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Predicting a Risk of Transition to a Higher Level of Care for Home Support Service Recipients

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Abstract. This longitudinal, non-randomized, retrospective study uses the Kaplan-Meier estimates method and the Cox Proportional Hazard model to assess the risk of home support recipients' transitioning to a higher level of care after being hospitalized. The Kaplan-Meier survival analysis revealed that 50% of home support recipients were expected to move on to a higher level of care by day 1,374. The Cox Proportional Hazard model indicated that the risk of transitioning to a higher level of care increases by about 2% as a client ages by one year, and by about 10% if there were no emergency room visits in the last 12 months. Also, the risk will decrease by about 13% if an individual is getting more than one hour of home support service per visit on average, compared to those who are receiving less than one hour of home support services per visit. These results will help project long term home support demand and resource planning for home support and the health care system.

Keywords. Home Support, Home and Community Care, Survival Analysis, Health Care Utilization

1. Introduction

Home support is designed to allow an individual to live independently at home, or in a care setting, by providing Activity of Daily Living (ADL) services [1]. Providing this support has become increasingly challenging with the rapid growth of the aging population [2]. In British Columbia (BC), Canada, the number of people 65 years old and above in 2023 was estimated to be 1,083,695, which is 10% of the total BC population [3]. The number in that age group is projected to increase 18% in the next 5 years, 31% in the next 10 years and 46% in the next 20 years [3]. These figures indicate that there will be much more demand for home support to accommodate older adults who wish to live independently at home over the next 20 years. Because of the increase in demand, home support service providers have been facing several challenges and it is

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necessary to seek a way to reduce that burden. Understanding the demand on home support will lead to more effective resource planning for home support and other health service areas.

2. Aim and Objectives

This is a longitudinal, non-randomized, retrospective study which focuses on home support recipients who will be transitioning to a higher level of care. The objective of this study is to predict the risk of home support recipients moving on to a higher level of care after hospitalization based on their characteristics.

3. Methods

3.1. Dataset

The focused cohort was the long-term home support service recipients who were 65 and older and who had been admitted into acute care facilities. The analysis was conducted based on the data of home support recipients at a BC regional health authority between November 1, 2019 and March 31, 2023. The cohorts' demographic information and health care service use were derived from the data from multiple services within the health care system including the home and community care, acute care, and long-term care data systems. The datasets were linked based on an anonymized patient identifier.

3.2. Methods

The Kaplan-Meier method was used to give a general understanding of the cohort's risks of transition to a higher level of care [4]. The Cox proportional-hazard model, a semi-parametric survival analysis, was used to estimate the probabilities of home support recipients moving onto a higher level of care based on recipients' characteristics [5]. Survival analysis, including the Kaplan-Meier method and Cox proportional-hazard model, allows censoring in the case the event did not occur, in order to estimate the probability of time an event occurs [6].

The study time period is between the start of a referral that ended in hospitalization and the time the home support recipient is discharged from hospital. Individuals can have multiple home support referrals depending on their health needs. The episodes were included in the analysis if there was home support the day before or on the day of hospitalization. The event of this study is the transitioning to a higher level of care at hospital discharge, including admission to another inpatient care facility, or a residential care facility. Transfer to Medical Assistance in Dying (MAID) or death in a facility were also included as a higher level of care. An episode is considered to be censored if an individual was discharged from hospital to home support. Some individuals were discharged to home without a home support service. Individuals discharged home without home support services were not considered in this analysis.

The characteristics of the cohort as independent variables were included: 1) sex, 2) age of the cohort at the start of the home support referral which ended in hospitalization;

3) the average of home support service duration per visit, 4) whether admitted to hospital, 5) whether emergency visits occurred, and 6) whether a Care Manager visited.

In order to ensure the assumption of the Cox Proportional hazard model, the constant proportional hazard across time, the correlation between the Schoenfeld residual of each factor with the survival time at the significance level of 0.05 was checked [7]. Maximum Likelihood Estimate (MLE) was examined for coefficients significance for the characteristics with a significance level of 0.05 [5]. Microsoft SQL Server Management Studio and SAS 9.4 were used for data linkage, data preparation and statistical analysis.

4. Results

Out of 19,517 home support recipients in the health authority, a total of 5,785 individuals were admitted to acute care services at least once when they were receiving long-term home support services. The length of stay with home support services just before a hospital admission has a mean of 732.6 days with a median of 455 days and standard deviation of 831.2 days. Although a survival analysis can handle data which is not normally distributed [5], because of the large standard deviation, the mild and extreme outliers were removed [8]. After removing the outliers, a total of 5,556 individuals were included in the analysis. The length of stay for the new cohort has a mean of 583 days with a median of 409 days and a standard deviation of 543 days.

