Geographical Variables and Emergency Department Utilization in Children Enrolled in a Medicaid HMO

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Abstract

Background: Many patients use emergency departments (EDs) for primary care. Several studies have evaluated patient characteristics that influence pediatric ED use. However no previous studies have looked at proximity as an independent predictor of ED use.

Objectives: To determine whether ED use in a population of pediatric Medicaid enrollees is associated with the proximity of their primary care practices (PCPs), the proximity of the nearest ED, or the proximity of the nearest children's hospital.

Research Design: Cohort study

Subjects: 26,038 pediatric patients, assigned to 332 primary care practices affiliated with a Medicaid HMO.

Measures: Predictor variables were distance variables defining the proximity of the patient to his or her primary care practice site, proximity of the patient to the nearest ED, and proximity of the patient to the nearest children's hospital. The outcome variable was ED use of the study population.

Methods: The data were collected from a cohort study examining primary care practice characteristics and ED use. The association between ED use and proximity was investigated after adjusting for gender, age, race, and specific primary care site characteristics previously found to influence ED use.

Results: On average, patients made 0.31 ED visits/person/year (crude estimate). Distance was a significant predictor of ED use. Patients who lived between 1.54 miles and 3.13 miles from their PCP site had a 13% increase in ED use (RR 1.13 {95% CI 1.03, 1.24}) compared to patients who lived within a 0.7 mile radius of their PCP site when adjusting for age, race, sex, primary care site characteristics, and proximity to the ED. The increase

was only marginally significant for patients living greater than 3.13 miles from their primary care site (RR 1.10 {95% CI 0.99, 1.21}). Additionally, patients living greater than 1.19 miles from the nearest ED had an 11% lower ED use than those living within a half mile radius of the nearest ED (RR 0.89 {95% CI 0.81, 0.99}). Several other variables were strong predictors of ED use such as ethnicity, age, and primary care site characteristics.

Discussion: Proximity is associated with ED use. Patients living closer to an ED have a higher ED use rate. Patients living closer to an assigned primary care site had a reduced ED use rate. These geographical variables play a significant role in ED utilization but several characteristics of primary care practices as well as patient characteristics appear to be stronger predictors of ED use.

Introduction

The emergency department is one of the few places in the United States health care system in which patients can receive care regardless of complaint or insurance status. Each year more than 20 million children seek emergency medical care in the U.S. comprising almost 22% of all ED visits.[1] According to the Committee on Pediatric Emergency Medicine, one of the biggest threats to children's health is a lack of reasonable access to basic health care.[2]

Anderson and Aday (1974) proposed a useful framework to understand the complexity of the numerous factors that influence access to care.[3] They determined that the two major aspects of accessibility are socio-organizational (the characteristics of the available resources) and geographic (the time and physical distance that must be traversed to get care). Based on this framework, the proximity of the nearest ED and a primary care site to a patient's home likely play a major role in the process of accessing the health care system, however this aspect has not been well studied and holds little mention in the access to care literature. The few studies investigating this feature have shown that proximity may play a significant role in the decision making process to seek care in an ED. Phelps et al, in 2000, determined that 20% of caretakers report bringing their child to the ED because it was closer to their home than their child's primary care physician's (PCP) office. [4] After an extensive literature search, a single article was found that directly evaluated proximity as a predictor of ED utilization, and this study examined a population outside the US.[5] This paper will postulate that proximity is a physical characteristic of the patient's health care delivery system that could affect the decision to seek care at a specific health care site. In our study, we hypothesize that proximity is associated with pediatric ED utilization and investigate this association using data from a cohort study. We believe that caretakers of patients may have chosen an ED for their health care needs because it was geographically more accessible than the child's primary care practice.

Methods

Overview of the Primary Care Access Project (PCAP)

This study is a secondary analysis using data originally collected by Lowe et al. for the Primary Care Access Project.[6] The PCAP study was conducted in one of the four Health Maintenance Organizations (HMOs) serving Medicaid enrollees in the five-county Delaware Valley region of Southeastern Pennsylvania. Under state regulation, the HMO assigned each of its enrollees to a primary care practice to serve as the enrollee's "medical home." The HMO provided a database that identified a total of 653 primary care practices. Based on the original PCAP sample size calculations and projected participation rate, 440 of these practice sites were randomly selected. The original study investigators were able to confirm that 382 of the practices provided primary care to eligible subjects during the study period.

