# PRIMARY CARE SUPPLY AS A PREDICTOR OF POTENTIALLY AVOIDABLE HOSPITALIZATIONS IN ILLINOIS

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## **OBJECTIVES**

- Describe the bivariate association between primary care supply, SES, and health characteristic predictors suggested by prior literature and whether or not a potentially avoidable hospitalization was due to an Ambulatory Care Sensitive Condition (ACSC).
- Use Generalized Estimating Equation (GEE) analysis models to examine the relationship between the odds of a potentially avoidable adult hospitalization due to an ACSC and whether or not an adult patient resides in

a ZIP code that is a primary care shortage area, adjusting for other covariates.

### BACKGROUND

- Ambulatory care sensitive conditions (ACSCs) which are considered potentially avoidable hospitalizations have been studied for over twenty years.<sup>1,2</sup>
- Prior studies have examined demographic, social and health factors regarding their relationship to the occurrence of ACSC hospitalizations.<sup>3-6</sup>
- Chen et al.<sup>7</sup> reported that estimated total charges of \$9.5 billion were associated with hospitalizations due to ACSCs in rural hospitals nationwide. It was found that 14% of the nation's ACSC hospital charges in rural areas were for uninsured or Medicaid patients.
- Demographic Variables:
- ACSCs as reasons for hospitalizations have been increasing as a proportion of all hospitalizations and are especially high among African Americans, residents of the Midwest, and adults over the age of 65 years<sup>8-11</sup>
- Minority status (black or Hispanic), higher rates of hospital use, and low income have been associated with higher rates of ACSC hospitalizations<sup>12</sup>
- Adjusted rates of adult ACSC hospitalizations were found to increase with increasing rurality
- Provider Supply

 Using ZIP code characteristics, Schrieber and Zielinski<sup>14</sup> found that ACSC admissions may be related to deficits in primary care availability, accessibility, or appropriateness

- A study by Laditka<sup>15</sup> provided support for physician supply being associated with rates of ACSC hospitalizations in urban areas, but not in rural areas
- Health Status

The number and complexity of chronic conditions which a person aged 65 or older is experiencing increases the risk of ACSC hospitalization.<sup>1</sup>

### METHODS

- Data
- De-identified inpatient hospitalization data from 2003-2007 was obtained from the Illinois Dept. of Public Health for all Illinois residents aged 18 years or older with a hospitalization occurring in Illinois. Discharge data for these 6,662,267 adult hospitalizations were examined to classify whether or not the hospitalization was due to an ACSC. Due to computer limitations, a random 25% sample was selected for multivariate analyses with n = 1,667,248.
- The Agency for Healthcare Research and Quality (AHRQ) within HHS has identified a list of potentially avoidable hospital discharges that are termed ambulatory care sensitive conditions (ACSC) for adults.<sup>16</sup> This study is based on the 13 adult ACSC definitions from AHRQ in the "Guide to Prevention Quality Indicators, Version 3.1, March 2007." The dependent variable is whether or not the hospitalization was due to an ACSC.
- The patient's gender, age, diagnoses and procedures were provided with the data, as well as the ZIP code and county of the patient's residence. Since 106 patients and older were excluded from all analyses, 239 discharges were excluded with ages between 106 to 122. • Variable definitions and sources:
- Avoidable Hospitalization Conditions: ICD-9-CM codes and other aspects of each discharge were used to identify ACSC-related discharges as based on AHRQ definitions.<sup>15</sup> The ACSCs chosen by AHRQ were carefully selected by a panel of general internists, expert clinical consultants and anonymous reviewers based on four criteria: (1) consensus by other studies; (2) importance as a health problem; (3) necessity of hospitalization if timely and effective ambulatory care is provided; and (4) clearlycoded conditions
- Primary Care Shortage ZIP Codes were identified as Primary Care Health Professional Shortage Areas (PC-HPSAs) by the Centers for Medicare and Medicaid Services. The 2007 classification of whether or not a ZIP code was designated as a primary care shortage area was obtained from CMS and used in this study<sup>16</sup>
- ZIP code level demographic information on racial/ethnic and completed education for each Illinois ZIP code was obtained from the 2000 US Census.<sup>17</sup> The proportions for these variables totaled to one and they were treated as compositional data in the analysis.<sup>18</sup>
- Rurality status of each Illinois ZIP code was based on USDA Rural Urban Commuting Area designation.<sup>19</sup>
- County level indicators were obtained from the County Health Rankings website<sup>20</sup> and defined as follows:
- Uninsured adults variable is the estimated percent of the county adult population under age 65 that had no health insurance coverage in 2005
- Adult smoking prevalence variable is the estimated percent of the county adult population that currently smokes every day or "most days" and has smoked at least 100 cigarettes in their lifetime based on seven years of data from 2002–2008
- The adult obesity variable is the percent of the county adult population (age 20 and older) that has a body mass index (BMI) greater than or equal to 30 kg/m2 using 2006–2008 Behavioral Risk Factor Surveillance System (BRFSS) data
- Family poverty was assessed based on children in poverty and is the percent of children in a county under the age of 18 living below the Federal Poverty Line (FPL) Small Area Income and Poverty Estimates (SAIPE) program through the U.S. Census from 2007. The children in poverty measure is highly correlated with overall poverty rates, especially for working age adults with families
- Unemployment variable is the percent of the county civilian labor force, age 16 and older, that was unemployed but seeking work based on the Bureau of Labor Statistics (BLS), Local Area Unemployment Statistics (LAUS) 2008 annual estimate

