


How Might We Have Known? Using Administrative Data to Predict 30-Day Hospital Readmission in Clients Receiving Home Care Services from 2018 to 2021

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ABSTRACT

BACKGROUND: Reducing hospital readmissions can improve individual health outcomes and lower system-level costs. This study aimed to understand the characteristics of home care Personal Support clients who experienced a hospital admission (ie, hospital hold) and to identify factors that predict hospital readmission within 30 days of resuming home care Personal Support services.

METHODS: We conducted a retrospective cohort study using client administrative data from a home healthcare provider organization (2018–2021). The sample included clients (≥ 18 years) who received publicly funded Personal Support services and experienced a hospital hold. Descriptive statistics and a binary logistic regression model analyzed the relationship between demographics, hospital service utilization, home care service utilization, and contextual factors on the outcome of 30-day hospital readmission.

RESULTS: Approximately 17% ($n = 662$) of all clients with a hospital hold ($n = 3992$) were readmitted to hospital within 30 days. Compared with non-readmitted clients, those with greater home care Personal Support service intensity after the index hospital hold were less likely to experience a hospital 30-day readmission. In contrast, those with greater acuity, higher assessed care needs, more hospital holds overall, more extended hospital stays (≥ 2 weeks), and lower social support had a higher likelihood of 30-day hospital readmission.

CONCLUSION: The findings from this study provide a greater understanding of factors associated with home care clients' risk of hospital readmission within 30 days and can be used to inform targeted, evidence-based support to reduce home care clients' hospital readmissions.

KEYWORDS: Hospital readmission, home care, risk factors, retrospective cohort study

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Background

Home care is heavily relied on to support an integrated, accessible, and sustainable health system. Approximately 1.2 million Canadians utilize home care services annually,¹ and Personal Support Workers (PSWs) provide 70% to 80% of paid home care.² The demand for home care has grown significantly over the last decade,³ and this trend is expected to continue. This growth is attributed to Canadians living longer with complex and chronic conditions, a preference for aging-in-place, and capacity pressures on hospitals leading to more rapid discharges and increasingly interconnected relationships between in-home and hospital services.^{3–8}

Previous work has found that, as a population with higher medical complexity, one-sixth (16.8%) of those receiving home

care experienced unplanned hospital readmission within 30 days of discharge.⁹ The 30-day hospital readmission rate is a common indicator of health system performance^{10,11} because readmission is associated with high costs and poor clinical outcomes.^{8,12,13} Little is known about the relationship between home care service utilization and predictors of hospital readmissions. An improved understanding of this relationship would provide an opportunity to reduce hospital readmissions, improve patient experience and outcomes, and reduce health system expenditures. The objectives of this study were to understand the characteristics and health service utilization of clients receiving home care Personal Support services who experienced a hospital hold and to identify factors that predict hospital readmission within 30 days of resuming home care service.



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Methods

Design, population, and setting

This retrospective cohort study used client clinical and administrative data from one large home healthcare provider organization in the Greater Toronto Area. The sample included all existing adult (aged 18+) clients who were already receiving publicly funded Personal Support services (excluding palliative care) from this organization and experienced a hospital hold between October 1, 2018 and September 30, 2021. A hospital hold was defined as a hospital admission of 2 or more days, resulting in home care Personal Support services being placed on hold.

