PRIMARY CARE SUPPLY AS A PREDICTOR OF POTENTIALLY AVOIDABLE CHILDREN'S HOSPITALIZATIONS IN ILLINOIS

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OBJECTIVES

- Describe the bivariate association between primary care supply and potentially avoidable hospitalizations of children.
- Use multivariate models to examine the relationship between the odds of a potentially avoidable child hospitalization and whether or not the child resides in a primary care shortage area.

BACKGROUND

- Potentially avoidable hospitalizations due to ambulatory care sensitive conditions have been studied for over twenty years.[1,2]
- Prior studies have examined the relationship of demographic, social and health factors to the occurrence of these potentially avoidable hospitalizations.[3-6]
- The relationship between the presence of federally qualified community health centers (CHCs) or rural health clinics (RHCs) on children's ACSC hospitalization was assessed and no effects on Pediatric-ACSC (P-ACSC) hospitalization rates were found related to presence of a CHC or a RHC.[7]
- Chen et al.[8] reported that in 2002 estimated charges of $9.5 billion were associated with potentially avoidable hospitalizations in rural hospitals nationwide. It was also found that 14% of the nation's potentially avoidable hospital charges in rural areas were for uninsured and Medicaid patients.
- **In this study the phrase "potentially avoidable child hospitalizations" refers to hospitalizations due to pediatric ambulatory care sensitive conditions.**

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.[9-12]
- Minority status (Black or Hispanic), higher rates of hospital use, and low income have been associated with higher rates of ACSC hospitalizations.[12]
- Adjusted rates of adult ACSC hospitalizations were found to increase as the population grew more rural.[13]

Provider Supply

- ZIP code characteristics have found that potentially avoidable hospitalizations may be related to deficits in primary care availability, accessibility, or appropriateness.[14]
- A study by Laditka[15] provided support for physician supply being associated with rates of ACSC hospitalizations in urban areas, but not in rural areas.

METHODS

Data

- The dependent variable is whether or not the child's hospitalization was due to a pediatric ACSC, i.e., a potentially avoidable hospitalization.
- The child's gender, age, diagnoses and procedures were provided with the data, as well as the ZIP code and county of the patient's residence.
- De-identified inpatient hospitalization data from 2003-2007 was obtained from the Illinois Department of Public Health for all Illinois residents ages less than 18 with a hospitalization occurring in Illinois. Discharge data for these 1,292,119 child hospitalizations were examined to classify whether or not the child had a potentially avoidable hospitalization.
- In 2004, the Agency for Healthcare Research and Quality (AHRQ) within HHS had identified a list of six pediatric potentially avoidable hospital discharges that were termed ambulatory care sensitive conditions (ACSC).[16] The current study is based on the pediatric ACSC definitions from AHRQ in the "Guide to Prevention Quality Indicators, Version 3.1, March 2007" (examples of two provided in a handout).

Variable definitions and sources

- Avoidable Hospitalization Conditions: ICD-9-CM codes and other aspects of each discharge were used to identify pediatric ACSC-related discharges as based on AHRQ definitions.[16] The pediatric ACSCs chosen by AHRQ were carefully selected by an expert panel of 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) clearly-coded conditions.
- 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.[17]
- ZIP code median income level, racial, ethnic and completed education characteristics for each Illinois ZIP code was obtained from the 2000 US Census.[18] The proportions for the racial, ethnic and completed education level variables totaled to one and they were treated as compositional data in the analysis.[19]
- The rural status of each Illinois ZIP code was based on USDA Rural Urban Commuting Area designation (RUCA codes).[20] Rural ZIP codes have a RUCA code of four or higher.

Analysis

- Both descriptive and analytic analyses were done using SPSS 19. Chi-square tests of bivariate relationships were done (2-sided).
- Because hospitalization data is at the individual level and whether the ZIP code was in a primary care HPSA is a group level variable, Generalized Estimating Equations (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 a child having a potentially avoidable 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 (children living in a given ZIP code having the same designation regarding primary care shortage area status).