#### Analysis

- Because hospitalization data is at the individual level and whether the ZIP code was a primary care HPSA is a group level variable, GEE was used to analyze the clustered data. The GEE procedure was used to assess whether residing in a CMS designated primary care shortage ZIP code predicts increased risk of having an ACSC hospitalization, controlling for the effects of other covariates. GEE extends the generalized linear model to allow for analysis of repeated measurements or other correlated observations, such as clustered data (residents in a given ZIP code being given the same designation regarding the primary care shortage area status).
- The dependent variable for GEE analysis can be continuous, counts, binary, or events-intrials. In this project, the dependent variable was binary (specifically, whether or not the patient's hospitalization was an avoidable ACSC hospitalization). Covariates can be either categorical, proportion, or integer variables. After consulting with a biostatistician (the co-author), it was decided that the most useful way to examine the data would be to use whether or not the individual patient had an ACSC reason for hospitalization as the dependent variable.
- Both descriptive and analytic analyses were done using SPSS 17.1.
- · Modeling approach:
- Individual level values for sex and age were available from the discharge data, and as well as the ZIP code and county of residence. AHSC status was determined using AHRQ definitions. Whether or not the patient lived in a CMS designated primary care shortage area was included in the first GEE model, with sex and age as predictors
- SES and demographic covariates were added in a second GEE model; race/ethnicity percentages, completed education indicators, as well as a county level 2007 indicator for percent of children in poverty, were added. Median family income in the ZIP code was initially added in the second model, but dropped since it did not add to the prediction (OR = 1.00)
- The final model added three health related indicators: percent of adults uninsured in 2005 (no health insurance), the percent of obese adults, and percent of adults who smoke in the county of residence
- County level supply of PC physicians was obtained from the County Health Rankings web site.<sup>20</sup> Primary care providers included practicing physicians specializing in general practice medicine, family medicine, internal medicine, pediatrics, and obstetrics/gynecology, with the indicator being rate of these primary care physicians per 100,000 population.
- Separate additional models, assessing the impact of primary care supply as a predictor of ACSC hospitalizations, were done using the primary care physician rate per 100,000 population at the county level. The findings regarding variables predicting ACSC hospitalization were not found to differ markedly. The results that follow use CMS primary care shortage status at the ZIP code level as the physician supply indictor in the models

### RESULTS

- The pattern of ACSC hospitalizations among all Illinois adult hospitalizations, 2003 -2007 with a valid age value (ages 18 to 106), n = 6,662,267 is shown in Graph 1
- The three most frequent types of ACSC hospitalizations were congestive heart failure (CHF) 3.7%, bacterial pneumonia 3.0%, and chronic obstructive pulmonary disease (COPD) 1.6%.

