Constructing Episodes of Inpatient Care

How to Define Hospital Transfer in Hospital Administrative Health Data?

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Background: Hospital administrative health data create separate records for each hospital stay of patients. Treating a hospital transfer as a readmission could lead to biased results in health service research.

Methods: This is a cross-sectional study. We used the hospital discharge abstract database in 2013 from Alberta, Canada. Transfer cases were defined by transfer institution code and were used as the reference standard. Four time gaps between 2 hospitalizations (6, 9, 12, and 24 h) and 2 day gaps between hospitalizations [same day (up to 24 h), ≤1 d (up to 48 h)] were used to identify transfer cases. We compared the sensitivity and positive predictive value (PPV) of 6 definitions across different categories of sex, age, and location of residence. Readmission rates within 30 days were compared after episodes of care were defined at the different time gaps.

Results: Among the 6 definitions, sensitivity ranged from 93.3% to 98.7% and PPV ranged from 86.4% to 96%. The time gap of 9 hours had the optimal balance of sensitivity and PPV. The time gaps of same day (up to 24 h) and 9 hours had comparable 30-day readmission rates as the transfer indicator after defining episode of care.

Conclusions: We recommend the use of a time gap of 9 hours between 2 hospitalizations to define hospital transfer in inpatient databases. When admission or discharge time is not available in the database, a time gap of same day (up to 24 h) can be used to define hospital transfer.

Key Words: hospital transfer, time gap between hospitalizations, transfer institution code, readmission rate

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Administrative health data have been widely used in the study of health resource use, reimbursement, and quality of care.[1–3] Each record represents 1 discharge from a hospital. Interhospital transfer of patients is often needed for diagnostic or therapeutic interventions. Therefore, 2 or more records could be generated for the same episode of care. Many countries do not collect information on health care utilization that includes hospital transfer in their administrative health data. Researchers face a challenge in determining whether a hospital admission is a readmission or a transfer. In 2012, The Patient Protection and Affordable Care Act established the Hospital Readmissions Reduction Program to reduce the payment for hospitals with "excess readmissions."[4] Therefore, definition of hospital transfer is a fundamentally important step for administrative health data analysis.

Defining the episode of care by identifying and then combining transferred cases has great implications for health service research, resource planning, and evaluation of quality of care.[5] In outcome studies, sequential hospitalizations for the same patient should be combined as one episode of care. To analyze length of stay, the total of length of study should be combined. In the risk adjustment, comorbidities recorded in an episode of care should be combined to provide a full picture of the patient's condition. Treating sequential hospitalizations as independent hospitalizations would result in lower hospital standardized mortality rate than combining hospitalizations as one episode of care.

Various time gaps between 2 consecutive hospitalizations have been used to identify hospital transfer cases in studies using administrative health data. For example, van Walraven et al[6] used ≤6 hours between 2 hospitalizations to define hospital transfer in the study of early death or urgent readmission. Eastwood et al[7] used ≤12 hours to define hospital transfer in the study of readmission among patients with heart failure. Iwashyna et al[8] used ≤24 hours to define hospital transfer in a study of medical care beneficiaries for patients with acute myocardial infarction transferred from nonrevascularization hospitals to revascularization hospitals. When admission and discharge time were not recorded in the database, time difference of same day (up to 24 h) or ≤1 day (up to 48 h) were often used in the literature.[9,10] None of these definitions, however, have been validated.

In this study, we used the Canadian administrative health data, also called hospital discharge abstract data (DAD), to identify the optimal time gap between 2 hospitalizations for hospital transfer definition.[11] The Canadian DAD contains unique and mandatory hospital indicators that flag which hospital a patient was transferred to or from another hospital. That indicator allows us to identify the records with a hospital transfer.

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METHODS

Data Source

This is a cross-sectional study. We used the DAD between January 1 and December 31, 2013 from the province of Alberta, Canada to identify transfer cases. Alberta had ~4.03 million people in 2013.[12] The DAD in Alberta includes all hospital discharges. The following records were excluded: (1) records for newborns because birth is generally not equivalent to first admission for treatment; (2) records with the hospitalization time frame fully enclosed within another record; (3) records with an admission date within 7 days after the discharge date for a record for the same patients in 2012 or records with a discharge date up to 7 days preceding the admission date for a record for the same patient in 2014.