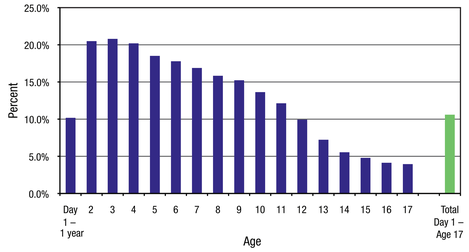
Modeling approach

- Individual level values for the hospitalized children's sex and age were available from the discharge data, and as well as the ZIP code and county of residence. P-ACSC hospitalization status was determined using AHRQ definitions.
- Separate models were developed related to:
  1. prediction of only low birth weight hospitalizations; and
  2. all other pediatric ACSC hospitalizations (except low birth weight).
- **The results that follow use whether or not a ZIP code was a CMS primary care shortage area as the physician supply indictor in the models.**

RESULTS

- Hospitalizations of children less than 24 hours of age, (n = 827,051 or 63.3% of the hospitalizations) are separated to provide a more clear examination of the P-ACSC pattern among children admitted at ages one day and older.
- The pattern of ACSC hospitalizations among Illinois children ages one day through 17 years of age during 2003 -2007, n= 465,068 are shown in Graph 1. The percent of other P-ACSC hospitalizations varies by age, ranging from 3.9% among youth age 17 years to 20.8% among children age three years (Chi-square =14810.343 df=16, p<.001).
- Overall, 10.6% of the children ages day one through age 17 years were hospitalized for a P-ACSC hospitalization.
- Among children less than 24 hours of age (births), 6.0% were coded as low birth weight (less than 2,500 grams) in these data.
- The reasons for P-ACSC as a percentage of hospitalizations among ages day one through age 17 were:
  - Asthma 4.7%;
  - Diabetes short term complications 0.7%;
  - Gastroenteritis 2.7%;
  - Perforated appendix 1.1%; and
  - Urinary tract infection 1.3%

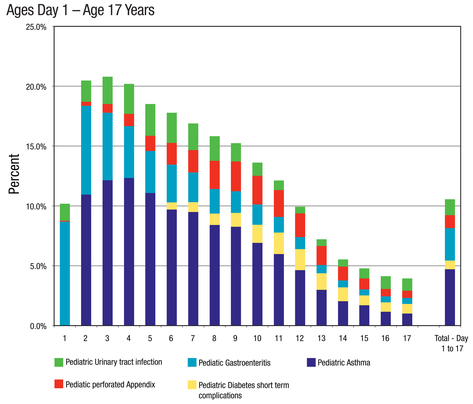
Figure 1. Percent of Pediatric Hospitalizations Due to a P-ACSC by Age, Illinois, 2003-2007, Ages Day 1 – Age 17 Years



Note: Less than 24 hours of age at admission are excluded (hospitalized due to being born)

- The details related to specific P-ACSC hospitalizations by age are shown in Graph 2. In general, the percentage of P-ACSC admissions due to gastroenteritis and asthma decrease as children get older. Short-term complications of diabetes and perforated appendix occur among children age six years and older. Regarding overall age patterns, the percentage of admissions that are due to P-ACSC drops gradually from a high at age three years of 20.8%, to a low at age 17 years of 3.9% among children ages day one through age 17 years.

Figure 2. Reasons for P-ACSC by Age of Child, 2003-2007, Illinois, Ages Day 1 – Age 17 Years



Bivariate Associations for Categorical Variables

- Table 1 provides information on the bivariate relationships between the dichotomous covariates and P-ACSC hospitalization status. In part due to the sample size, all variables showed a statistically significant (p <.05) association with P-ACSC status
- The cross tabulation results indicate that children's P-ACSC hospitalizations were more likely among:
  - Females (7.3%) than males (7.1%)
  - Those not living in a CMS PC Shortage ZIP Code (7.3%) than in a PC Shortage ZIP Code (6.0%)
  - Those living in non-rural areas (7.3%) than in rural areas (6.2%)

Table 1. Bivariate Relationship of Categorical Predictor Variables to P-ACSC Hospitalization Status

