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Research

Postoperative outcomes for Nunavut Inuit at a Canadian quaternary care centre: a retrospective cohort study

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Abstract

Background: Structural aspects of health care systems, such as limited access to specialized surgical and perioperative care, can negatively affect the outcomes and resource use of patients undergoing elective and emergency surgical procedures. The aim of this study was to compare postoperative outcomes of Nunavut Inuit and non-Inuit patients at a Canadian quaternary care centre.

Methods: We conducted a retrospective cohort study involving adult (age ≥ 18 yr) patients undergoing inpatient surgery from 2011 to 2018 at The Ottawa Hospital, the quaternary referral hospital for the Qikiqtaaluk Region of Nunavut. The study was designed and conducted in collaboration with Nunavut Tunngavik Incorporated. The primary outcome was a composite of in-hospital death or complications. Secondary outcomes included postoperative length of stay in hospital, adverse discharge disposition, readmissions within 30 days and total hospitalization costs.

Results: A total of 98 701 episodes of inpatient surgical care occurred among patients aged 18 to 104 years; 928 (0.9%) of these involved Nunavut Inuit, and 97 773 involved non-Inuit patients. Death or postoperative complication occurred more often among Nunavut Inuit than non-Inuit patients (159 [17.2%] v. 15 691 [16.1%]), which was significantly different after adjustment for age, sex, surgical specialty, risk and urgency (odds ratio [OR] 1.25, 95% confidence interval [CI] 1.03–1.51). This association was most pronounced in cases of cancer (OR 1.63, 95% CI 1.03–2.58) and elective surgery (OR 1.58, 95% CI 1.20–2.10). Adjusted rates of readmission, adverse discharge disposition, length of stay and total costs were significantly higher for Nunavut Inuit.

Interpretation: Nunavut Inuit had a 25% relative increase in their odds of morbidity and death after surgery at a major quaternary care hospital in Canada compared with non-Inuit patients, while also having higher rates of other adverse outcomes and resource use. An examination of perioperative systems involving patients, Inuit leadership, health care providers and governments is required to address these differences in health outcomes.

Differences in health outcomes for First Nations, Inuit and Métis Peoples in Canada persist despite repeated commissions and calls to action.[1–3] Racist and colonial policies such as the *Indian Act*, land dispossession, forced relocation and residential school systems have contributed to ongoing social inequities for Indigenous Peoples in the form of inadequate housing, lack of access to clean water, food and income insecurity, and inequitable experiences in health care in Canada.[4–6]

There is increasing evidence of health disparities for Indigenous Peoples, such as higher rates of communicable and noncommunicable diseases and unintentional injury.[7–9] Similar trends are seen in the surgical population. A recent systematic review of postoperative outcomes for Indigenous Peoples in Canada showed higher rates of adverse events after surgery, including death (adjusted 30% relative decrease in survival), postoperative complications and hospital readmission.[10]

First Nations, Inuit and Métis Peoples in Canada are highly heterogeneous populations, accounting for more than 684 communities (630 First Nations and 54 Inuit) and 70 distinct languages.[11] Data are lacking on outcomes specifically for Inuit, which represents an important gap in our understanding of the pattern of surgical disease and outcomes in Canada.

Competing interests: Caitlin Champion reports a research grant from the Northern Ontario Academic Medicine Association for the Canadian Frostbite Collaborative project. Nadine Caron reports being a board member for the Heart and Stroke Foundation of Canada, a board member for CyberPatient, co-director for the Centre for Excellence in Indigenous Health, a First Nations Health Authority Chair in Cancer and Wellness, a UBC Indigenous Health Special Advisor, and a board member for the Canadian Cancer Society. No other competing interests were declared.