Of these original practices, 28 declined participation and 1 was eliminated due to concerns about data quality. Therefore the PCAP study reported data on 353 practices (92% of the practices meeting inclusion criteria). Of the practice sites utilized in the PCAP study, 343 were utilized by pediatric patients (aged 18 and younger) and were therefore included in this secondary analysis (90% meeting inclusion criteria).

Patients were included in the original PCAP study if they were enrolled in the HMO and were assigned to a study practice at any time between August 1, 1998 and July

31, 1999. Of the 57,850 subjects utilized in the original PCAP study, 28,895 subjects were aged 18 and under. There were 2,857 subjects excluded from this analysis because of missing data for one of the main predictor variables leaving a total of 26,038 subjects (assigned to 332 sites) included in this analysis. The excluded subjects were compared to the included subjects to determine if any bias would be introduced by this exclusion.

Patient data for the initial PCAP study was collected from several sources. A database maintained by the HMO provided patient demographics and ED count data, as well as site demographics. Another source of data collection was a survey instrument of PCP site characteristics that was designed specifically for the PCAP study. The survey instrument was administered by trained site surveyors, and collected data including practice site capacity to treat urgent conditions, practice site administrative characteristics, practice site availability of specialized equipment, and patient demographic characteristics.

Ethical considerations

The data were de-identified prior to analysis by removing any reference to patient name as well as replacing the last 2 digits of a subjects' address with the digit 5. After the distance variables were determined using GIS, the address variable was removed from the dataset to provide further anonymity. This study was approved by the institutional review board (IRB) at OHSU. Permission was also obtained from the University of Pennsylvania to use this data for analysis.

Key variables

<u>Outcome variable</u>

The outcome in this analysis is the number of ED visits of each subject during the study period of one year.

Predictor variables

The main predictor variables of interest were three measures of geographical distance. The first of these variables describes the distance in miles from the subject's home to the assigned PCP site. The other two variables describe the distance from the subject's home to the nearest hospital that treats children in their ED and the distance from the subject's home to the nearest of four designated "children only" hospitals. The distances were obtained by the original PCAP investigators using the latitude and longitude measurement of the subject's de-identified address and the address of the location of interest. Geographical Informational System (GIS) was used to determine a distance between these locations in a linear point to point measurement, in miles. In the analysis all three distance variables were categorized into four groups based on quartiles. The quartiles were divided as follows: for distance from home to PCP: 0 to 0.7 miles, >0.7 to 1.54 miles, >1.54 to 3.13 miles, and > 3.13 miles; for distance from home to nearest ED: 0 to 0.58 miles, >0.58 to 0.82 miles, >0.82 to 1.19 miles, and > 1.19 miles; and for distance from home to nearest children's only ED: 0 to 1.51 miles, >1.51 to 2.11 miles, >2.11 to 2.92 miles, and > 2.92 miles. About 9.6% of patients had multiple listings for the distance from home to PCP variable due to switching their PCP site at some point during the study period.

Another distance variable, the number of blocks to the nearest public transit stop, was measured by each site surveyor and divided into three categories: 0 blocks, 1-3 blocks, and >4 blocks.

Additional predictor variables can be seen in Table 2 and are divided into two categories: patient characteristics and site characteristics. Co-variables selected for the model were suspected confounders of the relationship between distance and ED use. Patient characteristics included age, ethnicity, gender, Medicaid category of assistance, obstructive airways diagnosis, eczema diagnosis, and important medication for a child. Some of these variables require further explanation. To account for the degree of disease burden of a patient population, two variables were considered in the model. One variable indicates whether a child has obstructive airways disease. Since the HMO paid primary care physicians on a capitated rather than fee-for-service basis, this information was not reliably identifiable from physician encounter data and the presence of obstructive airway disease was ascertained from pharmacy claims data. Patients who filled a prescription for a beta-2 agonist, methylxanthine, leukotriene modifier, inhaled bronchodilator, inhaled steroid, or inhaled mast cell stabilizer, were assigned a diagnosis of obstructive airways disease. This variable was included to control for possible higher rates of ED utilization in children whose illness is not well controlled, or whose PCP site does not have the capacity to treat an exacerbation of their illness. Additional variables accounting for other diseases in the population, such as HIV, were not used in this pediatric analysis due to extremely low prevalence of disease. Instead, a variable representing any chronic prescription medication in a child under the age of 15 was used to account for ED utilization due to other the burden of disease from other illnesses. This variable did not include medications given for acute infection and symptom control.