Graph 1 ACSC Hospitalizations by Reason, All Illinois Adult Hospitalizations, 2003-2007



- Overall 13.9% of the 6,662,267 adult hospitalizations with valid ages (under 106) were ACSC hospitalizations. The percentage of ACSC hospitalizations was the same in the 25% random sample used in the multivariate GEE analyses. Sampling was needed due to the computational limits of running the analysis on a personal computer.
- There were differences within age groups: 9.3% of the 3,894,535 patients aged 18-64 versus 20.3% of the 2,767,732 patients aged 66 or more experienced an ACSC hospitalization (p = .001).
- Bivariate Associations for Categorical Variables
- Table 1 provides information on the bivariate relationships between the dichotomous covariates and ACSC hospitalization status. In part due to the sample size, all variables had a statistically significant (p < .05) association with ACSC status
- The cross tabulation results indicate that ACSC hospitalizations were more likely among: • Males (15.1%) than females (13.0%)
- Those living in a CMS PC Shortage ZIP Code (17.0%) than a non PC Shortage ZIP Code (13.3%)
- Those living in rural areas (17.8%) than non-rural areas (13.1%)
- ACSC hospitalizations were less likely among those patient's living in dense urban areas whose resident ZIP code had a RUCA code of one (13.2%) than those living in other less urban or rural areas (16.3%)



 
 Table 1
 Bivariate Relationship of ACSC Status and Dichotomous Covariates, 25%
Random Sample Illinois Adult Hospitalization, 2003-2007, n= 1,667,248

Dichotomous Variable	NOT ACSC Hospitalization n=1,436,663 (%)	Was ACSC Hospitalization n= 230,575 (%)	Chi-Square P-Value					
Gender								
Female	87.0	13.0	.001					
Male	84.9	15.1						
CMS Primary Care Shortage Status of Patient's ZIP Code								
NOT a PC shortage area	86.7	13.3	.001					
NOT a PC shortage area	83.0	17.0						
Rural Status								
Urban (RUCA < 4)	86.9	13.1	.001					
Rural (RUCA $>$ 4)	82.2	17.8						
Dense urban status:								
NOT dense urban (RUCA=1)	83.7	16.3	.001					
Was dense urban (RUCA > 1	86.8	13.2						

- Table 2 provides the relationship between continuous variables and ACSC hospitalization status. The sample size influences the consistent P-value of .001.
- Age is substantially higher for those with AHC hospitalizations, as would be expected (see Graph 2).
- Regarding racial/ethnic characteristics of patient ZIP codes:
- A higher proportion of Caucasians live in the ZIP codes of patients NOT having an ACSC discharge
- The proportion Black, **NOT** Hispanic, was higher in ZIP codes of patients who did have an ACSC discharge
- The proportion Hispanic was higher in ZIP codes of patients **NOT** having an ACSC discharge
- Table 2 Bivariate Relationship of ACSC Status and Continuous Covariates, 25% Random Sample Illinois Adult Hospitalization, 2003-2007, n= 1,667,248

Variable	NOT ACSC Hospitalization n=1,436,663 Mean	ACSC Hospitalization n= 230,575	One-Way ANOVA P-Value					
Age	55.36	67.18	.001					
Race/ethnicity in patient's residence ZIP code								
Proportion Caucasian non Hispanic	0.6505	0.6423	.001					
Proportion Black non Hispanic	0.1835	0.2058	.001					
Proportion Hispanic origin	0.1189	0.1092	.001					
Proportion other	0.0469	0.426	.001					
Completed education level of adults > age 25 in patient's residence ZIP code								
Proportion <b>NOT</b> high school graduates	0.4767	0.4870	.001					
Proportion of high school graduates	0.2824	0.2913	.001					
Proportion some college or more	0.2411	0.2220	.001					
Proportion unemployed in patient's residence county	6.55	6.60	.001					
Percent children below poverty level in patient's residence county	11.50	12.46	.001					
Percent uninsured in patient's residence county	15.75	15.66	.001					
Percent obese in patient's residence county	24.91	25.00	.001					
Percent smokers in patient's residence county	22.64	22.95	.001					





