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Comparative Statistical Analysis of Inpatients with Diabetic Myocardial Infarction: Patient Length of Stay

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ABSTRACT

Purpose: The purpose of this study was to assess whether certain patient and hospital characteristics would have significant effects on the length of stay for patients admitted to non-federal hospitals with Type 2 Diabetes (T2D) and Myocardial Infarction (MI) using a comparative data analysis. **Methods:** This was a retrospective data analysis of inpatient Diabetes and Myocardial Infarction discharges (ages 20-84 years old) from the 2006 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS). Descriptive, bivariate, and dummy coded linear regression analyses were used to identify the association of patient and hospital characteristics with the inpatient T2D and MI length of stay. Data analysis and management were performed using SPSS version 17.0. Sample selection was based on the International Classification of Diseases, Ninth Revision (ICD-9) codes. Inclusions were inpatients diagnosed with both T2D and MI, admitted in non-federal hospitals, and age 20 years to 84 years old. **Results:** The descriptive results showed that males (1,862 or 67%) were admitted more than females (912 or 33%). The bivariate analysis showed a significant result between gender and patient insurance, $X^2(1, N = 1480) = 1.598, p < .001$. The adjusted dummy coded linear regression with MI severity and patient comorbidities on length of stay was significant for Gender ($B = .931, p < .000$), Age ($B = .039, p < .000$), and Hispanics ($B = .832, p < .017$) when compared to Whites. Another significant predictor of patient length of stay was Medicaid ($B = 2.266, p < .000$). Adjusted statistical analysis with only MI severity was significant for atrial fibrillation ($B = 1.740, p < .003$) and cardiogenic shock ($B = 2.482, p < .000$) when compared to cardiac arrest. **Conclusions and Recommendations:** There were inequalities seen in this study related to age, gender, ethnicity, and insurance possession of diabetic myocardial infarction inpatients. Most importantly is that as patient advocates, healthcare professionals need to screen their patients for complications of heart disease when they present with diabetes on admission. More data driven results are needed to evaluate the inequality that exists in hospitalized patients with both type 2 diabetes and myocardial infarction to improve the quality of healthcare.

INTRODUCTION

There is an increase in the admission rates of Myocardial Infarction (MI) inpatients with Type 2 Diabetes (T2D) despite public awareness campaigns. Thalib et al reported that the risk of in-hospital mortality after acute myocardial infarction (AMI) is almost doubled among diabetic patients.¹ This correlation was found to be significantly higher among patients with T2D. Patients with diabetes are hospitalized twice as often as those who do not have this disease, and they are likely to stay in the hospital 30%

longer.² Because diabetes appears to be becoming more prevalent in the United States, the need for MI inpatient with T2D care is likely to increase.³ The American Diabetes Association (ADA) has documented that T2D accounted for 90% to 95% of all 17 million diagnosed cases of diabetes in the United States.⁴ Although this disease affects all age groups, diabetes becomes increasingly prevalent with age, and it has the greatest effect on elderly people, as well as ethnic populations. More than approximately 18% of adults older than 65 years have diabetes, the majority of which are also diagnosed with T2D. As the fifth leading cause of death in the United States, diabetes has a significant effect on health, quality of life, longevity, and health care systems.⁵

MI mortality was 652,091, ranking first, while diabetes ranked sixth with a mortality rate of 75,119, with a total cost of \$174 billion (\$116 billion in direct medical cost alone).⁶ Diabetes mellitus may be an important factor for long-term survival in patients with MI.⁷ Approximately \$86 billion, or 12% of all U.S. health care expenditures can be attributed to diabetes. Half of that 12% can be attributed to complications of diabetes alone.^{8,9} Currently, only a few studies have focused on patients with both MI and T2D treatments and their association with relevant outcomes. To address these gaps in knowledge, the incidence and risk factors of MI and T2D and the patient and hospital characteristics and their relationship with subsequent patient LOS using the HCUP NIS large database were described.

What is Known?

Most studies on hospital characteristics and their treatment outcomes have been focused on other acute and chronic diseases like AIDS, chronic heart failure and pneumonia, acute myocardial infarction alone, and cardiovascular diseases.¹⁰⁻¹³ Others are hospital characteristics and patient safety indicators, preventable adverse effects, surgical outcomes, and effects of hospital characteristics and economy on T2D.^{1,15-17}

What the Study Adds

This is a first study to adopt a multivariate dummy coded quantitative statistical method with dependent and multiple independent variables to better understand the effects of patients and hospital characteristics on the inpatient MI with T2D admitted to non federal hospitals.