Data

Client-level longitudinal data consisted of capturing demographics (age, sex, number of contact persons listed, acuity of care needs), hospital utilization (duration of hospital hold, number of hospital holds), home care utilization pre- and post-hospitalization (weekly number of Personal Support visits, whether there were canceled visits or missed care, non-hospital holds, and wait time for a home care visit [time between administrative notification to resume service and the next Personal Support visit]), and contextual factors (geographic region, presence of COVID-19, day-of-week of administrative notification to resume service [weekday vs weekend]). The phase of the COVID-19 pandemic was characterized by local wave (Wave 1: February 26, 2022-August 31, 2020; Wave 2: September 1, 2020-February 28, 2021; Wave 3: March 1, 2021-July 31, 2021; Wave 4: August 1, 2021-September 30, 2021 [end of sample]).¹⁴ The number of contact persons (eg, spouse, child, friend) listed on the client's home care organization file was used as a proxy for available social support. Client acuity was defined as low, medium, or high based on "emergency response level" (urgency of service) scores received as part of the home care service referral package. Canceled visits refers to clients canceling a scheduled home care visit. In contrast, missed care refers to the organization's inability to fill an individual scheduled visit (eg, due to a PSW calling in sick). The non-hospital-related hold variable captured service holds placed by clients for reasons other than hospitalization (eg, vacation, COVID-19 concerns). The index hospital hold refers to the first hospital hold in the period examined. The outcome variable of interest, 30-day hospital readmission, was defined as a secondary hospital hold lasting at least 2 days, starting within 30 days of the index hospital hold.

Analysis strategy

Descriptive summaries of the study population consisted of frequency distribution (proportions) or means, and bivariate tests of significance (chi-square and *t*-tests; $P \leq .05$) stratified by the outcome variable ("Readmitted to hospital within 30 days" vs "Not readmitted to hospital within 30 days"). The

relationship between demographics, health service utilization, and contextual factors on the outcome of 30-day hospital readmission was evaluated using binary logistic regression, and the relationship was interpreted using adjusted odds ratios (OR). All the predictor variables were tested in one block. SPSS software version 28 was used for statistical analysis.

Ethics review

The research ethics board of the University of Toronto approved this study (Protocol#: 00041813).

Results

Sample characteristics

Of the 20105 unique clients who received Personal Support services during the study period, 4224 experienced a hospital hold, of whom 3992 subsequently resumed home care Personal Support services.

Of the 3992 clients who resumed home care services following a hospital hold, 2696 experienced one hospital hold, while 1296 experienced multiple hospital holds (range: 2-13), and 662 were readmitted to hospital within 30 days following the index hospital hold. Study analyses compared the 662 home care clients who experienced a hospital hold, resumed home care services, and were subsequently readmitted to hospital within 30 days versus the 3330 who were not readmitted to hospital within 30 days post-index hospital hold.

Table 1 reports the sample characteristics of clients who experienced at least one hospital hold during the study period, separated by the outcome variable of interest (30-day hospital readmission status) and bivariate tests of significance. Most of the sample was female ($n=2430$, 60.9%), averaging 80.1 years ($SD=13.7$; range 18-106 years) (Table 1).

Differences by 30-day hospital readmission status

Demographics. Although sex differences were found in bivariate tests (Table 1), sex and age were non-significant in the full regression model (Table 2). Clients with low acuity were significantly less likely to be readmitted to hospital within 30 days than those with high acuity; those with unknown acuity had a significantly higher likelihood of experiencing hospital readmission (Table 2). Clients with more contacts listed on file were significantly less likely to be readmitted to hospital within 30 days (Table 2).

Hospital service utilization. Those who experienced a hospital readmission within 30 days were significantly more likely to have a higher total number of hospital readmissions across the entire study period (Table 2). Regression results indicated that clients with an index hospital hold of 14+ days were 1.4 times more likely to be readmitted when compared to those with the shortest hospital stays (2-4 days; $OR=1.41$, 95% CI [1.11,

Table 1. Client characteristics and the relationship between 30-day hospital readmission and demographic, health service utilization and contextual factors from October 1, 2018 to September 30, 2021.