Transfer Indicator as Defined by Institution Identifier

The hospital DAD in Canada were coded after the abstraction guidelines developed by the Canadian Institute of Health Information (CIHI). In the DAD, the field of "Institution identifier" denotes the facility where the patient received care. The fields of "Institution to" and "Institution from" denote the receiving facility and the hospital of origin, respectively. The above 3 variables are mandatory in the Canadian DAD and have high coding validity according to reabstraction studies.[13] Using the 3 variables, we defined the hospital transfer indicator in DAD. A hospitalization is a transfer if, for the same patient, the institution identifier for the index hospitalization matched "institute to" in its previous hospitalization or "institute from" in its subsequent hospitalization. We used the transfer indicator as the reference standard.

Use of Time or Day Gap Between 2 Hospitalizations to Define Transfer Cases

Time gaps between 2 adjacent hospitalizations for the same patient were calculated using discharge time in the first DAD record and admission time in the second DAD record. In DAD, admission time is defined as the time the patient was officially registered as an inpatient; discharge time is defined as the time the patient physically left the patient care unit of the facility. We examined 4 different time gaps (ie, 6, 9, 12, and 24 h) to identify hospital transfer.

When admission and discharge time were not recorded in the database, day gaps between 2 consecutive admissions for the same patient were identified as used by the Centers for Medicare & Medicaid Services and other studies. Two kinds of definitions were used:

(1) Same day (up to 24 h): an index admission was considered as a transfer if it was followed by an admission to another hospital in the same day. The time difference between 2 hospitalizations could be up to 24 hours depending on the discharge time of the first admission;

(2) ≤1 day (up to 48 h): an index admission was considered as a transfer if it was followed by an admission to another hospital within 0 or 1 day. The time difference could be up to 48 hours depending on the time of discharge for the index admission.

Statistical Analysis

We used the hospital transfer indicator and the above 6 definitions to define hospital transfer cases and episodes of care. We calculated the sensitivity and positive predictive value (PPV) for each definition, accepting the transfer indicator as the reference standard. Readmission within 30 days is defined as the occurrence of at least 1 hospitalization

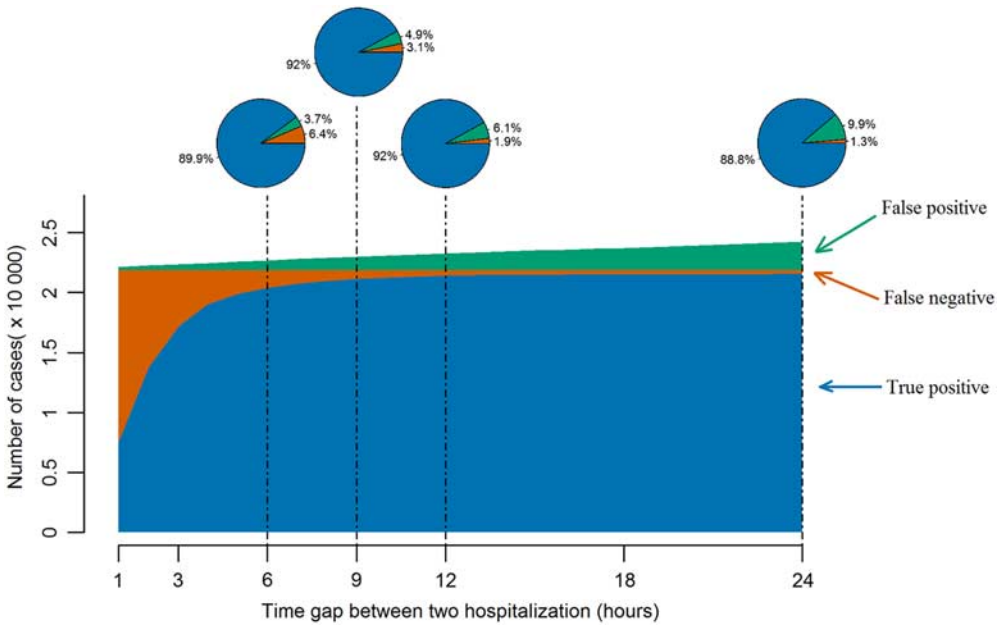

FIGURE 1. Number of transfers defined by different time gaps between 2 hospitalizations. We accepted the transfer cases defined by transfer indicator as reference standard.