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The Inuit reside primarily in Inuit Nunangat (homeland), which includes the Inuvialuit Settlement Region (Northwest Territories), Nunavut, Nunavik (Quebec) and Nunatsiavut (Newfoundland and Labrador), with population growth in cities such as Yellowknife, Edmonton, Winnipeg, Ottawa and Montréal.[4,12] The Inuit experience extreme health disparities and, on average, report worse overall scores on key social determinants of health, including access to health care.[12,13] It is postulated that structural aspects of health care systems, specifically limited surgical specialists, high provider turnover in Nunavut and perioperative processes, can influence the health of Inuit undergoing surgery.[14] This is further exacerbated by geographical remoteness, which can introduce substantial logistic, social and financial strains on individuals accessing care in urban centres.

Our objective was to compare postoperative outcomes of Nunavut Inuit and non-Inuit patients undergoing surgery at The Ottawa Hospital, the quaternary referral centre for adult patients from the Qikiqtaaluk Region of Nunavut. We hypothesized that Inuit from Nunavut would have higher rates of adverse outcomes than the non-Inuit population.

Methods

Study design and setting

We performed a retrospective cohort study involving all adult inpatients from the Qikiqtaaluk Region of Nunavut undergoing surgery at The Ottawa Hospital. The population of Qikiqtaaluk Region is 18 985 (53% of the total territorial population) and 80% are Inuit. The Ottawa Hospital provides specialized health care to adult residents of this region, including elective and emergency surgery for trauma, neurosurgery, thoracic surgery, vascular surgery, oncology care and complex orthopedic care, through scheduled surgical specialist clinics in Iqaluit and in collaboration with family physicians and general surgeons in Nunavut (Figure 1).[12,15]

