Travel Burden for Hospital Care in Canada

Methodology Notes

Canadian Institute for Health Information
Institut canadien d'information sur la santé

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ISBN 978-1-77479-300-8 (PDF)

How to cite this document:
Canadian Institute for Health Information. *Travel Burden for Hospital Care in Canada — Methodology Notes*. Ottawa, ON: CIHI; 2024.

Cette publication est aussi disponible en français sous le titre *Fardeau des déplacements pour des soins hospitaliers au Canada — notes méthodologiques*.
ISBN 978-1-77479-301-5 (PDF)

Table of contents

Acknowledgements

The Canadian Institute for Health Information (CIHI) wishes to acknowledge and thank members of our Sparsely Populated Regions Advisory Group who expressed an interest in understanding travel burden as it relates to the rural/remote populations they serve. This group and Healthcare Excellence Canada's Canadian Northern and Remote Health Network provided feedback and guidance as this work took shape. We gratefully acknowledge these groups and the many others who were consulted throughout the development of this work.

Overview

While travel for hospital care is sometimes unavoidable, it can represent a significant burden for patients, their families and health systems. We know that not all types of care are available at all hospitals across Canada, which means that travel burden varies depending on where you live and the type of care you require. Understanding travel burden can provide valuable insight for those who plan health services.

CIHI's Sparsely Populated Regions Advisory Group expressed a need for a better understanding of medical travel and for a means to assess whether patients were travelling more than they should to access care. This work was developed to address that need by looking at a specific piece of overall medical travel — travel for inpatient hospital care. The analysis leverages components of CIHI's Rural Health Systems Model to go beyond measuring distance alone and toward a more comprehensive understanding of travel burden.

This document describes the methods and approach used in this analysis to quantify and understand travel burden, as well as examples to demonstrate how to apply this approach in practice.

What is travel burden and how was it defined?

Needing to travel to receive hospital care can pose an access barrier for patients, particularly for residents of rural/remote areas. For health system decision-makers and planners, information about patient travel can help inform decisions about service planning — including where to locate sites and services, and the implication of changes — and allocation of services to maximize access and sustainability.

CIHI's Rural Health Systems Model sets out factors that are important for distinguishing among rural health systems, and outlines features of geography beyond distance alone that contribute to travel burden (i.e., travel time, travel cost and travel availability).

This work presents a novel approach to categorizing inpatient hospitalizations on a 5-point travel burden scale (from very low to very high) using information captured in hospital inpatient discharge records: patient's location of residence, hospital location and case characteristics. This information is combined to categorize relative travel burden using the logic detailed in the section Classifying travel burden.

Patient and hospital locations were used to estimate travel distance, travel time and travel availability. The data does not provide a direct measure of travel time or mode of transportation used, but it can be used to make inferences about travel.

Initial analyses used GIS-based methods to approximate travel time between patient and hospital locations using known speed limits on connected road networks, similar to previous approaches.[1, 2] The result showed a strong correlation (98%) between distance and travel time. However, since it was not possible to calculate travel time for cases with no contiguous road network between patient's location of residence and hospital location, travel distance (which can be calculated for every hospitalization) was used rather than travel time.

Road network availability between patient's location of residence and hospital location was used to flag cases with no contiguous road network connection. In these instances, patients likely relied on alternative transportation modes (e.g., planes, ferries) that entail additional coordination, longer travel time and additional cost (to patients, their families and health systems).

Kornelsen et al.[3] surveyed rural residents and found that the largest cost categories for respondents who sought medical care were travel-related, including the cost of transportation, accommodation and meals. These expenses are incurred for both the health care recipient and also for co-travellers. While it is common for patients who travel to hospital to be accompanied, in cases where the patient is a child or senior there is a greater need for a travel companion and often more complex travel coordination, both of which result in an increased travel burden.

Other components of travel burden include social and opportunity costs, lost income and patient stress. This information can be self-reported via survey;[3] however, with inpatient hospital discharge records it is necessary to make inferences based on the information captured. When a hospital admission is urgent or emergent, patients may not have the same opportunity to prepare and travel burden may be greater compared with a hospitalization that is scheduled or elective. This can result in greater actual and opportunity costs as well as increased burden due to the sudden need to accommodate work and home responsibilities.

