Federation of Business Disciplines Journal
Volume 9, 2020 38 - 46

IMPACT OF THE LENGTH OF STAY, COHORT OF PATIENTS AND AGE ON WHEELCHAIR MODE OF TRANSPORTATION AT A TEXAS NOT-FOR-PROFIT HEALTHCARE SYSTEM

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ABSTRACT

Intrahospital transports are required for diagnostic or therapeutic services. Depending upon the facility layout, transportation between service units is provided typically by wheelchair accompanied by trained personnel. In large healthcare facilities the patient transport service can be poorly managed and/or dysfunctional. This study investigates whether the dispatch mode is impacted by, type of disease and/or length of stay at the healthcare facility. Binary logistic regression analysis is used to obtain measurable variances and relationships of wheelchair usage by 1,385 patient's cases in this study. Length of stay is used as measure of severity of the patient's condition as used in previous research. Our analysis demonstrates wheelchair use is dependent on the age, length of stay, reason for admission and patient disease condition.

Keywords: logistic regression, knowledge discovery, transportation dispatch mode.

BACKGROUND

Most hospitals provide wheelchair service to accommodate patients with disabilities or mobility issues. With 4.6 percent (HHS, 2018) of the 53.2 million US population older than 65 years (Census, 2019) reporting hospital stays in the past year, wheelchair services and usage are a frequent source of complaints and dissatisfaction among hospital patients (Schaad, Bourquin, Panese, & Stiefel, 2019).

The US Department of Health and Human Services (HHS, 2010) provides detailed guidance regarding the access to medical care for individuals. Nonetheless, complaints on the

timely and accurate provision of wheelchairs from those with special or mobility needs are reported in the press (King & Jayaraman, 2017) with comments such as 'missed my appointment' or 'delivered to the wrong examining room.' This study analyzes patient wheelchair transportation relationship to the patient's length of stay, age and reason for hospitalization i.e., disease. The investigation adds to the literature as these relationships are rarely addressed by researchers. Published studies tend to concern patient flow (von Guionneau & Burford, 2018; Beaudry, Laporte, Melo & Nickel, 2010; Hanne, Melo & Nickel, 2009; Segev, Levi, Dunn & Sandberg, 2012); equipment management (Bradshaw, 2009; Buyurgan, Hajiyev, Lehlou, Rossetti, Rardin, & Jayaraman, 2009; Chiarini, 2013); safety (Gaal, Rebholtz, Hotchkiss & Pfaelzer, 1997; Kessler, Egan & Kubina, 2014): and sharing infection (Peretz, Koiefman, Dinisman, Brodsky & Labay, 2014).

Few research studies have been published regarding the decision process hospitals use to assign idle wheelchairs to patient discharge. Patient transportation frequently results in waiting time for patients, idle time in hospital units waiting for the patient, as well as an underutilization of staff and equipment. The problem can be more complex due to specific patient needs such as – assistance of medical personnel, special equipment needs during transportation, wheelchairs with alternative loading modes, required rest periods, and special isolation requirements to prevent spread of infection. The healthcare facility's goal is to provide an efficient and timely wheelchair service to patients during and after treatment. The requests for transportation to arrive in a dynamic fashion and the solution methodology requires profiling of patients requiring a wheelchair. This study characterizes profiling of patients requiring wheelchair as a dispatch mode in a healthcare system to resolve the problem. An investigation of the variances is based on age, type of diseases and length of stay in hospitals with respect to different dispatch modes.

RESEARCH QUESTIONS

Although type of disease typically does not correlate to wheelchair dispatch mode, the wheelchair dispatch mode does relate to the type of diagnosis and delivery to the appropriate department. For example, a patient entering the hospital with a bone fracture probably needs the wheelchair as a mode of transportation. However, someone exhibiting a heart attack, respiratory issue, abdominal obstruction, neurological problem and many other issues may use a wheelchair as intrahospital transportation.

Chiarini (2013) and Beaudry et al., (2010) reports patient transportation is related to patient diagnosis that in turn relates to the patients' length of stay in the hospital regardless of whether the problem is a fracture or an internal issue such as cardiovascular, lung, or neurological. Said another way, the quicker the patient gets treatment, the patient can respond to the treatment and get well with a shorter length of stay in the hospital as measured by the number of days a patient resides in a facility from day of admission until discharge (Abela et al., 2019; Buttigieg et al., 2018; Smith et al., 2006). This research is guided by the following question.