Site characteristics included self-report proportion of Medicaid patients in the practice, presence of physician assistants or nurse practitioners at the site, after-hours advice availability, X-ray availability at the site, nebulizers available at the site, peakflow meters prescribed or available at the site, weekday hours, evening hours, weekend hours, and pediatric capacity score. The after hours advice variable had three categories: live advice available upon initial call, live advice option after a message, and no live advice option. In order to account for the varied availability of specialized equipment at each PCP practice site, the pediatric capacity score prospectively assigned one point each for oxygen delivery systems, epinephrine, pediatric intravenous supplies, pulse oximeters, microscopes, pre-made splints, supplies for custom-made splints, suture supplies, pediatric sphygmomanometers, papoose boards, and x-ray equipment. This variable was coded into a categorical variable with three levels and was used as a marker for a practice site's capacity to treat an urgent pediatric health issue. Cutpoints for the categories are listed in Table 2.

The type of provider at each site was also examined and was divided into two categories: sites with nurse practitioners and physician assistants in addition to physicians, and sites with only physician providers. The site daytime, evening and weekend hours were treated as categorical variables using the same categories previously utilized in the PCAP study (Table 2).

Statistical analysis

To determine any differences between included and excluded subjects, continuous variables were compared using a two-sided t-test and categorical variables were compared using χ^2 tests. A GEE negative binomial model was used to model the number of ED visits while controlling for clustering within subjects that had more than one entry in the distance variable (D1) and any over-dispersion in ED count data. Associations between ED utilization and each variable were investigated first in a univariate analysis; variables with a p-value of ≤ 0.20 were then considered in the multivariate model. When several variables were found to be highly correlated, one variable was chosen to reduce collinearity. Age, gender, ethnicity, and evening and weekend site hours were determined a priori to be possible confounders due to previous analyses showing their association with ED use and were left in the model regardless of statistical significance. A backwards stepwise method was used to determine the multivariate model using a Wald statistic and a significance level of $p < 0.05$ for inclusion of a variable in the model. Risk ratios (RRs) derived from the model were used to measure the association between predictor variables and ED utilization rate. Various interactions were examined but were not found to play an important role in explaining the relationship between distance and ED utilization rate. Attempted interaction variables were race and distance, race and Medicaid assistance category, and age and Medicaid category. We examined the relationship between race and distance because Blanchard et al in 2003 found that minority Medicaid beneficiaries may be more likely to reside in areas where physician supply is lower, which may disproportionately contribute to lower levels of preventative care and higher rates of ED use. Analyses were performed using SAS v 9.1 (SAS Institute Inc., Cary, NC: 2003).

Results

Comparison of the included and excluded subjects are shown Table 1. The included and excluded subjects are similar in their ED utilization rates and demographic variables. Although most differences between the included and excluded subjects were statistically significant given the large sample size, the magnitude of these differences was small.

Table 2 describes the percentage of patients with each predictor variable as well as the proportion of PCP sites with each site characteristic. There were some predictor variables for which the percentage of sites differed from the percentage of patients with the characteristic. For instance, although 26% of sites had no evening hours, only 13% of patients were assigned to sites without evening hours. Of the included subjects, seventeen percent (17%) of the subjects were aged 2 years old or younger while 24% were ages 13 years old or greater (Table 2). The gender of the subjects was fairly evenly split with 49% male and 51% female. Fifteen percent of the subjects were White, 70% Black, 6% Asian, and 9% were identified as other. The Medicaid category of assistance was 68% AFDC, 21% pregnant women and children, 3% chronically needy, and 8% other. Eleven percent of the patients included in the analysis had a diagnosis of obstructive airways disease and 21% of the patients had a prescription for an important medication. Only 4% were identified as having a diagnosis of eczema. Eighty-two percent of patients were assigned to PCP sites where the proportion of Medicaid patients at the site was greater than 40%. Sixty percent of the patients had access to X-ray imaging at the clinic and 89% had access to a nebulizer. Fifty four percent of sites had peak flow meters on site and prescribe them. The majority (71%) of patients were enrolled in a PCP site that was open 20-40 weekday hours, 5 days a week. Fifty one percent of patients were enrolled in a PCP site that was open less than 4 evening hours a week. Seventy percent of patients were enrolled in a PCP site that was open 4 less weekend hours per week while 42% of patients were enrolled in a PCP site that had no weekend hours. The majority of patients (62%) were enrolled in a PCP site that had a pediatric capacity score between 6 and 8. Most patients (94%) were enrolled in a PCP site that was less than 3 blocks from the nearest public transit stop.