Additional information on how these factors were combined to classify travel burden is provided below.

Consultations and engagement

Development of this work and the travel burden metric were informed through multiple consultations with stakeholders, particularly those responsible for planning and coordinating health service delivery in rural/remote areas of Canada. Preliminary results of this work were shared with national working groups and with provincial representatives to gather feedback and input on the approach and applications of this work.

Data sources

This analysis uses 5 years of hospital discharge data for 2018–2019 to 2022–2023 combined.

Data sources

- Hospital Morbidity Database (HMDB), 2018–2019 to 2022–2023, CIHI
- Case Mix Group+ (CMG+) Client Tables, 2023, CIHI
- Geography Dimension File, Statistics Canada — for hospital latitude and longitude
- Postal Code^OM Conversion File Plus (PCCF+) Version 8A, Statistics Canada
- Road Network File, Statistics Canada[4]

Inclusion criteria

- Analytical institution type code = 1 (acute care only)
- Recorded sex or gender = male or female

Exclusion criteria

- Invalid health card number (HCN)
- Records with invalid admission or discharge dates
- Invalid or missing census subdivision (CSD) codes
- Missing age
- Admission categories representing cadaveric donors (R), newborns (N) and stillbirths (S)

Approach

Classifying travel burden

Each hospitalization was classified to 1 of 5 travel burden categories: very low, low, moderate, high or very high. 5 variables were created to assign travel burden (match in patient and hospital CSD, distance group, road availability, child/senior and urgent/emergent) following the steps below:

1. The patient postal code on the HMDB record was assigned to a CSD using PCCF+. The patient's CSD was then compared with the hospital's CSD to determine whether there was a match. In the case of a match, the HMDB record was assigned to the travel burden category "very low." If there was no match, distance group and road availability were assigned using steps 2 and 3.
2. The Euclidean or straight-line ("crow-fly") distance was calculated between the geographic centre of the patient's CSD and the latitude and longitude coordinates for the hospital. The resulting distance was grouped as follows:
    a. <10 km
    b. 10–24 km
    c. 25–74 km
    d. 75–199 km
    e. 200–499 km
    f. 500+ km

    Distance groups were based on case distribution and Statistics Canada's analysis of the Remoteness Index,[5] which estimates 200 km as the threshold for accessibility for a single day of road-based travel. Increased distance is associated with a greater travel burden.
3. Road availability was assigned based on whether there was a contiguous road network connecting the geographic centre of the patient's CSD with the latitude and longitude coordinates for the hospital. HMDB records contain no information on patient street address, so the geographic centre of the patient's CSD was used as a proxy for patient's location of residence. A radius of 25 km was established as a boundary within which to search for the start of a road network. The case was flagged as "no" for road availability if there was no contiguous road network found. No road availability is associated with greater travel burden.
4. Patients who were age 19 and younger (child) and those who were age 65 and older (senior) were associated with greater travel burden.

5. Information on admission category indicates whether the admission was scheduled/elective or urgent/emergent. Urgent/emergent admissions are associated with greater travel burden.

Using these 5 variables, the travel burden category was assigned based on the logic provided in the table in the appendix.

Creating episodes of care

The unit of analysis for this work is an episode of care. An episode of care refers to all contiguous inpatient hospitalizations for an individual and avoids analyzing transfers as 2 separate hospitalizations. This may be particularly relevant for travel burden for patients from rural/remote areas, as they may transfer to receive care not available locally or return to receive additional support following active acute treatment elsewhere.

To construct an episode of care, a transfer is assumed to have occurred if either of the following conditions are met:

- Admission for inpatient hospitalization occurs less than 7 hours after discharge from another inpatient hospitalization, regardless of whether either hospital codes the transfer; **or**
- Admission for inpatient hospitalization occurs between 7 and 12 hours after discharge from another inpatient hospitalization and at least one of the hospitals codes the transfer.

All hospital records with valid linkage keys (a combination of the encrypted HCN and the province that issues the number), admission dates/times and discharge dates/times were linked across provinces/territories. An acute care record from one facility was linked to a subsequent acute care record in any facility by matching the linkage keys.