RQ1. Is the hospital wheelchair dispatch mode related to the patient's length of stay in the hospital?

Worldwide, the World Health Organization estimates that 65 million people beyond middle age will require manual or power wheelchairs (WHO, 2008). Adults over age fifty are four times more likely to have complex health issues requiring hospitalization and rely on a wheelchair for

mobility during their healthcare treatment (Auger et al., 2015). Overall, the number of chronic conditions among adults age forty-four and older have increased since early 2000 (Paez et al., 2009). Given these trends, this research is guided by the following question.

RQ2. Is the hospital wheelchair dispatch mode affected by the patient's age?

This investigation also looks at the interaction and relationship of the study's variable that leads to the following question.

RQ3. What is the interaction and relations among hospital wheelchair usage as a transportation mode, the patient's length of stay in the hospital, the patient's disease, and their age?

DATA

Data collected from 40 hospitals in a system in Texas. The databases are merged and filtered for wheelchair usage yielding 1,385 observations. Binary logistic regression analysis is used on the dispatch mode of wheelchair and non-wheelchair usage. Analyses are conducted to reveal associations between age, length of stay and cohort of diseases that requires a wheelchair as the dispatch mode.

Cohort of Diseases

A wide range of disease conditions are categorized by a domain expert. Table 1 demonstrates these conditions and the number of observations in the dataset.

Table 1
Frequency of Distribution of Patients

Disease conditions	No. of Patients
Abdominal Pain and related Issues	143
Abnormal Lab	37
Abscess and related issues	23
Bleeding and blood related issues	56
Blood Pressure related issues	22
Dizziness and related issues	34
Emesis	70
Eye related issues	7
Face related Issues	8
Fall and related issues	41
Fatigue issues	57
Feet and Leg related issues	9
Fever and related issues	42
GI/GU issues	28
Head and neck related issues	20
Heart related issues	22

Mental Issues	36
Nasal Congestion	2
Neurologic Problem and related issues	75
Oral related issues	5
Pain in various body parts	181
Pregnancy related issues	145
Referral	2
Shortness of breath and respiratory issues	210
Skin related Issues	16
Sore throat	3
Trauma	64
Well Child	2
Other	25

Dispatch

The dependent variables considered in the analysis were two dispatch mode classifications: wheelchair (1) and non-wheelchair (0) use. The frequency of usage of wheelchair and non-wheelchair, which is composed of a range of methods is displayed in Table 2.

Table 2

Frequency of Distribution of Dispatch Mode

Dispatch Mode	Frequency	Wheelchair D
Wheelchair	429	1
Acadia	16	0
Air Evac	2	0
Ambulance	57	0
AMR	3	0
Car	432	0
Hospital Transport	34	0
Med Flight	4	0
Public Transportation	2	0
SW EMS	40	0
Walk-out	366	0

Length of Stay

Previous studies indicate that 30-65% of the large intra-diagnosis related groups length of stay variations can be explainable by indicators of case complexity and severity despite the homogeneity claimed for the diagnosis related groups (Berki et al.,1984). Hence, length of stay is used to represent severity of disease condition. Logistic regression is performed with length of stay, categorized in bins, and use of wheelchair. Length of stay is categories as a range of 0-31 days categorized as 1, 2, 3, 4, and 5 respectively using National Hospice and Palliative Care Organization (NHPCO) guidance (Teno et al., 2007).

Table 3
Length of Stay

1	0-2 days
2	3-7 days
3	8-14 days
4	15-29 days
5	30+ days

METHOD

Binary Logistic Regression

The binary logistic regression analysis is performed using SPSS. Binary logistic regression with diagnosis (disease), age and length of the hospital stay (LOS) to the wheelchair mode of transport with the results displayed in Table 4a and 4b and the variable analysis displayed in Table 5.

Table 4a
Model Summary

Step	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
1	1436.762[a]	.182	.256

These results provide an indication of the amount of variation in the wheelchair dependent variable explained by the model. The two values suggest that between 18.2 percent and 5.6 percent of the variability is explained by the model as suggested by Maddala (1983) and Cragg and Uhler (1970)..