The final model included the following fifteen variables: age, gender, ethnicity, distance from subject home to assigned PCP practice site, distance from subject home to nearest ED that treats children, distance from subject home to nearest children's hospital, self report proportion of Medicaid patients in the practice, estimated numbers of patients at the site, Medicaid category of assistance, presence of peakflow meters in the clinic, prescription for medication to treat obstructive airways disease, any prescription for a child under age 15, evening clinic hours, weekend clinic hours, number of blocks to nearest public transit stop.

The risk ratios of the three main predictor variables from the final model are presented in Table 3. Distance from subject home to assigned PCP practice site is marginally associated with ED utilization after controlling for all other variables in the model ($p = 0.06$). Compared to those living within 0.70 miles of their PCP site, those living between 1.54 and 3.13 miles (RR = 1.13, {95% CI 1.03, 1.24}) and greater than 3.13 miles (RR =1.10, {95% CI 0.99, 1.21}) from their PCP site tended to have a higher ED utilization when adjusting for all other co-variates in the model. Distance from subject home to the nearest ED that treats children is significantly associated with ED utilization. Compared to those living within a 0.58 mile radius of the nearest ED that treats children, those who lived greater than 1.19 miles from the ED had an 11% reduction in ED utilization rate. (RR = 0.89, {95% CI 0.81, 0.99}). There was no statistically significant association between ED utilization rate and distance from a subject's home to the nearest children's hospital. The number of blocks to the nearest public transit stop was a significant predictor of ED use with a 27% reduction in ED use rate in those assigned to a PCP site 0 blocks from public transit when compared to those assigned to a site >4 blocks from transit, when controlling for all other variables.

Several co-variables in the model were found to be significant predictors of ED utilization. These results can be found in Table 4. Age and ethnicity were significant predictors of ED use. Children aged 2-6 had the lowest ED use rate (RR = 0.29, {0.26, 0.31}) compared to teens aged 13-18. Asian subjects had a 65% lower ED use rate compared with whites (RR = 0.45, {0.35, 0.55}). Medicaid category of assistance was statistically significant with a 35% higher usage rate in those labeled other when compared to subjects in the AFDC category. Children who received prescriptions for an obstructive airways disease medication had a 41% higher rate of ED utilization (RR = 1.41, {1.35, 1.47}) when controlling for all other variables, and children having any prescription had a 39% (RR = 1.39, {1.34, 1.44}) higher rate of ED utilization. The evening hours variable was an overall significant predictor of ED utilization rate in this analysis, however only two of the individually defined categories were significant. Subjects assigned to a site with greater than 12 evening hours per week had a 20% lower ED use. (RR = 0.80, {95% CI 0.67, 0.95}).

Discussion

The distance from patient home to nearest ED was significantly associated with ED use when controlling for age, ethnicity, gender, and PCP site characteristics, and the distance from patient home to primary care site was marginally associated with ED use. Specifically, children used EDs more often if they lived closer to an ED and (marginally) if they lived further from their assigned PCP. The distance from patient home to the nearest children's hospital was not significantly associated with ED use. Ethnicity and age were strong independent predictors of ED use, as was Medicaid category of assistance and several PCP site characteristics.

There was no statistical difference in ED utilization rates based on proximity to the nearest pediatric hospital. It is possible that the average family does not specifically search out and use a children's ED if they were a further distance than the local community ED. It is also possible that the types of families that did use the pediatric hospital EDs had children that were known to require a higher level of care than the average child, making distance less of a factor in the decision making process when seeking care. Another system level characteristic that was important in influencing ED use was the distance of the PCP site from the nearest public transit stop. Compared to patients who were assigned to sites greater than 4 blocks from the nearest transit stop, patients assigned to sites less than 1 block from the nearest transit stop had a 32% lower ED use.

