Disparity in Access to Care Impacts Liver Transplant Mortality

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Abstract. This study aims to analyze how access to care influences patient mortality rates after liver transplants in adults by analyzing the relationships between insurance coverage, income, geographic location, and mortality rates post-transplantation. It was hypothesized that a sociodemographic variable, such as insurance type, geographical location, and income level would impact mortality rates post-liver transplant. Results showed that unknown insurance coverage increased the likelihood of mortality post-transplant, income level was not found to be a significant indicator, and patients living in the Northeast region of the United States were more likely to die post-liver transplant.

Keywords. Liver transplantation, mortality, health disparity

1. Introduction

Liver transplantation (LT) has become the most highly recommended treatment for end-stage liver failure; and the second most common transplant in United States (US) [1]. Due to the critical nature of these transplants, research regarding variables that might influence successful patient outcomes is in high demand. Many of these variables are physiologic and have been researched and analyzed extensively. However, there are many nonphysiological factors influence patients' daily lives and overall health and wellbeing. One such factor is access to care, known as, "the opportunity to reach and obtain appropriate health care services," [2]. One important factor within access to care is whether or not an individual can afford healthcare and health insurance. Research that has been done thus far suggests that barriers to access to care include high cost of care and poor insurance coverage, delays in receiving appropriate care, inability to receive preventive services, and preventable hospitalizations [3]. Previous research has not thoroughly analyzed the specific roles insurance coverage, income level, and geographic location play in liver transplant patient outcomes. This has left gaps in the knowledge

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base for providing quality care for a patient population that is already living months to years in critical condition.

In this study, liver transplant recipients' access to care are the main focus of study, and are analyzed based on patient insurance coverage, income level, and geographic location within designated regions of the US. These factors have not been thoroughly analyzed within surgical patients, and even less so for patients that are specifically post-liver transplant. Developing a larger knowledge base on how these factors impact liver transplant patient outcomes could provide individualized post-surgical treatment and enhanced outcomes for each liver transplant patient that goes beyond survival [4-7].

The purpose of this study is to investigate how access to care influences patient mortality rates after liver transplants in adults by analyzing the relationships between insurance coverage, income, geographic location, and mortality rates post-transplantation.

2. Method

This was a retrospective observational study using data from the OptumLabs® Data Warehouse (OLDW). OptumLabs is an open, collaborative research and innovation center founded in 2013 as a partnership between Optum and Mayo Clinic. Its core linked data assets include de-identified claims data for commercially insured and Medicare Advantage enrollees and EHR data from a nationwide network of provider groups, in total capturing more than 200 million lives [8].

The OLDW was queried for patients who underwent liver transplantation between 2007 (where EHR data became available in OLDW) to June 2018. All patients 18 years or older who received a liver transplant in the U.S. between that timeframe were included. Patients were excluded from the analysis if they refrained from any follow up visits or did not have information on the studied variables in OLDW. The University of Minnesota Institutional Review Board (IRB) (# 00000092) and OptumLabs (Statement of Work # 10190) approved this study.

2.1. Measures

Independent variables were: type of insurance coverage, average annual household income, and US geographic region.

- Insurance coverage was classified by the type of insurance obtained by each patient: commercial insurance, Medicaid, Medicare, other payor type, uninsured, and unknown.
- Average annual household income was recorded based on the average household income for the patient's zip code (3-digit-zip) of residence.
- US geographical regions were classified as Northeast, Southern, Western, or Midwestern regions of the US. These regions are identified based on the regional areas established by the Census Bureau.

The dependent variable or outcome of interest were whether patients were still alive during the follow-up period after LT.

Data were assessed for quality and missing data. If there were missing data points and statistical imputation was not an available option, that patient was excluded from the

analysis. This study controls for demographic characteristics within the sample population such as gender, age, race, geographic region, and education level.

2.2. Data Analysis

Mean and interquartile ranges (IQR) were used to describe continuous variables such as income level. Counts and percentages were used to describe categorical data such as type of insurance coverage and mortality rates. The data was analyzed using multiple logistic regression, using RStudio, version 3.1.3, an open source statistical software [9].