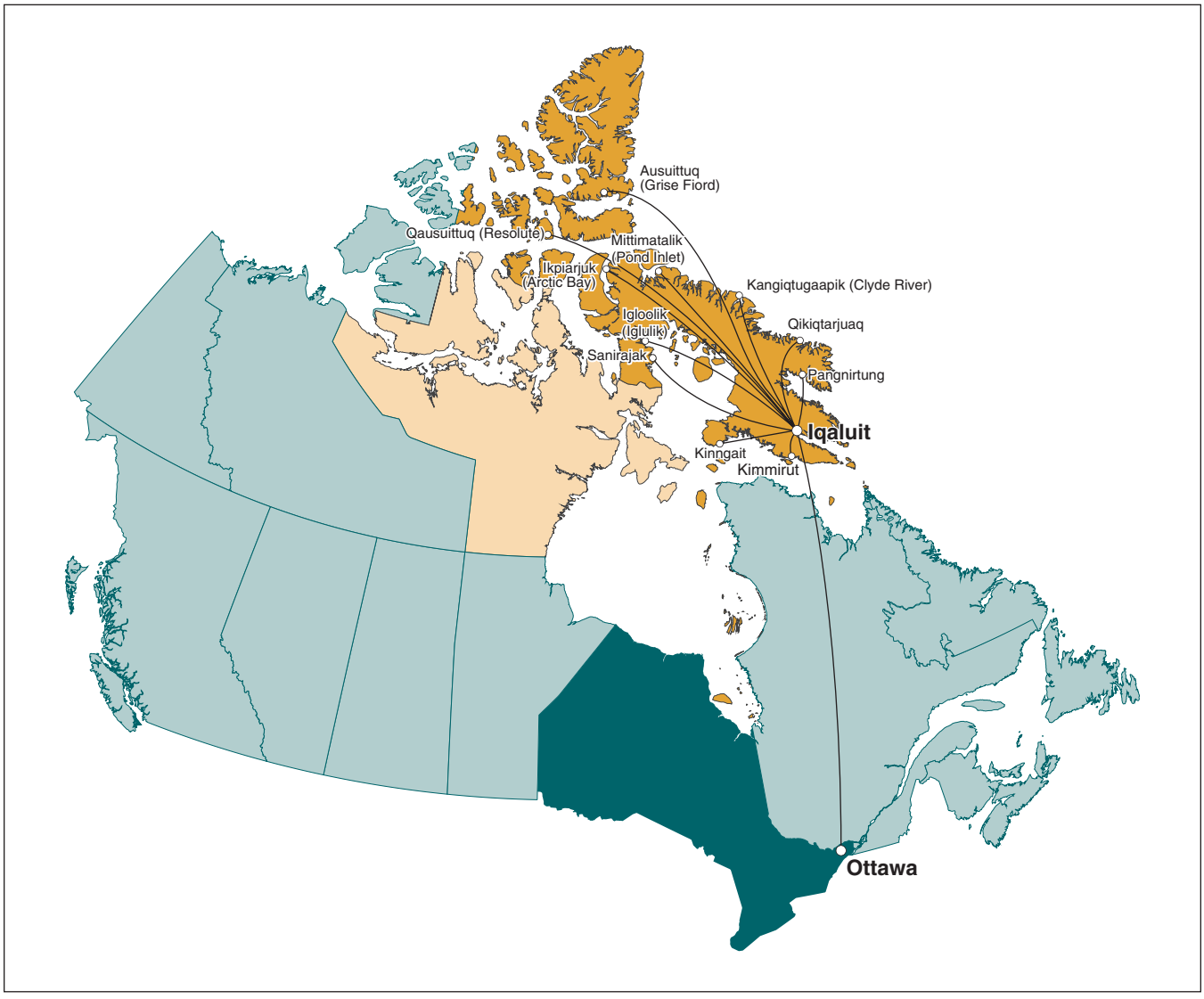

Figure 1: The patient referral pathway from Qikiqtaaluk to Ottawa.

The senior authors (J.A.M., D.I.M., M.D.B., J.H.-N. and N.R.C.) conceived the project and collaborated with Nunavut Tunngavik Incorporated (J.A.) on the design and conduct of the study. This manuscript is reported in keeping with recommended guidance for observational studies using routinely collected data.[16,17]

Participants

We identified all adults (age ≥ 18 yr) undergoing noncardiac, nonobstetric surgery during an inpatient admission from Apr. 1, 2011, to Mar. 31, 2018. First, we identified surgical procedures from the Surgical Information Management System (SIMS) database. Next, we deterministically linked the corresponding inpatient admission from the Canadian Institute for Health Information Discharge Abstract Database (DAD) using an anonymized unique identifier and created an episode-level analytic data set.

Data sources

All data were collected from The Ottawa Hospital Data Warehouse, which stores prospective clinical, electronic and administrative data for the hospital. Specific data sources used within this data warehouse included the DAD; the National Ambulatory Care Reporting System (NACRS); the SIMS database (Optum), which is the medicolegal record for surgical care at the hospital and records all details of surgical procedures; and The Ottawa Hospital's electronic health record database, which captures records of clinical care and laboratory data. The DAD and NACRS have had relevant data fields validated through reabstraction studies.[18,19] Data sources are further described in Appendix 1, available at www.cmajopen.ca/content/10/2/E304/suppl/DC1.

Exposure

The exposure was Nunavut Inuit identity, determined via the Nunavut health card number, which identifies Inuit Land Claim beneficiaries through the presence of a "5" in the ninth position of the number, an approach used previously.[20] By this indicator, individuals were categorized as Nunavut Inuit and were compared with all adult non-Nunavut residents receiving surgical care at The Ottawa Hospital.

Outcomes

The primary outcome was a composite of in-hospital death or complication (as death is a competing risk for complications and can be considered the most severe grade of complication). Death was identified from the DAD, and complications were identified using type 2 (i.e., arising in hospital) *International Classification of Diseases, 10th Revision* codes, based on clusters of Patient Safety Indicators (Appendix 2, available at www.cmajopen.ca/content/10/2/E304/suppl/DC1).[21,22] Validation of the Patient Safety Indicators among surgical patients at The Ottawa Hospital compared with prospectively collected complications in the National Surgical Quality Improvement Program (NSQIP) database shows concurrent validity (i.e., similar rates of complications [19% v. 22%] identified with each system), as well as a positive likelihood ratio of 6.4 and negative likelihood ratio of 0.4, using NSQIP data as the reference standard.[23]

Secondary outcomes included postoperative length of stay in hospital (from the DAD), unplanned readmissions (i.e., with a nonelective admission category) within 30 days of discharge (from creation of a new DAD record within 30 days of the index episode discharge among those discharged alive), adverse discharge disposition (discharge to a long-term or continuing care bed, or death in hospital as death is a competing risk for discharge outcomes from the DAD) and total hospitalization costs, using standardized methods that included both direct and indirect costs standardized to 2018 Canadian dollars.[24] This method accounts for an individual patient's resource intensity weight, their case mix group, and fixed and indirect costs to the hospital based on patient location of care and length of stay.