METHODS

Study Design

The design for this study was a secondary data analysis from the Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS). According to the company, HCUP (pronounced "H-Cup") is a family of health care databases and related software tools and products developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). HCUP databases bring together the data collection efforts of State data organizations, hospital associations, private data organizations, and the Federal government, to create a national information resource of patient-level health care data (HCUP Partners). HCUP includes the largest collection of longitudinal hospital care data in the United States, with all-payer, encounter-level information beginning in 1988. HCUP_NIS database contains data from 5 to 8 million hospital stays from 1,000 hospitals sampled to approximately a 20 percent stratified sample of U.S community hospitals. The NIS database excludes data elements that could directly or indirectly identify individuals. Access to the files is open to users who sign a Data Use Agreement. Users must agree to use the database for research and statistical purposes only, and to make no attempts to identify individuals.¹⁸

Study Population

For this study, 2774 participants were selected from hospital discharge data from the NIS-HCUP database for 2006. Selection of patients from the database was based on the ICD-9 codes.

Inclusion criteria:

- Inpatient diagnosed with both MI and T2D
- Admitted in non federal hospitals
- Age 20 years to 84 years.

Exclusion criteria:

- Obstetrics-gynecologic
- Ear-nose-throat
- Orthopedic and pediatric patients
- Short-term acute rehabilitation and long-term non-acute care patients
- Psychiatric and alcoholism/chemical dependency treatment patients

DATA COLLECTION TOOLS

Power Analysis

The sample for this study was inpatients from the NIS-HCUP Database for 2006. ICD-9-CM (International classification of diseases clinical modification) for MI and for type 2 diabetes was used to extract samples. All inpatients that were admitted with a diagnosis of MI and T2D constituted the study population. The study has sufficient power equal to or greater than .80. The database was further queried to identify the co-morbidities of diabetes and patient characteristics among the inpatients with MI and T2D. Database information for the study population was further queried for data on patients' hospital characteristics.

Statistical Analyses

Baseline characteristics, patients, and hospital characteristics were compared with the outcomes of the in-patients diabetic MI. Chi-square, independent t-tests, and one-way ANOVAs were used to detect statistically significant differences between the hospital, patients, and outcome characteristics in hospital status, ownership, location, size, insurance, comorbidities, admission types, procedures, gender, length of stay (LOS), transfer, and death. Multivariate dummy coded analysis of associated factors was used to determine the effect on the dependent variables (DVs) and their predictive strength.

RESULTS

Baseline Patient Characteristics

The frequency analysis showed that more males than females were admitted to the hospital with MI and T2D. The majority of the inpatients in this study were White and Hispanic. The mean age of all patients admitted was 64.76 years (SD $\pm$ 13.48). Many patients were admitted via the emergency room; Medicare and private insurances including HMOs were the two main payer sources used by men, while females depended largely on government insurance as shown in table 1. Major secondary diagnoses that were noted ranged from coronary atherosclerosis (565, 20%) to paroxysmal ventricular tachycardia (95, 3.4%). MI severity was also noted and included cardiogenic shock (38, 1.4%) to hypotension (7, 0.3%). These inpatients also underwent major procedures ranging from percutaneous transluminal coronary angiogram (PTCA-1184, 55.5%) to coronary artery stent (41, 1.4%).

Table 1. Characteristics of Inpatients with MI and T2D According to Insurance, Admission Type, LOS and Hospital Transfer in US Non Federal Hospitals in 2006 (N = 2774)

Insurance	Medicare	1200(43%)
	Medicaid	160(6%)
	Private including HMO	784(28%)
	Self Pay	169(6%)
	No Charge	12(1%)
	Other	645(26%)
Admission Type	Emergency	1684(67%)
	Urgent	630(25%)
	Elective	202(8%)
	Other	1(0%)
Length of Stay (Days)	0-12	213(7.7%)
	13-25	363(13.1%)
	26-38	448(16.1%)
	39-51	325(11.7%)
	52-64	220(7.9%)
	65-77	164(5.9%)
	Other	786(38.6%)
Hospital Transfer	Routine	62.7(62.8%)
	Transfer to Short Term Hospital	9.7(9.8%)
	Transfer to Home Health Care	10.2(10.2%)
	Against Medical Advice	.7(.7%)
	Died in the Hospital	7.2(7.1%)
	Died During Hospitalization	7.2(7.2%)

Hospital Characteristics

Table 2 shows that of the 1,042 hospitals that participated in the NIS 2006 survey, more hospitals (626, 60%) were located in urban rather than rural areas (416, 40%). The majority of the hospitals were in the South (415, 40%) and the least were in the Northeast region of the United States (137 or 13%). There were more non teaching than teaching hospitals, with small size hospitals outnumbering other hospital sizes. These hospitals were further subdivided into urban non teaching and urban teaching with public and nonprofit hospitals having the most numbers of hospitals as shown in table 2.

