913-020-05658-9

Health Quality Ontario. (2017). Health in the North: A report on geography and the health of people in Ontario's two northern regions. Retrieved from: http://www.hqontario.ca/portals/0/Documents/system-performance/health-in-the-north

Howell, C. R., Bradley, H., Zhang, L., Cleveland, J. D., Long, D., Horton, T., Krantz, O., Mugavero, M. J., Williams, W. L., Amerson, A., & Cherrington, A. L. (2023). Real-world integration of the protocol for responding to and assessing patients' assets, risks, and experiences tool to assess social determinants of health in the electronic medical record at an academic medical center. *Digital Health*, *9* (1). https://doi.org/10.1177/20552076231176652

Khoury, H., Sanaiha, Y., Rudasill, S. E., Mardock, A. L., Sareh, S., & Benharash, P. (2019). Readmissions following isolated coronary artery bypass graft surgery in the United States (from the nationwide readmissions database 2010 to 2014). *The American Journal of Cardiology*, *124*(2), 205–210. https://doi.org/10.1016/j.amjcard.2019.04.018

Kreatsoulas, C., & Anand, S. S. (2010). The impact of social determinants on cardiovascular disease. *The Canadian Journal of Cardiology*, *26*(Suppl C), 8C–13C. https://doi.org/10.1016/s0828-282x(10)71075-8

Kusno, A. L., & Duff, E. (2023). Heart failure care in rural Canada: Nurse practitioners addressing the disparity. *NP Current*, *4*(3). Retrieved from https://npcurrentjournal.ca/index.php/bios/article/view/27

Lathrop, B. (2020). Moving toward health equity by addressing social determinants of health. *Nursing for Women's Health, 4*(1), 36-44. https://doi.org/10.1016/j.nwh.2019.11.003.

Laurentian University. (2023). *Master of science in nursing (MScN)*. Accessed on: September 10th, 2024. Retrieved from: https://laurentian.ca/program/nursing-mscn/details

Law, T. J., Stephens, D., & Wright, J. G. (2022). Surgical wait times and socioeconomic status in a public healthcare system: a retrospective analysis. *BMC Health Services Research*, *22*(1), 579. https://doi.org/10.1186/s12913-022-07976-6

Marshall, E.G., Wuite, S., Lawson, B., Andrew, L., MacKenzie, A., Woodrow, A., & Peddle, S. (2022). "What do you mean I can't have a doctor? This is Canada!" – A qualitative study of the myriad consequences for unattached patients awaiting primary care attachment. *BMC Primary Care, 23*(60). https://doi.org/10.1186/s12875-022-01671-5

National Association of Community Health Centers (2016). *PREPARE.* Retrieved from: https://prapare.org/wp-content/uploads/2021/10/PRAPARE-English.pdf

Northern Ontario School of Medicine University. (n.d.). *MD program*. Accessed on: September 10th, 2024. Retrieved from: https://www.nosm.ca/education/md-program/

O'Neill, J., Tabish, H., Welch, V., Petticrew, M., Pottie, K., Clarke, M., Evans, T., Pardo, J., Waters, E., White, H., Tugwell, P. (2014). Applying an equity lens to interventions: Using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. *Journal of Clinical Epidemiology, 67*(1), pg. 56-64. doi:10.1016/j.jclinepi.2013.08.005

Ontario College of Family Physicians. (2023). *More than four million Ontarians will be without a family doctor by 2026.* Retrieved from: https://ontariofamilyphysicians.ca/news/more-than-four-million-ontarians-will-be-without-a-family-doctor-by-2026/

Ontario Health. (2024). *Results for surgery.* Accessed on: August 28th, 2024. Retrieved from: https://www.ontariohealth.ca/public-reporting/wait-times-results

Poon, S., Leis, B., Lambert, L., MacFarlane, K., Anderson, K., Blais, C., Demers, C., Ezekowitz, J. A., Hawkins, N. M., Lee, D. S., Moe, G., Sandhu, R. K., Virani, S. A., Wilton, S.,

Zieroth, S., & McKelvie, R. (2022). The state of heart failure care in Canada: Minimal improvement in readmissions over time despite an increased number of evidence-based therapies. *Canadian Journal of Cardiology Open*, *4*(8), 667–675. https://doi.org/10.1016/j.cjco.2022.04.011