Race was also a significant predictor of ED utilization rate in this study population. Unlike other studies that have shown increased ED use in Blacks, this study showed a similar ED use rate in Blacks and Whites. Asians, compared to Whites, had a significantly lower ED utilization rate. There are several explanations for this difference. There may be a difference in the availability of specific services (such as interpreters) at a hospital versus a community PCP site which would influence the decision to seek out medical care at a specific site. It makes sense that children who have underlying chronic illness may be more likely to have need for emergency services, as was observed in this study. This may be a direct indicator of the severity of their illness or a secondary factor representing a lack of adequate management of their chronic illness. An asthma exacerbation in a child may need a higher level of care than a PCP site can provide, or may take additional staff support that a PCP site cannot give. In either case it is not a surprise to see that children identified as having obstructive airways disease have a 41% higher ED utilization rate. Improving the chronic management of these patients would likely see a reduction in ED visits. Interestingly, the pediatric capacity score was not a significant predictor of ED utilization rate in this analysis. This may indicate that the ED visits were not due to the lack of urgent care capabilities of the site, and rather due to some other reason. It may be that many of the ED visits in this cohort were not for urgent conditions; however this cannot be determined without actually classifying the ED visits.

The number of hours a PCP site was open on the weekends was a significant predictor of ED utilization. Compared to PCPs that had no weekend availability, sites with weekend office hours that were less than 2 hours per weekend showed a significant reduction in ED utilization 0.79 (0.70, 0.90). However, this association was not statistically significant when a clinic was open greater than 2 hours on the weekend. An explanation for the difference between the overall significance of weekend availability of a clinic site and the specific hour cut points may be as simple as categorization of the variable into categories that masked the association. Having greater than 12 weekday evening hours per week was associated with a 20% decrease in ED use. This is a previously examined characteristic which plays a controversial role in the debate about access to care for children. There is limited evidence that it may be more cost effective to have children use an ED when necessary during the weekend and evening hours rather than maintaining a primary care site for extended weekend and evening hours.[7, 8] This analysis does not guide this debate in one direction or the other; it merely finds that children are less likely to visit the ED if they are enrolled in a PCP site that is available during weekend and evening hours.

One strength of our study is the evaluation of a rarely-evaluated aspect of access to care: the relationship between physical proximity and ED utilization. In this cohort geography had a statistically significant role in influencing ED utilization rates. The further a patient lived from the PCP site, the more likely he or she was to visit an emergency department. Our hypothesis that proximity plays a significant role in the way a population accesses the health care system was validated, if one views ED visits as a proxy for limited access to primary care. In this framework, ED visits may be due to an immediate inability to access the primary care site that day (due to overcrowding or inability to physically get to the PCP site) or a persistent lack of access leading to acute exacerbation of a poorly managed chronic illness, such as asthma.

Many researchers have attempted to classify accurately ED visits as appropriate or inappropriate in order to use the burden of "inappropriate" visits to represent diminished access to care. Some researchers have developed a means of assigning a probability to an ED visit in order to better classify an ED visit for analyzing use patterns in a population. One such schema was developed by Billings et al and is called the NYU ED Classification Algorithm. The NYU algorithm assigns a probability of a visit being non-emergent, emergent but safely treatable in a primary care setting, emergent but likely preventable with better primary care, and emergent but not preventable. [18]

This study did not attempt to classify the different type of ED visits. There are several reasons to avoid this type of classification. [17]] Given the lack of a validated methodology for classifying the urgency or appropriateness of ED visits, we used all ED visits as the outcome variable and as our proxy for access to care.

The previously mentioned Anderson and Aday framework [3] determined that the two major aspects of accessibility are socio-organizational and geographic. They go on to divide the determinants of access to care into three levels: policy-level features, health delivery system features, and population features. Policy level features include the financing of health care such as health insurance coverage, and workforce issues such as physician availability. The system level features include resources such as personnel and capital, and organizational factors such as scheduling and the geography or proximity of health resources. Population features are characteristics of the patient population such as predisposing factors (age, gender), enabling factors (income), and need (health status). Other aspects such as the perceived health needs of the population, the willingness of the population to seek care, and the attitude of the population toward the health care system influence access to care as well. These determinants of access to care can further be classified based on whether they are mutable (e.g., insurance coverage) or immutable (e.g., patient gender or age). While much of the research in this area has been focused on population characteristics and policy level features, little research has been aimed at investigating the relationship between system level features and access to care. Unlike policy-level and population features, health delivery system features are more likely to be mutable because they are directly controlled by physicians and other health care professionals. For this reason, changes can happen quickly, though on a smaller scale. Policy level changes, while wide-reaching, usually take years to implement.

