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Research Article

The Relationship between Registered Nurse Staffing and Inpatients HIV/AIDS Clinical Outcome: Severity of Illness

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Abstract

Hospitals with a higher proportion of registered nurses (RNs) or baccalaureate prepared nurses are associated with lower mortality rates in acute myocardial infarction, congestive heart failure, chronic obstructive pulmonary disease, pneumonia, and stroke. Others include lower rates in decubitus ulcers, failure to rescue, and postoperative deep vein thrombosis or pulmonary embolism and shorter length of stay. A staff of 10% more RNs with higher baccalaureate degree decreased death by a minimum of 4%. However, studies on the relationship between RN full time staffing and inpatients severity of illness are lacking. A retrospective data analysis of inpatient HIV/AIDS discharges was conducted from the 2007 and 2010 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) to determine the nursing variables that affect the patient outcomes. Statistical analysis involved the use of crosstab and multivariate regression for hospital characteristics, and severity of illness. The results showed that RN full time Equivalence (FTEs) per 1000 patient days is one of the most critical variables that affect patient severity of illness for inpatients HIV/AIDS discharges. In addition, a stronger relationship was found in 2010 than 2007 as hypothesized in the study. These findings highlight the need for more RNs to be employed full time in acute care hospitals for improved patient satisfaction with a clinical implication that acute care nurses need training at higher level for empowerment and better patient outcomes.

INTRODUCTION

There are many licensed practicing positions in nursing, from the certified nursing assistant (CNA) to licensed practical nurse (LPN) and registered nurse (RN). However, registered nurses are further categorized into diploma, associate, and baccalaureate (professional) levels. Research indicates that nurses hold the key to lowering mortality rates and keeping patients safe, both of which guarantee positive outcomes. In addition, studies have shown that hospitals with a higher proportion of registered nurses are associated with lower rates of adjusted 30-day mortality in acute myocardial infarction, congestive heart failure, chronic obstructive pulmonary disease, pneumonia, and stroke [1,2]. A staff with 10% more BSN prepared nurses decreased death by a minimum of 4%. Though the percentage does not seem like much, in the case of magnet hospitals where the percentage of BSN prepared nurses is higher, it can be interpreted that the outcomes would show more improvement [3]. There are few or no studies on the relationship between the RN full time equivalence (FTEs) and inpatient severity of illness. .

A consensus report issued by the Institute of Medicine (IOM) of the National Academy of Sciences (United States), entitled "*The Future of Nursing: Leading Change, Advancing Health*", issued recommendations for the future of nursing. It recognized nursing as the largest part of the nation's health care force. Nurses must be equipped to work within rapidly changing health care systems today. The 2010 IOM recommendation #4 goal is to increase the number of baccalaureate RNs from 50% to 80% by 2020 [4]. Besides patient outcomes, the higher academic degree in nursing is essential for professional growth, nurse's empowerment, better patients' outcomes and satisfaction.

Research had proven that education impacts a nurse's ability to practice [5]. In today's complex healthcare environment,

nurses must strive to be highly skilled, educated, and competent to provide the best care. According to American Association of Colleges of Nursing (AACN), "*BSN nurses are prized for their skills in critical thinking, leadership, case management, and health promotion and for their ability to practice across a variety of inpatient and outpatient settings",* [6]. Hence, many hospitals in the United States, especially magnet hospitals, are now requiring the BSN degree as the minimum requirement in hiring nurses.

Other variables that affect patients' outcomes include latest technology in computer systems and hospital beds, larger work areas, and newer equipment. The increase in the quality of the hospital encourages more patients to be admitted in such hospitals. Hence, the demand of more patients attracts skilled nurses who work in a particular hospital, while decreasing the staff-to-patient ratio. This enables the nurses to spend more time with the patients to coordinate their care, affording the nurse's time to find solutions to increase efficiency and morale. This model enables healthcare providers, patients and all involved in the healthcare system to benefit.

Patient outcomes are translated into the number one priority for nurses, which is patient safety. Although research has shown that a higher degree does improve patient outcomes, there are other factors, such as unit staffing and organization, patient morbidities, technology, and resources that contribute to the outcome, including the patient's willingness to participate in their care. All these variables play an integral part in the patient outcome [7].