Price, J. D., Romeiser, J. L., Gnerre, J. M., Shroyer, A. L., & Rosengart, T. K. (2013). Risk analysis for readmission after coronary artery bypass surgery: developing a strategy to reduce readmissions. *Journal of the American College of Surgeons*, *216*(3), 412–419. https://doi.org/10.1016/j.jamcollsurg.2012.11.009

Public Health Agency of Canada. (2022). *How to integrate intersectionality theory in quantitative health equity analysis? A rapid review and checklist of promising practices.* Retrieved from: https://www.canada.ca/content/dam/phac-aspc/documents/services /publications/science-research-data/how-integrate-intersectionality-theory-quantitative-health-equity-analysis/intersectionality-report.pdf

Public Health Agency of Canada. (2024). *Social determinants of health and health inequalities.* Retrieved from: https://www.canada.ca/en/public-health/services/health-promotion/population-health/what-determines-health.html

Registered Nurses' Association of Ontario. (2015). *Coming together, moving forward: Building the next chapter of Ontario's rural, remote and northern nursing workforce –report.* Retrieved from: http://rnao.ca/sites/rnao-ca/ files/RR_May8.pdf

Scaini, M., & Alacon, V. (2023). RNAO has the strategy for government to adopt in wake of auditor general report. *Registered Nurses' Association of Ontario.* Retrieved from: https://rnao.ca/news/media-releases/rnao-has-the-strategy-for-government-to-adopt-in-wake-of-auditor-general-report

Scheckel, M. M., Hedrick-Erickson, J., & Stieve, D. (2020). Learning what I need to know: Experiences of rural cardiac surgery patients. *Online Journal of Rural Nursing and HealthCare, 20*(1). https://doi.org/10.14574/ojrnhc.v20i1.605

Sehgal, A., Henderson, R., Murry, A., Crowshoe, L., & Barnabe, C. (2024). Advancing health equity for Indigenous peoples in Canada: development of a patient complexity assessment framework. *BMC Primary Care 25*(144). https://doi.org/10.1186/s12875024

Shah, R. M., Zhang, Q., Chatterjee, S., Cheema, F., Loor, G., Lemaire, S. A., & Ghanta, R. K. (2019). Incidence, cost, and risk factors for readmission after coronary artery bypass grafting. *The Annals of Thoracic Surgery*, *107*(6), 1782-1789. doi: 10.1016/j.athoracsur.2018.10.077.

Statistics Canada. (2021). *2021 census of population.* Retrieved from: https://www12.statcan.gc .ca/census-recensement/2021/dp-pd/prof/details/page.cfm?

Su, H., Zhang, J., Liu, Y., Peng, H., & Zhang, L. (2022). Pre and postoperative nurse-guided incentive spirometry versus physiotherapist-guided pre and postoperative breathing exercises in patients undergoing cardiac surgery: An evaluation of postoperative complications and length of hospital stay. *Medicine*, *101*(52), e32443. https://doi.org/10.1097/MD.0000000000032443

Tam, D. Y., Fang, J., Tran, A., Tu, J. V., Ko, D. T., Deb, S., & Fremes, S. E. (2018). A clinical risk scoring tool to predict readmission after cardiac surgery: An Ontario administrative and clinical population database study. *The Canadian Journal of Cardiology*, *34*(12), 1655–1664. https://doi.org/10.1016/j.cjca.2018.09.004

Tsuji, S. R. J., Zuk, A. M., Solomon, A., Edwards-Wheesk, R., Ahmed, F., & Tsuji, L. J. S. (2023). What is wellbeing, and what is important for wellbeing? Indigenous voices

from across Canada. *International Journal of Environmental Research and Public Health*, *20*(17), 6656. https://doi.org/10.3390/ijerph20176656

United Nations. (2015). Transforming our world: the 2030 agenda for sustainable development. Accessed on September 9th, 2024. Retrieved from: https://sdgs.un.org/2030agenda

Upadhya-O'Brien, A., & Janssen, R. (2023). *Integrated health equity framework: for EDI-AR and SDOH at Hamilton Family Health Team.* Retrieved from: https://www.hamilton fht.ca/en/who-we-are/resources/HFHT-Health-Equity-Framework-FULL.pdf

Vervoort, D., Afzal, A. M., Ruiz, G. Z., Mutema, C., Wijeysundera, H. C., Ouzounian, M., & Fremes, S. E. (2024). Barriers to access to cardiac surgery: Canadian situation and global context. *Canadian Journal of Cardiology*, *40*(6), 1110–1122. https://doi.org/10.1016/j.cjca.2023.11.011

Winters, C. & Lee, H. J. (Eds.). (2018). Rural nursing: Concepts, theory and practice. (5th ed.). Springer Publishing Company.