3. Results

Table 1 provides the descriptive characteristics of the 26,819 patients included in this analysis. The majority were male (n=16,420, 61%), Caucasian (n=19,249, 72%). More subjects in the study were in the South and Midwest regions, 37% (n=9,830) and 33% (n=8,893), respectively. The average age was 55.94 years old. The most common form of insurance coverage within the sample was commercial insurance (n=10,674), while a total of 6,077 were either marked as unknown, uninsured, other payor type, or had no value given. The average household income for the patients in this sample was $43,031.

Table 1. Descriptive characteristics of patients who received liver transplantation from 2008 to 2017 from a nation US sample (n=26,819).

Variable	Count (n)/mean	Percentage (IQR)	Missing Values
Age			1,956
Age	55.94	(50-64)	
Sex			51
Male	16,420	61%	
Female	10,348	38%	
Race			
Caucasian	19,249	72%	
African American	2,049	8%	
Asian	796	3%	
Geographic Region			957
South	9,830	37%	
Midwest	8,893	33%	
Northeast	4,281	16%	
West	2,858	11%	
Education			789
College Educated	24.12%	(18-28)	
Insurance Coverage			2,021
Commercial	10,674	40%	
Medicare	8,335	31%	
Unknown	2,237	8%	
Medicaid	1,733	6%	
Uninsured	1,224	5%	
Other	595	2%	
Income			789
Household Income	43,013	(35,334-47,758)	

The analysis (Table 2) showed a negative correlation between mortality rates and Commercial, Medicare, Medicaid, Uninsured, and Other types of insurance coverage. While each insurance coverage type showed statistically significant results (p<0.01 and p<0.001), the only insurance coverage type that was a risk factor rather than a protective factor was the Unknown category. Although not statistically significant and based on

relatively small number, this category had an odds ratio of 1.099, indicating a 9.9% higher likelihood of mortality post-transplantation.

Table 2. Multiple logistics regression analysis of factors associated with mortality post post-liver transplant.

Variable	Coefficient	Standard Error	P value	OR
Insurance				
Commercial	-7.553E-01	6.291E-02	<0.001	0.47
Medicare	-1.614E-01	6.242E-02	0.01	0.851
Unknown	9.403E-02	7.331E-02	0.199	1.099
Medicaid	-4.733E-01	8.646E-02	<0.001	0.623
Uninsured	-7.957E-01	1.075E-01	<0.001	0.451
Other	-6.518E-01	1.363E-01	<0.001	0.521
Income				
Household Income	-1.001E-06	1.598E-06	0.529	0.999
Geographic Location				
South	-2.204E-01	3.960E-02	<0.001	0.802
Midwest	-7.773E-01	2.515E-01	0.002	0.459
Northeast	1.918E-01	4.895E-02	<0.001	1.211
West	-5.625E-01	6.339E-02	<0.001	0.569

Geographic location was a risk factor if the patient was living in the Northeast region of the US with an odds ratio of 1.211 (p<0.001), indicating a 21% more likelihood of experiencing death after receiving a liver transplant in the Northeast region so long as all other variables are kept consistent. Results showed that having insurance coverage was a statistically significant protective factor in predicting mortality. Specifically, patients with commercial insurance coverage and uninsured patients were around 50% less likely to die, having the best likelihood when comparing to other insurance coverage types.

4. Discussion

We aimed to investigate if insurance coverage, income, and geographic location have an influence on patient mortality rates after liver transplants in adults in U.S. patients. Based on the results of the study, having insurance coverage is a protective factor, and based on the type of insurance people are less likely to die than others. The main finding of this study is the fact that living in the Northeast region was a risk factor for higher mortality rates after transplantation, confirming disparity in geographical donation and allocation, a current topic of discussion.

This study included a large sample from all US liver transplant patients. In the US, there were 74,257 liver transplants during the same time frame of data collection for this study [1]. Our study sample accounted for roughly 36% of the total population of interest, with similar characteristics of the entire US LT population. Specifically, this study included 61% males which is a near-even match to the 64% males for the overall LT population, with 72% Caucasian, while the target population is 73.9% Caucasian. Likewise, the average age for patients was 55.94 years old while the target population includes a majority of liver recipients aged 50-60.