Table 2. Characteristics of the Hospitals with MI and T2D Inpatients in Non Federal Hospitals during 2006 (N = 1042)

Variable	Group	Frequency/Percent
Bed Size	Small	481(46%)
	Medium	253(24%)
	Large	308(30%)
Ownership	Public	189(18%)
	Non-Profit	185(18%)
	Private, Invest Own	160(15%)
	Private, Collapsed Category	133(13%)
	Other	375(36%)
Location	Rural	416(40%)
	Urban	626(60%)
Location/Teaching	Urban Non Teaching	436(42%)
	Urban Teaching	190(18%)
Region	Northeast	137(13%)
	Midwest	299(28%)
	South	415(40%)
	West	194(19%)
Teaching Status	Non Teaching	844(81%)
	Teaching	198(19%)

Bivariate Analysis: Length of Stay (LOS) and Patient Age

Table 3 showed that the effect of age was significant on the length of stay, $F(4, 2548) = 5.936$, $p < .000$. Bonferroni post hoc tests were significant between the 33 - 45 age group ($M = 3.44$, $SD = 3.99$), and 72 - 84 age group ($M = 4.80$, $SD = 5.04$), $p = .004$. Post hoc tests were also significant between the 46 - 58 age group ($M = 3.89$, $SD = 4.12$) and 72 - 84 age group ($M = 4.80$, $SD = 5.04$), $p = .002$. This result indicates that the older patients stayed longer in the hospital than their younger counterparts.

Table 3. Relationship Between Length of Stay and Age Groups

Age	Group	Mean Difference	p
20-32	33-45	-1.938	1.000
	46-58	-2.388	.813
	59-71	-2.811	.401
	72-84	-3.296	.163
33-45	20-32	1.938	1.000
	46-58	-.451	1.000
	59-71	-.874	.199
	72-84	-1.358*	.004
46-58	20-32	2.388	.813
	33-45	.451	1.000
	59-71	-.423	.677
	72-+	-.907*	.002
59-71	20-32	2.811	.401
	33-45	.874	.199
	46-58	.423	.677
	72-84	-.484	.433
72-+	20-32	3.296	.163
	33-45	1.358*	.004
	46-58	.907*	.002
	59-71	.484	.433

F (4, 2548) = 5.936, $p < .000$.

Multivariate Analysis: Effects of the Dependent Variables on LOS

Table 4 showed that coronary atherosclerosis was significant ($B = -1.312$, $p < .000$) as well as hypertension ($B = -2.080$, $p < .000$) when compared to uncomplicated T2D. Hence, MI inpatients with T2D stayed longer in the hospital as a result of their preexisting cardiac disease, namely coronary atherosclerosis and hypertension.

Table 4. Effects of Patient and Hospital Characteristics on LOS (Adjusted) with Comorbidities and MI Severity

Variable	B	Std. Error	Beta	t	p
Gender	.931	.193	.092	4.827	.000
Age	.039	.008	.113	4.794	.000
Ethnicity					
White	Reference Group				
Hispanic	.832	.348	.044	2.394	.017
Insurance					
Medicare	Reference Group				
Medicaid	2.266	.404	.112	5.601	.000
Private including HMO	1.061	.241	.101	4.397	.000
Self Pay	.999	.402	.050	2.484	.013
Hospital Teaching Status					
Rural	Reference Group				
Urban Teaching	-.982	.417	-.052	-2.353	.019
Hospital Region					
Northeast	Reference Group				
Midwest Region	-1.874	.385	-.123	-4.870	.000
South Region	-.762	.406	-.056	-1.877	.061
West Region	-1.605	.483	-.077	-3.320	.001
Comorbidities					
T2D Uncomplicated	Reference Group				
Coronary Atherosclerosis	-1.312	.226	-.110	-5.797	.000
HTN	-2.080	.483	-.080	-4.309	.000

Adj. $R^2 = .092$, $F (27, 2772) = 11.397$, $p < .001$

Table 5 showed that the dummy coded adjusted linear regression result on the effects of variables on LOS was significant for gender ($B = .971$, $p < .000$). Age was also a significant predictor of LOS, as well as ethnicity. Medicare insurance, private insurances including HMOs, and self-pay were significant when compared to Medicare. Other predictors were urban hospitals when compared to rural teaching status. Hospitals in the Midwest and West hospital regions were significant when compared to the hospitals in the Northeast region of the country.