TABLE 1. Sensitivity and PPV for Transfer Case Definitions Using Different Time Gaps Between 2 Hospitalizations

		Time Gap Between 2 Consecutive Hospitalizations for the Same Patient					
		6 h		9 h		12 h	
	No. Transfer Cases	Sensitivity (95% CI)	PPV (95% CI)	Sensitivity (95% CI)	PPV (95% CI)	Sensitivity (95% CI)	PPV (95% CI)
Overall	21,830	93.3 (93.0, 93.7)	96.0 (95.8, 96.3)	96.7 (96.5, 97.0)	94.9 (94.6, 95.2)	97.9 (97.7, 98.1)	93.8 (93.5, 94.1)
Sex							
Male	10,597	93.2 (92.8, 93.7)	96.1 (95.7, 96.5)	96.5 (96.1, 96.8)	95.0 (94.5, 95.3)	97.8 (97.5, 98.1)	93.7 (93.2, 94.1)
Female	11,233	93.5 (93.0, 93.9)	95.9 (95.5, 96.3)	97.0 (96.6, 97.3)	94.9 (94.5, 95.3)	98.1 (97.8, 98.3)	94 (93.5, 94.4)
Age categories (y)							
≤20	977	87.9 (85.7, 89.9)	94.2 (92.5, 95.6)	93.7 (91.9, 95.1)	92.0 (90.1, 93.6)	96.4 (95.1, 97.5)	89.5 (87.4, 91.2)
21–35	1899	91.3 (89.9, 92.5)	93.8 (92.6, 94.8)	95.4 (94.4, 96.3)	91.4 (90.1, 92.6)	96.6 (95.7, 97.3)	88.3 (86.8, 89.7)
36–50	2304	91.5 (90.3, 92.6)	94.5 (93.5, 95.4)	95.4 (94.5, 96.3)	92.5 (91.3, 93.5)	97.2 (96.4, 97.8)	90.8 (89.6, 91.9)
51–65	4801	93.5 (92.7, 94.1)	96.2 (95.6, 96.7)	97.1 (96.6, 97.5)	95.2 (94.5, 95.7)	98.3 (97.9, 98.6)	94.3 (93.7, 95.0)
66–75	4256	93.6 (92.8, 94.3)	96.5 (95.9, 97.1)	96.9 (96.3, 97.4)	96.0 (95.4, 96.6)	98 (97.6, 98.4)	95.4 (94.8, 96.0)
>75	7593	94.9 (94.4, 95.4)	96.9 (96.5, 97.3)	97.6 (97.2, 97.9)	96.3 (95.8, 96.7)	98.4 (98.1, 98.7)	95.6 (95.1, 96.0)
Location of residence							
Rural	6791	89.6 (88.9, 90.4)	95.9 (95.4, 96.4)	95.0 (94.4, 95.5)	94.7 (94.2, 95.2)	97.0 (96.5, 97.4)	93.9 (93.3, 94.4)
Urban	15,039	95.0 (94.7, 95.4)	96.1 (95.8, 96.4)	97.5 (97.3, 97.8)	95.0 (94.7, 95.4)	98.4 (98.2, 98.6)	93.8 (93.4, 94.2)

CI indicates confidence interval; PPV, positive predictive value.

in any acute care hospitals in Alberta within 30 days of discharge after an index episode of care (after combining hospital transfers). We stratified the sensitivity, PPV, and readmission rate by sex, age groups, and location of residence. The 95% confidence intervals were calculated for the above statistics.

The Conjoint Health Research Ethics Board at the University of Calgary approved this study.

RESULTS

In 2013, there were 325, 206 DAD records in Alberta that fit our inclusion criteria. Among all the patients, 40.7% were male and 32.8% were aged 66 and above.

Figure 1 illustrates the number and proportion of transfer cases by the different time gaps between 2 hospitalizations. The proportion of true-positive transfer cases is lower in time gap of 6 or 24 hours than in time gap of 9 or 12 hours. The number of true-positive transfer cases identified by time gaps slightly increased with the increase of time gap after the first 6 hours, whereas the number of false-positive cases steadily increased with the increase of time gap. The number of false-negative cases remained constant after the first 12 hours.

Among the 6 definitions, sensitivity ranged from 93.3% to 98.7% and PPV ranged from 86.4% to 96% (Table 1). Use of time gap of 9 hours had the optimal balance of false positive and false negative. Compared with 9 hours, use of 6 hours lead to lower sensitivity, especially for patients under age 50 or living in the rural area, and use of 24 hours lead to lower PPV, especially for patients under the age of 50 or living in urban area. Use of ≤1 day (up to 48 h) resulted in very low PPV in all categories compared with other definitions. Use of same day (up to 24 h) had lower PPV and sensitivity than the use of 9 hours.