	CLIENTS WITH AT LEAST ONE HOSPITAL HOLD N=3992	CLIENTS READMITTED TO HOSPITAL WITHIN 30 DAYS N=662 (16.2%)	CLIENTS NOT READMITTED TO HOSPITAL WITHIN 30 DAYS N=3330 (83.4%)	CHI-SQUARE OR T-TEST
	N OR MEAN (% OR SD)			P-VALUE
Demographics				
Sex				
Female	2430 (60.9%)	377 (56.9%)	2053 (61.7%)	.02
Male	1562 (39.1%)	285 (43.1%)	1277 (38.3%)	
Age (y)	80.1 (13.7)	78.5 (14.2)	80.5 (13.6)	<.001
Acuity				
High acuity	1129 (28.3%)	197 (29.8%)	932 (28.0%)	<.001
Medium acuity	1250 (31.3%)	199 (30.1%)	1051 (31.6%)	
Low acuity	1178 (29.5%)	158 (23.9%)	1020 (30.6%)	
Unknown	435 (10.9%)	108 (16.3%)	327 (9.8%)	
Number of identified contacts	2.59 (1.88)	2.52 (1.80)	2.60 (1.89)	.32
Hospital service utilization				
Number of hospital admissions	1.57 (1.12)	2.18 (1.45)	1.45 (0.99)	<.001
Hospital length of stay				
2-4 days	1220 (30.6%)	192 (29.0%)	1028 (30.9%)	.65
5-7 days	945 (23.7%)	165 (24.9%)	780 (23.4%)	
8-13 days	860 (21.5%)	138 (20.8%)	722 (21.7%)	
14+ days	967 (24.2%)	167 (25.2%)	800 (24.0%)	
Home care utilization				
Wait time for home care (days)	1.91 (7.99)	2.21 (5.22)	1.85 (8.43)	.15
Daily average PS visits pre-hospital hold	0.59 (0.65)	0.57 (0.67)	0.59 (0.65)	.40
Daily average PS visits post-hospital hold	0.75 (0.73)	0.52 (0.61)	0.80 (0.75)	<.001
Non-hospital-related pre-hospital hold				
Yes	117 (2.9%)	10 (1.5%)	107 (3.2%)	.02
No	3875 (97.1%)	652 (98.5%)	3223 (96.8%)	
Non-hospital-related post-hospital hold				
Yes	239 (6.0%)	19 (2.9%)	220 (6.6%)	<.001
No	3753 (94.0%)	643 (97.1%)	3110 (93.4%)	
Missed care pre-hospital hold				
Yes	137 (3.4%)	23 (3.5%)	114 (3.4%)	.95
No	3855 (96.6%)	639 (96.5%)	3216 (96.6%)	

(Continued)

Table 1. (Continued)

	CLIENTS WITH AT LEAST ONE HOSPITAL HOLD N=3992	CLIENTS READMITTED TO HOSPITAL WITHIN 30 DAYS N=662 (16.2%) N OR MEAN (% OR SD)	CLIENTS NOT READMITTED TO HOSPITAL WITHIN 30 DAYS N=3330 (83.4%)	CHI-SQUARE OR T-TEST P-VALUE
Missed care post-hospital hold				
Yes	243 (6.1%)	37 (5.6%)	206 (6.2%)	.56
No	3749 (93.9%)	625 (94.4%)	3124 (93.8%)	
Canceled visit pre-hospital hold				
Yes	1486 (37.2%)	272 (41.1%)	1214 (36.5%)	.02
No	2506 (62.8%)	390 (58.9%)	2116 (63.5%)	
Canceled visit post-hospital hold				
Yes	1757 (44.0%)	319 (48.2%)	1438 (43.2%)	.02
No	2235 (56.0%)	343 (51.8%)	1892 (56.8%)	
Context				
Hospital hold COVID-19 timing				
Not during COVID-19	2272 (56.9%)	392 (59.2%)	1880 (56.5%)	.08
Wave 1	500 (12.5%)	76 (11.5%)	424 (12.7%)	
Wave 2	532 (13.3%)	75 (11.3%)	457 (13.7%)	
Wave 3	548 (13.7%)	103 (15.6%)	445 (13.4%)	
Wave 4	140 (3.5%)	16 (2.4%)	124 (3.9%)	
Notice to resume home care service				
Weekday	3468 (86.9%)	579 (87.5%)	2889 (86.8%)	.62
Weekend (Sat/Sun)	524 (13.1%)	83 (12.5%)	441 (13.2%)	
Region				
Region 1	1772 (44.4%)	279 (42.1%)	1493 (44.8%)	.27
Region 2	1115 (27.9%)	201 (30.4%)	914 (27.4%)	
Region 3	1105 (27.7%)	182 (27.5%)	923 (27.7%)	

1.81]); although, we note that differences between groups are relatively small and the length of index hospital stay did not differ significantly when examined independently (Table 1).