It is not possible to link interjurisdictional transfers for Manitoba residents who were admitted/transferred in and out of Manitoba nor for patients admitted/transferred in and out of Quebec. Results from hospitals that routinely transfer patients to or from these provinces may be affected, including those in adjacent regions (e.g., New Brunswick residents who receive care in Quebec, Manitoba residents who receive care in Ontario).

Multiple hospital records within an episode can result in multiple travel burden categories being assigned. For the purposes of this analysis, the highest travel burden category was selected to reflect the maximum patient travel burden at any point in the episode. Other analytical variables specific to each hospital record (e.g., CMG+) were matched to the selected hospital record with the maximum travel burden category.

Calculating age–sex-standardized rates

Age–sex-standardization was used to adjust for variations in age and sex population distributions. The direct standardization method was employed using the Canada 2011 population as the standard. Additional information on these calculations can be found in the resource *Calculating Stratified Rates and Inequality Measures: Methodology and Code in SAS and R*.

Assigning urban and rural/remote location

The most geographically precise information on patient's location of residence in hospital records is the postal code. PCCF+ Version 8A was used to assign Statistical Area Classification type (SACtype), where SACtypes 1 to 3 are categorized as urban and SACtypes 4 to 8 are categorized as rural/remote. For more information, see CIHI's equity stratifier guidance document on geographic location.

Applying CMG Care Level and CMG Provider Service Group

The CMG+ methodology was designed to aggregate acute inpatients with similar clinical and resource-utilization characteristics. In 2022, new aggregation variables were added to categorize each case into mutually exclusive groups for analytical purposes. 2 of these variables are used in the travel burden analysis. CMG Care Level aggregates hospital care into mutually exclusive levels that reflect the degree of specialization for each case, while CMG Provider Service Group reflects the dominant most responsible provider assigned to cases in each CMG.

Hospitalizations from Quebec were not included in the original CMG+ aggregation methodology. Additional analysis determined that the current CMG+ aggregation categories could be applied to CMGs assigned to Quebec hospitalizations. This would ensure that Quebec data could be included and the analysis of travel burden could be pan-Canadian.

Examples: Travel burden in practice

Health system planners routinely examine the range of services provided at their hospitals to ensure ongoing safety and sustainability. To do this, they consider several things, including historic service use, self-sufficiency, health system performance measures, health workforce availability, policies and best practices, demographic and technological trends, and anticipated changes in service delivery. By using CIHI's travel burden methodology, health system planners can include information that goes beyond distance alone to better understand the impacts of their plans on access to hospital care.

The examples in this document are fictional.

Example 1: Adding a hospital service

Hassim, the director of planning for North Health Region, is developing a business case to bring labour and delivery services to the town of Telon Lake's 16-bed community hospital. Hassim has already done an analysis to determine that a labour and delivery service of 4 beds would meet the local population's need for the next 15 years. Currently, Telon Lake resident births occur outside the community, but a new 4-bed program would mean far fewer people in the town would need to travel — and people in neighbouring communities would need to travel less.

Hassim applies the travel burden methodology to the past 3 years of hospital data for residents of Telon Lake and the surrounding communities. He isolates the labour and delivery cases and identifies how many fall in each travel burden category.

Current state (most recent 3 years)

Community	Very low	Low	Moderate	High	Very high	Total	*Percentage high and very high*
Telon Lake	0%	47%	47%	5%	1%	100%	6%
Community A	0%	0%	4%	69%	26%	100%	95%
Community B	0%	0%	10%	40%	50%	100%	90%
Total	**0%**	**31%**	**34%**	**21%**	**15%**	**100%**	**36%**

Based on the current travel burden distribution for Telon Lake and the 2 neighbouring communities, Hassim learns that no labour and delivery cases have very low travel burden and that 36% of cases have high or very high travel burden.

Hassim duplicates the data set of historic cases and overwrites the discharge facility with Telon Lake's hospital for labour and delivery cases that could be served in the proposed unit (primarily uncomplicated births). Hassim re-runs the travel burden methodology on the modified data set to estimate the impact of having labour and delivery services available at Telon Lake's community hospital.