The current study is relevant in many ways: (1) Nurses are knowledge workers and the data they generate are now been made visible due to data interoperability as evidenced in this study (2) little or no research has been conducted to establish the effect of RN FTEs staffing on HIV/AIDS in patients and their severity of illness (3) this study adds to the future use of big-data-to-knowledge (BD2K) research to make nurses efforts more visible and (4) identification and understanding of outcomes in inpatients with HIV/AIDS is an important step toward developing strategies to effects of nurses workload on the outcomes of other chronic diseases.

Hence, the proposed aims and hypothesis highlight the contribution of RNs in acute care hospital that revealed more information on the relationship between RN staffing and the outcomes of HIV/AIDS inpatient population:

A. Specific Aims

Aim 1: To determine whether in nonfederal hospital there is a strong relationship between hospital characteristics (size, status, region, location, ownership and providers) and severity of the inpatients HIV/AIDS.

Aim 2: To determine whether in nonfederal hospital the relationship between RN FTEs and severity of the inpatients HIV/AIDS is significant in both 2007 and 2010.

Aim 3: To determine whether in nonfederal hospital the relationship between RN FTEs and severity of the inpatients HIV/AIDS is stronger in 2010 than 2007 discharges.

Research Hypotheses

Hypothesis 1: In nonfederal hospital discharges there will be a strong relationship between teaching hospital and severity of the inpatients HIV/AIDS.

Hypothesis 2: In nonfederal hospital the relationship between RN FTEs and severity of the inpatients HIV/AIDS will be strong in both 2007 and 2010 discharges.

Hypothesis 3: In nonfederal hospital the relationship between RN FTEs and severity of the inpatients HIV/AIDS will be stronger in 2010 than 2007 discharges.

THEORETICAL FRAMEWORK

The framework for this study is based on the Quality of Health Model of Care. This model, proposed by the American Academy of Nursing Expert Panel on Quality Health Care (1998), [8] is useful for measuring reciprocal directions of influences of multiple variables that impact quality of care and desired health outcomes (figure 1) [8].This dynamic model applied to evaluating health care delivery systems allows researchers to use databases to delineate the relevant interrelationship between patient level characteristics, the context in which care is provided, the quality of provider intervention, and, ultimately, health outcomes. This framework is an expansion of Donabedian's[5]linear framework, which posits that structure affects process and process affects outcome and that patient and hospital characteristics are considered mediating outcomes. The Quality of Health Model broadens Donabedian's framework for quality improvement and outcomes management by examining dynamic relationships with indicators that not only act upon, but reciprocally affect the various components. Studies have interpreted the model as follows: the more time and money there is for working with quality improvement (structure), the more positive is the attitude towards such work (process), and the more regular is the evaluation of quality-related goal accomplishment (outcome) [9]. It was concluded that this model could be an aid to implementing a systematic and evidence-based system for working with quality improvements in hospital departments [9]. Implications for the current study include influence upon organizational or system-level improvements to hiring more qualified staff, development of interventions and training more RNs to improve clinical interventions.

METHODS

Study design

The design was a secondary data analysis from the HCUP Nationwide Inpatient Sample (NIS) [9]. The HCUP is a family of health care databases and related software tools and products

Figure 1 Quality of Health Model.

developed through a federal–state–industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). This dataset contains all-payer data on hospital inpatient stays from selected states; however, only a few studies have focused on HIV/AIDS studies and such studies are mainly on cost effectiveness, [10-12] with only one study in hospital characteristics outcomes since 1999 [13].

Inclusion and Exclusion Criteria

The NIS database samples were selected and extracted on the basis of the following criteria: (a) inpatient diagnosed with HIV/AIDS and related co morbidities (b) inpatient admitted to nonfederal(defined as all academic medical centers or other teaching hospitals, community, short-term general, and other special hospitals) (c) 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, due to sexual orientation, alcohol and drug abuse, and mental disorders. Excluded are (a) hospitals not accessible by the general public, such as prison hospitals or college infirmaries (a) pediatric inpatients (b) discharges from federal and government hospitals.