Covariates

From the DAD, we identified patient age (18–64, 65–74 and ≥ 75 yr), sex and the specific *Canadian Classification of Health Interventions* code for the index surgery, and all Elixhauser comorbidities present on admission.[25] From the SIMS database, we identified the primary surgical service (orthopedic surgery, general surgery, gynecologic oncology, benign gynecology, neurosurgery, plastic surgery, dental surgery, thoracic surgery, urology, vascular surgery or otolaryngology); urgency (elective, urgent, cancer), with urgent cases defined by the use of "E" (emergency) code on the anesthetic record; and the American Society of Anesthesiologists (ASA) Physical Status Classification System score.[26,27] From the health record, we computed the Laboratory-based Acute Physiology Score (LAPS), an externally validated score that predicts physiology-associated risk of death based on laboratory values, and identified whether the individual had received cancer treatment at the The Ottawa Hospital Cancer Centre in the year before surgery.[28]

Statistical analysis

All analyses were performed using SAS version 9.4 (SAS Institute). We compared baseline characteristics of those with and without Nunavut Inuit identity using absolute standardized differences (where values > 0.1 suggest a substantial difference).[29] A 5% level of significance based on 2-tailed tests was used for the primary outcome, which was prespecified. With Bonferroni multiplicity adjustment for 4 secondary outcomes, a 1.25% level of significance was applied to secondary analyses. Sensitivity analyses were considered exploratory.

We performed unadjusted and multivariable adjusted analyses for each outcome. For binary outcomes (death or complication, readmission, adverse discharge disposition), we used logistic regression models; for skewed continuous outcomes (length of stay, costs), we used generalized linear models with a log link and γ response distribution, as recommended for surgical data.[30] In all adjusted models, we accounted for instances where an individual had more than 1 episode of surgical care using generalized estimating equations. If more than 1 surgery was required during an admission, we included

only the first procedure during that hospitalization. We included prespecified terms for surgical service (categorical, with orthopedics as reference), age (categorical, with 18–64 yr as reference), sex (binary), urgency (categorical, with elective as reference) and procedural risk using the Procedural Index for Mortality Risk score, an internally validated score (linear, as in its validation).[31,32] Adjustment for comorbidity and physiologic status was not performed in the primary analysis, as they were thought to be intermediates on the causal pathway from having Nunavut Inuit identity to outcome and would therefore introduce overadjustment bias.

We performed several prespecified sensitivity analyses. First, both components of the primary outcome were analyzed individually. Next, to evaluate whether comorbidity and physiologic status may mediate some adverse outcome burden, we reran the primary adjusted model with additional terms for LAPS (linear), Elixhauser score (linear, a validated score predicting in-hospital death) and ASA score (binary 1–2 v. ≥ 3).[33] Prespecified subgroup analyses were also completed within patients with cancer and based on urgency (elective v. urgent).

All analyses were performed as complete case analyses as no exposure or outcome data were missing and all covariate data were complete other than missing Procedural Index for Mortality Risk and LAPS scores for 91 and 90 participants (< 0.1%), respectively.

Ethics approval

The Ottawa Health Science Network Research Ethics Board approved the study (20180324).

Results

We identified 98 701 episodes of inpatient surgical care at The Ottawa Hospital during the study period; 928 (0.9%) of these involved Nunavut Inuit, and 97 773 involved non-Inuit patients. Those with Nunavut Inuit identity were more likely to have urgent surgery, were younger and had a differential distribution of surgical procedures (Table 1).