There was a total of 10,932 episodes of hospital admissions of the cohort. Fifty four percent were admitted to hospital once, 23% were admitted twice, 11% were admitted three times and 12% of them were admitted to hospital four or more times, with a maximum of 19 times. The average age at hospital admission was 84.7 years old; the median age was 86 years old.

Figure 1 shows Kaplan-Meier survival estimates of home support clients who moved onto a higher level of care after being hospitalized. Table 1 shows the mean, standard deviation, point estimates with 95% confidence intervals of survival probability at each quartile. Fifty percent of home support recipients were expected to move on to a higher level of care by day 1,374. That is a long time for half of home support recipients to move on to a higher level of care after hospitalization.

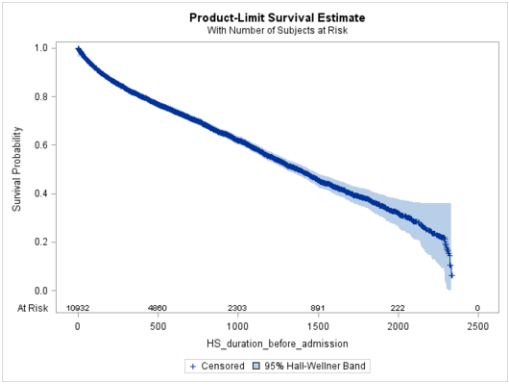

Figure 1. Kaplan-Meier Survival Estimate for Home Support clients who were hospitalized.

Table 1. Survival Time Point Estimate at Quartiles

Mean (Standard Error)	Quartile	Point Estimate Days (yrs)	95% Confidence Interval Lower	Upper
1326,14 (11.66)	75	2183 (5.9)	2139	2270
	50	1374 (3.8)	1313	1422
	25	567 (1.6)	529	597

The hazard ratios of the home support recipients' characteristics based on Cox Proportional Hazard model are shown in Table 2. The following variables were eliminated from the final model due to their violation of constant proportional hazard ratio: hospital admission in last 12 months and case manager visits in the last 12 months, and recorded sex.

Based on the hazard ratio, there is about a 2% increase as a client age by one year, and about a 10% increase if there were no emergency room visits in the last 12 months, in the risk of transitioning to a higher level of care after a hospital admission. In addition, if an individual is getting more than one hour of home support service per visit on average, the hazard of a transitioning to a higher level of care at hospital discharge will decrease by 13%, compared to those who are receiving less than one hour of home support services per visit.

Table 2. Schoenfeld Residual Correlation with Survival Time Significance and Cox Hazard Ratio. (* indicates a violation of Cox proportional hazard model assumption).

Home Support Recipients' Characteristics	Model 1	Model 2	Final Model	
	P-values Coefficient Schoenfeld Residual	P-values Coefficient Schoenfeld Residual	P-values Coefficient Schoenfeld Residual	Cox Hazard Ratio
Age at Home Support Referral Start	<.0001 0.0911	<.0001 0.0860	<.0001 0.1352	1.018
Emergency room visits Last 12 months (Yes, No)	0.1527 0.211	0.0685 0.3407	0.0329 0.2717	Yes: 1 No: 1.097
Average Home Support hr/day Last 12 months (<=1hr, 1+hr)	0.0231 0.4368	0.0006 0.4008	0.0001 0.2915	<=1: 1 1+: 0.868
Recorded Sex (F, M)	<.0001 0.0585	<.0001 0.0425*	Not Included	Not Included
Hospital Admission Last 12 months (No, Yes)	0.0091 0.0012*	Not Included	Not Included	Not Included
Case Manager Visit Last 12 months (No, Yes)	<.0001 <.0001*	Not Included	Not Included	Not Included

5. Discussion

The trends of longer life expectancy, and higher expenses in the health care system, as well as letting aging people stay home as long as they wish, means the demand for home support will continue to grow [2,9]. The study showed that about 75% of home support recipients stay in home support for about 5 years. This will add additional pressure on home support. It is also interesting to see that the risk of transitioning to a higher level of care increases for those who receive less time for each visit. This indicates that having

more time in home support may help older adults stay longer at their home. Additionally, providing home support to the older population would help the health care system save costs. For example, according to the Office of Seniors Advocate BC, there would be an annual saving of $32,000 per person by providing two hours of home support services daily, compared to long-term care facility services [10] .

There are some limitations in this analysis. First, only a few characteristics of the recipients were part of the analysis due to the Cox Proportional Hazard model assumption. Second, some of quality issues in the data created issues around the start and end of home support referrals. As a result, it may not be possible to determine the true referral length.

6. Conclusions

This study can be used for further projection of home support needs and to help develop a strategic resource plan for the health care system.

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