Dichotomous Variable	Not a P-ACSC hospitalization n = 1,199,308 (%)	Was a P-ACSC hospitalization n = 92,811 (%)	Chi-Square P-Value (d.f., Chi-square)
Gender			
Female	92.7	7.3	< .001
Male	92.9	7.1	(1, 33.832)
CMS Primary Care Shortage Status of Patient's ZIP Code			
Was NOT a PC Shortage area	92.7	7.3	< .001
Was a PC Shortage area	94.0	6.0	(1, 321.178)
Rural Status			
Was Non-rural (RUCA < 4)	92.7	7.3	< .001
Was Rural (RUCA > 4)	93.8	6.2	(1, 260.208)

Note: Gender was missing for 165 discharges

- Table 2 provides the relationship between continuous variables and P-ACSC hospitalization status. The sample size influences the consistent P-value of < .001.
- Mean age is slightly higher for those with P-ACSC hospitalizations.
- Regarding racial/ethnic characteristics of patient ZIP codes:
  - The proportion of Caucasians is higher in the ZIP codes of patients **not** having an P-ACSC discharge (.6187 versus .5801, respectively)
  - The proportion Black, not Hispanic, is higher in ZIP codes of patients who did have a P-ACSC discharge (.2182 versus .1770, respectively)
  - The proportion Hispanic is higher in ZIP codes of patients **not** having an ACSC discharge (.1574 versus .1560)
- Education level of adults 25 years of age and older differed by patients' ZIP codes:
  - A higher proportion of adults who did not complete high school live in the ZIP codes of children who had a P-ACSC hospitalization
  - About the same proportion of high school graduates live in ZIP codes of children who did or did not have a P-ACSC hospitalization
  - The proportion completing some college or more was higher in ZIP codes of patients **not** having a P-ACSC hospitalization
- The proportion of adults in poverty was higher in the ZIP codes children who had a P-ACSC hospitalization.

Table 2. Relationship Between Continuous Predictor Variables and P-ACSC Hospitalization Status – All Child Hospitalizations

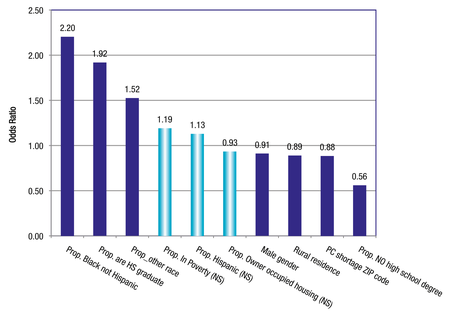
Variable	Not P-ACSC hospitalization n=1,199,308 Mean	Was P-ACSC hospitalization n= 92,811 Mean	One-way ANOVA P-Value
Age	3.0235	3.3177	<.001
Proportion of households in child's residence ZIP code that housing is owned (not rented)	.6564	.6452	
Race/Ethnicity Pattern in Child's Residence ZIP code			
Proportion Caucasian – non Hispanic	.6187	.5801	<.001
Proportion Black – non Hispanic	.1770	.2182	<.001
Proportion Hispanic origin	.1574	.1560	<.001
Proportion Other	.0468	.0455	<.001
Completed Education level of Adults > age 25 in the Child's Residence ZIP code			
Proportion Not High School Graduates	.2102	.2167	<.001
Proportion that are High School Graduates	.2755	.2742	<.001
Proportion Some College or more	.5143	.5091	<.001
Proportion of Adults in Poverty in Residence ZIP code	.1183	.1267	<.001

Multivariate Results

Two separate models examining predictors of P-ACSCs were developed using GEE analyses and are shown in Figures 3 and 4. The first model is for children less than 24 hours of age who were at risk for being low birth weight (LBW) which is one of the P-ACSCs. The second model predicts likelihood of hospitalizations for one of the other five P-ACSCs among children ages day one through 17 years.