Scenario: Provide labour and delivery services at Telon Lake's community hospital

Community	Very low	Low	Moderate	High	Very high	Total	*Percentage high and very high*
Telon Lake	57%	32%	6%	4%	1%	100%	5%
Community A	0%	39%	4%	35%	22%	100%	57%
Community B	1%	31%	35%	19%	14%	100%	33%
Total	**37%**	**32%**	**12%**	**11%**	**7%**	**100%**	**18%**

Hassim learns that in this scenario only 18% of cases would have high or very high travel burden, and 37% would have very low travel burden. Hassim includes this information and other evidence in the business case.

Example 2: Consolidating hospital services

Alex, the director of planning for a health region serving many communities with 11 hospitals of various types, is faced with the challenge of ensuring service sustainability across 2 community hospitals in neighbouring cities. They would like to better understand the travel burden implications of consolidating these 2 facilities at Facility A's location.

Alex begins by examining the catchment areas of the 2 facilities. Facility A primarily serves the community in which it is situated, while Facility B serves the community it is in as well as 3 other rural communities. Alex applies the travel burden methodology to the most recent 3 years of hospital discharge data to understand the current state.

Current state (most recent 3 years)

Facility	Very low	Low	Moderate	High	Very high	Total	*Percentage high and very high*
Facility A	63%	20%	10%	5%	3%	100%	8%
Facility B	63%	3%	17%	14%	4%	100%	18%
Total	**63%**	**13%**	**13%**	**9%**	**3%**	**100%**	**12%**

To understand the implications of consolidating services at Facility A, Alex makes a duplicate data set of the historic cases and assigns Facility A as the discharge facility for all cases that had been discharged from Facility B. They re-run the travel burden methodology on this modified data set to learn what the resultant travel burden might have been had Facility A treated all cases that had been discharged from either facility.

Scenario: Consolidate at Facility A

Facility	Very low	Low	Moderate	High	Very high	Total	*Percentage high and very high*
Facility A	36%	38%	10%	9%	7%	100%	16%

Alex learns that in this scenario there could be a greater proportion of hospital discharges with a high or very high travel burden than in the current state. They use this information, alongside other planning inputs, to formulate a recommendation for their leadership team.

Example 3: Comparing across geographies

Akira, the director of surgical services for the Prairie West Zone, expanded the orthopedic surgery service at one of her region's hospitals in 2021, and she would like to understand whether residents in her region travel more for orthopedic surgery than residents in other health regions.

Akira uses CIHI's Rural Health Systems Model to help identify health regions that are reasonable comparators to her own. Then, using the most recent 3 years of hospital discharge data, she examines the travel burden distributions by health region. She also calculates the age-standardized rate for high and very high travel burden.

Current state (most recent 3 years)

Health region	Percentage of cases with high and very high travel burden			Age-standardized rate for high and very high travel burden		
	2020	2021	2022	2020	2021	2022
Prairie West Zone	39%	22%	23%	25.1	21.2	22.4
Comparator Region A	38%	41%	40%	33.1	33.9	34.0
Comparator Region B	45%	42%	40%	29.1	30.2	30.1

Akira's analysis shows a marked decrease in the proportion of Prairie West Zone resident cases that had high or very high travel burden following expansion of the orthopedic surgery program. She attributes this decrease to the repatriation of Prairie West Zone resident cases that previously would have needed to travel south for orthopedic surgery. Akira also notes that the age-standardized rate for high and very high travel burden for orthopedic surgery in her region is quite a bit lower than in the 2 comparator regions. Akira revisits the Rural Health Systems Model to better understand what might be contributing to these differences and identifies that the comparator regions she selected may be influenced to a greater degree by industry — in particular, the forestry and winter sport industries, which are far less prevalent in Akira's health region.

Appendix: Travel burden classification

The following table displays the logic by which travel burden was categorized:

Distance group	Road availability	Child/ senior	Urgent/ emergent	Burden category	Total cases	Average annual frequency	Percentage of total
CSD match	Yes	—	—	Very low	7,571,056	1,514,211	55.2%
<10 km	Yes	—	—	Very low	728,832	145,766	5.3%
10–24 km	Yes	No	No	Very low	436,501	87,300	3.2%
10–24 km	Yes	No	Yes	Low	494,206	98,841	3.6%
10–24 km	Yes	Yes	No	Low	202,319	40,464	1.5%
10–24 km	Yes	Yes	Yes	Low	809,280	161,856	5.9%
25–74 km	Yes	No	No	Low	446,805	89,361	3.3%
25–74 km	Yes	No	Yes	Moderate	525,772	105,154	3.8%
25–74 km	Yes	Yes	No	Moderate	288,607	57,721	2.1%
25–74 km	Yes	Yes	Yes	Moderate	755,934	151,187	5.5%
75–199 km	Yes	No	No	Moderate	184,098	36,820	1.3%
75–199 km	Yes	No	Yes	High	227,770	45,554	1.7%
75–199 km	Yes	Yes	No	High	164,683	32,937	1.2%
75–199 km	Yes	Yes	Yes	High	263,063	52,613	1.9%
200–499 km	Yes	No	No	High	68,966	13,793	0.5%
200–499 km	Yes	No	Yes	Very high	106,079	21,216	0.8%
200–499 km	Yes	Yes	No	Very high	61,009	12,202	0.4%
200–499 km	Yes	Yes	Yes	Very high	101,047	20,209	0.7%
<10 km	No	—	—	Low	4,719	944	0.0%
10–24 km	No	No	No	Low	965	193	0.0%
10–24 km	No	No	Yes	Moderate	3,228	646	0.0%
10–24 km	No	Yes	No	Moderate	818	164	0.0%
10–24 km	No	Yes	Yes	Moderate	4,220	844	0.0%
25–74 km	No	No	No	Moderate	4,840	968	0.0%
25–74 km	No	No	Yes	High	8,593	1,719	0.1%
25–74 km	No	Yes	No	High	5,931	1,186	0.0%
25–74 km	No	Yes	Yes	High	10,402	2,080	0.1%
75–199 km	No	No	No	High	7,984	1,597	0.1%
75–199 km	No	No	Yes	Very high	16,061	3,212	0.1%
75–199 km	No	Yes	No	Very high	6,507	1,301	0.1%
75–199 km	No	Yes	Yes	Very high	14,752	2,950	0.1%
200–499 km	No	—	—	Very high	31,280	6,256	0.2%
500+ km	—	—	—	Very high	161,385	32,277	1.2%

Note
— This variable was not considered for the assignment of travel burden.

Glossary of terms

Child/senior: Binary variable that indicates whether the patient was an adult (age 20 to 64) or a child (age 19 or younger)/senior (age 65 and older).

CMG+: Case Mix Group+ methodology. Designed to aggregate acute care inpatients with similar clinical and resource-utilization characteristics.

CMG Level of Care: Variable that aggregates each CMG assigned to individual hospital records into mutually exclusive levels that reflect the degree of specialization: general, specialized and highly specialized.

CMG Provider Service Group: Variable that aggregates each CMG assigned to a hospital discharge record into a mutually exclusive group reflecting the dominant most responsible provider assigned to all cases in each CMG.

CSD centroid: The geographic centre of a census subdivision (CSD) represented by a set of latitude and longitude coordinates.

Distance: Euclidean or straight-line ("crow-fly") distance representing the shortest distance between 2 points (centroid of the patient's CSD and the hospital's latitude and longitude) measured along the surface of a spherical coordinate system, not accounting for roads, other paths or non-road-based travel routes.

Distance groups: Categorical variable that groups straight-line distances into intervals based on natural breaks in the data distribution and the volume of records in each range.

Episode of care: Unit of analysis. Based on combining all contiguous inpatient hospitalizations to reflect the comprehensive patient journey from initial hospitalization to final discharge.

Hospital CSD: Census subdivision where the hospital of discharge is located.

Patient CSD: Census subdivision of the patient's location of residence according to patient postal code. Determined through probabilistic assignment based on PCCF+ and generally equates to municipality.

Remoteness Index: Developed by Statistics Canada to characterize the degree of remoteness of a geographic location. Based on factors including distance to services and population density.

Road availability: Binary variable that indicates whether there was a contiguous road network connecting the centroid of the patient's CSD (within a 25 km boundary) with the latitude and longitude coordinates for the hospital. If no road network was identified, it was assumed that alternate travel modes would be required to transport the patient from their residence to the hospital.

Urgent/emergent: Binary variable based on hospital admission category to distinguish between urgent/emergent and scheduled/elective.

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