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The Relationship between Inpatient HIV/AIDS Characteristics and Hospital Charges: Use of Big Data

Priscilla O. Okunji[1], Johnnie Daniel[2] & Saadatmand Frough[3]

[1] College of Nursing, and Allied Health Sciences, Howard University, Washington DC, USA

[2] College of Sociology and Anthropology, Howard University, Washington DC, USA

[3] College of Medicine, Howard University, Washington DC, USA

Correspondence: Priscilla O. Okunji, Ph.D., College of Nursing, and Allied Health Sciences, Howard University, Washington DC, USA.

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Abstract

With the adoption of Electronic Health Records (EHR) by acute care hospitals, research in biomedical field has become increasingly data-intensive as investigators are rapidly using large, complex, and diverse datasets. Big data to knowledge (BD2K) focus is to enhance the advances in data acquisition, analytics, policy, and training which are critically needed for the effective use of big data. Current information shows that minorities are more likely to be diagnosed with HIV infection compared to their white counterparts. There are few research studies on the association between hospital charges and inpatient HIV/AIDS characteristics. The goal of this study was to conduct an investigation on the association and the factors that affect hospital charges of inpatient HIV/AIDS adults with mental illness and behavioral disorders. An estimation of inpatients HIV/AIDS hospital charges was conducted by data extraction and analytics from the Nationwide Inpatient Sample (NIS) Healthcare Costs and Utilization Program (HCUP) for 2007 and 2010. Regression analysis was used to test the study hypotheses. The critical ranking effects of variables were seen in the specific hierarchical association between the hospital charges and total number of procedures, hospital staff, total number of comorbidities, bipolar, and drug abuse. The outcome of our research could be used to support the advances in clinical data analytics, big data to knowledge (BD2K) and data science.

Keywords: hospital, charges, HIV/AIDS, inpatient, HCUP, data, analysis

1. Introduction

The mission of Big Data to Knowledge (BD2K) initiative is for researchers to increase data science research in biomedical field through the Big Data that are being generated. With rapid adoption of Electronic Health Records (EHR) by acute care hospitals, researchers in biomedical and policy fields are increasingly utilizing large, complex, multidimensional, and diverse datasets to enhance outcomes and make informed decisions.

Unfortunately, the sharing, location, extraction, and analyses of data generated by others, and utilization of associated software with the data is often challenging due to limited tools, accessibility, and required skills. Today, biomedical research systems are rapidly generating large amount of data from electronic health records without maximizing the use of both translational and clinical opportunities that these data offer. There are few or no studies on the longitudinal association among inpatient with HIV/AIDS and hospital charges, by patients' characteristics, hence the rational for this proposed study.

Monitoring and tracking changes in health care disparities is critical. There is an increasing interest in the reporting of data for quality improvement activities that provides an impetus to improve not only the quality of data but also the quality of care provided in acute care hospitals. Although there has being reports on US population exhibiting increased HIV/AIDS incidence rates and mental disorders, little information was found on the association between mental health and behavioral disorders on patient outcomes among hospitalized HIV/AIDS adults. This limitation in research has shown to be associated with the fact that this disease burden has been carried out primarily at the individual level due to the lack of national data sources linking clinical and

administrative data. Furthermore, research on the disparities on the burden of HIV/AIDS among minority population groups is well-known and documented.

In addition, adults who have mental illnesses and behavioral disorders may be vulnerable to certain disorders and this condition places these individuals at increased risk for HIV infection and access to HIV/AIDS care services may be delayed as well. Hence, mental health has become a critical component of HIV care maintenance. It has been reported that HIV/AIDS patients who have mental illnesses or behavioral disorders do not usually comply with HIV treatment interventions which may result in a devastating public health consequences due to the non-adherence to antiretroviral (ARV) medications leading to ARV drug resistance and further transmission of the HIV. In addition, combination of HIV/AIDS, mental illness, and behavioral disorders cause low productivity, resulting into serious economic implications at the state and national levels if not addressed. Therefore, it is critical that this study investigate on the variables that would enable sustainability on HIV prevention interventions that could reduce HIV transmission rates and infection. The objectives of our study include: (1) determine patients characteristics using datasets that contribute to HIV/AIDS hospital charges, (2) identify patient characteristics which impact hospital charges in HIV/AIDS patients, this would enable appropriate health care services be mobilized in areas that HIV/AIDS patients are most vulnerable resulting to stronger effect for positive health outcomes; and (3) determine accurate costs to efficiently target limited resources for the greatest public health benefit of inpatients HIV/AIDS.