Postoperative complications or in-hospital death

Among Nunavut Inuit, 159 died or had a complication in hospital after surgery (17.2%; 155 with complications and 15 deaths), compared with 15 691 (16.1%; 15 223 with complications and 1446 deaths) for those without Nunavut Inuit identity (unadjusted odds ratio [OR] 1.06, 95% confidence interval [CI] 0.89–1.27). After adjustment for age, sex, surgical specialty, risk and urgency, Nunavut Inuit were significantly more likely to experience the primary outcome (adjusted OR 1.25, 95% CI 1.03–1.51). This association was most pronounced in cases of cancer (OR 1.63, 95% CI 1.03–2.58) and elective surgery (OR 1.58, 95% CI 1.20–2.10).

Sensitivity analysis including additional adjustment for chronic and acute illness found no significant association (OR 1.15, 95% CI 0.94–1.41). Heterogeneity in effect estimates were identified between subgroups, with larger and significant associations between Nunavut Inuit identity and outcome identified in elective surgery and for cancer surgery, but not after urgent surgery (Figure 2; Appendix 3, available at www.cmajopen.ca/content/10/2/E304/suppl/DC1).

Secondary outcomes

Table 2 describes secondary outcomes by exposure, as well as adjusted and unadjusted effect estimates. Before adjustment, patients with Nunavut Inuit identity were significantly more likely to have an adverse discharge disposition, longer length of stay and higher costs. After adjustment, these significant associations persisted, along with a significant association with readmission.

Interpretation

In this single-centre retrospective cohort study, we found that patients with Nunavut Inuit identity had higher odds of postoperative morbidity and death, especially after elective and cancer surgeries. Rates of health care resource use were also higher. These findings help to address an important knowledge gap around surgical and perioperative outcomes for Inuit and highlight the urgent need to improve systems of care, in partnership with Nunavut Inuit representative organizations, to help ameliorate outcomes for Nunavut Inuit patients requiring surgery.

At least 2 systematic reviews describe associations between Indigenous status and perioperative outcomes. One, focused on Indigenous people from the United States, Australia and New Zealand, found higher rates of death after cardiac surgery.[34] A second, which synthesized results from available Canadian studies, similarly found an adjusted 30% relative decrease in survival across surgery types and narratively described increased rates of complications compared with the general population.[10] However, both studies identified important knowledge gaps and limitations that the current study helps to address. First, defining Indigenous exposure is often a source of bias. In our study, we were able to identify Nunavut Inuit identity directly from government-issued health cards. Second, no Inuit-specific data were identified in any previous review, meaning that a core Indigenous population in Canada has been excluded from evaluation of perioperative outcomes, a gap that the current study directly addresses.

Our finding that Nunavut Inuit have a 1.25-fold increase in the odds of morbidity and death is consistent with existing perioperative risk estimates for Indigenous Canadians. However, the causal pathway underlying this effect is likely multidimensional and complex (Figure 3), reflecting upstream social determinants and related chronic health conditions, process factors related to access, and challenges in receiving care thousands of kilometers from one's home community. It is not surprising that resource use was higher, but these data provide crucial context that despite spending nearly 20% more on care, outcomes were more than 20% less favourable.

Inuit experience poor social determinants of health, including inadequate access to health services, which can ultimately lead to worse acute health outcomes.[4,13] This was supported by our findings. In patients undergoing emergency surgery,

Table 1 (part 1 of 2): Baseline characteristics of patients undergoing inpatient surgery from 2011 to 2018 at The Ottawa Hospital, *n* = 98 701