Home care service utilization. Prior to the index hospital hold, service intensity and client-initiated non-hospital-related holds on service were significantly associated with 30-day hospital readmission (Table 2). Clients with higher home care service intensity before their initial hospital stay were more likely to be readmitted to hospital within 30 days; each additional daily Personal Support visit before the index hospital hold corresponded with a 2.4 times increase in the likelihood of readmission (OR=2.39, 95% CI [1.90, 2.97]). Conversely, clients

who had placed non-hospital-related holds (eg, vacation, concerns related to COVID-19, etc.) prior to or after the index hospital hold were less likely to experience readmission (OR=0.44, 95% CI [0.22, 0.89]; OR=0.31, 95% CI [0.19, 0.52]; Table 2).

Average home care service intensity across the entire sample increased following the index hospital hold (from 0.59 to 0.75 visits/day, or 4.1 to 5.3 visits/week ($t_{3991}=17.89$, $P<.001$)), with approximately half (56%) of the sample receiving an increase in Personal Support visit frequency. Home care service intensity after the index hospital hold significantly predicted 30-day hospital readmission (Table 2): those who were readmitted within 30 days received less frequent home care visits

Table 2. Regression output for 30-day hospital readmission.

VARIABLE	DESCRIPTION	EST.	SE	P	ADJUSTED ODDS RATIO (95% CI)
Demographics					
Sex	Female (ref) vs Male	0.162	0.093	.083	1.18 (0.98-1.41)
Age (y)	Continuous	-0.003	0.003	.397	1.00 (0.99-1.00)
Acuity	High acuity (ref)				
	Medium acuity	-0.167	0.123	.175	0.85 (0.66-1.10)
	Low acuity	-0.317	0.134	.018	0.73 (0.56-0.95)
	Unknown	0.549	0.160	<.001	1.73 (1.23-2.37)
Number of identified contacts	Continuous	-0.07	0.026	.008	0.93 (0.88-0.98)
Hospital service utilization					
Number of hospital admissions	Continuous	0.524	0.039	<.001	1.69 (1.57-1.83)
Hospital length of stay	2-4 days (ref)				
	5-7 days	0.233	0.125	.064	1.26 (0.99-1.61)
	8-13 days	0.102	0.132	.438	1.11 (0.86-1.44)
	14+ days	0.348	0.126	.006	1.41 (1.11-1.81)
Home care service utilization					
Wait time for home care (days)	Continuous	-0.003	0.006	.658	1.00 (0.90-1.0)
Daily average PS visits pre-hospital hold	Continuous	0.871	0.110	<.001	2.39 (1.90-2.97)
Daily average PS visits post-hospital hold	Continuous	-1.484	0.123	<.001	0.23 (0.18-0.29)
Non-hospital-related pre-hospital hold	Yes vs No (ref)	-0.819	0.357	.022	0.44 (0.22-0.89)
Non-hospital-related post-hospital hold	Yes vs No (ref)	-1.162	0.257	<.001	0.31 (0.19-0.52)
Missed care pre-hospital hold	Yes vs No (ref)	-0.016	0.271	.952	0.982 (0.580-1.663)
Missed care post-hospital hold	Yes vs No (ref)	0.203	0.215	.345	1.198 (0.789-1.821)
Client-canceled visit pre-hospital hold	Yes vs No (ref)	0.164	0.100	.101	1.18 (0.97-1.43)
Client-canceled visit post-hospital hold	Yes vs No (ref)	0.316	0.098	.001	1.37 (1.13-1.66)
Context					
Hospital hold COVID-19 timing	Not during COVID-19 (ref)				
	Wave1	0.127	0.148	.392	1.14 (0.85-1.52)
	Wave2	0.012	0.148	.934	1.01 (0.76-1.35)
	Wave3	0.605	0.136	<.001	1.83 (1.40-2.39)
	Wave4	-0.126	0.285	.659	0.88 (0.50-1.54)
Notice to resume home care service	Weekday (ref) vs Weekend	-0.090	0.138	.517	0.92 (0.70-1.21)
Region	Region 1 (ref)				
	Region 2	0.380	0.115	<.001	1.46 (1.17-1.83)
	Region 3	0.170	0.120	.157	1.19 (0.94-1.50)

