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Percutaneous coronary intervention in patients with acute myocardial infarction in a Vermont hospital 2015-2019: exploring associations between travel time and length of stay.

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ABSTRACT

OBJECTIVE: To examine if travel time between patients experiencing acute myocardial infarction (AMI) and a Percutaneous coronary intervention (PCI) center influenced hospital length of stay (HLOS) and discharge destination.

METHODS: Data was extracted from the Vermont Uniform Hospital Discharge Data Reporting System (2015-2019). A logistic regression model examined the association between travel time to PCI center and hospital length of stay (HLOS). Additionally, a χ^2 test was performed alongside a logistic regression analysis to examine the association between HLOS and patient discharge outcomes.

RESULTS: Logistic regression analysis found no statistically significant relationship between HLOS and travel time from the PCI center but did show a significant increase in risk for a HLOS over five days in encounters over the age of 65.

CONCLUSIONS: Increased travel time did not affect outcomes for patients presenting for AMI treated with PCI. However, there was a strong relationship between increased HLOS and poor discharge outcome. Increasing the density of PCI-equipped hospitals does not appear to be necessary to reduce HLOS or improve discharge outcomes in the population represented by this data set.

INTRODUCTION

Percutaneous coronary intervention (PCI) reduces cardiac death and myocardial infarction in patients with unstable coronary artery disease.[1] PCI centers require infrastructure and trained personnel to function effectively. The number of these facilities has grown faster in areas than the population at risk for AMI.[2]

Timing of PCI is critical in saving heart muscle. Consensus dictates time to PCI treatment should be under 90 minutes in facilities with PCI-capability and under 120 minutes if patient transport is required.[3] Rural areas are concerned with having the required infrastructure and personnel to perform PCIs in a timely manner. When PCIs are not initiated quickly, negative health outcomes and death may occur. Vermont is reported to have the lowest density (per capita rate) of PCI centers in the United States.[2] Patients in Vermont may be at risk of experiencing delays in PCI and complications reflected by longer hospital length of stay (HLOS).

HLOS is an important measure of hospital performance, having implications on cost and quality of care. When complications arise in PCI care, HLOS increases signicantly.[4] HLOS may also be influenced by timeliness of PCI and is associated with decreased likelihood for discharge on evidence-based medication regimens.[5] Vermont is reported to have low prevalence of AMI when compared to other states.[6] It remains unclear if low density of PCI centers has any implications on health outcomes in Vermont. This study examined the Vermont Uniform Hospital Discharge Data Reporting System (VUHDDS) to understand if travel time between patients experiencing AMI and PCI center affects HLOS and discharge destination.

METHODS

Data from this study was derived from VUHDDS, maintained by the Vermont Association of Hospitals and Health Systems Network Service Organization. Trends were examined among instances where AMI was treated by PCI, at a large academic hospital in the Burlington hospital service area (HSA) in Vermont.

This cross-sectional analysis assesses a total of 820 hospitalizations that satisfied the criteria for AMI treated by PCI between 2015-2019, constituting the sample size.

ANALYSIS

VUHDDS describes sex and age as categorical variables; age was later modified to fit the model. HSAs were categorized using ground vehicle transportation travel time from respective servicing hospitals to the primary in-state PCI center using Google Maps (Google LLC Mountain View, CA, USA), in 30-minute intervals. Differences in the distribution of selected characteristics in hospitalizations with varying HLOS were examined by using χ^2 test.

A logistic regression model with a 95% confidence interval was used to examine association between travel time to PCI-center from each outlying hospital in the respective HSA (under 30 minutes, 30-60 minutes, over 60 minutes) and HLOS (Less than 5 days, 5 days or more). Variables controlled for in this analysis include age (30-49, 50-64, 65+) and sex (Male, Female).

Because HLOS and associated discharge outcome are linked, χ^2 test was performed alongside logistic regression analysis to examine the association between HLOS and patient discharge outcomes – defined as positive (home or law enforcement-based) or adverse (other facilities including skill nursing or death).

The University of Vermont Institutional Review Board reviewed this project and determined that it qualified as exempt from additional review.