Appendix A

Budget

Total Budget: $590

Funds

University of Ottawa Admission Scholarship Aid Year 2022-2023

RNAO Nursing Education Initiative Grant

University of Ottawa Graduate Nurses Association Grant

Timeline: 1 year

Supplies

Phone including long distance charges within Ontario - $0

Video conferencing system (Zoom, Teams) - $0 (In-kind from University of Ottawa)

Equipment

Printer and computer - $0

NVIVO qualitative analysis software - $0 (In-kind from University of Ottawa)

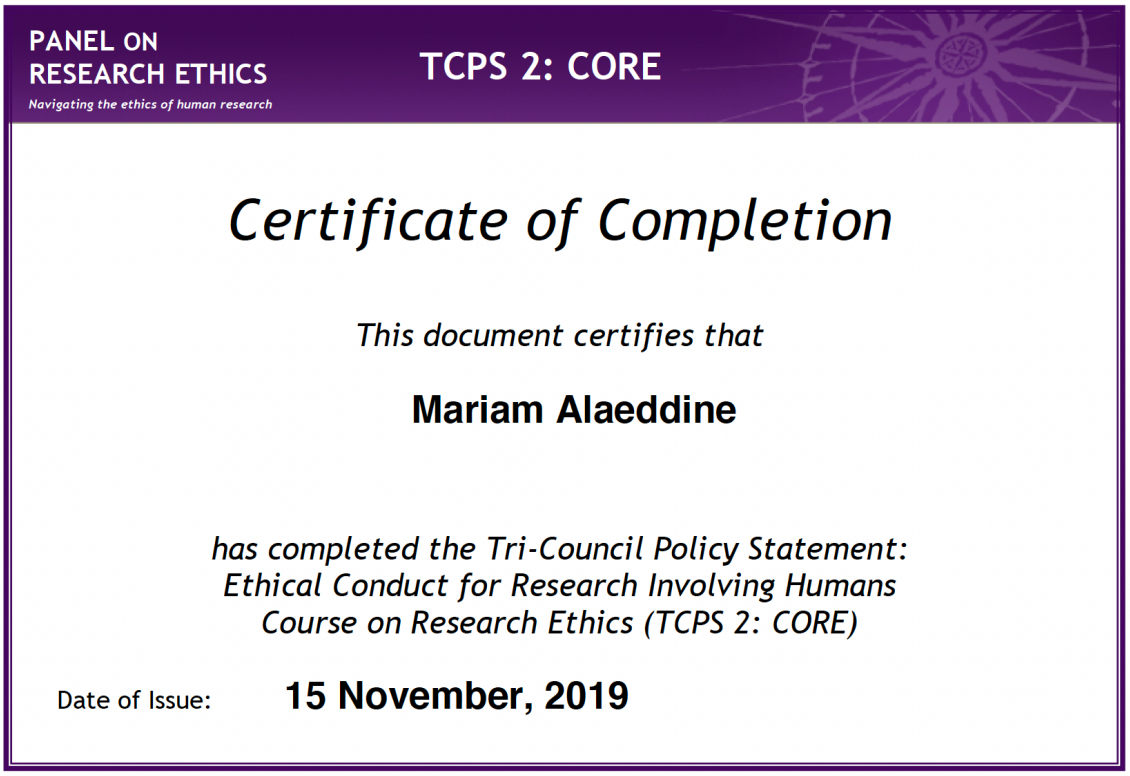
SPSS analysis software - $120

Other

HSN Decision Support Fee - $250

Appendix B

TCPS 2: CORE Certification



Appendix C

HSN Decision Support Program Approval

Health Sciences North Research Institute
Institut de recherches d'Horizon Santé-Nord

REQUEST FOR DECISION SUPPORT/ HEALTH RECORDS APPROVAL			
Project Title:	**Postoperative Coronary Artery Bypass Graft Readmissions in Rural,**		
Principal Investigator (PI):	**Dr. Krystina Lewis**		
Main Project Contact: *If not the same as the PI*	**Mariam Alaeddine (Student at UOttawa - academic requirement)**		
Contact Phone #:		**Contact Email:**	