Readmission rate with 30 days has been widely used as an indicator of hospital health care performance. Overall, use of same day (up to 24 h) and 9 hours had comparable readmission rates as the transfer indicator (Table 2). Use of 12 hours, 24 hours, and ≤1 day (up to 48 h) underestimated the readmission rate, whereas use of 6 hours slightly overestimated the readmission rate.

DISCUSSION

A definition for hospital transfer in administrative health data is required to establish a standardized way to define the episode of care and readmission in health services research. We compared 6 methods for defining hospital transfer with the reference standard of transfer indicators in the Canadian data. We found that a time gap of 9 hours between 2 hospitalizations was the optimal method of defining hospital transfer. A time gap of same day (up to 24 h) between 2 hospitalizations can be used to assess readmission rate if only admission and discharge date were recorded in the database.

In this study, we accepted the transfer cases defined by transfer indicators as the reference standard. The Canadian DAD requires the mandatory recording of transfer institution codes during data collection process. This ensures the completeness of indicators in the data. Nonclinical data elements are highly reliable in DAD according to the CIHI reabstraction program.[13] In the reabstraction study, CIHI coding specialists verified the information in DAD submitted by hospital coders though a chart review. It was found that institution code and transfer to or from codes had near-perfect agreement, with difference observed for <2% of the records. Other nonclinical data such as admission and discharge time, age, and sex also had near-perfect agreement. Meanwhile, CIHI conducts periodic data quality checks and returns records with missing information to hospitals for rechecking to ensure the integrity of the data. Therefore, transfer indicator can be accepted as the reference standard to define transfer cases.

The time gap between hospitalizations is widely used to define hospital transfer in the literature. Time of discharge and admission are commonly recorded in the database. In

TABLE 1. *(Continued)*

Time Gap Between 2 Consecutive Hospitalizations for the Same Patient				
24 h		**Same Day**	**≤1 d**	
Sensitivity (95% CI)	**PPV (95% CI)**	**PPV (95% CI)**	**Sensitivity (95% CI)**	**PPV (95% CI)**
98.6 (98.4, 98.7)	90.0 (89.6, 90.4)	94.3 (93.9, 94.6)	98.7 (98.5, 98.8)	86.4 (85.9, 86.8)
Sex				
98.5 (98.2, 98.7)	89.6 (89, 90.1)	94.4 (93.9, 94.8)	98.6 (98.3, 98.8)	85.9 (85.2, 86.5)
98.7 (98.5, 98.9)	90.4 (89.9, 90.9)	94.1 (93.7, 94.6)	98.8 (98.0.6,99)	86.9 (86.3, 87.5)
Age categories (y)				
98.0 (96.9, 98.7)	82.1 (79.8, 84.2)	90.8 (88.8, 92.5)	98.3 (97.2,99.0)	77.7 (75.3, 80.0)
97.5 (96.7, 98.1)	79.6 (77.9, 81.2)	89.7 (88.3, 91.0)	97.6 (96.8,98.3)	73.3 (71.5, 75.0)
98.0 (97.3, 98.5)	85.7 (84.3, 87.0)	91.2 (90.0, 92.3)	98.2 (97.5,98.7)	81.3 (79.8, 82.8)
98.8 (98.5, 99.1)	91.1 (90.2, 91.8)	94.7 (94.0, 95.3)	98.9 (98.6,99.2)	87.9 (87.0, 88.8)
98.7 (98.3, 99.0)	92.9 (92.1, 93.6)	95.4 (94.8, 96)	98.8 (98.4,99.1)	90.6 (89.7, 91.4)
98.9 (98.6, 99.1)	93.2 (92.6, 93.7)	95.9 (95.4, 96.3)	98.9 (98.7,99.2)	89.9 (89.2, 90.5)
Location of residence				
98.1 (97.7, 98.4)	91.1 (90.4, 91.7)	93.9 (93.3, 94.4)	98.2 (97.9,98.5)	87.9 (87.2, 88.7)
98.8 (98.6, 98.9)	89.5 (89.0, 90.0)	94.4 (94, 94.8)	98.9 (98.7,99.0)	85.7 (85.1, 86.2)

this study, we tested the commonly used definitions and assess their validity against the unique transfer indicator in the Canadian data. This study provides a validated and harmonized definition for hospital transfer in administrative health data. Note that the time gap between 2 hospitalizations depends on many factors.[14] Generally, patients with potentially fatal conditions (such as acute myocardial infarction) are transferred rapidly from one hospital to another hospital with specialty services such as coronary care units, whereas elective patients discharged from one hospital may wait for next hospitalization at homes.[15] Hospital transfer time also depends on access to hospitals across different geographic areas. Patients living in rural areas generally take longer transportation time from rural hospital to urban hospital.[16] Health care system structure and processes for transfer approval are also factors related to transfers. Canada has universal health care system and patients are likely to comply with a physician order of transfer. In counties without universal health care, uninsured patients and women were significantly less likely to undergo interhospital transfer, which leads to a difference in transfer rates.[17]