Age

- Completed education of adults age 25+ in patient's ZIP codes differed also: - A higher proportion not completing high school live in ZIP codes of patients who had an ACSC discharge
- A higher proportion of high school graduates live in ZIP codes of patients who had an ACSC discharge
- The proportion completing some college or more was higher in ZIP codes of patients **NOT** having an ACSC discharge
- The percent of unemployed is similar in the ZIP codes of patients who had or did not have an ACSC hospitalization.
- The percent with family poverty (percent of children in poverty) is higher in the ZIP codes of patients who had an ACSC hospitalization.
- The percent of adults uninsured is similar in the ZIP codes of patients who had or did not have an ACSC hospitalization.
- The percent of adults who are obese and who smoke is slightly higher in the ZIP codes of patients who had an ACSC hospitalization.
- Multivariate results:
- The three models developed using GEE analyses are shown in Table 1
- The full model with individual, SES, demographic and health related variables showed the lowest adjusted corrected Quasi Likelihood under Independence Model Criterion (QICC) using an independent correlation matrix. Exchange-



- able and unstructured correlation matrices were also used, but the QICC was lowest using the independent correlation matrix
- Median family income in the patient's ZIP code and proportion of residents living in owner-owned housing were initially included, but were dropped from final models due to lack of importance in the model (OR = 1.00) and for parsimony
- Using the full model, the variables with the highest odds ratios related to increased chances of an ACSC hospitalization were:
- Proportion of adults aged 25+ **NOT** high school graduates in the patient's ZIP code, with an OR = 2.018
- Family poverty measure the proportion of children in poverty in the patient's county, with an OR = 1.80
- Proportion Black, NOT Hispanic, in the patient's ZIP code, with an OR = 1.449
- Living in a rural location, with an OR = 1.196
- Proportion Hispanic in the ZIP code, with an OR = 1.181
- Male gender, with an OR = 1.116
- ZIP code of patient was a CMS Primary Care Shortage Area, with an OR = 1.068 Living in a dense urban area (RUCA code = 1) showed a statistically significant effect of slightly lowering the odds of ACSC hospitalization (OR = .947).

Graph 3 Full GEE Model, Rank Ordered Odds Ratios for Adult ACSC Hospitalization in Illinois, 2003-07



Table 3 Full GEE Analysis Predicting Odds of ACSC Hospitalization with Individual Level, PC Shortage Status, Demographic, SES and Health Related Variables Included, N = 1,667,248

Variables of Patient	Individual Level Variables Only			Demographic and SES Variables Only			Dnly		Full Model (Individual, Demographic, SES and Health Related Predictors)			phic, ors)
	Odds Ratio	Confid. Interval		P-value Odds Ratio		Confid. Interval		P-value	Odds Ratio Confid. Inte		Interval	P-value
		Lower	Upper			Lower	Upper			Lower	Upper	
(Intercept)	0.026	0.026	0.027	0.001	0.013	0.012	0.014	.001	0.015	0.012	0.018	0.001
Gender was male	1.113	1.103	1.123	0.001	1.116	1.105	1.128	.001	1.116	1.105	1.128	0.001
Age of patient at discharge	1.029	1.029	1.029	0.001	1.030	1.030	1.030	.001	1.030	1.030	1.030	0.001
ZIP code designated as primary care shortage area by CMS, 2007	1.196	1.182	1.211	0.001	1.068	1.047	1.088	.001	1.068	1.047	1.090	0.001
Patient lived in rural location (RUCA code 4 or more)					1.211	1.180	1.244	.001	1.196	1.165	1.228	0.001
Patient lived in dense urban location (RUCA code 1)					0.962	0.939	0.985	.001	0.947	0.925	0.971	0.001
Proportion Black not Hispanic in patient ZIP code, 2000					0.902	0.850	0.956	.001	1.449	1.392	1.509	0.001
Proportion Hispanic in patient ZIP code, 2000					1.336	1.287	1.386	.001	1.181	1.112	1.254	0.001
Proportion other races/ethnicity in patient ZIP code, 2000					1.023	0.963	1.087	.464	0.912	0.806	1.031	0.141
Proportion adults ages 25+ highest completed education high school graduates in ZIP code, 2000					0.752	0.664	0.851	.001	1.028	0.922	1.146	0.620
Proportion adults ages 25+ NOT high school graduates in ZIP code, 2000					1.122	1.008	1.249	.035	2.018	1.787	2.279	0.001
Proportion age 16 and older, that are unemployed in county, 2008					2.285	2.018	2.587	.001	1.027	1.019	1.035	0.001
Family poverity measure-proportion of children in poverty in county, 2007					1.028	1.020	1.036	.001	1.801	1.647	1.969	0.001
Estimated proportion of adults <65 who were uninsured in county, 2005					1.690	1.478	1.933	.001	0.986	0.983	0.990	0.001
Proportion of adults obese ages 20+									0.995	0.990	1.001	0.089
Estimated proportion of adults who were smokers in county, 2002–2008									1.007	1.005	1.009	0 .001
Corrected Quasi Likelihood under Independence Model Criterion (OICC)a Indep. Corr matrix	1273982.045				1020839.951				1013218.703	3 (lowest with full model)		