Please refer to Appendix A for instructions and request requirements	
REQUEST DETAILS	
Is this a mandatory academic requirement for a Northern Ontario School of Medicine student?	Yes ☐ No ☑ If yes, please indicate the student name:
Please outline which medical databases will be used (i.e., Meditech, paper charts, etc.) if known?	Meditech/EMR
Do you require Decision Support services? If you are unsure how this service can support your study, please contact Health Information Services at HISResearch@hsnsudbury.ca to schedule a meeting	Yes ☑ No ☐ Report writing only
CHART REVIEWS: Please outline the parameters of the chart review and include the time period. *Example: All charts for children between the ages of 12-18 admitted to the Emergency Department with a head injury between January 1, 2011 to December 31, 2018*	N/A ☐ All patient readmitted within 30 days after their Coronary No physical charts; EMR review only
CLINICAL RESEARCH: Do you expect that the research will require chart reviews as part of the patient's enrollment and follow up in the study?	Yes No ☐ N/A ☑
Number of charts requested (estimated):	300
Time frame for chart request: *Example: All charts required by June 1st OR chart pulls can be spread out over a time period (June 1 to August 1)*	All Charts required by May 2023
Health Records will provide a fee quote based on the above information. *Note: There is no fee for NOSM student projects completed as part of mandatory academic requirements.* **Principal Investigators are responsible for all fees. Health Records will invoice for services rendered.**	

APPROVAL	
PROGRAM DECLARATION *Please note that the expected turn-around time for review and approval is two (2) weeks.*	
As evidenced by my signature below, my program is aware of the research project being proposed and acknowledges that this program is supportive of the research and able to accommodate and support the project as set out herein.	
Health Records Program Manager Signature:	
Date of Approval:	Jan 3, 2023
Please print Manager Name:	Kim Giroux
Please retain a copy of this document for your records and return the original to the Principal Investigator.	

Appendix D

Health Sciences North Research Ethics Boards Approvals

Health Sciences North
Horizon Santé-Nord

Research Ethics Office
41 Ramsey Lake Road
Sudbury, ON P3E 5J1
reb@hsnsudbury.ca

To:	Krystina Lewis
Study Title:	Postoperative Coronary Artery Bypass Graft Readmissions in Rural, Remote and Northern Communities
Sponsor / Funder:	University of Ottawa School of Nursing
REB Review Type:	Delegated
Date of Review:	January 24 2023
Date of Final Approval:	October 06 2023
Expiry Date:	**October 06 2024**

Notification of REB FINAL Approval

Documents Approved:

- HSN REB Application (signed January 11, 2023)
- Research Protocol (Version 1.1_January 11, 2023)
- Appendix A - Preliminary Interview Script (Version: 11/01/2023)
- Appendix B – Initial Contact Script (Version: 11/01/2023)
- Appendix C – Consent Form (Version: 11/01/2023)
- Appendix D – Withdrawal of Consent (Version 11/01/2023)

Documents Acknowledged

- Appendix E – Budget
- Appendix F – TCPS 2: CORE Certification (Alaeddine)
- Appendix G – HSN Decision Support Program Approval (Signed: January 3, 2023)

Project Number: 23-002

This Project Number has been assigned to your project. Please use this number on all future correspondence.

The Research Ethics Board of Health Sciences North (REB HSN) has reviewed the above research protocol and considers it to be ethically acceptable.

As Principal Investigator, you are responsible for the ethical conduct of this study as outlined under the *Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans (2nd Edition)*.

Please take note of the following list of ethics requirements you must fulfill over the course of your study:

- You are responsible for renewing the approval for this study prior to the expiry date by submitting an Annual Renewal Form or if the study is complete, a Final Report form. Please add August 25 2024 to your calendar as a reminder to complete and

Health Sciences North
Horizon Santé-Nord

Research Ethics Office
41 Ramsey Lake Road
Sudbury, ON P3E 5J1
reb@hsnsudbury.ca

To:	Krystina Lewis
Study Title:	Postoperative CABG Readmissions in Rural, Remote and Northern Communities
Sponsor / Funder:	University of Ottawa
REB Review Type:	Delegated
Date of Approval:	29 January 2024
Expiry Date:	6 October 2024

Notification of Amendment Approval

Documents Approved

- Amendment Request Form (signed January 15, 2024)
- REB Research Protocol (dated January 15, 2024)

Project Number: 23-002

The Research Ethics Board of Health Sciences North has reviewed and approved the amendment request for the above research protocol. The quorum for approval did not involve any member associated with this project.