Table 5. Effects of Patient and Hospital Characteristics on LOS (Adjusted) with Gender, Age and Ethnicity

Variable	B	Std. Error	Beta	t	p
Gender	.971	.194	.096	4.994	.000
Age	.048	.008	.136	5.809	.000
Ethnicity					
White	Reference Group				
Hispanic	.809	.351	.043	2.305	.021
Medical Insurance					
Medicare	Reference Group				
Medicaid	2.227	.409	.110	5.446	.000
Private including HMO	.899	.243	.085	3.694	.000
Self Pay	1.059	.407	.054	2.606	.009
Other Source of Pay	.971	.583	.032	1.665	.096
Hospital Location/Teaching Status					
Rural	Reference Group				
Urban Non-Teaching	-.577	.344	-.043	-1.678	.094
Urban Teaching	-1.031	.421	-.054	-2.448	.014
Hospital Region					
Northeast Region	Reference Group				
Midwest Region	-1.681	.388	-.110	-4.336	.000
South Region	-.761	.411	-.056	-1.852	.064
West Region	-1.662	.489	-.080	-3.400	.001

Adj. $R^2 = .076$, $F(21, 2547) = 10.989$, $p < .001$

DISCUSSION AND CONCLUSION

The statistical analysis showed that older patients stayed longer in the hospital than their younger counterparts, $F(4, 2548) = 5.936$, $p < .000$. Bonferroni post hoc tests were significant between the 33 to 45 age group ($M = 3.44$, $SD \pm 3.99$), and the 72 to 84 age group ($M = 4.80$, $SD \pm 5.04$), $p < .004$. This result is in line with Hogan and colleagues who reported that although MI and T2D disorders affect all age groups, the diseases become increasingly prevalent with age, and it has the greatest effect on elderly people, as well as ethnic populations.⁵ It is estimated that more than 18% of adults older than 65 have diabetes, the majority diagnosed with T2D.⁵ According to the authors, diabetes is the fifth leading cause of death in the United States, and as such, this disease has a significant impact on health, quality of life, longevity, and health care systems.⁵

This study also indicates that females length of stay was greater than their male counterparts, $X^2(1, N = 2773) = 1.870E2$, $p < .001$. The result supports the fact that women usually do not exhibit classic symptoms of MI as do men; because of this, they are not aggressively treated and their conditions are usually complicated by the time they are diagnosed with MI. Silent myocardial ischemia (SMI), a common disorder, has been studied by different research groups for the last 25 years.¹⁹ It is known that SMI is more common in patients with T2D than in the general population, even though the factors that contribute to the health care disparity in treatments and outcomes are not well established. This result has then confirmed that despite the fact that the number of males that were admitted far outnumbered their female counterparts, the fewer females that were admitted stayed longer in the hospital than the males.¹⁹

Furthermore, the results indicated that patients with Medicaid and Medicare had longer hospital stays than those with private insurance. Medicaid and Medicare were the major insurances used by the inpatients with MI and T2D in 2006, $F(5, 2762) = 72.816$, $p < .001$. Each year in the United States, the number of people who are underinsured and uninsured increases. This analysis explains why the method of healthcare payment is crucial to the patient outcome. In the researchers view, private

insurance companies focus on profit may be the reason patients had shorter lengths of stay and not necessarily that the patients received the expected care before being discharged. Hence, a policy change is needed to eliminate the disparities seen in this study as it relates to age, gender, ethnicity, and insurance possession of diabetic myocardial inpatients. Most importantly is that as patient advocates, healthcare professionals need to screen their patients for complications of heart disease when they present with diabetes on admission.

There were still unexplained variances found in this study that might have been a result of the independent variables that were not included because of the nature of the database used. One example is the HbA1c which is an indicator of diabetes severity. There were no laboratory results in the database such as the diabetes severity, which would have helped in accounting for the confounders. Other variables that would have helped to lower the residual variances are the weight, height measures for Body Mass Index (BMI), and lifestyles like smoking and drinking habits of the patients. These independent variables unfortunately were not available in the database. These variables might have helped to account for an authentic disparity result that was found in this study. Finally, the database also lacked information about the practice patterns of providers, and the adequacy of the therapy used to prevent disease progression.

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KEY TERMS

Inpatient, Hospital, Characteristics, Comparative Analysis, Length of Stay, Myocardial Infarction