Measures

Measures were as follows: Age (21 years and above); gender (male, female); race (white, black, Hispanic, Asian, Native American); insurance (Medicare, private including HMO, self-pay, no charge); primary diagnosis (HIV/AIDS); co morbidities (measured ones included schizophrenia, bipolar, depression, alcohol, drug abuse); admission type (emergency, urgent, elective), treatment procedure (principal, secondary).

Hospital Measures

Measures were as follows: Teaching status (teaching, nonteaching); ownership (public, private nonprofit, private invest own); location (rural, urban); region (Northeast, Midwest, South, West); Size of hospital (small, medium, large); providers (RN and LPN Full Time equivalence (FTE=1.00, measured as nurses workload and is used to track cost reductions in an organization).

Outcome Measures

Severity of illness (Minor loss of function, Moderate loss of function, Major loss of function, Extreme loss of function)

Study Timeline

The first quarter involved obtaining Institutional Research Bureau (IRB) approval, purchasing and accessing the NIS dataset, ensuring that it meets the volume, velocity and veracity as expected in any big data attributes. Extraction was made possible by a standardized format (ICD 9, ICD 10 was not available at the time this study was conducted. The corresponding author, who is an Informatician and co-author a Statistician were able to identify and emerge the core and hospital datasets with the selection of the ICD 9 codes that correlate with the selected variables in the NIS dataset for data view. The second and third quarters involved the data analytics (80% of the study efforts), managing, and cleaning to identify the dependent and independent variables as well as patient characteristics to be entered into the statistical tool for analysis, easy retrieval, and sharing. The fourth quarter involved data analysis using descriptive, bivariate, and multivariate analysis to determine whether there was a significant difference between the severities of illness by RN FTEs.

Statistical Analysis

Descriptive, chi-squares, and regression analysis were used to detect statistically significant differences between hospital and severity of illness. Multivariate analysis of associated factors was used to determine the effect on the dependent variables and their predictive strength [14]. Data analysis was conducted in the following order. First, descriptive statistics were used to summarize patient demographics and dependent and independent variables. Next, bivariate statistics (Pearson's correlation coefficient, and chi-square test) were used to assess the significance of single-order relationships among hospital characteristics and other variables of interest. Finally, multivariate statistical techniques (*n*-way ANOVA for categorized confounders, ANCOVA for categorized and continuous confounders, and multiple regressions for continuous confounders) were used to develop modelsexplainingthecombinationofinterveningvariablesinfluencingpatientoutcomes. Dummy coded variable regression was used to determine the effects of the predictors on the outcomes.

Ethical Considerations

The research study was submitted to the Howard University IRB with a request for exempt status on the basis that there was no direct involvement with human subjects. Certificates for training in the Health Insurance Privacy and Accountability Act (HIPAA) and other training requirements were obtained from the Healthcare Cost and Utilization Project (HCUP) agent before the purchase of the database. The HCUP NIS database was obtained through the HCUP Central Distributor under the management of the Agency for Healthcare Research and Quality. The HCUP_NIS database excluded data elements that could either directly or indirectly identify individuals. Access to the files was open to users who had signed a Data Use Agreement, and users stated that they would use the database for research and statistical purposes only and that they had no intention of using the information to identify individuals or compromise the integrity of the data. In addition, all laptops and other electronic accessories used for the data storage and analysis were encrypted with password access and physically secured or destroyed upon completion of the data analysis according to pertinent requirements.

RESULTS

The regression result for hospital charges on the Model composed of patients' characteristics showed that there was a significant difference in 2007 and 2010 with p value for white (.151, .688), Medicaid (.250, .001), opportunistic infection (.327, .000),bipolar (.132, .000), schizophrenia (.534, .000), southern region (.006, .475), bed size (.383, .000), LPN FTEs (.000, .659), and NA FTEs (.808, .003) respectively. For teaching and non-teaching hospitals, the relationship between HIV/AIDS, mental diseases and drug abuse were highly significant with p = .000 for depression, and 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 is not heart, respiratory intubation/ mechanical ventilation, blood transfusion, other therapeutic procedures, and the total numbers of procedures for both years. Teaching hospital was significant at p = .000 for 2007 and 2010 [Table 1] as hypothesized in specific aim 1.