Characteristic	%*		
	Nunavut Inuit *n* = 928	Non-Inuit *n* = 97 773	Absolute standardized difference†
Sex, female	52.3	58.9	0.13
Age at surgery, yr, mean ± SD	51 ± 17	59 ± 18	0.43
Surgery type			
Orthopedic surgery	40.0	30.4	0.20
General surgery	20.3	21.5	0.03
Urology	6.6	12.5	0.20
Neurosurgery	6.8	9.1	0.09
Benign gynecology	5.7	7.8	0.08
Gynecologic oncology	1.0	3.1	0.15
Vascular surgery	1.6	6.8	0.26
Otolaryngology	2.8	4.5	0.09
Thoracic surgery	6.4	3.6	0.13
Plastic surgery	4.0	1.3	0.17
Dental surgery	3.9	1.2	0.17
Procedural urgency			
Elective	41.9	57.5	0.32
Urgent‡	58.1	42.5	0.32
Cancer	8.9	13.2	0.14
Comorbidities			
Alcohol use disorder	2.4	0.5	0.16
Anemia	§	0.2	0.01
Arrhythmia	1.7	2.5	0.51
Blood loss anemia	§	0.1	0.05
Heart failure	1.5	0.9	0.06
Chronic obstructive pulmonary disease	4.9	1.6	0.19
Connective tissue disease	§	0.5	0.01
Cancer with metastasis	7.0	5.7	0.06
Cancer without metastasis	14.9	18.2	0.09
Coagulopathy	§	0.7	0.02
Depression	§	0.5	0.02
Diabetes with complications	3.3	7.3	0.18
Diabetes without complications	4.2	6.4	0.10
Substance use disorder	§	0.3	0.03
Fluid or electrolyte abnormality	2.2	1.0	0.09
Hypertension with complications	§	0.1	0.03
Hypertension without complications	7.3	8.4	0.04
Hypothyroidism	§	0.5	0.08
Liver disease	§	0.5	0.01
Lymphoma	§	0.6	0.06
Neurologic disease	1.3	1.0	0.02
Obesity	§	4.2	0.23
Peptic ulcer disease	§	0.1	0.04

Table 1 (part 2 of 2): Baseline characteristics of patients undergoing inpatient surgery from 2011 to 2018 at The Ottawa Hospital, *n* = 98 701

Characteristic	%*		
	Nunavut Inuit *n* = 928	Non-Inuit *n* = 97 773	Absolute standardized difference†
Comorbidities cont'd			
Peripheral vascular disease	0.9	4.6	0.23
Paralysis	1.1	0.7	0.04
Psychosis	§	0.2	0.03
Pulmonary disease	§	0.1	0.01
Renal disease	§	1.6	0.12
Cardiac valve disease	0.8	0.3	0.06
Weight loss	§	0.2	0.06
Validated risk scores			
Elixhauser score, mean ± SD	2.0 ± 4.7	1.7 ± 4.2	0.07
Laboratory-based Acute Physiology Score, mean ± SD	12.0 ± 18.8	9.8 ± 17.5	0.12
American Society of Anesthesiologists Physical Status Classification System score			
1 to 2	85.9	84.1	0.05
3 to 5	14.1	15.9	0.05
Procedural Index for Mortality Risk score, mean ± SD	0.6 ± 2.0	0.4 ± 1.4	0.11

Note: SD = standard deviation.
*Unless stated otherwise.
†A value > 0.1 suggests a substantial difference.
‡Procedural urgency defined by the "E" (emergency) code on the anesthetic record denoting urgent cases.
§Cell sizes < 6 cannot be reported per health care privacy legislation.