The insurance coverage when Unknown showed to increase the risk of patient mortality after receiving a liver transplant, what was not found any previous study addressing this same finding. On the other hand, having insurance coverage, specifically commercial (what provides better and more resources than governmental ones) and uninsured status is indeed a protective factor. One explanation for uninsured being

protective is that we have a significant percent of patients who perform out of pocket payments for this procedure to have better care. Similarly, this sample also includes non-US citizens, who will not have US insurance, but uses the US health care system for transplantation. Transplantation is delivered to all who access the health care system in US and does not consider residence status as a requirement to deliver care, so many patients come to US looking for health care services, including liver transplantation.

Income levels were not significant factors influencing mortality rates in patient's post-liver transplantation. This result could be explained or better understood when examining the exact ways in which individual hospitals may conduct their billing processes. Understanding the ways in which hospitals are working to help patients overcome their unique barriers to accessing healthcare services can explain the unexpected finding that income levels have no significant impact on mortality rates of liver transplant recipients. While this was an unexpected finding, it is encouraging to consider the positive impact individualized care plans, including financial ones, are having on a patient population as vulnerable as those in need of a liver transplant.

This study found that liver transplant recipients living in the Northeast region of the US are at a greater risk of mortality post-liver transplantation than those living in other regions. The current literature regarding geographic location and liver transplant outcomes suggests that the Southern region of the country is at the highest risk of mortality instead [10]. However, even these studies did not provide ample reasoning as to why this might be the case. The United Network for Organ Sharing (UNOS) reports that donor livers are more readily and frequently available in the Midwest and Southern regions, while the coastal regions show less donor liver availability as well as higher need based on Model for End-Liver Disease (MELD) scores in those areas. This means that in coastal regions, such as the Northeast region, it could be much more likely that patients receiving liver transplants have been waiting longer and are therefore sicker when transplantation finally occurs, a factor that significantly increase the risk of post-procedural mortality. Such disparities between geographic regions of the US is a serious issue in equity of access to care across the country, which has inspired UNOS to begin efforts to rethink the current geographically-based procedure for organ donation [11].

5. Conclusion

The results of this study showed that in the case of liver transplant recipients, a lack of insurance coverage is a risk factor if left unaddressed by healthcare staff. Income levels were no longer a major factor that impact patient outcomes with the rise of individualized financial plans, and patients living in the Northeast region of the US had a higher risk of mortality post-liver transplant, providing support for current discussion on geographical disparity in liver transplantation.

Acknowledgements

References

[1]   UNOS, United Network for Organ Sharing. Transplant trends. (2018). Retrieved from https://unos.org/data/transplanttrends/#transplants_by_organ_type+year+2017

[2]   Levesque J, Harris M, Russell G. Patient-centred access to health care: Conceptualising access at the interface of health systems and populations. International Journal for Equity in Health, 12 (2013), 18.

[3]   Healthy People 2020. Social determinants of health. (2018) Retrieved from https://www.healthypeople.gov/

[4]   Hamel M, Godat L, Coimbra R et al. How has the Affordable Care Act changed outcomes in emergency general surgery? Journal of Trauma and Acute Care Surgery, 84(5) (2018), 693-701.

[5]   Kamath, P, Kim W. The Model for End-Stage Liver Disease (MELD), 2007.

[6]   Kanwal F, Dulai G, Spiegel B et al. A comparison of liver transplantation outcomes in the pre- vs. post-MELD eras. Alimentary Pharmacology & Therapeutics, 21(2), (2005), 169–177.

[7]   Pruinelli L, Monsen K, Gross C et al. Predictors of liver transplant patient survival: A critical review using a holistic framework. Progress in Transplantation, 27 (1), (2016), 98-106.

[8]   OptumLabs. OptumLabs and OptumLabs Data Warehouse (OLDW) descriptions and citations. Cambridge, MA:n.p., May 2019. PDF. Reproduced with permission from OptumLabs.

[9]   RStudio – Open source and enterprise-ready professional software for R. (2018). Retrieved April 4, 2018, from https://www.rstudio.com/

[10]   Mathur A, Ashby V, Fuller D et al. Variation in access to the liver transplant waiting listing the United States. NIH Public Access 98(1), (2014), 94-99.

[11]   Advisory Board. UNOS considers major changes to organ distribution | The Advisory Board Daily Briefing. (2017). Retrieved November 9, 2018, from https://www.advisory.com/daily-briefing/2014/09/08/unos-considers-major-changes-to-organ-distribution