- In developing both models, individual, SES, demographic and health related variables were included. Age was only included in the second model because age was always zero in the first LBW model. The final models presented are those having the lowest adjusted corrected Quasi Likelihood under Independence Model Criterion (QICC) using an independent correlation matrix. Exchangeable and unstructured correlation matrices were also used, but the QICC was lowest using the independent correlation matrix.
- Predictor variables with an odds ratio of 1.00 and variables not entered into the models are excluded from Figures 3 and 4.
- The first model (Figure 3) for children less than 24 hours of age examines predictors of P-ACSC hospitalizations (which was only LBW in at this age) found these predictors had significant odds ratios.
- Predictors increasing the chances of a P-ACSC – LBW at birth were:
  - Proportion of adults who are Black, not Hispanic, in the child's ZIP code. Each rise of one percent increases the chances of a LBW birth by 2.20 times relative to the control group which is the proportion of adults Caucasian – non Hispanic.
  - Proportion of adults that are high school graduates in the child's ZIP code. Each rise of one percent increases the chances of a LBW birth by 1.92 times relative to the control which is the proportion of some college or more.
  - Proportion of adults other race. A rise of one percent increases the chances of a LBW birth by 1.52 times relative to the control group which is the proportion of adults Caucasian – non Hispanic.
  - Proportion of adults who are Hispanic in the child's ZIP code. Each rise of one percent increases the chances of a LBW birth by 1.19 times relative to the control group which is the proportion of adults Caucasian – non Hispanic.
- Predictors **decreasing** the chances of a P-ACSC hospitalization were:
  - Child's gender was male (OR = 0.91). Control group is females.
  - Living in a rural ZIP code **decreased** the chances of a LBW birth OR = 0.89. The control group was living in a **non-rural** ZIP code (i.e., a RUCA code less than 4).
  - Proportion of adults that are **not** high school graduates in the child's ZIP code. Each rise of one percent decreases the chances of a LBW birth by about half (OR = .056) relative to the control which is the proportion some college or more.

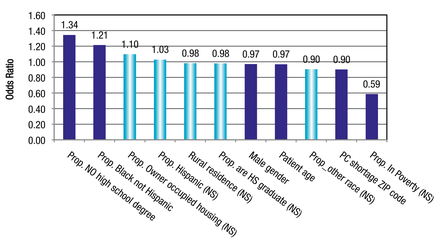
Figure 3. Odds Ratios for Predictors of P-ACSC Hospitalization, Children Age 0 (Low Birth Weight, Illinois 2003-2007, n = 818,391)



Note: The odds ratios for proportion in poverty, proportion Hispanic, and proportion owner occupied housing are not statistically significant (p < .05)

- Among children ages day one through age 17 years a P-ACSC hospitalizations (excluding LBW), prediction model (Figure 4) showed variables with significant odds ratios had differing effects. This model examines predictors of a non-LBW P-ACSC (asthma, diabetes short term complications, gastroenteritis, perforated appendix, or urinary tract infection)
- Some predictors **increased** the chances of a P-ACSC hospitalization:
  - Proportion of adults that are **not** high school graduates in the child's ZIP code An increase of one percent increased the chances of a P-ACSC by 1.34 times relative to the control which is the proportion of adults with some college or more
  - Proportion of adults who are Black, not Hispanic, in the child's ZIP code. Each rise of one percent increases the chances of a P-ACSC by 1.21 times relative to the control group which is the proportion of adults Caucasian – non Hispanic
- Some predictors **decreased** the chances of a P-ACSC hospitalization:
  - Gender was male (OR = 0.97). Control group is females
  - Children becoming older. Each one year increase in a child's age is associated with a decrease in chances of a P-ACSC (OR = 0.97)
  - Residing in a CMS designated primary care shortage ZIP code **decreased** the chances of a P-ACSC (OR = 0.90). The control group was **not** residing in a CMS designated primary care shortage ZIP code
  - Proportion of adults in the child's ZIP code that are in poverty. An increase of one percent decreases the chances of a P-ACSC (OR = .59)

Figure 4. Odds Ratios for Predictors of P-ACSC Hospitalization (excluding LBW), Children Ages Day 1 – Age 17 Years, Illinois 2003-2007, (n = 473,726)