Bipolar disorder, schizophrenia, and depression, have been associated with both HIV infection and HIV-associated risk behaviors. HIV is rapidly increasing among individuals with severe mental disorders, however research in this area has been limited in certain sites. Research findings have shown that patients with schizophrenia had received diagnoses of HIV/AIDS across 102 metropolitan areas. One site in New Jersey showed that MSA rates ranged widely, from 5.2% in Newark, to no cases in 16 of the MSAs. It has been shown that severe mental illness is associated with an increase in HIV risk, and pharmacologic treatments used for the management of HIV/AIDS and severe mental illness have changed the prognosis over the years and quality of life for many patients throughout the world. However, there is no significant change in the advances in treatment, metabolic abnormalities and syndrome for both HIV and severe mental illness population.

Indulging in risky behavior that leads to HIV has been shown to be around 50% in mentally ill population[4]. HIV prevalence in patients with mental disorders and out patients is 23% compared to just 0.4% for the rest of the population. In addition, studies have also shown that HIV-positive individuals may engage in unhealthy substance-use behaviors. These behaviors are integrated by some of the patients as a way to manage the disease-related symptoms. Limited research has also been focused on the role of serious mental illness (SMI) among injection drug users (IDUs) and non-IDUs in susceptibility to and transmission of HIV and certain published reports on HIV risk among Latino with SMI. Poor mental health has attributed to increased HIV risks have been reported. Therefore, mental and behavioral disorders have direct effect on the patient's mental health, and there is tendency that patients with HIV, particularly those with childhood sexual abuse histories have been found to abuse drugs as well. Drug abuse is believed to relieve individuals from momentarily pain. In addition, HIV may be contacted through IV drug use via unclean syringes that may leave the risk of HIV when contaminated by the infected material. Study has shown that certain factors (e.g., sexual orientation, age) may not reduce the chance of receipt of treatment.

Literature reviewed showed that inconsistent condom use for vaginal sex with casual partners was reported among substance users (43%), incarcerated participants (60%), whereas 26% of men who have sex with men reported inconsistent condom use for anal sex with casual partners. Same study reported that overall, 56% and 29% sex with casual partners under the influence of alcohol and drugs in the past 6 months, respectively. The authors recommended that substance use issues in relation to sexual risk behaviors be addressed in future research. The risk behaviors measures are used to guide tailored risk reduction strategies as HIV infection patterns shift toward rural minorities, particularly in regions where HIV disease remains highly stigmatized. Furthermore, Interactive Voice Response (IVR) systems has been used to enhance reports of sensitive behaviors in such areas and telehealth applications was used to extend the reach of care in rural, underserved areas.

Sexual contact with multiple partners either male or female is a risky behavior for contracting HIV/AIDS. Steady single partner, irrespective of sexual orientation is mostly harmless with more mental stability. Conversely having multiple partners may result into frustration, perversion etc, that in many cases may be counted as depression, and these acts increase the risk of HIV. In addition, sexual abuse among men, particularly those who

indulge in sexual abuses and rapes, may contribute to the contraction of HIV. It has been reported that men who have sex with men (MSM) account for more than 50% of all new HIV/AIDS diagnoses in the United States each year, and young MSM (ages 13-24) have elevated new infections. A longitudinal study with 114 young MSM (ages 16-20 at baseline) reported that increased levels of sensation seeking were found to significantly increase the correlation between frequency of unprotected sex and frequency of both alcohol use and drug use with partners. In addition, the analysis of the data used in the study showed that the average rates of alcohol use moderated the association between alcohol use prior to sex and sexual risk, such that the average alcohol use increased the positive association between the variables. The authors concluded that while drug use with partners increased sexual risk for all young MSM, the effects of alcohol use prior to sex were limited in low sensation-seeking young MSM as well as those who are high alcohol consumers on average.