#### DISCUSSION

- (OR = 2.018)

- (OR = 0.947)
- tions in urban areas.
- [1.05-1.18].
- hospitalization.

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• The multivariate GEE model findings generally confirm the pattern of the relationship between independent variables and ACSC hospitalization observed in the bivariate results.

• If a patient lived in a primary care shortage area, a slightly increased chance of an ACSC hospitalization occurring was observed (odds ratio of 1.06). • Since an ACSC hospitalization is one that could have likely been avoided if early

primary care had been obtained, it is not surprising that, except for the inner city categorical variable, the SES and demographic variables showed higher odds ratios in relation to increased chances of an ACSC hospitalization. - For each unit increase in the proportion of adults aged 25+ NOT high school graduates in the patient's ZIP code, the odds of an ACSC doubled

- For each unit increase in proportion of children in poverty in the patient's county the odds of an ACSC hospitalization nearly doubled (OR = 1.80) - For each unit increase in the proportion Black, NOT Hispanic, in the population of the patient's ZIP code, the odds of an ACSC hospitalization increased about 1.5 times (OR = 1.449)

 Living in a rural location increased the odds of an ACSC (OR = 1.196) - For each unit increase in the proportion Hispanic in the ZIP code there was a slight increase in the odds of an ACSC hospitalization (OR = 1.181) - If patient's gender was male, there was a slight increase in the odds of an ACSC hospitalization (OR = 1.116)

- Living in an urban location slightly decreased the odds of an ACSC

• The observed relationships are likely impacted by the health literacy level of the patient in relation to seeking early primary care for an ACSC, as well as ability to access primary care in ways impacted by SES attributes (e.g., financially, obtaining transportation, and being able to have a job that allows time off from work to obtain primary care). Access to public transportation and safety net providers may facilitate early use of primary care for ACSC condi-

 The findings suggest that efforts to increase the educational levels (at least completion of high school with post high school education preferred) and improve the economic development of communities (resulting in adequate levels of employment and income) could reduce the chances of ACSC hospitalizations occurring. Poverty was also found to be associated with access to care issues in a recent study by Petersen and Litaker.<sup>21</sup> The odds of unmet health care needs increased as the proportion in poverty increased. For each one percent increase in poverty in rural settings the OR = 1.11 [1.04-1.19]) and in urban settings OR = 1.11

• A study by Tracy et al.<sup>22</sup> indicates that a Medicare population with low health literacy was about 1.5 times more likely to have NOT received a variety of preventive health services. There are likely similar patterns between education level and appropriate use of primary care for an ACSC that might lead to a potentially avoidable hospitalization.

 In summary, based on this analysis, the attributes referred to as social determinants of health were more important than the supply of primary care physicians in influencing the odds of an ACSC hospitalization. Improving communication during the primary care visit is essential to reducing the chance of an ACSC

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