Note: Odds ratios are not significant for: proportion owner occupied housing, proportion Hispanic, rural residence, proportion high school graduate, and proportion other race

DISCUSSION

- The findings of the two multivariate GEE model did not confirm the expected relationship between primary care shortage status and increased chance of a ACSC hospitalization either in the LBW model or the model examining predictors of other P-ACSCs.
- If a patient lived in a primary care shortage area, a slightly decreased chance of a P-ACSC hospitalization occurring was observed (OR = .88 for the prediction of LBW and OR = .90 in model for other P-ACSCs). One possible explanation related to other P-ACSCs is that in primary care shortage areas there may also be reduced access to pediatric hospital care.
- Other possible explanations for the reduced chances of a child being hospitalized for a P-ACSC in a primary care shortage area are the influence of non-medical factors such as: 1) parent's articulation of a desire for the child to be hospitalized and 2) lower provider concern related to litigation risk if the child is not hospitalized.
- A similar reduced risk was observed related to the child residing in a rural location (OR = .89 for the prediction of LBW), but did not show a significant odds ratio related to risk of hospitalization for other P-ACSCs. Perhaps in rural areas pediatric hospital care may be less accessible and efforts are made to manage the P-ACSC on an outpatient basis or parents may be less strong in conveying interest in the child being hospitalized for these P-ACSCs.
- The importance of the level of completed education beyond a high school education is supported by the **OR** found for only a high school degree in the LBW model (OR = 1.92) indicating about twice the risk of the child being LBW. In the model predicting other P-ACSC not having a high school degree had the highest risk of a P-ACSC (OR = 1.35). This supports the importance of parental health literacy level in relation to seeking early care for a pediatric ambulatory sensitive condition such that it does not become more acute necessitating hospitalization. Likewise, LBW is increased if desired maternal behaviors are not adopted due to lack of understanding about their importance. The reasons for a higher proportion of adults in the child's ZIP code not completing high school being associated with reduced risk of LBW are unclear (OR = .056).
- The finding that increasing poverty in the child's ZIP code decreased risk of other (non-LWB) P-ACSC hospitalizations may be related to access to care. Instead of obtaining primary care and being admitted the child may be treated for the P-ACSC in an emergency room.
- Since a P-ACSC hospitalization is one that could have been less likely if early primary care had been obtained (or in the case of LBW, early maternity care), it is not surprising that racial and ethnic variables also showed significant odds ratios in relation to increased chances of a P-ACSC hospitalization due to access to care or cultural patterns related to greater use of episodic care instead of a consistent primary care provider.
  - For each unit increase in the proportion of adults aged 25 years and older Black, not Hispanic, in the child's ZIP code, the odds of a LBW P-ACSC were increased (OR = 2.20 and OR = 1.21 for other P-ACSC hospitalizations). Since rural location was not found to increase the risk of a P-ACSC it is likely that the increased likelihood is associated with the proportion of Black, not Hispanic, occurring in non-rural areas.
- In neither model, did the proportion of adults who were Hispanic in the child's ZIP code show a significant relationship to odds of a P-ACSC hospitalization.
- If patient's gender was male, there was a slight decrease in the odds of a P- ACSC hospitalization in both models.

IMPLICATIONS

- The findings suggest that efforts to increase educational levels (an increase in post high school education or focused efforts to provide effective and culturally relevant patient education) could reduce the chances of ACSC hospitalizations occurring.
- As might be expected, the risk of many of these P-ACSC hospitalizations declines as a child grows older. This is supported by both the bivariate findings related to age shown in Figure 2 and also the multivariate results indicating an odds ratio of 0.98 among related to P-ACSC hospitalizations not due to LBW.
- Limitations are: 1) this study was done in one state and 2) individual level measures of all variables except P-ACSC status, age, gender and rural/non rural status were not available. Therefore, ZIP code level values for SES variables were used.
- 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 a P-ACSC hospitalization. Improving communication with parents in a way that is sensitive to health literacy seems essential to reducing the chances of a P-ACSC hospitalization.

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