The reference group for categorical variables is represented by (ref). Significant *P*-values ($P < .05$) are in bold.

(average 0.5 visits/day; 3.6 visits/week) than those who were not readmitted (average 0.8 visits/day; 5.6 visits/week; OR 0.23, 95% CI [0.18, 0.29]).

Client-initiated home care service cancellations in the 30 days after the index hospital hold significantly predicted 30-day hospital readmission. Clients readmitted to hospital within 30 days were 1.4 times more likely to have canceled at least one of their scheduled home care visits within the 30 days following home care service resumption (OR = 1.37, 95% CI [1.13, 1.66]).

Service delivery characteristics, namely wait times for a first home care visit after the hospital hold and missed care (the home care organization not providing a scheduled visit), were not significantly correlated with 30-day hospital readmission. Similarly, whether the client transitioned back to home care on a weekend or weekday was not significantly associated with the likelihood of 30-day hospital readmission.

Context. During Wave 3 of the COVID-19 pandemic, clients with a hospital hold had a 1.8 times higher likelihood of being readmitted to hospital within 30 days compared to those admitted prior to the COVID-19 pandemic (OR = 1.83, 95% CI [1.40, 2.39]; Table 2). Regional differences were also found in 30-day hospital readmission rates within this sample.

Discussion

This study examined the transitions of care between the increasingly interconnected hospital and home care sectors, focusing on the differences between home care clients who were and were not readmitted to hospital within 30 days following a hospital stay. Approximately one-fifth (21%) of individuals receiving in-home Personal Support experienced a hospital hold during the study period, with 95% subsequently resuming home care services, and one-third (32%) of these individuals experiencing subsequent hospital holds within the study period. Hospitalization also led to higher home care utilization for the majority (56%) of clients, with an average 27% increase in care visit frequency following a hospital stay.

The sample of individuals who experienced at least one hospital hold had higher initial levels of service, averaging 0.59 visits/day, than previously-reported levels of service intensity for Personal Support clients (average 0.41 hours/day),¹⁵ indicating a higher intensity of care needs even before hospitalization, as assessed by care coordinators from the provincial funder, the Home and Community Care Support Services. Within this sample, clients who were allocated higher levels of service before their index hospitalization were more likely to experience a hospital readmission within 30 days.

Study findings reinforce that increased home care services after a hospital stay are protective against 30-day readmission (average of 3.6 visits/week for those with a 30-day readmission compared to 5.6 visits/week for those without). Clients who received higher service levels following an index hospital

hold and more fully utilized the services offered (ie, fewer client-initiated cancellations) had a significantly lower likelihood of 30-day hospital readmission. This suggests that offering modest increases in Personal Support at home following hospital discharge may be an effective strategy for reducing readmissions.

It has been reported that home care services were disrupted during the COVID-19 pandemic,^{16,17} and that delays in initiating home care service (specifically in nursing) increase the risk of returning to hospital within 30 days (emergency department visit or readmission).¹⁸ We found that wait times for Personal Support home care services were relatively short (averaging just under 2 days after hospital release), that provider-driven missed care was relatively rare (3.4%-6.1% of all visits), and that neither factor was associated with 30-day hospital readmission (Table 2).