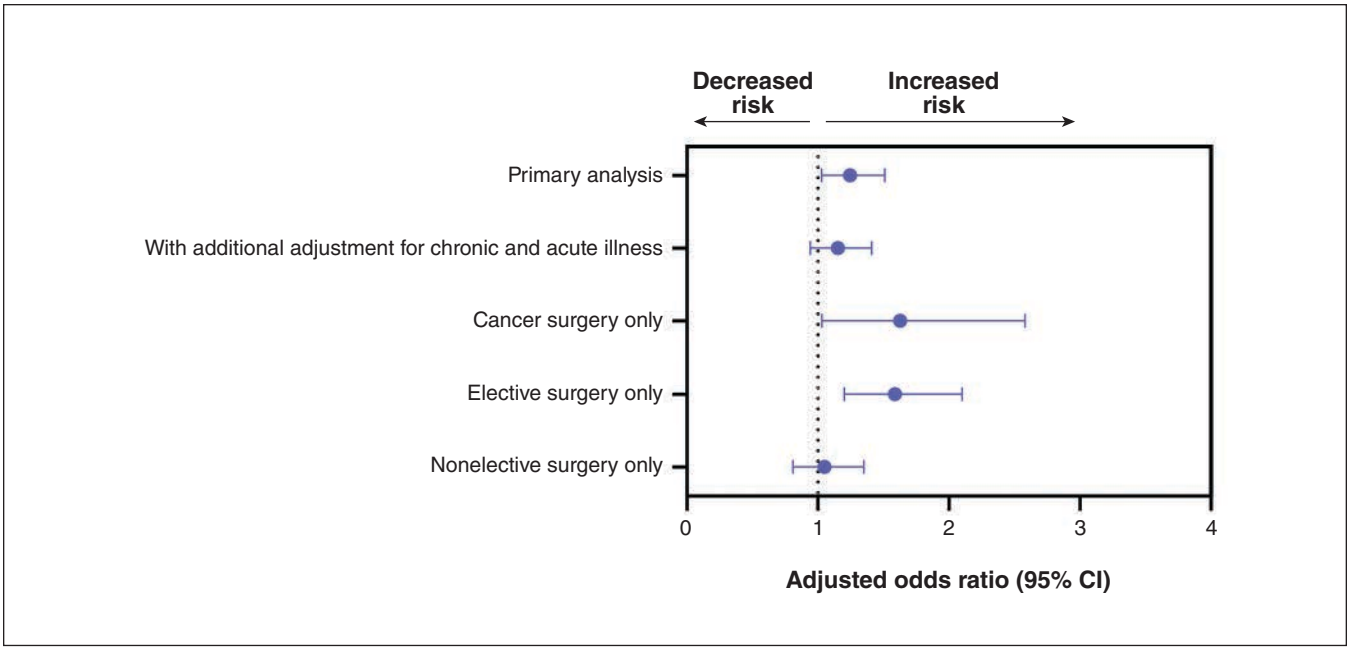

Figure 2: In-hospital death or complication among Nunavut Inuit, adjusted for age, sex, surgical specialty, risk and urgency. Note: CI = confidence interval.

Table 2: Secondary outcomes among patients undergoing inpatient surgery

Outcome	Nunavut Inuit *n* = 928	Non-Inuit *n* = 97 773	Unadjusted effect estimate* (95% CI)	Adjusted effect estimate*† (95% CI)
Readmission, no. (%)‡	76/903 (8.4)	6582/95 242 (6.9)	1.27 (0.99–1.62)	1.4 (1.09–1.77)
Adverse discharge disposition, no. (%)‡	202/928 (21.8)	12 605/97 772 (12.9)	2.47 (2.33–2.62)	2.18 (1.78–2.68)
Length of stay, d, mean ± SD	8.9 ± 14.4	6.6 ± 12.0	1.35 (1.21–1.50)	1.28 (1.17–1.40)
Total cost, mean ± SD§	18 017 ± 30 832	14 703 ± 25 884	1.23 (1.09–1.38)	1.17 (1.07–1.23)

Note: CI = confidence interval, SD = standard deviation.
*Cost analyses expressed as ratios of means; institutional discharge and readmissions expressed as odds ratios.
†Adjusted for age, sex, surgical specialty, risk and urgency.
‡Analyses of readmissions and adverse discharge dispositions limited to people discharged alive from hospital.
§2018 Canadian dollars.