Table 4b
Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	39.030	8	0.000

The Chi-square value of 39.030 is very significant indicating support the model (Hosmer & Lemeshow, 2000).

Table 5
Variables in the Equation

		B	S.E	Wald	df	Sig	Exp (B)	95.0% CI for Exp B Lower	Upper
Step 1[a]	Age	-0.043	0.003	205.170	1	0.000	0.958		.963
	Disease	-0.001	0.007	0.005	1	0.942	0.999	.985	1.014
	LOS	-0.002	0.003	0.280	1	0.596	0.998	.992	1.005
	Constant	3.269	0.232	199.322	1	0.000	26.281		

a. Variable(s) entered on step 1: Age, Disease, LOS.

Significant relationship is found between age and wheelchair as a dispatch mode.

Table 6 Classification Table displays how well the model is able to predict the correct category wheelchair use versus non-wheelchair use. The model correctly 80.1 percent overall. A majority (63.4%) of the cases that did not use a wheelchair and an overwhelming 87.7 percent of the cases that did use a wheelchair.

Table 6
Classification Table

Observed			Predicted Wheelchair not used	used	Percentage Correct
Step 1	Wheelchair	not used	272	157	63.4
		used	118	838	87.7
	Overall Percentage				80.1

Multi-collinearity in binary logistic regression

An important consideration in regression is the effect of correlation among independent variables called multi-collinearity. The collinearity diagnostics using SPSS and its results displayed in Table 7.

Table 7 Collinearity Diagnostics

Model	Dimension	Eigenvalue	Condition Index	VIF
1	Constant	2.869	1.000	
	Age	0.808	1.884	1.006
	Disease	0.245	3.424	1.004
	LOS	0.079	6.026	1.001

The condition indices are calculated as the square roots of the ratios of the largest eigenvalue to each successive eigenvalue. Values greater than 15 indicate a possible problem with collinearity (Liu et al., 2003). . The model coefficients are analyzed to find the variance inflation factor (VIF) statistic for the model variable resulting in no VIF being greater than 1.006. Hair et al. (2010, 201) suggests a variable VIF of 1 would have no multicollinearity. a

DISCUSSION AND CONCLUSION

There are many patient conditions and afflictions, which may result in the need of a wheelchair. Those who need help moving— for instance, because they are unable to walk on their own, prefer use of wheelchair. Binary logistic regression is used for analysis with wheelchair usage as a binary code. The main advantage of binary logistic regression (LR) over simple multiple regressions is LR allows the use of binary dependent variable types in wheelchair usage. Length of stay is classified into bins as per the National Hospice and Palliative Care Organization (NHPCO) (Teno et al., 2007). The likelihood of wheelchair usage is looked at based on age, length of stay, and cohorts of patients to help with the predictability of using the wheelchair.

All the variables were significant in predicting the use of a wheelchair. Using length of stay as proxy for severity of disease (Berki et al., 1984), the analysis found that the higher the length of stay, the higher the use of wheelchair (analysis not reported). Age also has significant influence on wheelchair usage. Higher age patients are likely to use a wheelchair when compared to lower age patients. This was as expected as old age patients are likely to use a wheelchair more than youthful patients.

The general purpose of the study is to support decision makers in selecting the dispatch mode of patients from the various possible choice alternatives under the presence of multiple priorities. As a conclusion, these results can provide very useful information for predicting wheelchair usage, and the results obtained from this study provides a contribution to healthcare management literature.

LIMITATIONS AND FUTURE RESEARCH

Using logistic regression, the outcome is a discrete predicted categorical outcome that is vulnerable to overfitting. Correlational studies only demonstrate that a predicted outcome of one variable from the behavior of other variables and may have limitations with respect to generality of the findings.

This study finds a significant relationship between the age, length of stay, and reason for visit as significant variables in predicting the usage of a wheelchair. The next step is to classify the disease condition and age group and severity into different bins based on the likelihood of usage of wheelchair. This will have significant practical advantages in the usage of wheelchairs in

hospitals. With these results, it should be possible to evaluate how effectively place wheelchairs in the different healthcare departments and floors via an agent-based simulation.

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