There are some limitations in our study. First, we used the DAD-derived hospital transfer indicator as the gold/reference standard. Transfer to/from codes are mandatory in the Canadian DAD. However, some incompleteness or error of transfer institution coding in DAD is still expected. Second, this study used the DAD from Canada to define the hospital transfer. Caution should be used with attempts to generalize the results to other datasets from other countries.

The time gap between 2 hospitalizations is the most widely used way to define hospital transfer in administrative health data. To define one episode of care, we recommend the use of a time gap of 9 hours between 2 hospitalizations for the same patient to define hospital transfer. Same day (up

TABLE 2. Readmission Rate (%, 95% Confidence Interval) Within 30 Days With the Episode of Care Defined by the Transfer Indicator and Different Time Gaps Between 2 Hospitalizations

		Time Gap Between 2 Consecutive Hospitalizations for the Same Patient					
	Transfer Indicator	**6 h**	**9 h**	**12 h**	**24 h**	**Same Day**	**≤1 d**
Overall	10.2 (10.08, 10.31)	10.33 (10.22, 10.44)	10.03 (9.92, 10.14)	9.87 (9.76, 9.97)	9.53 (9.43,9.64)	10.21 (10.11, 10.32)	9.22 (9.12, 9.32)
Sex							
Male	9.20 (9.07, 9.34)	9.32 (9.19, 9.46)	9.06 (8.93, 9.20)	8.91 (8.78, 9.04)	8.60 (8.47, 8.73)	9.22 (9.09, 9.36)	8.32 (8.19, 8.45)
Female	11.68 (11.50, 11.87)	11.84 (11.66, 12.02)	11.48 (11.3, 11.66)	11.31 (11.13, 11.49)	10.93 (10.76, 11.11)	11.70 (11.52, 11.88)	10.57 (10.4, 10.75)
Age categories (y)							
≤20	9.11 (8.77, 9.45)	9.30 (8.96, 9.65)	9.02 (8.69, 9.37)	8.83 (8.50, 9.17)	8.46 (8.13, 8.79)	9.08 (8.75, 9.43)	8.22 (7.9, 8.56)
21–35	6.62 (6.44, 6.80)	6.66 (6.49, 6.85)	6.49 (6.32, 6.67)	6.37 (6.20, 6.55)	6.06 (5.89, 6.23)	6.57 (6.39, 6.75)	5.80 (5.63, 5.97)
36–50	9.25 (8.99, 9.52)	9.35 (9.09, 9.62)	9.07 (8.81, 9.33)	8.90 (8.64, 9.16)	8.57 (8.32, 8.83)	9.19 (8.93, 9.45)	8.28 (8.03, 8.54)
51–65	11.03 (10.78, 11.28)	11.19 (10.93, 11.44)	10.84 (10.59, 11.09)	10.69 (10.44, 10.94)	10.37 (10.13, 10.62)	11.09 (10.84, 11.35)	10.09 (9.84, 10.33)
66–75	12.66 (12.33, 13.00)	12.90 (12.56, 13.24)	12.52 (12.19, 12.86)	12.34 (12.01, 12.67)	11.99 (11.66, 12.32)	12.77 (12.43, 13.1)	11.71 (11.39, 12.04)
>75	13.66 (13.38, 13.95)	13.83 (13.54, 14.11)	13.43 (13.15, 13.71)	13.23 (12.96, 13.52)	12.87 (12.59, 13.15)	13.74 (13.46, 14.02)	12.40 (12.12, 12.67)
Location of residence							
Rural	11.55 (11.30, 11.80)	12.09 (11.83, 12.35)	11.43 (11.18, 11.68)	11.13 (10.88, 11.38)	10.69 (10.45, 10.94)	11.80 (11.54, 12.06)	10.30 (10.06, 10.54)
Urban	9.85 (9.73, 9.97)	9.88 (9.76, 10.00)	9.67 (9.56, 9.79)	9.55 (9.43, 9.66)	9.24 (9.12, 9.35)	9.81 (9.69, 9.93)	8.95 (8.83, 9.06)

to 24 h) discharge and admission in different hospitals for the same patient can be used for the study of readmission if only admission and discharge date were recorded in the database.

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