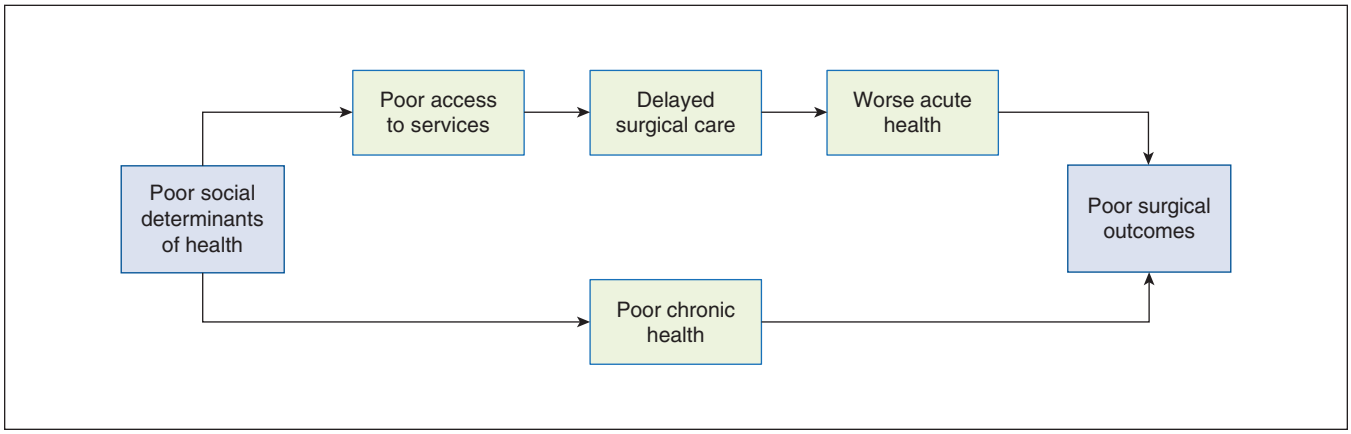

Figure 3: Proposed association between social determinants of health and poor surgical outcomes for Nunavut Inuit.

there was no significant difference in postoperative morbidity or death between Nunavut Inuit and the non-Inuit population. Instead, the differences in perioperative health outcomes were more prominently observed in patients undergoing elective and cancer surgery. This may be due to systemic barriers in accessing timely and culturally appropriate surgical care faced by Nunavut Inuit, leading to presentations with more advanced disease and thereby increasing risk of postoperative adverse events. This is in keeping with the cancer care literature, in which barriers to accessing care are well documented, with some evidence that Indigenous patients may present at a later stage in cancer progression.[35,36]

Future research in accordance with the principles outlined in the National Inuit Strategy on Research[37] is required to inform policy change, eliminate the outcome disparities described and integrate Inuit Qauijimajatuqangit (traditional knowledge) into current health practices. There is a need to examine the upstream and downstream factors that influence surgical outcomes for Inuit, such as the impacts of the social determinants of health, access to health care, cancer screening programs and systemic racism. This approach needs to be done in collaboration with Inuit leaders, patients, family members, clinicians, and territorial and provincial health care administrators to address issues along the entire surgical care pathway.

This study has several strengths, including a reliable identifier for Inuit identity, which remains a recurring challenge in literature on Indigenous health outcomes in Canada. The study has a valid exposure and valid outcomes, strong control for confounders and effective exploration of effect modification. Our study also accounts for both clinical and economic outcomes.

Limitations

The study also has some limitations. The focus is centred around the acute hospitalization for a primary surgical procedure without describing the entire perioperative journey for Nunavut Inuit. There is the potential for misclassification of complications for emergency surgery. Furthermore, we could not identify exact surgeries that resected malignancies, so we used a preoperative visit to The Ottawa Hospital's cancer treatment centre as a proxy, meaning we had no information on the cancer stage at presentation, and misclassification of surgical indication was possible. Granular cost estimates that identify the specific items and events leading to differences in

costs were not available. We recognize that Nunavut patients who receive care at The Ottawa Hospital have unique referral patterns because of systemic factors related to low population density and decreased access to physicians for both primary and specialty care. Large distances for follow-up care may also influence discharge patterns in the recovery phase, which can affect hospitalization times and costs.

Conclusion

Nunavut Inuit had a 25% relative increase in their odds of morbidity and death after surgery at a major quaternary care hospital in Canada compared with non-Inuit patients, while also having higher rates of other adverse outcomes and resource use. Further elucidation of the complicated journeys for surgical patients from Inuit Nunangat to the network of referral hospitals across Canada is needed to reduce barriers in the transitions of care as patients move across health systems. There is a need for data linkage and integration between territorial and provincial health systems to better understand longitudinal trajectories.

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