According to Anderson and Aday, access to care can be qualitatively deficient or quantitatively deficient. An example of a qualitative deficiency would be a child with Medicaid being assigned to a medical home that is not able to serve all of the child's health needs, such as the lack of nebulizer treatments in the clinc. An example of a quantitative deficiency would be a lack of any health services for the child or a clinic too far away for the child to access the clinic. In our current health care system both types of deficiencies exist. Focusing further research into the proximity aspects of the health delivery system may be able to limit both qualitative and quantitative deficiencies in the system. By providing ways to improve the current geography of the system as well as making educated decisions about where physically more resources are necessary, we can create a new means for improving access to care.

Access to primary care has multiple benefits for children.[9] Several studies have evaluated health outcomes in children related to the accessibility of primary care. Decreased cost of care, improved immunization rates, increased preventative health education, decreased emergency department use, and improved patient and parent satisfaction are all described benefits of access to primary care in the current literature.[8-10] There are many factors that continue to limit access to health care in children who have public health insurance and an assigned medical home. Many studies demonstrate that differences in health care access are clearly related to socioeconomic and racial disparities.[1, 11, 12] Poor children are less likely to have a usual source of health care, less likely to have continuity of care, and more likely to have unmet health need than their non-poor counterparts despite having health insurance.[13] In 2004 27% of US children were enrolled in Medicaid for health care coverage.[14] Providing health care insurance has been shown to improve access to care for children, however there are a number of barriers to health care that insurance has not been able to overcome. These "non-insurance" barriers include both personal and family factors, and structural factors related to the organization of the health care delivery system.[11] While Medicaid may improve access to care for poor children who are otherwise uninsured, poor children with Medicaid are less likely than non-poor children (regardless of insurance status) to receive routine care in physicians' offices, and are more likely to lack continuity of providers between routine and sick care.[9] For children seen in an ED in the US in 2003, more than 40% had a designation of Medicaid as the expected source of payment which is greater than one would expect, given a 27% enrollment rate.[10]

The use of open-ended surveys has become useful for evaluating the unique reasons for seeking care in an ED. A few studies have show that proximity may play a significant role in the decision making process to seek care in the ED. Phelps et al determined that 20% of caretakers report bringing their child to the ED because it was closer to their home than the PCP office. [4] Geography, and the role of proximity in access to care and ED utilization is a topic not extensively pursued in the US literature. After an extensive literature search, a single article was found that directly evaluated proximity as a possible contribution to ED use. In Stockholm, Sweden Magnusson (1980) used a national database to compare ED utilization rates in different areas within a hospital catchment region.[5] Traveling distance in minutes, proportion of immigrants (non-Swedish nationality) and mean age in the area were examined. Magnusson determined that traveling distance and ED utilization rate were highly inversely correlated (Pearson's correlation coefficient = -.7889, $p < .001$), showing that those subjects living closer to the hospital used the ED more than those who lived farther away.

Areas of past research in the United States have mostly focused on examining frequent users of the ED and describing the patients who commonly use the ED for non-urgent or "inappropriate" uses. Most of these studies have looked at demographic characteristics of this unique subset of patients. Few studies have attempted to elucidate the health delivery system level characteristics that may be creating this subset of patients. Many studies have found that frequent users of the ED (reported as >3 visits per year) are also frequent users of other health care resources. Zuckerman et al found that frequent users tend to rate themselves as having poorer health than their non-frequent user comparison groups, and are more likely to be both US citizens and African American.[15] In Zuckerman's study, subjects who had seen a doctor more than 3 times in the previous year were 5 times more likely to be frequent ED users. Being uninsured was not a risk factor for frequent ED use, however publicly insured patients were 2.08 times more likely to be frequent ED users. Analysis of frequent ED use is not limited to the United States. A study out of the National University of Ireland in Galway found that 84% of frequent ED users had access to cost-free primary care.[16]

There are several limitations of this study. One limitation is the coding of the GIS variables. By using the latitudinal and longitudinal coordinates for determining distances, there are many factors that are not able to be accounted for. There may be other barriers in the geography of the city that mileage does not account for, which may make access to certain PCP practice sites more difficult or visits to the ED more accessible. These factors are unable to be identified in this dataset. Future studies focusing on open ended interviews may be helpful in elucidating the unidentified barriers that may be hidden in the data such as bus schedules and traffic patterns, which may have influenced care decisions.