Table 2 showed that the number of respiratory intubation/ mechanical ventilation and total number of co morbidities were ranked highest in standard coefficient (0.318 and 0.305) for both years. Others include medical procedures performed on a patient, other vascular catheterization, depression, hepatitis c, blood transfusion and drug abuse ranging from 0.127 – 0.061. Opportunistic infection, bed size, schizophrenia, urban location and NA FTEs were the least factors that affect the disease severity of HIV/AIDS persons admitted to non-federal hospitals [Table 2]. In addition, the ranking effects showed stronger association with LPN FTEs (0.022) than RN FTEs (0.008) staffing in 2007. However, in 2010 a stronger association was observed for RN FTEs (0.01) than for LPNFTEs (0.002) in 2010 (Table 2) as hypothesized in specific aim 3.

Hence, the overall results has confirmed the hypotheses that: (1) there is a strong relationship between teaching hospital and severity of the inpatients HIV/AIDS as the authors hypothesized in specific aims #1, (2) the relationship between RN FTEs and severity of the inpatients HIV/AIDS is significant in both 2007

Table 1: Results of the Regression of Length of Severity of Illness on Model Composed of Individual Characteristics, 2007 and 2010.

	2007				2010		
	Unstandardized Coefficients	**Unstandardized Coefficients**	**p value**		**Unstandardized Coefficients**	**Unstandardized Coefficients**	**p value**
Individual Characteristics							
Age	.002	.031	.000		.003	.039	.000
Male	.056	.003	.000		.064	.035	.00
White	-.015	-.008	.151		.004	.002	.688
Medicaid patient	.011	.006	.250		.003	.017	.001
Comorbidities							
Alcohol abuse	-.148	-.046	.000		-.148	-.050	.000
Drugs abuse	-.128	-.061	.000		-.146	-.071	.000
Hepatitis b	0.11	.022	.000		.077	.033	.000
Hepatitis c	0189	.067	.000		.142	.047	.000
Opportunistic illness	.013	.005	.327		.082	.033	.000
Candidiasis of the mouth	-.099	-.006	.274		-.101	-.006	.230
Depression	-.238	-.079	.000		-.205	-.078	.000
Psychosis	-.165	-.048	.000		-.148	-.051	.000
Bipolar	.035	.014	.132		-.181	-.083	.000
Schizophrenia	-.017	-.004	.534		-.218	-.056	.000
Total number of comorbidities	.164	.305	.000		.166	.381	.000
Medical Procedures Used in Treatment							
Diag. cardiac cath./coronary arteriography	-.118	-.014	.007		-.117	-.015	.003
Other vascular cath, not heart	.274	.105	.000		.264	.012	.000
Respiratory intubation/ mechanical ventilation	1.142	.318	.000		.898	.270	.000
Blood transfusion	.158	.065	.000		.141	.056	.000
Other therapeutic procedures	-.058	-.021	.000		-.094	-.028	.000
Total number of procedures (npr)	.046	.27	.000		.051	.143	.000
Hospital Characteristics							
Southern region	.070	.040	.000		.006	0..4	.475
Bed size of hospital	-.006	-.005	.383		-.035	-.026	.000
Urban Location of hospital	.014	.002	.642		-.010	-.002	.712
Teaching hospital	-.028	-.015	.009		-.021	-.001	.004
RN FTEs per 1000 patient days	-.006	-.008	199		.007	.010	.081
LPN FTEs per 1000 patient days	-.063	-.022	.000		-.009	-.002	.659
Nurse aides per 1000 patient days	-.002	-.001	.808		.028	.016	.003
Constant term	2.132		.000		2.167		.000
Multiple R	.601		.000		.607		.000
Multiple R	.361		.000		.369		.000
Number	25275		.000		27455		

Table 2: Ranking of Effects of Independent Variables on Severity of Illness.