Though alcohol is very similar to that of drug abuse, however, impact of alcohol can reduce a person's sense of judgment and risky sexual act. Hence excessive alcohol abuse is several times more prevalent in HIV positive people than the general population. Heavy alcohol intake, illicit drug use, and cigarette smoking, are unhealthy practices that are engaged in by many HIV-positive individuals, often as a way to manage their disease-related symptoms. The authors reported that some of individuals who identified high levels of specific symptoms also reported significantly higher substance-use behaviors, including amphetamine and injection drug use, heavy alcohol use, cigarette smoking, and marijuana use.

Our preliminary data in 2008 had revealed that out of the 50,372 inpatient with HIV infections, 15,866 had AIDS only, 716 had both schizophrenia and HIV/AIDS, 393 with both bipolar and HIV/AIDS and 1,163 with depression and HIV/AIDS. Based on this initial data, it was evident that there were correlations between HIV/AIDS and mental diseases.

1.1 Theoretical Framework

In order to validate the critical factors that could significantly contribute to better understanding of HIV/AIDS patients' outcomes and prevention, as well as advancing research in this area, the Health-Related Quality of Life (HRQOL) theory was used as the theoretical framework. Factors that affect HRQOL for the inpatients HIV/AIDS were consistent with the variables that were being examined in this secondary data analysis study. The posits of the independent variables (patients and hospital characteristics) potentially have a profound impact on the dependent variable (hospital charges). The HRQOL theory is used in this study as a general population health status profile that provided better insight and understanding of HIV/AIDS patients at the national level.

1.2 Specific Aims and Hypothesis

Specific Aim # 1: To determine any significant difference between patient, hospital characteristics and inpatients HIV/AIDS hospital charges.

Research Hypothesis 1: There is a significant difference between patient characteristics (age, gender, race, income, insurance, primary diagnosis, comorbidities, admission type, treatment procedure) and hospital charges for inpatients HIV/AIDS.

2. Research Designs and Method

This is a secondary data study utilizing data from the HCUP Nationwide Inpatient Sample (NIS). The HCUP manages the health care datasets 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 aggregates 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 acute care hospital data in the United States, with all-payer (source of payment for the hospital length of stay). This database has all-payer data on hospital inpatient stays from selected states, however only few studies have focused on HIV/AIDS characteristics and Hospital Charges and reported studies are mainly on cost effectiveness with only one study in hospital characteristics outcomes since 1999.

2.1 Study Population

In this study, data were selected from the hospital discharge information according to hospital and patients' characteristics such as insurance, income, comorbidities, admission types, procedures, and hospital charge. Other

discharge disposition such as patient transfers was examined for 2007 and 2010. This range was selected due to data availability. Selection of samples was aided by the existing NIS database and ICD-9-CM.

2.2 Inclusion and Exclusion Criteria

The NIS data samples were selected and extracted on the basis of the following criteria: (a) inpatient diagnosed with HIV/AIDS and related comorbidities (b) inpatient admitted to nonfederal hospitals, (g) age 21 years and above. Note: Age group 21 years and above was specified in this study because of the increased prevalence of HIV/AIDS in this population. The exclusions were (a) pediatric inpatients (b) discharges from federal and government hospitals.

2.3 Patient Measures

Measures were as follows:

Age (21 years and above); gender (male, female); race (white, black, others); income ($1,000-38,999; $39,000-$47,999; $48,000-$62,999; $63,000 and above); insurance (Medicare, Medicaid, private including HMO, Others); primary diagnosis (HIV/AIDS); comorbidities (schizophrenia, bipolar, depression, alcohol, drug abuse); admission type (emergency, urgent, elective), treatment procedure (principal, secondary).