Another limitation of this study, as with all observational studies, is the difficulty in establishing a cause and effect relationship between the predictor variable and the outcome variable. The purpose of this study is to reveal associations that will be helpful in guiding the efforts of community providers to improve health care access to their patients. The next step in this process is to identify changes that may successfully accomplish this goal. By examining the association between ED utilization and geographic variables related to the health care environment, it may be possible to direct intervention trials toward specific pediatric populations in which barriers to primary care continue to exist despite the assignment of a medical home. One such intervention may be to encourage the Medicaid HMOs to utilize a GIS program when assigning a child to a PCP site. This small adjustment may be able to limit the impact proximity has on ED use and access to primary health care. Another possible intervention would be to target the neighborhoods within a half mile radius of each ED with an educational outreach program to educate parents about the importance of primary care and continuity of care. This may help to limit the use of the ED by parents who are uneducated about the health benefits of maintaining a primary care provider for their child. The findings in this study may be able to change future Medicaid practices to decrease emergency department visits, encourage a better relationship between a child and his or her PCP, and hopefully improve health outcomes.

TABLES

Table 1: Comparison of Included and Excluded subjects.

	Included subjects	**Excluded subjects**	**P-value**
N	26,038 (90%)	2,857(10%)	
ED utilization rate (Visits/yr, mean(SD))	0.31(.80)	0.27 (.71)	0.009
Gender (%male)	49%	47%	0.04
Ethnicity			<0.0001
White	15%	15%	
Black	70%	78%	
Asian	6%	3%	
Other	9%	5%	
Age (in years, mean, (SD))	7.7	8.5	<0.0001
Age categories (in years)			<0.0001
0-2	17%	14%	
≥2-6	22%	20%	
≥6-13	37%	39%	
≥13-18	24%	27%	

Table 2: Description of predictor variables, N = 26,038.

Patient Characteristics	**Patient Percentages**	**Site Percentages**
Diagnosis of eczema		
No	96%	
Yes	4%	
Obstructive airways disease prescription		
Yes	11%	
No	89%	
Any important medication for a child under 15		
Yes	21%	
No	79%	
GAC- Category of assistance		
Chronically needy	3%	
Pregnant women and children	21%	
Other	8%	
AFDC	68%	
Practice Site Characteristics	**Patient Percentages**	**Site Percentages**
Self report proportion of Medicaid patients in the practice		
90%+	9%	11%
60-89%	40%	22%
40-59%	33%	19%
10-39%	12%	36%
10%	6%	13%
Provider Type		
PA/NP/MD in practice site	56%	77%
MD only in practice site	44%	23%
After hours advice		
Live advice initially	42%	42%
Live advice option after message	54%	55%
No live advice option	4%	3%
X-Ray available in clinic		
No	60%	77%
Yes	40%	33%
Nebulizer in clinic		
No	11%	28%
Yes	89%	72%
Peakflow meter		
Doesn't recommend	16%	28%
Prescribes but doesn't hand out	21%	33%
Hands out but doesn't prescribe	9%	6%
Hands out and prescribes	54%	33%

Weekday hours		
0-20 hours, 1-3 days/week	1%	3%
0-20 hours, 4 days/week	2%	8%
20-40 hours, 4 days/week	6%	14%
0-20 hours 5 day/week	4%	8%
>40 hours, 5days/week	16%	11%
20-40hours, 5 days/week (ref)	71%	56%
Evening scheduled provider hours (in hours per week)		
None (ref)	13%	26%
1-4, none lasting until 8pm	27%	29%
1-4, at least 1 lasting until 8pm	11%	6%
5-7, none lasting until 8pm	16%	6%
5-7, at least 1 lasting until 8pm	4%	9%
8-11, none lasting until 8pm	15%	4%
8-11, at least 1 lasting until 8pm	7%	11%
12+ at least 1 lasting until 8pm	7%	10%
Weekend scheduled provider hours (in hours per weekend)		
None (ref)	42%	57%
> 0-2	2%	5%
> 2-4	26%	20%
> 4	30%	18%
Pediatric capacity score		
2-5	19%	42%
6-8	62%	49%
9-11	19%	8%
Number of blocks to nearest public transit stop (in blocks)		
0	56%	56%
1-3	38%	30%
>4	6%	14%

Table 3: Distance variable relative rates. N = 26,038.