Sincerely,

Dr. Dennis Reich, Chair, Health Sciences North Research Ethics Board

Date: 9-24-2024

IRB #: 23-002
Title: Postoperative Coronary Artery Bypass Graft Readmissions in Rural, Remote and Northern Communities
Creation Date: 3-6-2024
End Date: 9-9-2025
Status: Approved
Principal Investigator: Krystina Lewis
Review Board: Health Sciences North Research Ethics Board
Sponsor:

Study History

Submission Type Legacy	Review Type Unassigned	Decision
Submission Type Renewal	Review Type Full	Decision Approved

Key Study Contacts

Member Krystina Lewis	Role Principal Investigator	Contact
Member Mariam Alaeddine	Role Primary Contact	Contact

Appendix E

University of Ottawa Research Ethics Boards Administrative Approvals

16/10/2023

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

CERTIFICAT D'APPROBATION ÉTHIQUE I CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number	H-03-23-9038
Titre du projet / Project Title	Postoperative Coronary Artery Bypass Graft Readmissions in Rural, Remote and Northern Communities
Type de projet / Project Type	Thèse de maîtrise / Master's thesis
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	16/10/2023
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	06/10/2024

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Mariam ALAEDDINE	École des sciences infirmières / School of Nursing	Chercheur Principal / Principal Investigator
Krystina LEWIS	École des sciences infirmières / School of Nursing	Superviseur / Supervisor
J. Craig PHILLIPS	École des sciences infirmières / School of Nursing	Co-chercheur / Co-investigator

Conditions spéciales ou commentaires / Special conditions or comments

The expiry date is matched with the one on the ethics certificate from the Research Ethics Board of Health Sciences North.

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

H-03-23-9038 - MOD1-9038 - Modification approuvée / Modification Approved

(English message follows)

Cher/Chère Mariam Alaeddine,

Merci d'avoir soumis une demande de modification pour votre projet de recherche intitulé «Postoperative Coronary Artery Bypass Graft Readmissions in Rural, Remote and Northern Communities».

Ces modifications ont été approuvées et sont assujetties au certificat d'approbation éthique, valide jusqu'au 06-10-2024.

Inclusion criteria has been updated and the approval from the primary REB is attached.

Si vous avez des questions, n'hésitez pas à communiquer avec le Bureau d'éthique au ethique@uottawa.ca ou au 613-562-5387.

Vous pouvez voir votre demande en vous connectant à votre compte eReviews .

Cordialement,

Coordonateur / Coordinator
Coordonnateur de l'éthique
Président(e) : Daniel Lagarec
CÉR : Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board

Ceci est une réponse automatisée, merci de ne pas répondre à ce courriel.

Dear Mariam Alaeddine,

Thank you for submitting a modification request for your research project titled "Postoperative Coronary Artery Bypass Graft Readmissions in Rural, Remote and Northern Communities".

These modifications are now covered under the certificate of ethics approval, valid until 06-10-2024.

Inclusion criteria has been updated and the approval from the primary REB is attached.

If you have any questions, please contact the Ethics Office at ethics@uottawa.ca or 613-562-5387.

You can view your project at any time by logging into eReviews .

Best regards,

Coordonateur / Coordinator
Ethics Coordinator
Chair: Daniel Lagarec
REB: Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board

This is an automated message. Please do not reply directly to this email.

Appendix F

STROBE Guidelines for Case-Control Studies

	Item	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	i
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	ii
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	27
Methods			
Study design	4	Present key elements of study design early in the paper	45
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	45
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	46
		(*b*) For matched studies, give matching criteria and the number of controls per case	46
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	47
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	47
Bias	9	Describe any efforts to address potential sources of bias	47 & 49
Study size	10	Explain how the study size was arrived at	46
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	48
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	49
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	49
		(*d*) If applicable, explain how matching of cases and controls was addressed	46
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed	64

		eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	65
		(b) Indicate number of participants with missing data for each variable of interest	65 & 66
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	66
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	66 & 81 (table 7)
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses.	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	67 & 84
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	71 & 103
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	71 & 104
Generalisability	21	Discuss the generalisability (external validity) of the study results	71 & 105
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	114

Abbreviations: N/A: Not Applicable

*Give information separately for cases and controls.