2.4 Outcomes Measure

Hospital charges

3. Results

The regression results showed that there was a significant difference ($p < 0.05$) for hospital charges, on the Model composed for 2007 and 2010 individual characteristics (Medicaid patient), while male and white were significant with $p = .000$ for 2010. Comorbidities (alcohol abuse, drugs abuse, hepatitis b and c, opportunistic illness, psychosis, bipolar and schizophrenia and all medical procedures were significant with $p < .05$, exception was cardiac catheterization/coronary arteriography ($p = .156, .031$) for 2007 and 2010 respectively.

Hence, the relationship between hospital charges and HIV/AIDS patients with mental diseases and drug abuse was highly significant with $p = .000$ for the total numbers of all the comorbidities. In addition, all the treatment procedures used for the HIV/AIDS on admission were highly significant as well with $p = .000$ for other vascular catheterization that was not heart, respiratory intubation/mechanical ventilation, blood transfusion, other therapeutic procedures, and the total procedures (Table 1).

Table 1

Results of the Regression of Hospital Charges on a Model Composed of Individual Characteristics, 2007 and 2010

	2007			2010		
	Unstandardized Coefficients	Standardized Coefficients	p value	Unstandardized Coefficients	Standardized Coefficients	p value
Individual Characteristics						
Age	.000	-.001	.819	.000	-.003	.614
Male	.008	.002	.646	.067	.020	.000
White	-.016	-.004	.421	.126	.035	.000
Medicaid patient	-.074	-.023	.000	-.038	-.012	.020
Comorbidities						
Alcohol abuse	-.167	-.029	.000	-.080	-.015	.005
Drugs abuse	-.240	-.064	.000	-.220	-.059	.000
Hepatitis b	.052	.006	.280	.167	.017	.001
Hepatitis c	-.221	-.044	.000	-.246	-.044	.000
Opportunistic illness	.195	.044	.000	.146	.032	.000
Candidiasis of the mouth	.232	.007	.170	-.125	-.004	.428
Depression	.069	.013	.148	.164	.034	.000
Psychosis	.132	.022	.007	.086	.016	.033
Bipolar	-.251	-.057	.000	-.472	-.119	.000
Schizophrenia	-.147	-.019	.004	-.216	-.031	.000
Total number of comorbidities	.111	.116	.000	.115	.145	.000
Medical Procedures Used in Treatment				.162	.011	.031
Diag. cardiac cath./coronary arteriography	.115	.008	.156	.549	.117	.000
Other vascular cath, not heart	.652	.139	.000	.172	.028	.000
Respiratory intubation/mechanical ventilation	.156	.024	.000	.186	.041	.000
Blood transfusion	.277	.063	.000	-.498	-.082	.000
Other therapeutic procedures	-.525	-.108	.000	.247	.375	.000
Total number of procedures (npr)	.258	.399	.000			
Hospital Characteristics						
Southern region	-.285	-.091	.000	-.186	-.058	.000
Bed size of hospital	.105	.047	.000	-.015	-.006	.266
Urban Location of hospital	.696	.067	.000	.564	.058	.000
Teaching hospital	-.481	-.143	.000	-.485	-.139	.000
RN FTEs per 1000 patient days	.135	.103	.000	.243	.200	.000
LPN FTEs per 1000 patient days	-.127	-.025	.000	.083	.011	.039
Nurse aides per 1000 patient days	-.005	-.002	.757	.278	.088	.000
Constant term	1.645		.000	1.315		.000
Multiple R	.582		.000	.584		.000
Multiple R^2	.339		.000	.341		.000
Number	24625			27254		

The ranking results for hospital charges showed again that total procedures performed on a patient was the most critical variable that affects hospital charges of the inpatients HIV/AIDS. This was followed by the hospital status the patients were admitted to, healthcare providers and total number of comorbidities, specifically bipolar and other therapeutic procedures such as vascular catheterization, was high among the variables that affect the hospital charges in both 2007 and 2010 of inpatients HIV/AIDS (Table 2).