Distance from subject home to assigned PCP practice site (in miles)	**RR (95% CI)****	**Overall P-value**	**P-value**
0 to 0.7	(reference)	0.06	----
>0.7 to 1.54	1.05 (0.95, 1.15)		0.31
>1.54 to 3.13	1.13 (1.03, 1.24)		0.01
> 3.13	1.10 (0.99, 1.21)		0.06
Distance from subject home to nearest ED that treats children (in miles)			
0 to 0.58	(reference)	0.01	----
>0.58 to 0.82	0.91 (0.84, 0.99)		0.04
>0.82 to 1.19	0.87 (0.79, 0.95)		0.001
>1.19	0.89 (0.81, 0.99)		0.03
Distance from subject home to nearest children's hospital (in miles)			
0 to 1.51	(reference)	0.39	----
>1.51 to 2.11	0.97 (0.89, 1.06)		0.40
>2.11 to 2.92	1.05 (0.96, 1.14)		0.22
> 2.92	1.00 (0.90, 1.12)		0.88
Number of blocks to nearest public transit stop			
0	0.68 (0.57, 0.81)	<0.0001	<0.0001
1-3	0.89 (0.82, 0.97)		0.01
>4	(reference)		----

** Relative rates adjusted for variables listed in Table 4.

Table 4: Relative rates for other predictor variables in the model

	RR (95% CI)	Overall P-Value	P-Value
Patient Characteristics			
Age			
0-2	0.48 (0.44, 0.53)	<0.0001	<0.0001
≥2-6	0.29 (0.26, 0.31)		<0.0001
≥6-13	0.50 (0.47, 0.55)		<0.0001
≥13-18	(reference)		----
Gender			
Male	(reference)	0.15	----
Female	1.04 (0.98, 1.11)		0.15
Ethnicity			
White	(reference)	<0.0001	----
Black	1.01 (0.90, 1.12)		0.87
Asian	0.45 (0.35, 0.55)		<0.0001
Other	1.35 (1.17, 1.56)		<0.0001
Medicaid category of assistance			
Chronically needy	1.13 (0.94, 1.36)	<0.0001	0.18
Pregnant women and children	0.93 (0.86, 1.01)		0.10
Other	1.35 (1.21, 1.50)		<0.0001
AFDC	(reference)		----
Obstructive airways disease prescription			
Yes	1.41 (1.35, 1.47)	<0.0001	<0.0001
No	(reference)		----
Any important meds for a child under 15			
Yes	1.39 (1.34, 1.44)	<0.0001	<0.0001
No	(reference)		----
Practice Site Characteristics			
Self report percentage of Medicaid patients in the practice			
90%+	1.20 (0.94, 1.52)	0.002	0.13
60-89%	0.91 (0.72, 1.14)		0.42
40-59%	0.97 (0.78, 1.20)		0.76
10-39%	(reference)		----
10%	0.93 (0.74, 1.18)		0.54
Peakflow meter			
Doesn't recommend	0.87 (0.78, 0.97)	<0.0001	0.01
Prescribes/doesn't hand out	0.79 (0.71, 0.87)		<0.0001
Hands out/doesn't prescribe	0.79 (0.62, 1.00)		0.05
Hands out and prescribes	(reference)		----
Estimated number of patients at site			
Change per 1000 patients	1.01 (1.00, 1.07)	0.0007	0.0007

Evening hours			
None (ref)	(reference)	<0.0001	----
1-4 none till 8	0.93 (0.83,1.06)		0.31
1-4 at least 1 until 8	0.62 (0.49, 0.78)		<0.0001
5-7 none until 8	1.16 (0.99, 1.35)		0.05
5-7 at least 1 until 8	1.00 (0.80, 1.25)		0.98
8-11 none until 8	1.04 (0.87, 1.24)		0.63
8-11 at least 1 until 8	1.06 (0.89, 1.27)		0.48
12+ at least 1 until 8	0.80 (0.67, 0.95)		0.01
Weekend hours			
None (ref)	(reference)	0.001	----
> 0-2	0.79 (0.70, 0.90)		0.0003
> 2-4	1.00 (0.91, 1.10)		0.99
> 4	0.83 (0.62, 1.11)		0.22

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