2007		2010	
Respiratory intubation/mechanical ventilation	0.318	Total number of comorbidities Respiratory	0.381
Total number of comorbidities	0.305	intubation/mechanical ventilation	0.27
Total number of procedures (npr)	0.127	Total number of procedures (npr)	0.143
Other vascular cath, not heart	0.105	Other vascular cath, not heart	0.102
Depression	0.079	Bipolar	0.083
Hepatitis c	0.067	Depression	0.078
Blood transfusion	0.065	Drugs abuse	0.071
Drugs abuse	0.061	Schizophrenia	0.056
Psychosis	0.048	Blood transfusion	0.056
Alcohol abuse	0.046	Psychosis	0.051
Southern region	0.04	Alcohol abuse	0.05
Age	0.031	Hepatitis c	0.047
Male	0.03	Age	0.039
Hepatitis b	0.022	Male	0.035
LPN FTEs per 1000 patient days	0.022	Hepatitis b	0.033
Other therapeutic procedures	0.021	Opportunistic illness	0.033
Teaching hospital	0.015	Other therapeutic procedures	0.028
Bipolar	0.014	Bed size of hospital	0.026
Diag. cardiac cath./coronary arteriography	0.014	Medicaid patient	0.017
White	0.008	Nurse aides per 1000 patient days	0.016
RN FTEs per 1000 patient days	0.008	Diag. cardiac cath./coronary arteriography	0.015
Medicaid patient	0.006	Teaching hospital	0.011
Candidiasis of the mouth	0.006	RN FTEs per 1000 patient days	0.01
Opportunistic illness	0.005	Candidiasis of the mouth	0.006
Bed size of hospital	0.005	Southern region	0.004
Schizophrenia	0.004	White	0.002
Urban Location of hospital	0.002	Urban Location of hospital	0.002
Nurse aides per 1000 patient days	0.001	LPN FTEs per 1000 patient days	0.002

and 2010, again this result is in agreement with hypothesized statement of specific aim #2 and (3) the relationship between RN FTEs and severity of the inpatients HIV/AIDS is stronger in 2010 than 2007 inpatients discharged from non-federal hospitals as hypothesized in specific aim #3.

DISCUSSION

Although secondary data analysis requires extra rigor in data extraction, cleaning, and analysis, as an informatician and a clinician, the corresponding author was cognizant of the potential benefit that could be derived from the proposed study. The authors, experienced in informatics, statistics, biomedical and sociocultural research, were able to overcome statistical challenges and research methodology barriers with regards to needed modifications in the design and implementation of the study.

One potential limitation that emerged in connection with the standardized databases (clinical and administrative) is difficulty in authenticating hospitals' accuracy in reporting coded procedures and processes. To address these difficulties, the project design and data integrity employed appropriate statistical methods and used discharge diagnostic coding from the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). The proposed strategy of risk adjustment has worked well in other studies using administrative databases [15,16]. To maintain confidentiality, all study data were stored in password-protected and encrypted laptops, which were stored under lock and key when not in use.

The results of this study show that patient demographics such as age, gender, ethnicity, insurance, and hospital location, size, or region were not the most critical variables that associated with severity of patients' illness on admission to nonfederal hospitals, in both 2007 and 2010. The ranking effects show a stronger association for RN FTEs (0.01) than for LPN FTEs (0.002) in 2010, the year of the IOM recommendations. Clinical implications are that sufficient full-time RNs are crucial in acute care hospitals for more positive and satisfactory patient outcomes.

CONCLUSIONS

The results confirm the relationship between staffing of full-time nurses with RN degrees and patient outcomes, hence reinforcing that nurses are knowledge workers though invisible due to lack of data interoperability. The RN FTEs show stronger relationship with the severity of illness than other non-professional nurses FTEs (LPN and CNA). The results could be attributed to the fact that full time nurses who work consistently in hospital units/departments have the tendency to know the process and interact with their patients better than adjunct or agent nurses who infrequently come in contact with admitted patients. Hence, better relationship with patients that translates

to better care and patient's satisfaction. This finding also indicates that more nurses need training at higher nurse education levels (although the dataset did not specify the RNs' educational categories (diploma, associate, or professional baccalaureate) trained nurses. This finding is congruent with the 2010 Institute of Medicine recommendation on Future of Nursing to increase the proportion of nurses with a baccalaureate degree from 50% to 80% by 2020. The authors recommend that future studies be based on comparative study on the effects of standard diploma, associate, and professional baccalaureate RNs on the HIV/AIDS outcomes.

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