Table 2. Ranking Effects of the Independent Variables on Hospital Charges

2007			2010	
Total number of procedures (npr)	0.399		Total number of procedures (npr)	0.375
Teaching hospital	0.143		RN FTEs per 1000 patient days	0.2
Other vascular cath, not heart	0.139		Total number of comorbidities	0.145
Total number of comorbidities	0.116		Teaching hospital	0.139
Other therapeutic procedures	0.108		Bipolar	0.119
RN FTEs per 1000 patient days	0.103		Other vascular cath, not heart	0.117
Southern region	0.091		Nurse aides per 1000 patient days	0.088
Urban Location of hospital	0.067		Drugs abuse	0.059
Drugs abuse	0.064		Southern region	0.058
Blood transfusion	0.063		Urban Location of hospital	0.058
Bipolar	0.057		Hepatitis c	0.044
Bed size of hospital	0.047		Blood transfusion	0.041
Hepatitis c	0.044		White	0.035
Opportunistic illness	0.044		Depression	0.034
Alcohol abuse	0.029		Opportunistic illness	0.032
LPN FTEs per 1000 patient days	0.025		Schizophrenia	0.031
Respiratory intubation/mechanical ventilati	0.024		Respiratory intubation/mechanical ventilati	0.028
Medicaid patient	0.023		Male	0.02
Psychosis	0.022		Hepatitis b	0.017
Schizophrenia	0.019		Psychosis	0.016
Depression	0.013		Alcohol abuse	0.015
Diag. cardiac cath./coronary arteriography	0.008		Medicaid patient	0.012
Candidiasis of the mouth	0.007		Diag. cardiac cath./coronary arteriography	0.011
Hepatitis b	0.006		LPN FTEs per 1000 patient days	0.011
White	0.004		Other therapeutic procedures	0.008
Male	0.002		Bed size of hospital	0.006
Nurse aides per 1000 patient days	0.002		Candidiasis of the mouth	0.004
Age	0.001		Age	0.003

4. Discussion & Conclusion

The result of this study has shown that there is a strong relationship between individual characteristics, patient comorbidities, medical procedures/treatments and hospital charges. According to Heslin and Elixhauser (2016), the Patient Protection and Affordable Care Act (ACA) is expected to eliminate the gap in prescription drug coverage in Medicare Part D by 2020. This policy may reduce co-payments on expensive medications for Medicare patients with HIV/AIDS. However, for patients who may not be eligible for Medicaid or Medicare, the Patient Protection and ACA would have increased access to private insurance through the State health insurance exchanges that were introduced in late 2014. Hence, insurance plans offered on the exchanges must cover an essential benefits package but may not include lifetime or annual coverage provisions that can limit coverage for pre-existing conditions like HIV/AIDS.

Furthermore, it is also important to note that the results of this study has shown that critical ranking effects of variables were seen in the specific hierarchical association between the hospital charges and number of procedures, hospital staff, number of comorbidities, bipolar, and drug abuse. These findings are in correlation with the hypothesis that there would be a significant difference between patient (gender, race, insurance, comorbidities, and treatment procedure) characteristics and hospital charges for hospitalized HIV/AIDS adults with mental (schizophrenia, bipolar, depression) and behavioral (alcohol and drug abuse) disorders in non-federal hospitals.

In conclusion, this study has depicted the ranking effects of patient, hospital characteristics and hospital charges as it relates to the inpatients HIV/AIDS in 2007 and 2010 hospital discharges. The goal of Patient Protection and Affordable Care Act (ACA) is to eliminate the gap in prescription drug coverage in Medicare Part D by 2020 for patients with chronic diseases such as HIV/AIDS. The ranking effects of variables that affects the outcomes of inpatients HIV/AIDS were seen in the specific hierarchical association between the hospital charges and number of procedures, hospital staff, number of comorbidities, bipolar, and drug abuse. The clinical implication being

that the difference noted in this study should be factored into the allocation of budget and treatment procedures for ultimate positive outcomes for this special population.

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