Several factors indicated that home care clients with greater clinical and social needs had a higher risk of hospital readmission within 30 days. We found increased odds of hospital readmission for those with a higher total number of hospital holds and longer index hospital stays (14+ days), both indicative of greater clinical need, which aligns well with other research on predictors of 30-day hospital readmission.¹⁹⁻²² Similarly, we found a higher hospital readmission rate for clients rated as high versus low acuity. The finding that clients of unknown acuity experienced higher hospital readmission rates emphasizes the need for complete home care referral package information to support quality care. Finally, clients who placed their home care services on hold for non-hospital-related reasons were less likely to be readmitted to hospital within 30 days may indicate less reliance on home care for these individuals. Of all client characteristics captured in the model, only lower social support significantly contributed to a higher likelihood of 30-day hospital readmission. This is consistent with previous findings that social support reduces rehospitalization risk and promotes recovery.²³⁻²⁵ These clinical and social need indicators can be used at both a system and organizational level to identify clients at heightened risk of hospital readmission and provide targeted supports.

The 2 contextual factors which impacted 30-day readmission were the region and the local wave of the COVID-19 pandemic. The link between hospital readmission and geographical factors is well-documented and unsurprising, given that regional health systems are independently operated and vary by spending, access, and health care service delivery.^{26,27} With respect to the impact of discharge during Wave 3 of the COVID-19 pandemic, supplementary analyses found that hospital length of stay and service intensity following resumption of services did not significantly differ. Factors beyond the scope of this analysis that may help explain this effect include the fluctuating supply and demand for home care services,^{17,28} emerging COVID-19 variants,²⁹ and subsequent public health and health system restrictions.³⁰

This study provides insight into factors that influence the risk of 30-day hospital readmission, some of which may be modifiable. These highlight an opportunity to leverage existing, routinely-collected administrative data to identify those at greatest risk³¹ and allow supportive interventions (eg, social support and additional home care services) to be targeted appropriately. Results can be used to drive evidence-informed interventions to interrupt the traumatic and expensive cycle of hospital readmissions experienced by a subset of older home care clients.^{9,32} For example, emergent information and communication technologies (eg, tele-homecare, remote monitoring) could offer opportunities to manage and coordinate care for patients at high risk for readmission in a community setting.^{33,34} Similarly, newly designed interprofessional models of care have also shown promising results in lowering readmission rates in patients discharged from the hospital.^{35,36}

Limitations

One home care organization collected the administrative data used in this study for service planning, capturing dimensions of quality care, and decision-making, rather than research. As with any administrative health data set, its collection involves data input from multiple sources (ie, clients, Home and Community Care Support Services, home care organization) and is not always complete. Proxy variables were utilized to reflect important unavailable constructs (eg, number of contacts on file to indicate social support). To our knowledge, this is the only study to capture the influence of in-home personal support service characteristics on 30-day readmission; however, it does not include data related to the hospitalization or discharge experience. Triangulation with other data sources has the potential to create a more complete understanding of factors influencing hospital readmissions.

Conclusion

Findings from this study indicate that the risk of a 30-day hospital readmission in home care recipients was associated with higher client acuity, lower available social support, and longer hospital stays, while higher levels of home care service reduced the risk for readmission. These findings can be used at a systems level to provide a greater understanding of factors associated with home care clients' risk of hospital readmission within 30 days and can be used to inform supportive, evidence-based transition plans to enable people to return to and remain at home.

Author Contributions

Marianne Saragosa contributed to the study conception, data analysis, and interpretation and wrote the first draft of the manuscript. Katherine Zagrodney contributed to data analysis and interpretation, reviewed and commented on the manuscript, and approved the final version. Prakathesh Rabeenthira contributed to data analysis and interpretation, reviewed and

commented on the manuscript, and approved the final version. Emily King and Sandra McKay contributed to the study conception, data analysis, and interpretation, reviewed and commented on the manuscript, and approved the final draft.

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