RESULTS

820 admissions were included, 68.3% male (n=560) and 31.7% female (n=260) (Table S1). Admission age was categorized into three range groups, 9.3% 30-49 (n=76), 36.8% 50-65 (n=302), and 53.9% >65 years of age (n=442) (Table S1). The transfer time between HSA and PCI facility was categorized into <30 minutes (n=439, 53.5%), 30-60 minutes (n=267, 32.6%), and >60 minutes (Table S1). The mean HLOS was 2.55 days (SD=2.06) (Table S1). The average HLOS was calculated and plotted for HSA categories (Fig.S1). Across the categories of HSA distance, average HLOS was 2.56 days for HSAs <30 minutes from the PCI facility (SD=1.98), 2.40 days for an HSA 30-60 minutes from the PCI facility (SD=1.90), and 2.87 days for an HSA >60 minutes from PCI treatment facility (SD=2.63).

Based on mean HLOS across admissions, HLOS was grouped into categories with a five-day cut off, making the outcome of interest greater than one standard deviation higher than the mean. Logistic regression showed admissions with a HLOS five days or more were 18.16 times

more likely to require further care or to die (OR= 18.16; CI= 9.50, 34.69) (Table S2) than HLOS under 5 days. Therefore, longer HLOS was positively correlated with negative outcome.

Then, χ^2 test was conducted between HLOS and PCI distance ($\chi^2 = 0.69$) (Table S3). Logistic regression showed distance from PCI facility did not result in significant change in the odds ratio for HLOS (Table 1). The regression revealed admissions >65 years of age were 3.97 times more likely to have HLOS over five days (OR= 3.97; CI= 1.21, 13.01) (Table 1). This result shows age may be a more accurate predictor of abnormal HLOS than distance from PCI facility.

TABLE 1- Association Between Distance from PCI Treatment and Hospital Length of Stay in Vermont AMI Admissions 2014-2019

	B	S.E.	Wald	df	P	Odds Ratio (95% CI)
HSA Distance						
<30 min			0.44	2	0.80	
30-60 min	-0.14	0.26	0.31	1	0.58	0.87 (0.52, 1.44)
>60 min	0.06	0.33	0.04	1	0.85	1.06 (0.56, 2.01)
Age						
30-49 years old			12.00	2	0.002	
50-64 years old	0.63	0.63	0.99	1	0.32	1.87 (0.54,6.43)
Over 65 years old	1.38	0.61	5.16	1	0.02	3.97 (1.21, 13.02)
Sex						
Female	0.22	0.24	0.869	1	0.351	1.245 (0.79, 1.97)
Constant	-3.19	0.60	27.973	1	0.000	0.041

Note. PCI= Percutaneous Coronary Intervention; AMI= Acute Myocardial Infarction; S.E.= Standard Error; df= Degrees of Freedom; P= P-value; CI= Confidence Interval. Logistic regression between hospital service area distance from percutaneous coronary intervention facility and length of stay. HSA distance > 30 minutes served as a reference category, along with the 30-49 age group, and males for gender.

DISCUSSION

Findings indicated no statistically significant relationship between HLOS and distance traveled to PCI-equipped facility. The research hypothesis was that patients located in remote HSAs, with greater travel times before PCI, experience increased HLOS. The study used HLOS as an indicator of health outcomes, supported by regressions of the dataset.

Findings suggest other variables besides travel time account for extended HLOS. This study found individuals over age 65 were over three times more likely to have HLOS five days or more (P=0.02). Age, comorbidities, and modifiable risk factors are key areas of future research because of potential relationship to HLOS. According to a prior study, the impact of modifiable cardiovascular risk factors on mortality after PCI is unclear.[8]

In a related study, the relationship between PCI centers in remote locations and shorter waiting times was found to reduce requirements for transfer, leading to shorter HLOS. However, these patients experienced longer travel times than those in this study, traveling between 2.5 to 4 hours, possibly explaining differing results.[9] Another study produced findings in support of our hypothesis. Patients transferred to PCI centers in rural sections of Germany had worse 6-month mortality outcomes than those directly admitted to a PCI-equipped hospital.[10]

This study has several limitations and does not assess quality of care or variation in efficiencies of patients processed in differing HSAs. Our dataset included several HSAs within Vermont, but may have poorly represented the importance that race and ethnicity play in health outcomes. Another limitation was utilizing Google Maps to measure travel times. This method may not have produced measurements representing actual time delays experienced. Lastly, while this dataset powered our study, it produced a limited number of patients with both extended transfer times and HLOS characteristics.

Interventions focused on reducing transfer times and increasing density of PCI facilities may not be as critical to improving HLOS and health outcomes in Vermont as initially hypothesized. Areas with a low density of PCI centers and less advanced systems for handling AMI offer significant opportunities for further study. Regions assessing the need for additional PCI centers should not assume that low density of high-cost centers has direct implications on health outcomes. Further research may clarify the optimal density for PCI centers and the importance proximity plays in PCI care.

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